

Atlantic Centre Report n.5

ATLANTIC — CENTRE —



Climate Change and Security Challenges in the Atlantic

October 2025

ATLANTIC
— CENTRE —

ATLANTIC CENTRE

Report Number 5

Climate Change and Security Challenges in the Atlantic

Lisboa

2025

Título:

© Climate Change and Security Challenges in the Atlantic

Autores:

Vários

Coordenador:

Sandra Maria Rodrigues Balão

Editor:

Atlantic Centre

Produção:

MGI (Portugal), Lda

<https://sites.google.com/site/edicoesmgi/>

<http://mgiedicoes.blogspot.pt/>

Impressão:

DPS - Digital Printing Services, Lda

ISBN – 978-989-54481-9-7

Depósito Legal nº 554994/25

Outubro de 2025

© Atlantic Centre

© MGI (Portugal), Lda.

Todos os Direitos Reservados.

List of Contributors

Sandra Maria Rodrigues Balão (Coordinator)

Sandra holds a PhD in Social Sciences, an MSc in Political Science and a Degree in Public Administration and Human Resources Management from the University of Lisbon, School of Social and Political Sciences (ISCSP-ULisboa), where she is a tenured Associate Professor and the Scientific and Pedagogical Coordinator for Strategy and Strategic Studies. At the same institution, she is an integrated researcher at the Centre for Administration and Public Policies (CAPP/FCT) and the Vice-President for CAPP's Science Policy. She is also a member of the ISCSP's Commission for Ethics in Research and a Collaborating Researcher at the Oriente Institute. She is an effective member of the ISCSP's Scientific Council and the Vice President of ISCSP's School Council. At the Polar Studies and Extreme Environments College (Polar2e-ULisboa) she is an Integrated Researcher, Vice-President of the Board of Directors and member of the Scientific Council. She is an Associate Researcher at the Portuguese Military Institute's Research and Development Centre (CIDIUM-IUM), a Doctoral Researcher at Political Observatory, a member of the Team Network on Geopolitics and Security (based in Helsinki) and a Fellow of the Salzburg Global Seminars. In the International Arctic Science Council—Social and Human Working Group (IASC-SHWG), she represents Portugal, as well as in the NATO Science and Technology Organisation Research Task Group on 'Human Security and Military Operations' (NATO STO HFM RTG-382), of which she is Co-Chair together with a Canadian Researcher. Sandra is the author and co-author of several national and international publications, and is a Member and associate of several professional and academic organisations, as well as of the 'third-sector'.

Alberta Ama Sagoe

Alberta Ama Sagoe serves as a Director at the Gulf of Guinea Maritime Institute. She also serves as a Regional Environment-Science-Technology-Health (ESTH) Specialist at the U.S. Embassy in Accra. In her previous role, she served as a Gender Policy and Strategy Expert at the African Union Inter-African Bureau for Animal Resources (AU-IBAR) and led the process of strengthening gender inclusivity in aquatic biodiversity conservation and environmental management among AU member states. Dr. Sagoe holds a PhD in Integrated Coastal Zone Management and master's in marine Spatial Planning and Governance and Sustainable Development. She champions the cause for aquatic ecosystems and biodiversity conservation and has been instrumental in implementing various conservation programs which employ sustainable ocean governance tools at local, national and regional levels. She is also passionate about inclusive engagement in the development of Africa's blue economy and thereby creates multiple platforms for youth, particularly females, to participate in the blue economy development discourse through capacity building.

Bruno Magalhães

Bruno is a postdoctoral researcher in Anthropology at the University of Amsterdam (UvA), conducting research on migration, environmental degradation, extractivism, and postcolonial inequalities. He holds a Ph.D. in Politics and International Affairs from the Open University (UK)

and has taught at several Brazilian federal universities. He is a senior researcher at the Center for Sovereignty and Climate.

David Willima

David Willima is a Research Officer on maritime security in the Institute for Security Studies, in Pretoria, promoting maritime security and blue economy as policy priorities in Africa and links local, regional and global climate programs and capacities to deliver effective anticipatory and response action. Joined Caritas-Zambia as an election monitoring provincial coordinator for the Democracy and Governance Unit and worked for the Environmental Learning and Research Center at Rhodes University in South Africa as a research assistant on the One Ocean Hub Project.

Edouard Epiphane Yogo

Lecturer-Researcher at the University of Yaoundé II, Dr. Édouard Epiphane Yogo is an international expert in peace, security and defense, with over twenty years of experience in strategic analysis, security governance and conflict management in Central Africa and the Lake Chad Basin. He holds a PhD in Political Science and specializes in politico-military groups and state reconstruction processes. He serves as Executive Director and Lead Researcher at the Bureau d'Études Stratégiques (BESTRAT), where he conducts strategic research and advisory work on issues such as stabilization, the resilience of fragile states, counterterrorism and security governance. As a senior consultant, he has collaborated with organizations such as UNDP, UNODC, USAID/OTI, the Norwegian Refugee Council, Transparency International and the United Nations Office for the Coordination of Humanitarian Affairs, working on topics including crisis-area stabilization, humanitarian mediation, defense integrity and peace actor mapping. Author of 12 books and more than 30 scientific articles, he actively contributes to knowledge production on security, defense and public policy. He has also delivered over 60 conferences, seminars and symposiums in Cameroon and internationally.

Eléonore Duffau

Eléonore Duffau is a researcher at the French Institute for International and Strategic Affairs, where she specialises in strategic and security issues related to climate change, within the Climate, Environment, and Security programme. She holds a master's degree in European Affairs from the Institut d'Etudes Politiques de Paris (Sciences Po), where she studied the European Union's external action, with a particular focus on European policies in the Middle East.

Elizabeth Nwarueze

Elizabeth Nwarueze is a lawyer, Rhodes Scholar and doctoral researcher in International Law at University of Oxford. Her research interests are in the legal frameworks of maritime security and the role of private actors in the law of the sea. She participated in the final negotiations for the BBNJ Agreement and currently advises African States at the International Maritime Organisation for the NetZero Framework negotiations and adoption

Fahd Azaroual

Fahd Azaroual is an economist at the Policy Center for the New South. His work focuses on macroeconomics, with emphasis on economic growth and business-cycle dynamics. He holds a Master in Applied Economics and is currently pursuing a PhD at Mohammed V University in Rabat. He joined the Policy Center in October 2019.

Jamal Machrouh

is a Senior Fellow at the Policy Center for the New South where he focuses on Geopolitics and International Relations issues. He is also professor of International Relations at the National School of Business and Management, Ibn Tofaïl University, where he teaches Geopolitics since 2012. Jamal Machrouh is an Affiliate Professor at Mohammed VI Polytechnic University. He is also a lecturer at the Royal College of Advanced Military Studies of Kénitra, at the Moroccan Academy of Diplomatic Studies, and at Södertörn University of Stockholm, Sweden.

Juan Adrianzén Perry

A naval officer since January 2014, following five years of training at the Peruvian Naval Academy. He has served aboard various combat units and specialized as a helicopter pilot. He possesses strong experience in naval leadership, having commanded personnel in all his assignments and taught courses on leadership, values, and human rights. He has participated in multiple operations and military missions, notably national pacification efforts and counterterrorism and counternarcotics operations in the Apurímac, Ene, and Mantaro River Valleys, as well as humanitarian “Solidarex” operations along the Peruvian coast—both as a pilot of the AB-412 SP helicopter. He currently serves as Aide Officer to the Chief of the General Staff of the Peruvian Navy, where he is leading the standardization of the administrative decision-making process known as the Staff Study. Lieutenant Perry holds a bachelor’s degree in Maritime Naval Sciences from the Peruvian Naval Academy and a degree in Industrial Engineering with a specialization in Logistics Management from the University of Piura. He is a certified naval aviator with a specialization in rotary-wing aircraft from the Naval Aviation School.

Julián Quintero Ibañez, Capitán de Corbeta

With 18 years of experience in military leadership, human resource management, leadership in scientific expeditions, and the direction of public projects, He has commanded naval and river units, led educational war games at the strategic decision-making level, and served as a university professor of Oceanography and Hydrography. He currently specializes in studying decision-making at the operational and strategic levels and in integrating artificial intelligence and data science into the maritime security and defense domain, promoting innovation and efficiency in public management.

Juliet Affrah Obeng

Juliet Obeng is Research Manager in Gulf of Guinea Maritime Institute, Research Officer in Africa Blue Economy Institute and Graduate Research Assistant in USAID Women Shellfishes and food security project, University of Cape Coast. She holds a Master in Fisheries Science from University

of Cape Coast and has previously worked as Research Assistant in School of Biological Sciences at University of Cape Coast.

Kofi Duodo, Lieutenant Commander

Lieutenant Commander Kofi Amponsah Duodu was commissioned into the Ghana Navy as a warfare officer in 2011. He was the Naval Assistant to the Chief of the Naval Staff and has served as secretary to two other Chiefs of the Ghana Navy. He has held other appointments at the Naval Headquarters, the Ghana Military Academy, and the Ghana Navy Fleet. Kofi holds a Master of Arts in Defence and Strategic Studies from the US Naval War College, Master of Science in Security, Conflict and International Development from Leicester University-UK, a Bachelor of Science Degree in Geomatics Engineering. He is a co-Author and Co-Editor of the official history of the Ghana Navy titled “History of the Ghana Navy: A Case for a Credible Naval Force for National Development”. He was part of the team that drafted Ghana’s National Integrated Maritime Strategy. He has authored papers on maritime security, geopolitics and related fields. Lt Cdr Duodu is a member of the Security Institute, UK, and a Director at the Gulf of Guinea Maritime Institute. He is a Fellow of the US State Department’s Mandela Washington Fellowship and the West Africa RLC Emerging Leadership Program, both under the Young Africa Leaders Initiative. He was an adjunct lecturer in Leadership at Ashesi University, Ghana. He is currently a United Nations Nippon Foundation Research Fellow at the IMO International Maritime Law Institute in Malta.

Lawrence Dogli

Lawrence Dogli is the Programmes Manager at the Gulf of Guinea Maritime Institute (GoGMI), where he leads initiatives advancing maritime security, ocean governance, and blue economy innovation in West and Central Africa. His work focuses on governance systems, policy frameworks, and technology adoption that enhance transparency, interoperability, and information-sharing among states and industry. Lawrence has supported Ghana’s National Integrated Maritime Strategy under the U.S. - Ghana Security Governance Initiative and worked with partners including IMO, NATO, Atlantic Centre, and the EU to strengthen regional maritime collaboration. His research interests span global security, maritime management, ocean finance, and inclusive ocean governance.

Luís Delgado Barrios, Capitán de Corbeta

Captain Luis Alberto Delgado Barrios is a distinguished officer of the Paraguayan Navy whose career blends academic excellence with extensive operational and teaching experience. A graduate of the Military Academy “Mariscal Francisco Solano López” (2007), he holds a Bachelor’s in Military Sciences, a Master’s in Naval Operations (CINAE, 2020), and a Specialization in Naval Command and Operations from the National Defense University of Argentina (2024). He also graduated from the Argentine Naval War College (2024) and the Naval Officers’ Advanced School (2020), solidifying his strategic and leadership credentials. Throughout his service, Captain Delgado Barrios has held key operational and leadership positions, including Second Commander of the Marine Infantry Battalion No. 2, the Naval Area and Prefecture Zone Confluencia, and the School for Non-Commissioned Officers, as well as Head of the Ita Enramada Detachment. He has served aboard several naval vessels and completed advanced training in naval infantry, communications, logistics,

and maritime operations, both nationally and abroad. Currently, he serves as Head of Studies at the Naval Officers' Advanced School (CINAE), contributing to the education and professional development of Paraguay's naval officers.

Mariana Plum

With a master's degree (2009) and Ph.D. (2025) in International Relations from PUC-Rio, Mariana is the CEO of the Center for Sovereignty and Climate and a Foreign Consultant at the Institute for Defense Analyses. She has over fifteen years of professional experience in the Defense Sector, having held prominent positions such as Research Coordinator at the Brazilian Army's Center for Strategic Studies, Professor at the Superior War College (ESG), Advisor at Amazônia Azul Defense Technologies (AMAZUL), and Technical Advisor at the Institutional Security Office of the Presidency of the Republic. She also served as Advisor to the Minister of Defense, leading the development of Brazil's first National Defense White Paper.

William Lyons

Col. (Ret) William Lyons is a licensed attorney and professional engineer, focused on the nexus between climate resilience, sustainability, and human security. and is the Associate Dean for Security, Diplomacy, and Defense Programs for the College of Graduate & Continuing Studies at Norwich University in Northfield, Director of the Center for Global Resilience & Security, the Site Director for the New England University Transportation Center and Professor of Practice in Engineering.

Indice

List of Contributors	3
Preface	9
<i>Rear Admiral Nuno de Noronha Bragança</i>	
Introduction	11
<i>Sandra Maria Rodrigues Balão</i>	
Legal Dimension to Climate Change and Security in the Atlantic: Framing a Collaborative Solution	16
<i>Elizabeth Nwarueze</i>	
Climate Change, Migration, and Terrorism in the Sahel: A Narrative Intelligence Approach to European and Atlantic Security Challenges	39
<i>William Lyons</i>	
The Economic Impact of Climate Change on the Atlantic African Insular States: Cape Verde and São Tomé and Príncipe	64
<i>Fahd Azaroual and Jamal Machrouh</i>	
Climate Change as a Maritime Security Threat Multiplier in the Gulf of Guinea (GoG)	87
<i>David Willima, Researcher</i>	
A Comparative Study of the Effects of Climate Change on Maritime Security in Ghana and Nigeria	103
<i>Juliet Afrah Obeng, Alberta Ama Sagoe, Kofi Amponsah Duodu and Lawrence Dogli</i>	
Climate Change and Resource Exploitation in the Gulf of Guinea: A Looming Crisis for Environmental and Economic Security in Cameroon	145
<i>Edouard Epiphane Yogo</i>	
Climate Change, Human Mobility, and Regional Security: Perspectives from Brazil	171
<i>Bruno Magalhães, Mariana Nascimento Plum</i>	
Naval Technology and the Reconfiguration of Environmental Defense in South America: A Comparative Analysis of Securitization and the Triple Helix in Colombia, Paraguay, and Perú	190
<i>Julian Orlando Quintero Ibañez, Luis Alberto Delgado Barrios</i>	
Humanitarian Assistance and Disaster Relief Operations in the Atlantic: Lessons from the French Armed Forces Operation after Hurricane Irma	202
<i>Eléonore Duffau</i>	
Conclusion-Climate Change and Security Challenges in the Atlantic: a pole-to-pole prospective vision.	211
<i>Sandra Maria Rodrigues Balão</i>	

Preface

Rear Admiral Nuno de Noronha Bragança
Atlantic Centre Coordinator

In 2024, the Atlantic Centre celebrated the success of its VI Seminar, dedicated to the topic of Illegal, Unreported and Unregulated Fishing (IUUF) in the Atlantic. In Lisbon, on the 31st of October, representatives from all corners of the Atlantic gathered to discuss a subject that, at least within academia, still requires more attention and deeper research.

Yet, while we were discussing the elements of IUUF in Lisbon, two days before the Seminar, Spain's Valencian Community was dealing with the aftermath of one of the deadliest torrential rains known to date. Some weeks earlier, *Hurricane Kirk* laid waste to several regions in western Europe, and on that same year, *Hurricane Beryl* made history as the earliest Category 5 hurricane ever recorded in the Atlantic basin, ravaging Carriacou Island in Grenada and becoming the strongest storm ever to strike that island.

The signs the Atlantic was giving were clear and extremely loud. We, as an organisation committed to driving political dialogue, developing research and delivering capacity building towards the Atlantic community, could not turn a blind eye. Thus, with the consent of our 23 signatory states, and later the endorsement of the additional four states that joined in late 2024 and 2025, the theme of "Climate Change and Security Challenges in the Atlantic" became our collective focus for 2025, which is beautifully encapsulated in this Report.

Indeed, the Atlantic is facing unprecedented challenges, existential imperatives to many Atlantic Island states and unquestionable pressures on coastal communities across the basin. In 2025, September ranked as the third warmest September on record globally, surpassed only by 2023 and 2024. Ironically, the most intense warming was felt in the Arctic, a region where hot and dry weather will unequivocally trigger irreversible consequences.

These consequences are opportunities for many, however. As Arctic Sea ice shrinks and thins, new geopolitical interests amplify in proportion, almost like an uneven scale where environmental loss translates assertions of power. Emerging maritime trade routes, such as the North Sea Route and the Northwest Passage and new accessible fisheries areas, could soon become theatres of competition and potential conflict.

But we do not need to sail all the way up north to understand the gravity of our collective path. In fact, the V Atlantic Centre Report illustrates precisely that the sheer multidimensionality and interconnectedness of Climate Change is the catalyser of many security pressures we currently face.

We view that complex and interdependent challenges like climate change demand a comprehensive approach and collective response. There is a fine line between individual organizational action and collective, strategic engagement. The V Report falls within the latter.

In truth, throughout this Report, the Atlantic Community will be able to learn and dive deep into subtopics related to Climate Change in the Atlantic space like International Law, humanitarian assistance and disaster relief operations (HADR), the financial and economic toll of climate change

on Island Nations, while also delving into regional case studies from the Sahel, Gulf of Guinea, and South America.

What the Atlantic Centre aimed to address was the sheer magnitude of the octopus we have raised, whose tentacles squeeze even the smallest coastal village or community, be it in the municipalities of Ceará and Pernambuco in Brazil or in the villages of the greater Niger Delta. The slow embrace of an unavoidable storm is now visible to many and the time for collective action is now. Our communities, our livelihoods and our Atlantic Ocean depend on it.

The Atlantic Centre Coordinator

A handwritten signature in black ink, appearing to read 'Nuno de Noronha Bragança', with a stylized flourish above the name.

Nuno de Noronha Bragança
Real Admiral

Introduction

Sandra Maria Rodrigues Balão

The Atlantic Basin represents a geopolitical and environmental nexus of profound and unprecedented significance, situated at the intersection of accelerating climate change and complex security challenges. Stretching across diverse maritime and socio-political environments—from the tropical coasts of West Africa and the Caribbean to the polar extremes of the Arctic and Antarctic—this vast basin exemplifies the confluence of ecological vulnerabilities, evolving geopolitical contestations, intensified strategic competition, and deep socio-economic fragilities. As climate change continues to intensify, threatening ecosystems, livelihoods, and regional stability, an urgent, holistic understanding of the associated risks and governance challenges that will shape the Atlantic’s future security landscape is imperative (Balão, 2021).

This V Atlantic Centre report presents a comprehensive, interdisciplinary analysis, structured across nine chapters, each contributing empirical insights, legal evaluations, comparative case studies, and robust policy recommendations on the climate-security nexus. Theoretical foundations combine securitization theory, which investigates how climate change is framed as a security threat demanding exceptional governance interventions (Bueger & Edmunds, 2024), paired with resilience theory, which emphasizes the adaptive capacities and transformative potentials of interconnected socio-ecological systems (Folke et al., 2010; UNDRR, 2023). This dual theoretical framework facilitates a systems-based approach capturing complex nonlinear feedback and dynamic interactions among environmental, social, and institutional variables that shape security outcomes across the Atlantic Basin.

Despite growing scholarship, key knowledge gaps persist in fully elucidating how climate-induced transformations interact with existing governance structures and socio-political conditions to produce differential security outcomes along the Atlantic (Lyons, 2025; Azaroual & Machrouh, 2025). This report responds to this challenge through an empirical and normative lens focused on hotspots such as the Sahel (Lyons, 2025), West African coasts, resource-dependent economies, small island developing states (Azaroual & Machrouh, 2025), and the Gulf of Guinea maritime domain (Willima, 2025).

Empirical chapters reveal a tapestry of vulnerabilities. Coastal and insular communities face acute challenges from sea-level rise, fisheries depletion, and extreme weather phenomena, threatening sustainable development and social cohesion (FAO, 2024; European Parliament, 2022). Coastal communities and maritime industries are increasingly exposed to risks like piracy, illegal fishing, and resource conflicts—phenomena closely tied to environmental degradation and governance deficits (Obeng et al., 2024). Comparative case studies of Ghana and Nigeria, exploring institutional capacity and policy responses, exemplify variations in adaptive resilience and governance effectiveness.

The legal and governance examinations (Nwarueze, 2025) emphasize the enduring relevance of UNCLOS and the importance of integrating climate considerations within existing frameworks such as the BBNJ Agreement and soft law instruments stemming from the Rio Declaration (Boyle et al., 2021; Rajamani & Peel, 2021). These legal tools are complemented by strategic policy instruments from the EU and NATO, which operationalize whole-of-society and whole-of-strategy approaches to

foster multisectoral cooperation, community resilience, and system-wide adaptability (NATO, 2024; European Commission, 2023).

A pivotal contribution of this report is its emphasis on the inter polar dimension, acknowledging that climate change effects within polar regions—the Arctic and Antarctic—are deeply interlinked with Atlantic Basin security. Polar ice melting, “emerging” maritime passages (in the Arctic with the Polar Silk Route and the projected Transpolar Route; and in the Antarctic as a consequence of emerging ‘islands’ due to the retreat of the polar ice cap near Palmer Station, for example, as observed during the COASTANTAR2024 expedition) and shifting resource frontiers not only redefine regional geopolitics but also introduce governance challenges that heighten strategic competition (Balão, 2023, 2015, 2014, 2013) while demanding renewed scientific diplomacy and treaty-based cooperation (Balão, 2010a, 2010b; Van Schaik & Staeger, 2021; Oral, 2019). This broad frame integrates planetary interconnectedness and advances coherent governance addressing complex, interdependent climate-security realities.

Methodologically, the report applies a robust mixed-methods approach, triangulating detailed legal analysis, longitudinal environmental data monitoring, and comparative case studies (Folke et al., 2010; UNDRR, 2023). This comprehensive methodology ensures an empirically grounded, multidimensional understanding that informs actionable policy pathways while aligning with the global mandates of the Sustainable Development Goals (SDGs) and international law.

The structural organization of the report is deliberate: beginning with broad, northern Atlantic and overarching legal and normative frameworks, it moves through empirical regional analyses and sector-specific studies, to culminate in focused case studies and policy synthesis. Besides, it flows from legal-normative overviews through regional thematic studies to integrated analyses and strategic policy guidance.

In chapter 1, Elizabeth Nwarueze explores and critically examines national adaptation strategies within the international legal regime, exploring the nexus among adaptation, mitigation and collaboration, elaborating on the gaps in capacity among developing Atlantic states and emphasizing regional cooperation mechanisms under frameworks such as the UNFCCC and Paris Agreement (Boyle et al., 2021).

Such insights pave the way for introducing Chapter 2 by William Lyons. The author applies narrative intelligence to the Sahelian migration and terrorism phenomena, illustrating the socio-political ramifications of environmental stress to unpack the drivers of migration and insurgency in the region (European Parliament, 2022). He explores the human security implications of environmental degradation, migration flows, and the rise of radicalization, highlighting the need for security policies that are attuned to social narratives and identity dynamics within climate-vulnerable regions.

This contribution opens the challenging ‘Pandora Box’ of the economic impacts on Atlantic African insular states, which are addressed in Chapter 3 by Fahd Azaroual & Jamal Machrouh. The authors detail the acute vulnerabilities faced by small island developing states, such as Cape Verde and São Tomé and Príncipe, focusing on the intersection of climate hazards, economic dependency, and development challenges (FAO, 2024).

Articulated with the regional concerns previously addressed, David Willima delves into climate-driven maritime insecurity in the Gulf of Guinea (Chapter 4) offering a complementary perspective

on the challenges of and for the region. By examining and discussing resource depletion and environmental stress, he highlights how these factors exacerbate maritime crimes, underscoring the need for integrated governance approaches that mitigate transnational risks (Obeng et al., 2024).

In Chapter 5, Juliet Afrah Obeng and co-authors delve into a focused comparative study of Ghana and Nigeria's governance responses, revealing differing resilience capacities.

Edouard Yogo addresses resource exploitation and environmental security crises in Cameroon (Chapter 6), revealing compound environmental-economic security dilemmas demanding strengthened governance frameworks at national and regional levels.

Bruno Magalhães & Mariana Plum investigate in Chapter 7 how climate change drives human mobility in Brazil, creating complex social and security challenges. They highlight the increasing displacement caused by extreme weather events, which strains infrastructure and exacerbates vulnerabilities to violence and resource conflicts. Human mobility is framed as a critical security issue requiring integrated, cross-sector policy responses rather than merely a humanitarian concern. Their work emphasizes the need for adaptive governance solutions to address the multifaceted impacts of climate migration on regional security.

Julian Orlando Quintero Ibañez et al., in Chapter 8, examines technological innovation and civil-military collaboration in South America's environmental defense and the "Triple Helix" of government, academia, and private sector partnerships as critical enablers of climate-adaptive maritime security (Bueger & Edmunds, 2024).

Chapter 9, by Eléonore Duffau, examines Humanitarian Assistance and Disaster Relief (HADR) operations in the Atlantic, detailing lessons from the French Armed Forces' response to Hurricane Irma and emphasizing the strategic importance of civil-military coordination and preparedness in climate disaster contexts. This contribution emphasizes the practical and strategic dimensions of climate security, making it essential for improving disaster response frameworks in the Atlantic region.

The report situates these thematic and empirical insights within an evolving mosaic of international law and governance. The United Nations Convention on the Law of the Sea (UNCLOS) continues to underpin the maritime legal order, but it must be supplemented through emerging ecosystem-based instruments, such as the BBNJ Agreement, and adaptive soft law standards originating from the Rio and Stockholm Declarations (Rajamani & Peel, 2021). In addition, complementary regional governance efforts, such as the EU Maritime Security Strategy (2023) and NATO's Climate Change and Security Action Plan (2024), that embrace whole-of-society and whole-of-strategy paradigms, binding diverse actors around inclusive, anticipatory, and resilience-enhancing governance approaches (NATO, 2024; European Commission, 2023) were recognized as fundamentals to address both Climate Changes and Security Challenges in the Whole of the Atlantic as frameworks that exemplify the operationalization of international law into multilevel cooperative action.

All in all, this multidisciplinary report exemplifies a comprehensive pathway to navigate, mitigate, but fundamentally, to address the compounded climate security challenges confronting the Atlantic region.

References

- Baijt, D., Balão, S., Carvalho, J., Sousa, S., McDermott, L., Möller, C., Okros, A. & Roberts, A., (2025). International approaches to human security. *Canadian Military Journal*, 25(2), 62–67. <https://www.journal.forces.gc.ca/PDFs/CMJ252Ep62.pdf>
- Balão, S. (2023). A região do Ártico e o conceito estratégico da NATO de 2022. Correia, J. (coord). A NATO e as relações transatlânticas: de Madrid a Vilnius. Lisboa: Universidade Lusíada. ISBN 978-989; handle: <http://hdl.handle.net/11067/7116>; doi: <https://doi.org/10.34628/dsfq-6987>
- Balão, S. (2021). An Atlantic Arctic Policy for the 21st Century?. Paper presented at the International Studies Association Conference, Las Vegas. [online]. April 6.
- Balão, S. (2015). Ártico – Geopolítica Crítica e Guerra. In A. S. Lara (Org.), *Em Caso de Guerra* (pp. 39-88). Lisboa: MGI.
- Balão, S. (2014). Globalização, Geopolítica do Mar Português e o Ártico: Perspectivas para o século XXI. In C. M. Dias (Coord.), *Geopolítica e o Mar* (pp. 133-227). Lisboa: MGI
- Balão, S. (2013). Globalização, Geopolítica e Conflito: O caso do Ártico e a abertura da Rota do Norte. In A. S. Lara (Org.), *A Crise e o Futuro*. Rio de Mouro: Pedro Ferreira.
- Balão, S. (2010a). Globalização, Geopolítica, Geografias de Poder e a(s) Estratégia(s) para o Ártico. Ed. Autor. Policopiado, Lisboa, Outubro [Trabalho de Investigação Final do Curso de Defesa Nacional IDN-MDN/CDN2010].
- Balão, S. (2010b), Geopolítica e Geoestratégia do Ciberespaço. Contributos para uma Estratégia da Informação Nacional. *Proelium-Revista da Academia Militar*. IV Série. 13. Julho, Lisboa. 31-50.
- Boyle, A. E., Redgwell, C., & Birnie, P. W. (2021). *International law and the environment* (4th ed.). Oxford University Press.
- Bueger, C., & Edmunds, T. (2024). Climate security in maritime domains: Towards a securitized Atlantic. *Marine Policy*, 130, 104664. <https://doi.org/10.1016/j.marpol.2021.104664>
- European Commission. (2023). *European Union Maritime Security Strategy*. https://www.eeas.europa.eu/eeas/eu-maritime-security-strategy_en
- European Parliament. (2022). Climate change and migration: Challenges for human security. Policy Department for Citizens' Rights and Constitutional Affairs Directorate-General for Internal Policies. PE 655.591.
- FAO (2024). The State of World Fisheries and Aquaculture. <https://www.fao.org/publications/fao-flagship-publications/the-state-of-world-fisheries-and-aquaculture/en>
- Folke, C., Carpenter, S.R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society*, 15(4), 20. <https://www.ecologyandsociety.org/vol15/iss4/art20/>
- Germond, B., & Mazaris, A. D. (2019). Climate change and maritime security. *Marine Policy*, 99(2):262-266. DOI: 10.1016/j.marpol.2018.10.010.

IPCC. (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability (Working Group II contribution to AR6). Cambridge University Press. <https://www.ipcc.ch/report/ar6/wg2/>

Lazarou, E., & Tothova, L. (2022, June). Climate change considerations for EU security and defence policy (EPRS Briefing No. 729467). European Parliamentary Research Service. [https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/729467/EPRS_BRI\(2022\)729467_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/729467/EPRS_BRI(2022)729467_EN.pdf)

NATO. (2024). Climate change and security action plan. North Atlantic Treaty Organization.

Obeng, J. A., Sagoe, A. A., Duodu, K. A., & Dogli, L. (2024). Climate change and maritime security: A comparative case study of Ghana and Nigeria. *Journal of Maritime Affairs*, 20(2), 161-179.

Rajamani, L., & Peel, J. (2021). International environmental law: Changing context, emerging trends, and expanding frontiers. *Oxford Journal of International Environmental Law*, 30(1), 1-18.

UNDRR. (2023). Resilience guidance and frameworks. United Nations Office for Disaster Risk Reduction.

World Bank. (2013). Turn down the heat: Climate extremes, regional impacts, and the case for resilience. Washington, DC.

Legal Dimension to Climate Change and Security in the Atlantic: Framing a Collaborative Solution

Elizabeth Nwarueze

Introduction

The Atlantic Ocean is regarded as the busiest ocean in the world, strategically placed for the transit of high volumes of trade and commercial activities across four continents – Africa, Europe and the Americas (Hardin E, 2025). The World Bank estimates that the Atlantic Ocean contributes about \$1.5 trillion annually to the global economy, with a projected rise by 2050 following population and trade increase (Lete B., 2015). It is thus strategically located for trade and commerce, resources, a fast-growing population and essential to security.

The Atlantic Ocean is also the venue for some of the recurring threats in the maritime environment. With trade flows comes rapidly expanding piracy and armed robbery against commercial vessels. Reported attacks cover areas like the Gulf of Guinea and the Americas; countries like Nigeria, Togo and Côte d'Ivoire are the most affected by piracy attacks in the Gulf of Guinea and Venezuela and Brazil in the Americas (Richardson et al, 2012). These attacks lead to estimated losses of about five million barrels of oil per day, cause significant depletion in fish stocks and threaten the livelihood of coastal communities (Jacobson & Guedes, 2014). Political and economic upheavals within coastal territories trigger an increase in trafficking of people, weapons and illegal substances, organised crime and proliferating terror networks across countries bordering the Atlantic Ocean (IMF, 2025). Recent security concerns surround the destruction of critical energy infrastructure, the vandalism of oil pipelines and telecommunications channels, further deepening regional insecurity in an already vulnerable region.

These security threats are addressed at both international, regional and domestic levels as Atlantic countries aim to fulfil competing obligations in international law like the preservation and protection of the marine environment within and beyond national jurisdiction, and protection of essential national interests. As explained in the 5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), climate change exacerbates the risk of the loss of territory, human displacement, reduced access to resources by countries and loss of critical infrastructure (IPCC, 2023). In this regard, linkages between climate change and threats to the marine environment can be drawn (IPCC, 2014) and demand the attention of the international community as highlighted by the International Tribunal for the Law of the Sea (ITLOS):

The Tribunal observes that the conservation of living resources and marine life, which falls within the general obligation to protect and preserve the marine environment, requires measures that may vary over time depending on the activities involved and the threats to the marine environment (ITLOS, 2024).

The impacts of climate change and ocean acidification include shifts in fish distribution and decreases in fisheries that affect the “income, livelihoods, and food security of marine resource-dependent communities”, as well as impacts on marine ecosystems which will put “key cultural

dimensions of lives and livelihoods at risk”. For conservation measures to be effective, such impacts must be taken into account.

A notable aspect of the statement by the tribunal in relation to climate change and security is that climate change is a multiplier of security threats at sea. It is capable of affecting living resources which impact the economic wellbeing of communities, on food security and may cause physical effects like coastal hazards, erosion and flooding. The ripple effect of climate change to the marine environment puts pressure on coastal communities, heighten illegal fishing, promote illegal migration and potentially makes it difficult to control conflicts arising from reactions to loss of communities or the desire for survival (Kaye S., 2012).

Against the backdrop of climate change and its effects, this paper seeks to analyse the legal aspects of climate change within the Atlantic Ocean. First, the paper will illustrate the existing legal regime on the protection of the marine environment as a basis for situating climate change and the obligation of States at sea. Secondly, the paper will lay out the specific security challenges within the Atlantic region as a foundation for the upcoming consideration of national and regional efforts towards climate resilience in the marine environment. Third, the paper will examine the concepts of ‘adaptation’ and ‘mitigation’ as these relate to the specific countries in the Atlantic Ocean. The essence of this part would be to highlight adaptation plans on a national basis. In this regard, the national policies of select Atlantic countries covering all continents represented in the Atlantic will be examined, and gaps, where relevant, will be pointed out. Finally, the paper will examine ‘collaboration’ as both an obligation and a solution to climate change in the Atlantic.

Two major conclusions are drawn from the research: first, the Atlantic Ocean is made up of countries with different economic, political and technological advancements. This influences the direct concern of countries as expressed in their national policies. However, climate change is a central concern with transboundary implications thereby causing gaps between national interests and communal threats or concerns. The International Court of Justice (ICJ) in its Advisory Opinion on Climate Change emphasised the global nature of climate change which gives rise to State obligations to prevent transboundary harm (ICJ, 2025). Secondly, a corollary to the first point is that collaboration is done within the Atlantic, through region-based mechanisms. This enhances closed-circuit cooperation but limits the possibility of a centralised network of collaborators across the Atlantic. Noting that the frameworks are set and can be harnessed, the paper recommends a coordinated legal framework upon which Atlantic-focused maritime programmes can be based in order to guard against climate-induced threats in the Atlantic Ocean.

Legal Regime on the Protection of the Marine Environment.

The framework of international law concerning the marine environment is broad, fragmented, but also connected. Subjects like climate change, freshwater scarcity, use of resources and marine technology have been explored through different legal regimes as the law of the sea is interconnected with human rights, international trade, intellectual property protection and armed conflict (Rajamani & Peel, 2021). In this sense, the introduction of climate change to the overall consideration of marine environmental protection, the legal regime has gained depth, breadth and more nuance. As the ocean is described by the United Nations as the ‘largest carbon sink’ (UN, 2025), changes in climate foretell harsh developments to the marine environment, which in turn, produce harmful effects to human and

aquatic life. The IPCC has reported the discernible, fast and devastating impact of climate change (IPCC, 2018). This is exacerbated by human activities and threats to the marine environment like pollution, illegal, unreported and unregulated fishing and extraction of resources (Boyle et al, 2021). The existing legal regime on the protection of the marine environment is divided into multilateral treaties, regional agreements and a number of principles, standards and bilateral frameworks demonstrating the interest of States in overcoming the rapid climate disasters. These laws contribute to the awareness of States and the international community of the problem and assist in the development of legal obligations and measures which must be applied to preserve the marine environment. Split into international binding instruments and non-binding agreements, relevant international agreements are now discussed with specific focus on climate change.

International Agreements

The first international convention on the protection of the marine environment specifically addressed the issue of pollution of the sea by oil. The International Convention for the Prevention of Pollution of the Sea by Oil 1954 (OILPOL) applied to a limited gross tonnage of sea-going ships and prohibited the discharge of oil or any oily mixture which fouls the surface of the sea in prohibited zones comprising all sea areas within 50 miles from the nearest land (OILPOL, 1954). Although relevant for the issue it addressed at the time, three major limitations of the OILPOL inhibited the achievement of its full potential: first, there were only few contracting parties to the Convention, starting with only ten signatories; secondly, it applied only to one type of pollutant, being oil (OILPOL XVII, 1954); and thirdly, parties to the Convention could denounce it after the expiration of five years from the day the convention came into force (CHS, 1958). In this regard, the limited scope of the OILPOL was not suited to addressing the myriad challenges in the marine environment. Shortly after, the four Geneva Conventions relating to the marine environment were adopted.

Among the Geneva Conventions, the Convention on the High Seas 1958 contained provisions for the protection of the marine environment. For the first time, the prevention of pollution in the marine environment was presented as an obligation of every State and unlike the OILPOL which seemed to address pollution post-occurrence, the new provision in the 1958 Convention reflected a paradigm shift from responsive rulemaking to preventive rulemaking at sea. It also recognised the possibility of pollutive harm through direct use and exploitation of the sea. According to Article 24:

‘every State shall draw up regulations to prevent pollution of the seas by the discharge of oil from ships or pipelines or resulting from the exploitation and exploration of the seabed and its subsoil, taking account of existing treaty provisions on the subject’.

This same language was replicated in Article 25 covering the dumping of radioactive waste in the seas and the airspace above. Although the 1958 Convention was still narrow in focus and only slightly expanded to cover radioactive waste and exploratory pollution, it set the tone for making the preservation of the marine environment obligatory by Conventions that followed. Accordingly, the International Convention for the Prevention of Pollution from Ships (MARPOL) 1973 and its later iterations provided for the prevention of pollution by the discharge of harmful substances. ‘Harmful substances’ is defined in MARPOL as any substance which, if introduced into the sea, is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea’ (MARPOL, 2(2), 1973). This covered all possible forms of pollution and its reference to specific types of pollutive substances emanating from ships falls within the range of the discourse on preventing climate change in the marine environment.

The progress made in earlier international agreements influenced the content in the United Nations Convention on the Law of the Sea (UNCLOS) 1982. A major highlight of the third UN Conference on the Law of the Sea was the addition of a special Part XII dealing with the protection and preservation of the marine environment. First, the theme ‘protection of the marine environment’ points to the origination of ‘community interests’ (Benzing M., 2006) as against individual or national objectives among States (Wolfrum R., 2018). Newly included subjects like the legal regime of the Deep Seabed described as the ‘Common Heritage of Mankind’, (UNCLOS, 1982) the Exclusive Economic Zone and the protection of the marine environment provisions depict a paradigm shift from setting boundaries and territorial limits that characterised the 1958 Convention, to the recognition of transboundary and shared global essence of the marine environment. Subsequent instruments like the Convention on Biological Diversity and the Agreement for the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction (BNNJ, 2023) are reflective of the community approach that now serve as a background to upholding States’ obligations to prevent the negative effect of climate change.

Part XII of the UNCLOS 1982 starts with a general obligation as follows:

‘States have the obligation to protect and preserve the marine environment.’

This general obligation demonstrates the growing awareness of threats to the marine environment and according to the ICJ, consists of a positive obligation to take measures to preserve the marine environment and a negative obligation not to degrade it (ICJ, 2025). This position aligns with the statement of the delegation of Morocco during the Third Law of the Sea Conference that the ‘protection of the marine environment is now at the forefront of our major concerns since it is the core of maintenance of life on this blue planet’¹ This general obligation consolidates other provisions for pollution prevention through noxious substances during innocent passage and transit passage, conservation of living resources in the EEZ and on the High Seas, protection of the marine environment within the Area (UNCLOS, 145, 1982). It is therefore unsurprising that in the *Advisory Opinion on Climate Change*, the ITLOS took a blanket view of Article 192, noting that it represents a ‘statement of principle upon which the legal order for the protection and preservation of the marine environment under the Convention is based’². The following provisions like Article 194 lay further emphasis on the duty of States to take all measures to ‘prevent, reduce and control pollution from any source using the best practicable means at their disposal’. Other provisions in Part XII of the UNCLOS relates to multilateral and regional cooperation against pollution, (UNCLOS 197, 1982) monitoring and environmental impact assessments and specific rules for dealing with pollution from defined sources and the enforcement procedures by States against a violating State or vessel (UNCLOS XII, 1982).

Part XII of the UNCLOS provides the general framework upon which States draw their obligations to be conscious of activities in the marine environment. Additionally, this Part also recognises the obligations of States under special conventions relating to the protection of the marine environment (UNCLOS, 237, 1992). For instance, the obligations of States in the Convention on Biological

¹ Statement by Mr. Gharbi of Morocco, Resumed 11th Session – Plenary, Third UN Conference on the Law of the Sea, para 101.

² Request for an Advisory Opinion Submitted by the Commission of Small Island States on Climate Change and International Law, 21 May 2024, para 184.

Diversity and the Agreement on Biological Diversity in Areas beyond National Jurisdiction (BBNJ Agreement) can be observed without prejudice to the provisions of the UNCLOS.

The Convention on Biological Diversity (CBD) 1992 aims at conserving all living organisms in the marine environment, which includes sustainable use of its components and equitable sharing of benefits. It affirms the sovereign right of States to exploit their resources according to their environmental policies and in accordance with the responsibility to ensure that their activities do not cause damage to areas beyond national jurisdiction. This Convention applies primarily within national jurisdiction or for processes done within national jurisdiction, where the effect occurs beyond national jurisdiction (CBD, 4, 1992). The CBD replicates the overarching principles existing in the UNCLOS including monitoring, cooperation among States and internal and external adoption of conservation mechanisms. Flowing from the obligation to cooperate, States are required to promote sharing of information and access to technology and enhance scientific and technical cooperation. These provisions are similar in scope to the BBNJ Agreement concerning biological diversity in areas beyond national jurisdiction.

Other agreements discussed above were finalised and adopted prior to the last decade when climate change became a globally recognised threat to sustainability in the marine environment. The BBNJ Agreement is the most recent multilateral treaty in law of the sea and the wording of the agreement specifically takes account of the ways climate change affects the marine environment. It states in its preamble:

‘Recognizing the need to address, in a coherent and cooperative manner, biological diversity loss and degradation of ecosystems of the ocean, due, in particular, to climate change impacts on marine ecosystems, such as warming and ocean deoxygenation, as well as ocean acidification, pollution, including plastic pollution, and unsustainable use’

To address the impact of biological diversity loss, States are required to cooperate both at the international and regional levels. In this regard, the Agreement mandates States to be guided by principles including the polluter-pays principle, an ecosystem approach, the use of best available science and scientific information and the use of traditional knowledge of indigenous peoples and local communities where available. In so doing, the BBNJ Agreement provides rules for the sustainable use of the applicable areas in terms of extraction of marine genetic resources, including its equitable sharing of benefits, the use of area-based management tools, mandating environmental impact assessment and ensuring capacity building and the transfer of marine technology to developing States. Presently, the BBNJ Agreement has been signed by 145 States and ratified by 75 States.³ According to Article 68 of the Agreement, its provisions will come into force after 60 ratifications.

Two conclusions can be drawn from this layout of binding international agreements on climate change: first, the development of State obligation to protect the marine environment developed progressively, signalling the shift in maritime concerns from specific concerns to general ones and from individual interests to community objectives. Secondly, although climate change is the single most important concern for sustainability in the world, treaties addressing this concern was fairly recent. Accordingly, customary international law has been useful to read climate change into the existing legal framework on protection of the marine environment. The ICJ in its Advisory Opinion

³ Latest Report on 13 October 2025 by High Seas Alliance, available at <https://highseasalliance.org/treaty-ratification/>

notes the applicability of customary principles such as the duty to prevent significant harm and the duty to cooperate for the protection of the environment as relevant guiding principles for the interpretation of rules relating to climate change (ICJ, 2025). Some non-binding instruments have also been essential for capturing the specific commitments of States. These instruments are highlighted in the next part.

Non-binding instruments

International law concerning the environment has been enriched by a variety of non-binding principles decided upon by States at Conferences to further their commitment to the climate change objective. In this paper, two foremost declarations will be presented: the Rio Declaration of 1992 and the Stockholm Declaration of 1972.

The Rio Declaration on Environment and Development was the result of the 1992 United Nations Conference on Environment and Development ‘Earth Summit’ where, together with newly independent States, the international community sought to shape the agenda to guide the priorities of States for the coming years (Vinueles J., 2015). The Rio Declaration represents the commitment of States to sustainable development and although it consists of non-binding principles, such principles have significantly contributed to the development of international environmental law and law of the sea. Additionally, these principles are often given binding force through legislation and international or bilateral instruments. One example is Principle 2 of the Rio Declaration, which is fundamental to the commitment of States to the protection of the environment, is phrased similarly to Article 194 of the UNCLOS.

This principle has been legally mandated in many forms – from multilateral treaties to domestic law, and in the marine environment, ITLOS has indicated that the obligation to prevent transboundary pollution is stringent because of the severity of transboundary pollution. Additionally, Principle 9 requiring States cooperation to strengthen capacity building for sustainable development through exchanges of scientific and technological knowledge is replicated in the CBD and forms one of the four pillars of the BBNJ Agreement. Two parts of Principle 9 are relevant to climate change in the marine environment. First, the need for capacity building recognises the transboundary nature of harm in the marine environment and the need to adopt minimum best practices for controlling pollution and sustaining the environment. Secondly, the importance of science for this purpose cannot be overestimated. Knowing the different capacities of States to harness science and technology for conservation, this principle encourages equal distribution of scientific information among States through exchange of information and sharing of mechanisms. The Precautionary Approach (Rio, 15, 1992), Polluter-pays Principle (Rio, 16, 1992) and Environmental Impact Assessment (Rio, 17, 1992) are cornerstones of the Rio Declaration and in recently adopted agreements, these principles are framed as legal obligations for States in the marine environment.

Prior to the Rio Declaration, the Stockholm Declaration of 1972 was adopted as an international instrument without binding force but as an articulation of global values from increasing environmental awareness. Scholars have indicated that this instrument is one of the foremost and most influential instruments in the evolution of environmental legal regime (Mahmoudi et al, 2003). Principle 2 of the Declaration is the foundation of the ecosystems approach, which is institutionalised in the UNCLOS, the Fish Stocks Agreement and other multilateral treaties on the marine environment (Fletcher & Bianchi, 2014). The Principle states that the natural resources of the earth including air,

water, land, flora and fauna and representative samples of natural ecosystems must be safeguarded for the benefit of present and future generations. Principle 6 calls for halting pollutive discharge of toxic substances to the environment and Principle 18 calls for the application and use of science and technology for the identification, avoidance and control of environmental risks for the common good of mankind. Capacity-building and concern for developing States is the focus of Principles 20 to 24 and Principle 25 calls for States to ensure that international organisations play a coordinated role for the protection of the marine environment. From the summary of parts of the Stockholm Declaration, the influence in modern treaties on the marine environment is clear. Capacity-building and the use of science have been discussed as having been adopted in several agreements, and the principle against pollutive discharge has also been replicated in the MARPOL and UNCLOS.

As States continue to develop mechanisms around their legal obligation to preserve the marine environment, especially with knowledge and evidence of the potential of climate change to affect the sustainability of the environment, these principles and approaches have become useful for States and international organisations to frame their best practice strategies.

Having laid out the existing legal regime on the protection of the marine environment as a background to the formation of rules around climate change affecting the oceans, the next part of this paper will focus on the specific security challenges occurring as a result of climate change in the Atlantic and the position of Atlantic States in legal implementation, which is a necessary precursor to operational and strategic mechanisms for climate compliance within the Atlantic Ocean.

Climate Change in the Atlantic

The effects of climate change on the marine environment include the extinction of living resources, coral reefs and highly essential biodiversity, the reduced ability of the sea to moderate carbon emissions and transboundary environmental issues like sea-level rise, displacement of populations, overall health and generational hazards through gradual depletion of the ozone layers (Cowie J, 2013). Although these consequences affect the whole world, some impacts may be unique to a State or region as a result of their topographical structure and design or the economic and cultural preparedness of a people. Before accounting for the specific application of the legal regime on climate change to the Atlantic, it is necessary to first understand the problems facing the region as a result of climate change. In this regard, two observations can be highlighted:

- (a) Although the Atlantic is considered a geographic ocean region, there are several sub-regions within the Atlantic Ocean with unique security challenges resulting from climate change. In this sense, combing through the whole of the Atlantic with one solution brush may be ineffective as a step to finding solutions to the challenges. These sub-regions are designed for different purposes, for instance, for the purpose of fisheries, seven regions are delineated in the Atlantic Ocean by the Food and Agriculture Organization.⁴ For this study, the Atlantic

⁴ 'Marine Fisheries' in The World Factbook, available at <https://www.cia.gov/the-world-factbook/oceans/atlantic-ocean/> accessed 5 May 2025. Northeast Atlantic covers countries like Norway, Russia, Iceland, UK and Denmark and includes the North Sea, Baltic Sea, Atlantic waters around Greenland, Iceland and the British Isles; Eastern Central Atlantic covers the west coast of Africa, Morocco, Mauritania, Senegal, Nigeria, Ghana, Cameroon and Sierra Leone; Northwest Atlantic covers North America's Continental Shelf including the United States, Canada and Greenland; Mediterranean and Black Sea region covers waters east of the Gibraltar Strait including Turkey, Italy, Tunisia, Spain and Russia.

Ocean will be divided into North and South Atlantic to discuss the problems common in those regions.

- (b) To factor in adherence to the legal regime through adaptation plans, it is observed that countries in the Atlantic tend to implement international agreements on a national basis and regionally, based on geography. This foregrounds that certain challenges may be peculiar to South America or West Africa, rather than to the South Atlantic Ocean in general. Following this view, the paper will consider adaptation and collaborative plans on the basis of such national and regional efforts. While considering the national efforts, examples will be drawn from countries representing the continents surrounding the Atlantic Ocean.

Climate Change and Security Challenges in the North and South Atlantic Ocean

The IPCC predicted a dramatic impact from climate change. This impact includes natural disasters like flood, drought, heat waves and storms in many areas of the world (IPCC, 2007). The IPCC Fifth Assessment Report offered insight into the dimensions of climate change that surround security and the unique concerns across all regions of the world. The essence is to bring this security implication to the fore and ensure that threats associated with climate change do not exacerbate into further uncontrollable situations. Within the North and South Atlantic regions, issues like water security, food security, energy security and the maintenance of critical infrastructure are central areas of focus (McElroy & Baker, 2012). Though the issues relating to climate change coincide in general areas, there are specific concerns to be taken into account by countries in both ends of the Atlantic separately.

North Atlantic

The 2024 North Atlantic Treaty Organisation Secretary General's Report on Climate Change and Security Impact Assessment indicate the current climate change and security issues in the North Atlantic (NATO, 2024). The report considered the speed and scale of climate change and the urgency of addressing the root causes as it develops into security concerns. Climate change was defined as a 'non-traditional security challenge' for reason that while its effect mainly occurs on the environment, the ripple effect threatens human life and security at sea by increasing the internal displacement of persons, causing deaths by heatwave and wildfires, thereby putting pressure on the equipment, personnel and resources of countries within the North Atlantic. Within the maritime domain, the major concern highlighted in the report is the impact of climate change on the capabilities of the naval forces to respond to maritime crises, and how this potentially affects essential maritime infrastructure and technology. The impact of sea-level rise on ports and dry docks, the increased salinity and ocean acidification and their potential impact on vessel lifespan, corrosion and pollution are two major instances in this regard (Guedes Soares et al, 2009). Perhaps a scantily explored challenge from climate change is its negative effect on the use of modern technology in the ocean. This problem was highlighted in the 2023 Study by the Centre for Maritime Research and Experimentation. In that study, it was found that changes in height of the atmospheric surface evaporative duct and heavy rainfall may impact radar performance, especially at higher frequencies and impact situational awareness at sea. This same problem may cripple submarine operations affecting both the transmission loss and ambient noise required for submarine detection (NATO, 2023). With ongoing armed conflict across several regions of the world, technical problems potentially make enemy submarines difficult to detect thus crippling the capability of naval forces to respond and exposing the region to danger (Goodman et al, 2023).

Finally, the forced displacement of people as a result of climate change may trigger more security implications in the North Atlantic as migrants navigate sea routes towards countries in the region. The European Parliament cites the World Bank Report that the increasing number of displaced persons caused by the impact of climate change may total 216 million by the year 2050 unless remedial action is taken (European Parliament, 2022). This number is greater than the population of Germany, France and Italy combined (World Bank, 2013)). Some of the climate concerns highlighted as triggers for massive and continued displacement on a large scale include water scarcity and extreme weather events, sea level rise and erosion of plantations, thereby causing food insufficiency and potentially, political crisis. Currently, countries in Europe are grappling with variations of human and security crises stemming from migration. Climate change can worsen this problem especially in developing countries and thereby overwhelm the resources in other countries.

South Atlantic

In addition to food security and environmental concerns which are common across the Atlantic, the major security concerns flowing from climate change in countries within the South Atlantic region are issues relating to climate change-induced migration, the increase in border porosity and crimes (White G., 2011). Unchecked borders will trigger issues like transnational crime, drug trafficking, armed robbery and piracy and migrant smuggling. Coupled with the limited capacity of the navies across the South Atlantic to safeguard the region, climate change is likely to heighten these challenges (Lete B., 2015).

The South Atlantic has endured through partnership and collaboration, for instance between the United States and countries in Latin America to deal with the rise in drug trafficking from the late 1980s to the early 2000s. Similarly, collaboration between the European Union and countries in the Gulf of Guinea through mechanisms like the Gulf of Guinea Action Plan 2015 – 2020 assisted in the repression of piracy and armed robbery at sea (Nincic D., 2013). Several collaborations resulting in the training of navies or technological exchange and cooperation have been useful for managing the thrust of crimes in the South Atlantic zone (Gilbert & Isike, 2010). Climate change comes with a new dimension to these challenges as the increase in food insecurity, propelled by the displacement of fisheries and erosion of plantations, may trigger even more need for inhabitants to opt for crimes to survive or instead, to migrate in large numbers. Considering the strategic location of sea routes in the South Atlantic, a nexus can be formed between climate-induced crimes and a potential crippling of global trade (Sandkamp et al, 2022).

Resolving Climate-Induced Security Challenges in the Atlantic through Legal Frameworks

The maritime security challenges in the Atlantic have been highlighted above. This part takes a further step by examining the legal pathways presented to the Atlantic community as a whole for overcoming the climate crisis. Two pathways will be discussed in this part in line with law: first, adaptation and mitigation and secondly, collaboration using existing joint and cooperatives mechanisms as basis.

Adaptation and Mitigation

‘Adaptation’ is defined by the IPCC as an ‘adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities’ (IPCC, 2007). This would include various types of responses to climate change from land planning, to reducing waste, government policies to control flood and drought, fortification of

coastal cities or creating capacity for water storage. The level of adaptation a State adopts often aligns with the specific climate threat it faces. Since the growth of the discourse on global response to climate change in the international community and following the adoption of the 1992 United Nations Framework on Climate Change (UNFCCC), adaptation became one of the recommended measures for managing climate emergency. According to Article 2 of the UNFCCC, an objective of the Convention is the ‘the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system’. In achieving this objective, the Article 2 continues:

‘Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.’

In essence, adaptation depends on several factors including sufficient time, the level of economic development and sustainability. This Article also indicates the obvious – that countries’ adaptation and response to climate change would differ considerably depending on internal factors. Nonetheless, the UNFCCC obligates all States to develop national or regional programmes for taking measures to facilitate adequate adaptation to climate change. Such facilitation for developed country parties includes assisting developing countries that are particularly vulnerable to the adverse effects of climate change in meeting the costs of adaptation (Oral N., 2019).

It has been highlighted in this paper that one of the challenges with having a uniform implementation programme with respect to climate change and security in the Atlantic is not only the diverse and unique threats that different Atlantic countries face, but also the differences in capacity to implement these measures, especially for developing Atlantic countries. This issue was in focus during the 2008 UNFCCC Conference resulting in the Bali Action Plan,⁵ the aim of which was to launch a comprehensive process to ensure the full implementation of the obligations in the Convention through sustained cooperative action like the transfer of marine technology to support adaptation or to provide an Adaptation Fund for developing countries unable to meet the costs of adaptation through the Kyoto Protocol.⁶ The subject of adaptation has also been highlighted in further Conferences and is incorporated into the 2015 Paris Agreement which reiterates the adaptation principle in Article 7, stating

‘Parties hereby establish the global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2.’

Mitigation is a term introduced by the IPCC defined as the process of reducing emissions or enhancing sinks of greenhouse gases so as to limit future climate change.⁷ There is no generalised strategy for mitigation, and countries adopt several strategies including the planting of trees and reduction of

⁵ United Nations Framework Convention on Climate Change. (2008, March 14). *Decision 1/CP.13: Bali Action Plan* (FCCC/CP/2007/6/Add.1). <https://unfccc.int/sites/default/files/resource/docs/2007/cop13/eng/06a01.pdf>

⁶ United Nations Framework Convention on Climate Change. (2001). *Decision 10/CP.7*. <https://unfccc.int/resource/docs/cop7/13a01.pdf#page=52>; United Nations Framework Convention on Climate Change. (2007). *Decision 1/CMP.3: Adaptation Fund*. https://www.adaptation-fund.org/wp-content/uploads/2015/01/Decision_1-CMP.3.pdf

⁷ 2014 IPCC Synthesis Report, 76

deforestation, reduction in the consumption of fossil fuel and adoption of clean and green energy initiatives. For instance, the mitigation measures by India comprised a total of 11 mitigation actions in the energy sector and a shift towards renewable energy in the power sector which prior contributed 43% of total GHG emissions in India (Srivastav A., 2021). Carbon policies in various sectors, the decarbonisation of transport, reduction of emissions in power generation and incentivisation of the use of cleaner energy in manufacturing were some of the mitigation strategies adopted by the European Union (Chen et al, 2020) and Mexico (Black et al, 2021). Although the UNFCCC does not expressly mention mitigation, this can be interpreted from the objective of the Convention in Article 2 which states:

‘The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve (...) stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.’ (Craig R., 2020)

Requiring countries to achieve stabilisation of emissions in order to mitigate climate impact is laudable, and countries translate this obligation to mitigation benchmarks annually in the form of a temperature goal above which no country is expected to emit or a greenhouse gases concentration goal. Presently, the goal as highlighted by the Conference of the Parties to the Paris Agreement is to pursue efforts to limit the temperature increase to 1.5 °c above pre-industrial levels (UNFCCC 1992). Achieving this set goal requires countries to pursue climate-friendly policies in order to mitigate climate risks.

It is relevant to set out some examples of national strategies for climate adaptation and mitigation by Atlantic countries, which are significant for security in the marine environment.

National references

In this part, national strategies of select Atlantic States are considered to demonstrate the level of adaptation on climate change in their maritime security framework. For this purpose, the national strategies of the United States of America, Ghana, France and Brazil are considered. These States represent both the North and South Atlantic and different regions existing within the Atlantic Ocean. The States also demonstrate varying levels of adaptation within the Atlantic.

United States of America

The Department of Defence of the United States released a 2015 Report to identify the most serious and likely climate-related security risks so that combatant commands may integrate mitigation strategies in their planning process (US DoD, 2015). The report highlights that climate change is an urgent and growing threat which contributes to increased national disasters, refugee flows and conflict over basic resources such as food and water. The goals identified by the DoD in its Climate Change Adaptation Roadmap were to identify, manage and integrate climate change considerations across the defence missions and activities, identify and assess the effects of changing climate on the department’s infrastructure, mission and activities and to collaborate with internal and external entities on understanding and assessing the challenges of a changing climate and developing appropriate response to those challenges. Four general areas of climate-related security risks were identified in the report and these are: (a) persistently recurring conditions such as flooding, drought and higher temperatures which could result in massive population displacement, the release of new

infectious diseases, strain on agriculture and an overwhelming need for humanitarian assistance (b) more frequent and severe weather events resulting in massive flooding, displacement and the new need for disaster preparedness and control (c) sea-level rise and temperature changes which may impact navigational safety in coastal regions, pose threat to fish and risk some communities being submerged by rising seas (d) decreases in Arctic ice over, type and thickness which will diminish land access as the permafrost thaws and make emergency response in the Arctic difficult. To guard against the significant depletion of the environment that may result from these identified threats, the identified measures to be adopted into the defence planning process include cooperation and building partner capacity and sharing best practices for mitigation of installation vulnerabilities through various United States command centres across Africa, Europe and Asia.

Ghana

The National Integrated Maritime Strategy of Ghana 2023 was launched in response to the need for sustainable development and maritime security in the Gulf of Guinea. Part of the strategic objectives listed for implementation is the development of a thriving blue economy to promote sustainable resource exploitation and capacity building and prevent the incidence of illegal fishing in Ghana's waters (NIMS, 2023).⁸ The priorities highlighted for the achievement of this objective include (a) protecting biodiversity and ensuring that fish stocks are exploited within biologically acceptable levels (b) ensuring the efficient management of beaches and coastal area and the effective management of waste and marine litter (c) developing and strengthening marine resource-based industries directly involved in sustainable extraction and harvesting of marine resources such as offshore oil and gas, fisheries, marine-based pharmaceuticals, aquaculture and seabed mining and (d) developing the capacity of individuals to gain employment in the maritime industry and other agencies operating within the maritime domain. In addition to this, Ghana views the development of a dynamic and diversified regional and international cooperation as a strategic objective, especially for tackling both issues of climate change and maritime security. The aim of the strategy is to integrate regional and international cooperation mechanisms into national frameworks and policies. This includes incorporating the policies adopted in the Yaounde Code of Conduct and the African Union AIMS Strategy of 2050.

France

The National Strategy for Security of Maritime Areas 2015 of France anticipates the effects of climate change and their impact on maritime security among other threats identified in the Strategy document. The report highlights that climate change is a risk for the populations and infrastructure in Metropolitan France thus necessitating the adaptation of climate-resilient strategies to its security operations. France determined that four areas require attention (a) undertaking a risk analysis caused by climate change for the state action at sea (b) improving the capacity to assess maritime emergency situations by strengthening surveillance systems in maritime areas and by sharing information for international cooperation (c) supporting the entry and implementation of the Polar Code and taking part in promoting the controlled organisation of navigation of extreme zones (d) maintaining a coherent network of nautical and air resources able to assist populations in areas identified as being

⁸ National Integrated Maritime Strategy 2023 at <https://www.docdroid.net/oUSVwmf/nims-authorized-edition-2023-c-pdf#page=29> para 3.3, accessed 28 March 2025.

at risk (NSSMA, 2015).⁹ This security strategy is followed by France's National Strategy for the Sea and Coast 2017 in which issues and potential threats of climate change are highlighted and a framework for the development of a sustainable blue economy is set out. The strategy proposes to ensure that the sea and the coastline of France contribute to mitigating the amount of greenhouse gases in the atmosphere and to achieve good resilience to natural hazards and consequences of climate change. The long-term framework brings 26 priority actions to fulfil four major goals for the preservation of the coast and these are (a) the ecological transition of the sea and the coast (b) the development of the maritime economy (c) the good environmental status of marine environments and the preservation of the attractiveness of the coastal zone (d) maintaining the international influence of France which rely on knowledge and innovation, support initiatives and remove barriers. Part of the mechanisms to be adopted in line with this overall strategy is to maintain the good environmental status of the marine environment and an attractive coastline. In doing so, a moratorium was applied since the start of 2016 to hydrocarbon exploration in the Mediterranean, both in the territorial waters of France and in the exclusive economic zone, taking into account the dramatic consequences likely to affect the whole of the Mediterranean in the event of an oil drilling accident. This moratorium extended to the Atlantic coast of mainland France (NSSC, 2017).¹⁰

Brazil

The Defense White Paper of Brazil issued in 2008 recognises its place as the country with the largest Atlantic coast in the world such that its interconnectedness to several countries within the Atlantic is strategic but also exposes it to maritime threats exacerbated by climate change. This White Paper is supplemented by a National Strategy of Defense which, in its Navy objectives, aims at ensuring the means to deny the use of the sea to any concentration of enemy forces approaching Brazil. In this regard strategies like defence of oil platforms, promptly responding to threats against sea lands by non-conventional or criminal forces and joining international peacekeeping operations have been itemised (NSD, 2008).¹¹ Although Brazil has a robust policy on defence mechanisms and collaboration with allied navies, more can be done to outline its defence strategy with climate change in consideration.

An examination of these defence strategies indicates that there is a sense of commonality on security challenges fuelled by climate change. Different mechanisms have been created to address concerns surrounding preservation of maritime territory and resources, slowing down of the spread of climate risks, maintaining a climate resilient infrastructure across all national departments and advancing science and technology to foster awareness and support preparedness towards climate emergency. The similarity of the selected national strategies form the basis for recommending collaboration as the solution to addressing the security impacts of climate change.

Collaboration

The ICJ observed that the obligation to cooperate in different areas on climate change is rooted in the UNFCCC. On this basis, the Court noted that international cooperation is indispensable in the field

⁹ National Strategy for Security of Maritime Areas 2015, page 36, 37 at https://internationalsection.edublogs.org/files/2020/10/strategie_nationale_de_surete_des_espaces_maritimes_en_national_strategy_for_the_security_of_maritime_areas.pdf accessed 28 March 2025.

¹⁰ France. (2017, February 23). *National strategy for the sea and coast (Decree 2017-222)*. https://www.mer.gouv.fr/sites/default/files/2020-11/17094_National-Strategy-for-the-Sea-and-Coastal_EN_fev2017.pdf

¹¹ Brazil. (2008). *National strategy of defense* (p. 20). https://www.files.ethz.ch/isn/154868/Brazil_English2008.pdf

of climate change and the customary duty to cooperate is reflected in several provisions of treaties relating to climate change (ICJ, 2025). With respect to the marine environment, collaboration is referenced in many provisions of the UNCLOS as a duty of States, especially with regard to the preservation of the marine environment. For the conservation of living resources, a coastal State is required to take into account, the best scientific evidence to ensure that the EEZ is not endangered by over-exploitation. Coastal States are required to cooperate with a competent international organisation to this end (UNCLOS, 61(2), 1982). Same cooperation is required for States whose nationals fish in a region with highly migratory species, and the UNCLOS requires that these States establish an appropriate international organisation to promote the conservation of these fisheries (UNCLOS, 64(1), 1982). States and multilateral cooperations are also required to preserve marine mammals, anadromous fish stocks (UNCLOS, 66(2), 1982) and for establishing equitable arrangements to allow the participation of landlocked States in exploiting fish resources within a region (UNCLOS, 69(3), 1982).

Similarly, from the security perspective, collaboration is emphasised for all States in the repression of piracy (UNCLOS, 100, 1982), illicit traffic in narcotic drugs and psychotropic substances (UNCLOS, 108, 1982) and for taking measures for their nationals as may be necessary for the conservation of living resources on the High Seas and for establishing regional fisheries organisations (UNCLOS, 117, 1982). To prevent, reduce and control pollution, States are required to cooperate on a global basis or on a regional basis in formulating international rules, standards and recommended practices and procedures for the protection and preservation of the marine environment (UNCLOS, 197, 1982). How this translates to Atlantic cooperation focused on safeguarding the Atlantic Ocean from climate-induced security challenges is discussed next.

Collaboration in the Atlantic

An examination of the defence strategies of some Atlantic countries indicates that there is a sense of commonality on security challenges propelled by climate change. These common challenges are pursued through different mechanisms in separate maritime regions bordering the Atlantic Ocean. Thus, the possibility of a joint mechanism as highlighted by the Declaration of Atlantic Cooperation, is possible. To finalise this paper, two immediate steps in line with international law are crucial for Atlantic countries to consider in building a climate-resilient Atlantic Ocean.

Establishing a common agenda

The first consideration for all Atlantic countries is to establish a common agenda for the promotion of a sustainable climate in the Atlantic. This would entail mapping out both the general and specific issues linking climate change to threats within the region and coming to an agreement on the steps to address them. In 2023, on the sidelines of the United Nations General Assembly, the Partnership for Atlantic Cooperation (PAC) was established to be a forum where Atlantic States can cooperate to address issues pertaining to the Atlantic. The commitment for the PAC was to promote a more “peaceful, stable, prosperous, open, safe, and cooperative Atlantic region and to conserve a healthy, sustainable, and resilient resource for generations to come.”¹² The Declaration on Atlantic Cooperation issued by 32 Atlantic States affirm specific commitments to maintaining a resilient and safe Atlantic Ocean with commitments to international law and the ideal of shared collaboration (EU,

¹² Statement by United States Secretary of States, Anthony Blinken on 18 September 2023.

2023). Though not founded for the specific purpose of climate change, the PAC Declaration links climate change to security in the Atlantic in paragraph 2, stating:

‘The Atlantic Ocean regulates our climate, is a vital source of food and energy, is essential for trade and livelihoods, and connects us culturally. The Atlantic Ocean also connects us in the face of challenges such as piracy, transnational organised crime, narcotics trafficking, as well as illegal, unreported, and unregulated (IUU) fishing, climate change, natural disasters, pollution, and environmental degradation, which pose a threat to our well-being, livelihoods, and the sustainable ocean economy. Thus, we share a commitment to cooperate and coordinate our efforts to achieve peace, stability, prosperity, and sustainability.’

In highlighting the intersection between climate change and security in the Atlantic, the Plan of Action sets out the methods for implementation of the PAC Declaration. While the implementation of PAC objectives is just starting, some existing collaborative mechanisms indicate the attention of partner States within the Atlantic to issues surrounding climate change and maritime security.

The European Union Atlantic Strategy and the 2013 – 2020 Action Plan focused on four themes being (a) the promotion of entrepreneurship and innovation, protection of the marine environment, (b) improving accessibility and connectivity and (c) creating a socially inclusive model of regional development. This was revised in the Atlantic Action Plan 2.0, exploring the European Union’s priorities within the period 2019 – 2024. It focused on unlocking the potential of the blue economy while preserving marine ecosystems and contributing to climate change adaptation and mitigation. The four pillars of the Action Plan are (a) ports as gateways and hubs for the blue economy (b) blue skills of the future and ocean literacy (c) marine renewable energy and (d) healthy ocean and resilient coasts. Under the mandate of this Action Plan, the EU formed the Atlantic Strategy Committee comprising representatives from the four EU countries bordering the Atlantic Ocean – France, Ireland, Portugal and Spain as well as representatives from the European Commission to organise the Atlantic Stakeholder Platform Conferences for further innovation and to promote blue economy in the Atlantic.¹³ These four countries form the national hubs for the Assistance Mechanism for the Atlantic Action Plan.¹⁴ The mechanism provides services to keep all stakeholders informed and encourage participation across interested parties in the Atlantic.

In addition to the Atlantic Strategy, the Revised EU Maritime Security Strategy and Action Plan was launched on 24 October 2023. In addition to its overall strategy, it acknowledges the climate crisis and environmental degradation and the continuous development of various forms of illegal trafficking and plundering of marine resources, IUU fishing and threats to critical marine infrastructure as a challenge in the oceans surrounding the European Union (CEU, 2023). According to the Strategy:

Climate change and marine pollution are expected to have substantial, long-lasting adverse consequences for maritime security. These may include biodiversity loss, depletion of fish stocks, flooding in coastal areas and islands, the loss of coral reefs, mangroves and other wetlands

¹³ European Commission., *Atlantic Strategy Committee*. <https://atlantic-maritime-strategy.ec.europa.eu/en/atlantic-strategy-glance/atlantic-strategy-committee>

¹⁴ European Commission. *Assistance mechanism for the Atlantic Action Plan*. <https://atlantic-maritime-strategy.ec.europa.eu/en/contact-us/assistance-mechanism-atlantic-action-plan>

In essence, this strategy aims at understanding the links between climate change and maritime security and taking action to prevent gaps in both areas. Accordingly, the Annex to the Revised Strategy lists its collaborative and capacity-building focus for the Atlantic as follows:

Atlantic			
1.1.13	Support anti-drug-trafficking operations by exchanging information and conducting joint operations, including on departing countries/ ports and destination EU ports and port facilities, including the Caribbean Sea.	As of 2021, on a rolling basis	MS, COM, MAOC-N, UMSA, EUROPOL, Frontex
1.1.14	Set up cooperation on maritime security with partners from across the Atlantic Ocean, including international and regional organizations from Africa and the Americas.	As of 2023	MS, COM, EEAS
1.1.15	Identify and promote regional maritime capacity-building activities to expand existing maritime security capacity-building programmes (e.g. the Rabat Process), improve their coordination and develop similar initiatives with partner countries and regional organisations.	On a rolling basis, as of 2024	MS, EEAS, COM
1.1.16	Conduct joint exercises and port calls with coastal like-minded Countries, in order to strengthen the EU role as a global maritime security provider and enhance cooperation in maritime security.	On a rolling basis	MS, COM, EEAS
Baltic Sea			
1.1.17	Set up a mechanism involving the COM, the Council of Baltic Sea States (CBSS) and HELCOM to coordinate scientific actions, operations, and data sharing to implement a plan of action for tackling UXO in the Baltic Sea and possible oil spills from	As of 2021	MS, COM, EEAS

Extracted from the Revised EU Maritime Security Strategy 14280/23.

Like the EU, Africa's 2050 Integrated Maritime Strategy also comprises the long-term plans of the African Union to enhance maritime viability across the oceans surrounding Africa. Among the threats the Strategy aims to address, transnational organised crime including illegal oil bunkering, human and drug trafficking and piracy and armed robbery at sea, IUU fishing, marine environmental degradation and climate change are in focus (AIMS 2050). One of the strategic objectives of this AIM Strategy is to establish a combined exclusive maritime zone of Africa for the development of its objectives of preservation of the marine environment.

The common agenda across regional frameworks within the Atlantic and with respect to climate change can be grouped into three aspects:

- (a) combatting IUU fishing and depletion of living resources
- (b) addressing piracy and transnational organised crime
- (c) preventing marine environmental degradation and pollution of the marine environment.

Across these three foremost climate change and security-related agenda in the Atlantic Ocean, Atlantic countries can deal with defined issues working as a unit shared into areas of key competencies. In relation to combatting IUU fishing, several Atlantic countries have enforced mechanisms whose approach is to discourage the uncontrolled depletion of fish stocks. The United States recently published a 5-year strategy for combatting IUU Fishing to cover 2022 – 2026, and a critical part of the plan is to establish common frameworks with regions of priority in the IUU Fishing

system (USG, 2022).¹⁵ By establishing common frameworks with Ecuador, Panama, Senegal, Taiwan and Vietnam for counter-IUU fishing operations, the United States will enhance monitoring, control and surveillance of marine fishing operations and ensure that only living resources sustainably and responsibly harvested can enter trade across the United States and its partners.

In addition to this example of transnational collaboration in one aspect of climate change and maritime security, the existence of regional fisheries management organisations (RFMO) provides basis for establishing a common goal and working collaboratively to combat IUU Fishing. Within the Atlantic Ocean, the North-East Atlantic Fisheries Commission (NEAFC), (NEAFC, 2024)¹⁶ Northwest Atlantic Fisheries Organisation, North Atlantic Salmon Conservation Organisation and the South-East Atlantic Fisheries Organisation (SEAFO) exist. Further collaboration exists in the form of a collective agreement between competent international organisations on cooperation and coordination on areas beyond national jurisdiction in the North East Atlantic between the NEAFC and the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) in 2014. This arrangement facilitates cooperation on the management of the area, and to keep a joint record of areas subject to specific measures in the region, Overall, the arrangement helps to foster a common agenda between the OSPAR mandate which is to deliver an ecosystem management approach relating to human activities in the marine environment, and the mandate of NEAFC which is to ensure long-term conservation and utilisation of fishery resources in the North-East Atlantic (NEAFC, 2024).¹⁷ As with a number of these RFMOs, the SEAFO maintains a comprehensive list of vessels caught in IUU fishing with records of how these vessels can be traced and the summary of their illegal activities.

It can be fairly concluded that in relation to combatting IUU fishing, a number of strategies exist across different bilateral and regional institutions and mechanisms. Indeed, the challenges related to IUU fishing are diverse even in the Atlantic Ocean and are often related to the type of fish and the proximity of certain Atlantic countries to one another. Yet combatting IUU fishing is a common agenda for all Atlantic countries and is a suitable common agenda within the Atlantic region.

Addressing piracy and transnational organised crime is the second common agenda for all Atlantic countries. Among the existing collaborative frameworks, the potential of piracy and other crimes like illegal trafficking in weapons, drugs and humans to cripple the Atlantic Ocean have been highlighted. The trend shows an upward movement of crime in specific zones around South America, Central America and the Gulf of Guinea. Although the link between climate change and transnational organised crime depends on a consideration of factors like economic and physical displacement and sometimes, political instability, Atlantic countries have so far devised strategies for mitigating the adverse effects of climate change through bilateral and regional cooperation, but hardly any existing pan-Atlantic mechanisms. Within the Gulf of Guinea, the Yaoundé Code of Conduct provides a framework for addressing security challenges within the West and Central Africa but is largely limited by lack of

¹⁵ United States Government. (2022). *National 5-year strategy for combating illegal, unreported, and unregulated fishing, 2022–2026* (p. 8). <https://leap.unep.org/en/countries/us/national-legislation/national-5-year-strategy-combating-illegal-unreported-and>

¹⁶ North-East Atlantic Fisheries Commission (NEAFC). (2024). *Press release from the 2024 annual meeting of the North-East Atlantic Fisheries Commission*. https://www.neafc.org/system/files/AM-2024_Press-Release.pdf

¹⁷ North-East Atlantic Fisheries Commission (NEAFC). (2024). *Collective arrangement between competent international organisations on cooperation and coordination regarding selected areas in areas beyond national jurisdiction in the North-East Atlantic*. https://www.neafc.org/system/files/14-09e_agreement_collective_arrangement_January_2024.pdf

capacity and finance to achieve its objective (Matteis & Simon, 2023). The lack of a coordinated and uniform approach to addressing crime also accounts for overlapping mechanisms within the Atlantic. The Regional Security System launched in 2021 by the Organisation of American States in coordination with the Organisation of Eastern Caribbean States (OECS), includes a strategic plan for addressing security threats in the Americas but depends largely on the individual plans and capacity of member States. A similar hurdle exists in the Africa region where a number of initiatives are set out to promote maritime security but lack the requisite structure to unite in achieving the objectives. In this sense, the security frameworks of individual countries in the Atlantic overlap alongside separate collaborative efforts. Thus, this is an area where an Atlantic coordinated response will be both timely and effective.

Capacity building and sharing of information and technology

All existing strategies for climate resilience and security in the Atlantic emphasise capacity building as an essential part of collaboration. As highlighted earlier in this paper, it is mandated by the Conventions and multilateral agreements and has been developed through bilateral and regional arrangements among Atlantic countries. For the PAC, the Declaration sets out some of the strategies for the achievement of its mandate including identifying specific issues for high strategic policy at the expert level with actions taken individually, in smaller groups or by the entire group, cooperating on activities to yield benefits for Atlantic States and to avoid duplication of efforts, promoting greater scientific cooperation by information, capacity building and access to technology. Much of the discussion will be done through working groups, taking into account the different vulnerabilities and capabilities of African States and these working groups may involve external partners, including academics, civil society groups and the private sector to contribute as observers while decisions by the group will be taken by consensus. In this regard, an emphasis on development and progressive collaboration will ensure that all Atlantic countries are prepared to contribute significantly to the formulation of strategies required for building a sustainable Atlantic Ocean. In addition, the PAC Plan of Action explores a broad support framework for the achievement of its objectives by including all stakeholders from the private sector and community groups. This forum can serve as a good platform for gathering Atlantic countries together to make progressive decisions for the future of the Atlantic especially as to climate change and the associated security challenges, but the continuance of the PAC is questionable, especially with the recent political developments and reprioritisation ongoing with the United States.

As an example, Africa's AIM 2050 strategy builds on several regional initiatives and agreements aimed at leveraging the cooperation of member countries for information sharing, security and coast guard networks, disaster risk reduction, sustainable fisheries and management of stocks and promoting maritime safety. To achieve the objectives, major steps include promoting inter-agency and transnational cooperation on maritime safety and security through an inter-agency approach. The mandate will cut across capacity development, increasing joint regional surveillance operations at sea and establishing sea-going navies or coastal networks around Africa, increasing shared situational awareness capability, harmonising force structure element capability requirements and improving an integrated coastal area management in Africa (AIMS 2050).

The Human Angle to Climate Change and Maritime Security

A conclusion that can be gleaned from diverse initiatives existing in the Atlantic region is that the framework for a possible collaboration across all Atlantic countries already exists and needs to be harnessed. In the past decade, collaboration has flowed through regional lines, cutting across countries with shared challenges or capacities. Climate change is the key transboundary challenge of this decade, especially as it can cause significant security challenges to countries in the Atlantic and exacerbate the current security challenges within the region. The legal framework for the protection of the marine environment and for addressing security challenges emphasise collaboration and with this, capacity-building and information sharing. The overlapping mechanisms and strategies within the Atlantic region can be coordinated to form a central framework for addressing climate change and its related security challenges, taking into account the differences among Atlantic countries and the specific vulnerabilities of the regions within the Atlantic.

Secondly, from a consideration of the challenges on both sides of the Atlantic divide – North and South – it is apparent that the human dimension to climate change and maritime security poses a definite risk within the Atlantic Ocean. This justifies a link between threat to the environment and to the rights of people. As observed by the ICJ, the protection of the environment and the protection of human rights have been generally recognized as interdependent since at least the Stockholm Declaration of 1972. For the South Atlantic, climate change exacerbates existing transboundary maritime crimes such as drug and human trafficking and causes a ripple effect in developing economies that may trigger mass migration using dangerous sea routes. On the other hand, the North Atlantic faces the risk of dealing with severe climate-related migration issues alongside collaboratively tackling maritime crimes within the Atlantic Ocean. The migration and refugee crisis are worsened by the fact that presently, there is no unified legal regime for the recognition of climate refugees or the grant of asylum in international law. The Refugee Convention does not factor climate change in its definition of ‘refugees’ and the interpretation of the UNHCR confirms that climate-induced migration cannot be relied on in establishing refugee status (Scopp M., 2025). The topic of migration is one that allows countries a wide margin of appreciation, and this has been demonstrated by recent cases in which the court has assessed climate change and security (Öneryıldız v. Turkey, 2013).

The core elements to be established under the Refugee Convention are that a claimant outside the country of nationality or former habitual residence must demonstrate that there is (a) a well-founded fear (b) of being persecuted (c) for reason of race, nationality, membership of a particular social group or political opinion (UNHCR, 2001). While linkages have been formed in scholarship to potentially introduce claims of displacement caused by climate change under the Refugee Convention and human rights instruments, no clear guidelines have been established for tackling environmentally-induced displacement, thus, leaving judicial interpretation to do so (Papadopoulou D., 2006). The International Court of Justice in its Advisory Opinion on the Obligation of States with respect to Climate Change noted that conditions resulting from climate change are likely to endanger the lives of individuals and may lead them to seek safety in another country. In the Court’s view,

‘States have obligations under the principle of non-refoulement where there are substantial grounds for believing that there is a real risk of irreparable harm to the right to life in breach of Article 6 of the ICCPR if individuals are returned to their country of origin’ (ICJ, 2025)

Accordingly, while the question of the recognition of climate change as a ground for displacement and refugee status, the Opinion by the ICJ provides a persuasive basis for States and the international community to consider more intently, the human ramifications of climate change.

Conclusion

This paper has examined the legal dimensions to climate change and security in the Atlantic. It builds from the existence of binding international agreements and non-binding commitments which demonstrate the interest of States in addressing threats increased by climate change. The legal regime on climate change is fragmented, existing in different instruments. In relation to the maritime space, the overarching obligation of States is to protect the marine environment. This obligation is implemented through national or regional mechanisms aimed at ensuring that the resilience of the ocean is preserved especially through the national defence strategies.

Despite the efforts of States to halt or reverse the speed and negative impacts of climate change, the reality remains that limitations on capacity and information sharing exist as a hindrance to achieving States' objectives. This is especially so in the Atlantic where differences in capability and preparedness exacerbate threats in the Atlantic. The paper demonstrates that similar maritime security threats are experienced in both North and South Atlantic. Hence, ensuring that adaptation and mitigation strategies are coordinated across the Atlantic Ocean becomes not only a viable solution, but also the obvious one. In this regard, this paper discusses two elements to be considered towards a potential collaboration by Atlantic States – establishing a common agenda and ensuring the development of capacity and exchange of information. The Pan Atlantic Declaration provides a basis upon which Atlantic States could consider collaborating on climate change. Such collaboration will be a step in the right direction to eradicate threats and lead to a climate-resilient Atlantic Ocean.

References

Treaties

- i. International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL), May 12, 1954, *United Nations Treaty Series*, 332, art. III(1), annex A(1).
- ii. United Nations. (1992). *United Nations Framework Convention on Climate Change* (Rio de Janeiro, May 9, 1992; in force March 21, 1994), 1771 U.N.T.S. 107.

Books and Book Chapters

- i. Benedek, W., De Feyter, K., Marks, S., & Weydert, C. (2014). *Introduction*. In W. Benedek, K. De Feyter, S. Marks, & C. Weydert (Eds.), *The common interest in international law* (p. 1). Intersentia.
- ii. Besson, S. (2018). Community interests in international law: Whose interests are they and how should we best identify them? In E. Benvenisti & G. Nolte (Eds.), *Community interests across international law* (pp. 36–37). Oxford University Press.
- iii. Black, S., et al. (2021). *A comprehensive climate mitigation strategy for Mexico*. International Monetary Fund.
- iv. Boyle, A. E., Redgwell, C., & Birnie, P. W. (2021). *Birnie, Boyle & Redgwell's international law and the environment* (4th ed.). Oxford University Press.

- v. Chen, J., et al. (2020). *EU climate mitigation policy*. International Monetary Fund.
- vi. Cowie, J. (2013). *Climate change: Biological and human aspects* (2nd ed.). Cambridge University Press.
- vii. Craig, R. K. (2020). Mitigation and adaptation. In E. Johansen, S. V. Busch, & I. U. Jakobsen (Eds.), *The law of the sea and climate change: Solutions and constraints* (pp. 49–80). Cambridge University Press.
- viii. Kaye, S. (2012). Climate change and maritime security. In R. Warner & C. Schofield (Eds.), *Climate change and the ocean* (pp. 153–165). Edward Elgar Publishing.
- ix. Mahmoudi, S., Moore, J. N., & Nordquist, M. H. (Eds.). (2003). *The Stockholm Declaration and law of the marine environment* (1st ed.). Brill.
- x. Rajamani, L., & Peel, J. (2021). International environmental law: Changing context, emerging trends, and expanding frontiers. In L. Rajamani & J. Peel (Eds.), *The Oxford handbook of international environmental law* (2nd ed.). Oxford University Press.
- xi. Scott, M. (2020). *Climate change, disasters, and the refugee convention*. (Cambridge Asylum and Migration Studies). Cambridge University Press.
- xii. Srivastav, A. (2021). Climate mitigation and India's commitment to the global community. In *Energy dynamics and climate mitigation* (Advances in Geographical and Environmental Sciences). Springer.
- xiii. Viñuales, J. E. (2015). The Rio Declaration on Environment and Development: Preliminary study. In J. E. Viñuales (Ed.), *The Rio Declaration on Environment and Development: A commentary* (p. 4). Oxford University Press.
- xiv. White, G. (2011). *Climate change and migration: Security and borders in a warming world* (pp. 3–12). Oxford University Press.
- xv. Wolfrum, R. (2018). Identifying community interests in international law: Common spaces and beyond. In E. Benvenisti & G. Nolte (Eds.), *Community interests across international law* (p. 34). Oxford University Press.

State, Regional and International Documents

- i. Brazil. (2008). *National strategy of defense* (p. 20). https://www.files.ethz.ch/isn/154868/Brazil_English2008.pdf
- ii. Council of the European Union. (2023). *Council conclusions on the EU's Atlantic strategy* (p. 6). <https://www.consilium.europa.eu/media/67499/st14280-en23.pdf>
- iii. European Commission. (n.d.). *Assistance mechanism for the Atlantic Action Plan*. <https://atlantic-maritime-strategy.ec.europa.eu/en/contact-us/assistance-mechanism-atlantic-action-plan>
- iv. European Commission. (n.d.). *Atlantic Strategy Committee*. <https://atlantic-maritime-strategy.ec.europa.eu/en/atlantic-strategy-glance/atlantic-strategy-committee>
- v. European Parliament. (2022). *Thinking about tomorrow: The future of climate migration*. At a Glance. [https://www.europarl.europa.eu/RegData/etudes/ATAG/2022/729334/EPRS_ATA\(2022\)729334_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/ATAG/2022/729334/EPRS_ATA(2022)729334_EN.pdf)
- vi. France. (2017, February 23). *National strategy for the sea and coast (Decree 2017-222)*. https://www.mer.gouv.fr/sites/default/files/2020-11/17094_National-Strategy-for-the-Sea-and-Coastal_EN_fev2017.pdf
- vii. Intergovernmental Panel on Climate Change. (2007). *Climate change 2007: Impacts, adaptation and vulnerability*. Cambridge University Press.
- viii. Intergovernmental Panel on Climate Change. (2014). *Climate change 2014: Synthesis report* (pp. 4–16, 20).
- ix. Intergovernmental Panel on Climate Change. (2018). *Global warming of 1.5°C—Special report* (pp. 4–12).

- x. Intergovernmental Panel on Climate Change. (2023). *AR6 synthesis report: Climate change 2023* (Section A.2.5). https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_FullVolume.pdf
- xi. International Monetary Fund. (2025, April 15). *The IMF and the fight against money laundering and the financing of terrorism*. <https://www.imf.org/external/np/exr/facts/aml.htm>
- xii. National Oceanic and Atmospheric Administration (NOAA). (2022). *National 5-year strategy for combating illegal, unreported, and unregulated fishing, 2022–2026* (p. 8). <https://leap.unep.org/en/countries/us/national-legislation/national-5-year-strategy-combating-illegal-unreported-and>
- xiii. North-East Atlantic Fisheries Commission (NEAFC). (2024). *Collective arrangement between competent international organisations on cooperation and coordination regarding selected areas in areas beyond national jurisdiction in the North-East Atlantic*. https://www.neafc.org/system/files/14-09e_agreement_collective_arrangement_January_2024.pdf
- xiv. North-East Atlantic Fisheries Commission (NEAFC). (2024). *Press release from the 2024 annual meeting of the North-East Atlantic Fisheries Commission*. https://www.neafc.org/system/files/AM-2024_Press-Release.pdf
- xv. United Nations. (1992, May 9). *United Nations Framework Convention on Climate Change* (entered into force March 21, 1994), 1771 U.N.T.S. 107.
- xvi. United Nations. (2025, March 14). *The ocean – the world’s greatest ally against climate change*. Climate Action. <https://www.un.org/en/climatechange/science/climate-issues/ocean>
- xvii. United Nations Framework Convention on Climate Change. (2001). *Decision 10/CP.7*. <https://unfccc.int/resource/docs/cop7/13a01.pdf#page=52>
- xviii. United Nations Framework Convention on Climate Change. (2007). *Decision 1/CMP.3: Adaptation Fund*. https://www.adaptation-fund.org/wp-content/uploads/2015/01/Decision_1-CMP.3.pdf
- xix. United Nations Framework Convention on Climate Change. (2008, March 14). *Decision 1/CP.13: Bali Action Plan* (FCCC/CP/2007/6/Add.1). <https://unfccc.int/sites/default/files/resource/docs/2007/cop13/eng/06a01.pdf>
- xx. United Nations High Commissioner for Refugees (UNHCR). (2001, April). *Interpreting Article 1 of the 1951 Convention relating to the status of refugees*.
- xxi. United States Department of Defense. (2015). *National security implications of climate-related risks and a changing climate*. <https://man.fas.org/eprint/dod-climate.pdf>
- xxii. World Bank. (2013). *Groundswell Part 2: Acting on internal climate migration*. <https://openknowledge.worldbank.org/entities/publication/2c9150df-52c3-58ed-9075-d78ea56c3267>
- xxiii. World Meteorological Organization. (2020). *United in science 2020: A multi-organization high-level compilation of the latest climate science information*. https://public.wmo.int/en/resources/united_in_science

Cases

- i. AF (Kiribati) [2013] NZIPT 800413 (June 25, 2013).
- ii. Intergovernmental Tribunal for the Law of the Sea. (2024, May 21). *Advisory opinion on climate change submitted by the Commission of Small Island States on Climate Change and International Law* (para. 409).
- iii. Öneriyıldız v. Turkey [GC], Application No. 48939/99, 41 EHRR 20 (ECHR, 2004).

Journal Articles

- i. Fletcher, W. J., & Bianchi, G. (2014). The FAO–EAF toolbox: Making the ecosystem approach accessible to all fisheries. *Ocean & Coastal Management*, 90, 20–26.
- ii. Germond, B., & Mazaris, A. D. (2019). Climate change and maritime security. *Marine Policy*, 99, 262–266.
- iii. Jacobson, M., & Guedes, A. (2014, September). *Significant trends in illicit trafficking: A macro view of the problem and potential means to address it*. Atlantic Future.
- iv. Lete, B. (2015). *Addressing the Atlantic’s emerging security challenges* (Atlantic Future Scientific Paper No. 34).
- v. Mattheis, F., & Siman, T. (2023). Maritime regional security governance in the Atlantic: Antagonisms, overlaps and cooperation. *Nação e Defesa*, 164(1), 9–22. <https://doi.org/10.47906/ND2023.164.01>
- vi. McElroy, M., & Baker, D. J. (2012). *Climate extremes: Recent trends with implications for national security*. Harvard University.
- vii. Nincic, D. J. (2013). Trends in modern piracy: Cycles, geographical shifts, and predicting the next “hot spots.” *SAIS Review of International Affairs*, 33(2), 105–115. <https://doi.org/10.1353/sais.2013.0028>
- viii. Oral, N. (2019). International law as an adaptation measure to sea-level rise and its impacts on islands and offshore features. *The International Journal of Marine and Coastal Law*, 34(3), 415–439. <https://doi.org/10.1163/15718085-23434024>
- ix. Papadopoulou, D. (2006). Environmental calamities and the right to life: State omissions and negligence under scrutiny: Öneriyıldız v. Turkey [Grand Chamber], Application No. 48939/99, Judgment of 30 November 2004. *Environmental Law Review*, 8(1), 59–65. <https://doi.org/10.1350/enlr.2006.8.1.59>
- x. Sandkamp, A., Stamer, V., & Yang, S. (2022). Where has the rum gone? The impact of maritime piracy on trade and transport. *Review of World Economics*, 158, 751–778. <https://doi.org/10.1007/s10290-021-00449-4>
- xi. Scopp, M. (2025, August 6). *Climate-induced displacement: Establishing legal protections for climate refugees*. Human Rights Research Centre. <https://www.humanrightsresearch.org/post/climate-induced-displacement-establishing-legal-protections-for-climate-refugees>

Climate Change, Migration, and Terrorism in the Sahel: A Narrative Intelligence Approach to European and Atlantic Security Challenges

William Lyons

Introduction

The intersection of climate change, migration, and terrorism represents one of the most complex security challenges of the 21st century, yet traditional analytical frameworks often fail to capture the intricate human dimensions that drive these interconnected phenomena (Reyer et al., 2017; Torres & Casey, 2017). While quantitative approaches have dominated policy research in this domain, focusing primarily on statistical correlations between environmental stressors, population movements, and conflict incidents (Buhaug, 2015; Schleussner et al., 2016), they frequently overlook the critical role that identity formation and collective narratives play in shaping individual and group responses to environmental displacement (Adger et al., 2014; Mortreux & Barnett, 2017).

Climate-induced migration does not occur in a vacuum; it unfolds within specific cultural, political, and social contexts where competing narratives about causation, responsibility, and legitimate responses shape how communities interpret their experiences of displacement (Hunter et al., 2015; McMichael et al., 2012). These narratives influence not only how displaced populations understand their predicament but also how host communities, governments, and extremist organizations frame and respond to migration flows (Boas, 2015; Farbotko & McMichael, 2019). When traditional analytical methods treat these human stories as mere background noise to be controlled for statistically, they miss the fundamental mechanisms through which environmental stress transforms into social tension and, in some cases, violent extremism (Ide, 2018; Koubi et al., 2018). This is true for climate and violence induced migration from Africa to Europe, relying on illicit migratory flows in the Atlantic to accomplish this mass migration (International Organization for Migration, 2023).

Narrative intelligence—the systematic analysis of how stories, meanings, and interpretive frameworks shape human behavior and social dynamics—offers a powerful lens for understanding these complex relationships (Mattern, 2005; Bruner, 2004). Unlike conventional approaches that seek to establish direct causal links between climate variables and security outcomes, narrative intelligence examines the intermediary processes through which environmental changes are interpreted, contested, and acted upon by diverse social actors (Burke et al., 2015; Scheffran et al., 2012). This approach recognizes that the path from climate stress to insecurity is mediated by the stories people tell about their experiences, the explanatory frameworks they adopt to make sense of their circumstances, and the collective identities that emerge from shared narratives of displacement and dispossession (Adger et al., 2014; Brown & Westaway, 2011).

The application of narrative intelligence to the climate-migration-terrorism nexus reveals several critical insights often obscured by traditional analytical methods. First, it illuminates how extremist organizations strategically exploit narratives of environmental injustice and displacement to recruit members and justify violence (Malet & Hayes, 2021; Smith & Jones, 2020). Second, it demonstrates how competing narratives about climate migrants—whether framed as victims deserving assistance

or threats requiring containment—shape policy responses that can either mitigate or exacerbate security risks (Bettini, 2013; Baldwin, 2013). Third, it reveals how the absence of coherent, empowering narratives about climate adaptation can create meaningful vacuums that extremist ideologies readily fill (Oels, 2012; Gemenne et al., 2014).

Nowhere is this interplay of climate, migration, and security narratives more consequential than in contemporary European politics, where competing storylines about environmental displacement have fundamentally reshaped policy discourse and electoral dynamics (Lazaridis & Campani, 2017; Hartmann, 2010). European policymakers and publics increasingly encounter climate migration through overlapping narratives of environmental crisis, cultural threat, and security vulnerability that blur traditional distinctions between humanitarian and security responses (Bettini et al., 2017; Methmann & Oels, 2015). Right-wing populist parties have proven particularly adept at weaving climate migration into broader narratives of civilizational decline and national insecurity, portraying environmental displacement not as a consequence of global warming requiring collective action, but as evidence of impending social collapse that demands border fortification and cultural preservation (Sakellariou, 2017; Veron, 2010).

Meanwhile, progressive narratives that frame climate migrants as victims of environmental injustice requiring European solidarity often struggle to gain political traction in contexts where security concerns dominate public discourse (Nash, 2018; Torres & Bergmann, 2019). These competing narrative frameworks do not merely reflect policy preferences; they actively construct the political possibilities for European responses to climate migration, determining whether environmental displacement is understood as a humanitarian challenge requiring assistance, a security threat demanding containment, or a justice issue necessitating systemic change (Wunderlich, 2012; Bourbeau, 2015).

This paper argues that integrating narrative intelligence into our analytical toolkit is essential for developing more nuanced and effective responses to the security challenges posed by climate-induced migration. By examining the stories that shape how different actors interpret and respond to environmental displacement, we can better understand the conditions under which climate migration becomes a pathway to radicalization and identify intervention points for more effective prevention strategies (Werrell & Femia, 2018; Rüttinger et al., 2015). Rather than treating narratives as second or third order affects to be explained away, this approach positions them as central mechanisms through which environmental changes translate into social and political outcomes (O'Brien & Barnett, 2013; Pelling & High, 2013).

The following analysis draws on narrative intelligence from open source intelligence (OSINT) geographically referenced to the Sahel where people and communities are experiencing significant climate-induced migration, examining how different narrative frameworks have shaped the trajectory from environmental stress to security outcomes (Brzoska & Fröhlich, 2016; Abel et al., 2019). Through this lens, we demonstrate that effective counter-terrorism and climate adaptation strategies must engage seriously with the power of stories to shape human behavior, moving beyond purely technical or military approaches to address the deeper narrative foundations of extremist appeal in the context of environmental change (Carius, 2009; Detges, 2016).

Literature Review

Theoretical Foundations: The Threat Multiplier Framework

Origins and Development of Climate Security Concepts

The conceptual foundation for understanding climate change as a security issue was fundamentally shaped by Sherri Goodman's coinage of the term "threat multiplier" in 2007 through the CNA (Center for Naval Analyses) Military Advisory Board report on climate security. Goodman, who served as the Pentagon's first Chief Environmental Officer, is credited with educating a generation of US military and government officials about the nexus between energy, climate change and national security. Her 2024 book, "Threat Multiplier: Climate, Military Leadership, and the Fight for Global Security," provides the definitive account of how climate considerations became integrated into military planning and security assessments.

The "threat multiplier" concept captures how climate change effects interact with and have the potential to exacerbate pre-existing threats and other drivers of instability to contribute to security risks. The concept has been characterized as "definitional" in having "set a baseline for how to talk about the issue" and having shaped "the way in which people studying climate policy think about risks". The strength of this world vision in US national security policy makers is apparent, as the term has quickly spread throughout the entire American national security system and is particularly favored by the individual armed services.

Theoretical Evolution and Critiques

Recent scholarship has called for moving beyond the "threat multiplier" framework, arguing that "the language of threat multiplier doesn't tell you much about what combination of factors we should be worried about" (New Security Beat, 2020). Critics suggest that if we can't say more than "bad things go together," then what can we say about what to do to diminish the negative security consequences of climate change? This critique has led to more sophisticated analytical frameworks that identify specific risk factors and targeted interventions (Oxford Academic, 2024).

Recent academic work has applied "worldmaking" analysis to understand how the threat multiplier frame shapes policy responses, demonstrating how these framings "are connected and embodied in real-world practice, and how visions of the global have implications for specific local consequences and outcomes" (Oxford Academic, 2024). This approach highlights the importance of understanding not just what the threat multiplier concept describes, but how it shapes institutional responses and resource allocation (Kassa, 2023).

Climate Change Vulnerabilities in the Sahel

The Sahel's unique geographical position makes it particularly vulnerable to climate change impacts. Van Ackern and Detges (n.d.) highlight how the region's position between the Sahara Desert and the more humid savannas creates inherent climatic instability that is exacerbated by global warming trends. The authors emphasize that climate change in the Sahel manifests through increased drought frequency, erratic rainfall patterns, and progressive desertification, creating what they term a "cascade of vulnerabilities" that affects multiple dimensions of human security.

Sartori and Fattibene (n.d.) expand on this vulnerability framework by examining how climate change undermines human security across multiple domains. Their analysis reveals that environmental

degradation in the Sahel operates as a "threat multiplier", amplifying existing socio-economic challenges and creating new security risks. The authors document how declining agricultural productivity, water scarcity, and ecosystem degradation interact with pre-existing governance challenges to create conditions conducive to both migration and violent extremism.

Contemporary analysis confirms that "the Sahel's temperature is rising at 1.5 times the global average, as extreme weather events multiply and become more severe. Long-term shifts in temperature and rainfall patterns are destabilising entire communities -- disrupting traditional ways of life, eroding livelihoods and threatening food security" (IEMed, n.d.).

Dieng's (2021) comprehensive analysis in the International Review of the Red Cross provides crucial context by framing the Sahel's challenges within broader development and governance frameworks. Dieng argues that while climate change presents significant challenges, it also creates opportunities for regional cooperation and sustainable development initiatives. However, the author acknowledges that realizing these opportunities requires addressing the fundamental vulnerabilities that make Sahelian communities susceptible to climate shocks.

Climate-Induced Migration Patterns

Migration Dynamics and Scale

The relationship between climate change and migration in the Sahel has received extensive scholarly attention, with researchers documenting both the mechanisms and patterns of climate-induced displacement. Eboreime et al. (2025) provide one of the most comprehensive analyses of this relationship in their study "From Drought to Displacement." Their research demonstrates how prolonged drought conditions trigger multi-stage migration processes, beginning with short-term seasonal movements and potentially escalating to permanent displacement when adaptive capacity is exceeded.

The authors' epidemiological approach reveals that climate-induced migration in the Sahel follows predictable patterns related to rainfall variability and agricultural productivity. Their findings indicate that a 10% decrease in seasonal rainfall correlates with a 15-20% increase in migration flows from affected areas (Eboreime et al., 2025). This quantitative analysis provides crucial evidence for understanding the scale and timing of climate-induced displacement in the region.

Current data shows that a large majority of those forced to move (more than 90%) choose to remain in the region, rather than travel to Europe. This is largely due to a lack of material resources needed to leave the continent. However, given the demographic trends, neighbouring countries will not be able to absorb the flows forever. As such, it is likely that people will look increasingly toward Europe as their lifeline (Center for Strategic and International Studies, 2025).

The Atlantic route from West Africa to Europe is particularly important for those who do emigrate to Europe. The Atlantic route became the most active irregular passage from Africa to Europe in 2024, with 36,000 African migrants intercepted. Overall, African irregular migration to Europe dropped significantly from 282,000 in 2023 to 146,000 in 2024, largely due to enhanced EU-funded interdiction efforts African Migration Trends to Watch in 2025 (Williams, W. 2025). The Canary Islands saw an 18% increase in arrivals to almost 27,730 in 2023 (Frontex 2023), fueled by departures from Mauritania. Mali was the leading country of origin for irregular migration to Europe in 2024

with roughly 16,500 people, while Guinea topped the list in 2023 with approximately 21,700 individuals (Williams, W. 2025)

Demographic and Economic Pressures

The total population of Africa will grow from the current 1.2 billion to 2.5 billion by 2050 (Policy Center for the New South, 2024). Niger, with the highest fertility rate in the world — 7.3 children per woman — will see its population multiply from 20 million to almost 70 million people in this timeframe. These demographic pressures intersect with climate vulnerabilities to create unprecedented migration challenges.

With few options, thousands of people from the Sahel --- many of them under 25 --- leave Niger each month in an effort to reach Europe, often to travel to North Africa with the aim of crossing the Mediterranean Sea. As of July 2023, migrant departures from Libya to Europe were at their highest point since 2017. The majority were from Niger, Egypt, Sudan, Chad and Nigeria (European Council for Foreign Relations, 2020).

Migration as Adaptation Strategy

Vigil's (n.d.) work on climate change and migration offers important insights into the qualitative dimensions of displacement in the Sahel. The author's field-based research reveals how migration decisions are embedded within complex social networks and cultural practices, challenging simplistic narratives about climate refugees. Vigil emphasizes that while climate change acts as a significant driver of migration, the decision to migrate involves multiple factors including family obligations, economic opportunities, and security considerations.

Migrating is a way for people to adapt to changes in the climate, but it can also involve loss. Mobility has long been used as a strategy to cope with and adapt to changes. However, leaving a home often means losing out financially or socially, making people even more vulnerable (Overseas Development Institute, 2023).

Naz and Saleem (2024) contribute to this literature by examining conflict and migration patterns across the broader Sahel region. Their comparative analysis reveals significant variations in migration patterns between different Sahelian countries, with factors such as governance quality, economic development, and conflict intensity mediating the relationship between climate change and displacement. The authors argue that understanding these variations is crucial for developing targeted policy responses.

Terrorism and Violent Extremism

Climate-Terrorism Nexus: Empirical Evidence

The connection between climate change and terrorism in the Sahel represents one of the most contested areas in the literature. Climate change does not directly lead to more terrorism in the Central Sahel. Rather, factors associated with climate change appear to be a catalyst for localised conflicts, mainly driven by disruptions in agricultural production patterns and resource scarcity. And local conflict offers fertile ground for the establishment of terror groups (Institute for Security Studies, 2024).

Violent-extremist groups, including factions associated with ISIS and al-Qaeda, are embedding themselves in societies already grappling with economic and environmental hardships. These groups exploit resource scarcity -- especially around water and land -- to recruit those who have been pushed to the edge, exacerbating governance voids and fragmenting the region. Mali and Burkina Faso now rank as the world's first and third most terrorism-affected countries (The Tony Blair Institute for Global Change, 2024).

Raineri's (n.d.) work "When (Fighting) Climate Change Fuels Terrorism" provides a nuanced analysis of how environmental policies and climate adaptation measures can inadvertently contribute to extremist recruitment and activities. The study concludes that one-size-fits-all approaches to environmental challenges and climate change mitigation are 'recipes for disaster'. The tension created by top-down climate policies has created a 'fertile ground for terrorist groups'.

Larémont's (2021) analysis of climate change and conflict in the Western Sahel offers empirical evidence for the climate-terrorism nexus. The author documents how environmental degradation contributes to resource-based conflicts that can be exploited by extremist groups. Larémont's research reveals that terrorist organizations in the Sahel have become adept at capitalizing on climate-induced grievances, using environmental narratives to legitimize their activities and recruit followers.

Terrorist Group Dynamics

The first and most active of these groups is JNIM, an Al-Qaeda coalition formed in 2017 following the merger of prominent violent Islamist factions including Ansar Dine, Macina Liberation Front, al-Mourabitoun and al-Qaeda in the Islamic Maghreb, or AQIM. The second is IS-Sahel, IS's most established and successful affiliate faction in sub-Saharan Africa (The Tony Blair Institute for Global Change, 2024).

Our analysis finds terrorist groups that embrace violent Islamist ideologies are now responsible for nearly two-thirds of all incidents of insecurity in the central Sahel. These groups have demonstrated remarkable adaptability in exploiting climate-induced vulnerabilities for recruitment and operational purposes (The Tony Blair Institute for Global Change, 2024).

Zoubir's (n.d.) comprehensive examination of security challenges in the Sahel places violent extremism within a broader context of migration and instability. The author argues that climate change contributes to terrorism not through direct causation but by creating conditions that favor extremist narratives and recruitment strategies. Zoubir emphasizes that understanding this indirect relationship is crucial for developing effective counter-terrorism policies.

Tesfaye's (n.d.) work provides additional empirical evidence for the climate-conflict nexus in the Sahel. The author's quantitative analysis reveals correlations between drought severity and conflict intensity, while acknowledging that the relationship is mediated by numerous social, political, and economic factors. Tesfaye's findings suggest that climate change increases the probability of conflict but does not determine its occurrence.

European Migration and Security Policy Responses

European Union Migration Governance

This is why the Sahel is particularly vulnerable: displacement usually does not lead to conflict in the absence of other contributing factors, but many parts of the Sahel are already extremely fragile. The combination of poverty, dependence on agriculture, environmental degradation, and population growth is creating a vicious circle, which can be expected to translate into increasing forced migration. This, of course, is a concern for European policymakers. But what should concern them even more is the complete absence of any long-term policies to address these trends (European Council for Foreign Relations, 2020).

The European Union remains committed to providing support for refugees and displaced people and their host communities and will continue to work with international partners to address the root causes of irregular migration and forced displacement, and to strengthen migration governance and management in partner countries (European External Action Service, 2025).

Securitization and Border Management

Recent efforts to address irregular migration through the Sahel have changed flows, not stopped them. As a result, migrants are at greater risk while the networks of illicit actors that move them grow stronger. The first of these was a 2015 law criminalizing migrant smuggling, which Niger adopted under heavy European pressure. As a result, 2016 migrant flows through Agadez fell from 330,000 to 70,000 per year by 2017, touted as a victory by European policymakers (Center for Strategic and International Studies, 2025).

The securitisation policies introduced, for example, hinder the application of the Freedom of Movement frameworks established under the Economic Community of West African States (ECOWAS), including their ability to provide limited forms of protection in situations of cross-border disaster displacement (Forced Migration Review, 2025).

European Security and Counter-Terrorism Responses

EU-Africa Security Cooperation

The EU supports counter-terrorism initiatives and activities on the African continent. On 16 December 2024, the Council approved conclusions aiming to enhance efforts to address terrorism and violent extremism, calling for increased EU engagement with African-led counter-terrorism initiatives (United Nations, 2022).

The European Union, Africa's leading security partner, contributes more than 90 per cent of the African Union's budget for peace operations through the European Peace Facility, noting its contribution of more than €2.25 billion (European Parliament, 2020).

The European Union has conducted three military CSDP missions and operations to train and advise the Armed Forces of Somalia (EU training mission (EUTM) Somalia -- 2010), Mali (EUTM Mali -- 2013) and the Central African Republic (EUTM CAR -- 2016), one naval military operation (EU naval force operation (NAVFOR) ATALANTA -- 2009), and three civilian missions to train and advise the internal security forces of Mali (EU capacity-building mission (EUCAP) Sahel Mali -- 2012),

Niger (EUCAP Sahel Niger -- 2014) and Somalia (EUCAP Somalia -- 2014) (European Parliament, 2020).

Climate Security Integration

Due to its geography, demography and proliferation of conflicts, the Sahel region is the most threatened in the world by climate change. Any deterioration of the situation in the Sahel has repercussions on Europe and its relations with Africa. Today, the United Nations (UN), the European Union (EU) and the G-7 are defining climate change as a threat to global and national security though acknowledging that the links between climate change, conflict and vulnerability are neither simple nor linear (IEMed, n.d.).

Temperatures are rising 1.5 times faster in the Sahel region than in the rest of the world, and whereas, according to the United Nations, around 80 % of agricultural land in the region is degraded, with some 50 million people who depend on livestock farming in conflict over the land (United Nations, 2025).

Regional Security Implications

The G5 Sahel: Origins, Mission, and Dissolution

The Group of Five for the Sahel (G5 Sahel) represented one of the most significant regional security initiatives aimed at addressing the interconnected challenges of terrorism, organized crime, and climate-induced instability in the Sahel. The G5 Sahel was created on 16 February 2014 in Nouakchott, Mauritania, at a summit of five Sahel countries: Burkina Faso, Chad, Mali, Mauritania, and Niger (Wikipedia, 2024). The organization adopted a convention of establishment on 19 December 2014, and was permanently seated in Mauritania, with coordination organized on different levels and military aspects coordinated by the respective countries' Chiefs of Staff.

The purpose of the G5 Sahel was to strengthen the bond between economic development and security, and together battle the threat of jihadist organizations operating in the region, including AQIM, MOJWA, Al-Mourabitoun, and Boko Haram (Alliance Sahel, 2020). The G5 Sahel was structured around a steering mechanism comprising three main entities: the Conference of Heads of State, the Council of Ministers, and the Executive Secretariat, headquartered in Nouakchott. The organization's mandate exceeded that of Operation Barkhane in that it addressed both terrorism and transnational organized crime through joint cross-border operations and included the facilitation of humanitarian operations, development activities, and the restoration of state authority (CSIS, 2017).

In 2017, the G5 Sahel established the G5 Sahel Joint Force (FC-G5S), a military coalition designed to combat terrorist groups and organized crime across the region's porous borders. The Joint Force was authorized by the African Union Peace and Security Council in April 2017 and strengthened by the adoption of UN Security Council Resolution 2359 in June 2017, which welcomed the G5 Sahel as an opportunity for increased "regional counter-terrorism cooperation" (Security Council Report, 2024). The force received strong backing from France, which deployed approximately 4,000 troops in the region through Operation Barkhane, and secured €50 million in funding from the European Union.

However, the G5 Sahel faced increasing challenges as political instability swept through member states. Following a series of military coups in Mali (2021), Burkina Faso (2022), and Niger (2023), the organization began to fracture. Mali withdrew from the G5 Sahel in May 2022, citing "instrumentalization" and opposition to its planned presidency due to the political situation following its coups d'état (Wikipedia, 2024). The situation deteriorated further when Burkina Faso and Niger announced their withdrawal from all instances of the G5 Sahel on 2 December 2023, stating that the organization was "failing to reach its objectives" (Security Council Report, 2024). Three days later, on 6 December 2023, Chad and Mauritania, the remaining members, announced the dissolution of the G5 Sahel framework, which according to its founding convention could be terminated at the request of at least three member states (Security Council Report, 2024).

The dissolution of the G5 Sahel marked the end of a significant experiment in regional security cooperation and highlighted the challenges of maintaining multilateral institutions amid political instability. The three countries that withdrew—Mali, Burkina Faso, and Niger—subsequently formed the Alliance of Sahel States (AES) in September 2023 as an alternative framework for collective defense and mutual assistance, though this new organization has been characterized by closer ties to Russia and a more antagonistic relationship with Western partners (International Crisis Group, 2024). The end of the G5 Sahel has left Mauritania and Chad seeking alternative security partnerships, with implications for regional counter-terrorism efforts and the broader architecture of Sahel security governance.

Regionally, the formation of the Alliance of Sahel States (AES) and the imminent withdrawal of Mali, Niger and Burkina Faso from the Economic Community of West African States (ECOWAS) signal a shift towards isolationism, weakening collective security programmes, including those combatting violent extremism (Security Council Report, 2024).

The literature reveals that climate change in the Sahel creates what can be termed "security spillovers" that affect regional stability. Multiple authors document how environmental degradation in one area can trigger migration flows that destabilize distant regions, while terrorist groups exploit these movements to expand their operational reach. This regional dimension of climate security challenges traditional approaches to both environmental policy and counter-terrorism (United Nations, 2024).

The security implications of climate change in the Sahel extend beyond national borders, creating regional challenges that require coordinated responses. Singer's (n.d.) analysis of climate-induced migration as a threat to peace and security highlights how displacement can destabilize neighboring regions and create cascading security challenges. Singer argues that large-scale migration can overwhelm host communities' adaptive capacity, potentially leading to local conflicts and creating new opportunities for extremist recruitment.

Regionally, the formation of the Alliance of Sahel States (ASS) and the imminent withdrawal of Mali, Niger and Burkina Faso from the Economic Community of West African States (ECOWAS) signal a shift towards isolationism, weakening collective security programmes, including those combatting violent extremism (Security Council Report, 2024).

The literature reveals that climate change in the Sahel creates what can be termed "security spillovers" that affect regional stability. Multiple authors document how environmental degradation in one area can trigger migration flows that destabilize distant regions, while terrorist groups exploit these

movements to expand their operational reach. This regional dimension of climate security challenges traditional approaches to both environmental policy and counter-terrorism (United Nations, 2024).

Methodological Considerations and Gaps

The reviewed literature employs diverse methodological approaches, from quantitative analyses of climate and conflict data to ethnographic studies of migration experiences. This methodological diversity strengthens the overall evidence base while highlighting important gaps in current knowledge.

Several authors acknowledge the challenges of establishing causal relationships between climate change, migration, and terrorism. The complex, multi-causal nature of these phenomena makes it difficult to isolate climate effects from other contributing factors. Most researchers adopt a "contributory cause" framework rather than claiming direct causation.

Despite routine declarations that connect Sahelian terrorism to climatic and environmental factors, available scientific evidence does not allow us to conclude whether (and what) climatic factors impact (and how) conflict variability and terrorism (Institute for Security Studies, 2024).

The literature also reveals significant geographical and temporal gaps in coverage. While some areas of the Sahel have received extensive attention, others remain understudied. Additionally, most research focuses on recent developments, with limited historical analysis of long-term climate-security relationships.

Policy Implications and Recommendations

The reviewed literature suggests several important policy implications for addressing climate change, migration, and terrorism in the Sahel. Multiple authors emphasize the need for integrated approaches that address environmental, social, and security challenges simultaneously rather than treating them as separate issues.

Climate Adaptation and Resilience

Climate adaptation emerges as a crucial policy priority, with several authors arguing that enhancing community resilience can reduce both migration pressures and extremist recruitment opportunities. However, the literature also warns about the potential for poorly designed adaptation measures to exacerbate local grievances.

In particular, the production potential of agricultural and pastoral economies in the Sahel must be strengthened by integrating innovative and resilient technical solutions to the adverse effects of climate change. Similarly, improving local and institutional mechanisms for managing resources and community tensions is vital to reducing the scope for terrorist groups to exploit vulnerabilities.

Narrative Intelligence: A Framework for Understanding Climate Change, Migration, and Terrorism as Security Challenges

The traditional security paradigm, focused on military threats and state-to-state conflicts, struggles to adequately address the complex, interconnected challenges of the 21st century. Climate change, migration, and terrorism represent security threats that transcend borders, evolve rapidly, and resist conventional analytical frameworks. Narrative intelligence—the systematic study of how stories

shape understanding, decision-making, and collective action—offers a powerful lens for comprehending these phenomena and their security implications (Miskimmon et al., 2013).

Understanding Narrative Intelligence

Narrative intelligence encompasses the ability to recognize, analyze, and strategically employ the stories that drive human behavior and institutional responses. Unlike traditional intelligence that focuses primarily on facts and data, narrative intelligence examines how information is packaged, transmitted, and interpreted through story structures that give meaning to events and shape responses to them (Mattern, 2005).

This approach recognizes that security challenges are not merely objective phenomena but are fundamentally shaped by how they are understood, communicated, and acted upon by various stakeholders. The stories we tell about climate change, migration, and terrorism directly influence policy responses, public support, and the effectiveness of security measures (Jackson, 2005).

Climate Change Through a Narrative Lens

Climate change presents perhaps the most complex narrative challenge in contemporary security discourse. The dominant scientific narrative emphasizes long-term, gradual changes punctuated by extreme events, but this temporality conflicts with political and media cycles that favor immediate, dramatic stories (Hulme, 2009).

The security implications of climate change emerge through multiple narrative frameworks. The "threat multiplier" narrative positions climate change as exacerbating existing tensions—drought intensifying resource conflicts, sea-level rise displacing populations, extreme weather overwhelming state capacity (CNA Corporation, 2007). This framing helps security professionals understand climate change within familiar paradigms of instability and conflict.

However, alternative narratives reveal different security dimensions. The "systemic risk" narrative emphasizes cascading failures across interconnected systems, from supply chains to financial markets (O'Brien et al., 2018). The "transformation" narrative focuses on opportunities for building resilience and new forms of security cooperation (Nelson et al., 2007). Each narrative framework reveals different aspects of climate security while potentially obscuring others.

Narrative intelligence suggests that effective climate security strategies require understanding and engaging with multiple story frameworks simultaneously. This means recognizing how different communities experience and narrate climate impacts, how these narratives influence political feasibility of responses, and how security institutions can adapt their own narratives to encompass longer temporal horizons and systemic thinking (Adger et al., 2014).

Migration as Narrative and Security Challenge

Migration represents one of the most contested narrative battlegrounds in contemporary security discourse. The stories we tell about migration fundamentally shape whether it is viewed as threat, opportunity, or humanitarian imperative—with profound implications for security policy and practice (Huysmans, 2000).

The "invasion" or "crisis" narrative frames migration as an external threat requiring defensive measures. This story structure emphasizes sovereignty, control, and protection of existing communities, leading to security responses focused on border enforcement, detention, and exclusion

(Bigo, 2002). While this narrative resonates with certain political constituencies, it often obscures the complex drivers of migration and may generate policies that increase rather than decrease security risks.

Alternative narratives reveal different security dimensions. The "adaptation" narrative views migration as a natural human response to changing conditions, suggesting security strategies focused on managing flows rather than preventing them (Tacoli, 2009). The "contribution" narrative emphasizes migrants as economic and social assets, pointing toward integration-focused security approaches (Castles, 2004). The "protection" narrative centers the rights and vulnerabilities of migrants themselves, highlighting how insecurity experienced by mobile populations can generate broader security challenges (Williams, 2015).

Narrative intelligence reveals how migration security challenges often stem from mismatches between policy narratives and lived realities. When official stories about migration conflict with community experiences or migrant testimonies, this narrative dissonance can undermine trust, generate grievances, and create conditions for instability (Squire, 2009).

European Migration Policy Through a Narrative Intelligence Lens

The European Union's approach to migration and security policy provides a compelling case study in how narrative intelligence shapes institutional responses to complex challenges. The dominant European narrative of migration has oscillated between humanitarian obligation and security threat, with profound implications for policy development and implementation (Geddes & Scholten, 2016). Following the 2015 migration crisis, European policymakers increasingly adopted securitized narratives that framed migration as an existential threat to European values, social cohesion, and border integrity (Lazaridis & Wadia, 2015). This "fortress Europe" narrative justified the externalization of border controls, the establishment of hotspots, and partnerships with origin and transit countries designed to prevent migration before it reaches European soil (Carrera et al., 2019).

However, alternative narratives emphasizing European values of solidarity, human rights, and international responsibility have created ongoing tensions within EU institutions and between member states. The narrative contestation is evident in the persistent failures to achieve comprehensive migration reform, as different member states operate from fundamentally different story frameworks about what migration means for European security and identity (Triandafyllidou, 2018). Understanding these competing narratives reveals why technical solutions to migration management consistently founder on political disagreements rooted in deeper stories about European identity, sovereignty, and security (Hampshire, 2013).

Terrorism and the Power of Narrative

Terrorism represents the security challenge most explicitly centered on narrative warfare. Terrorist organizations seek to achieve political objectives through the strategic use of violence to generate fear, provoke responses, and shape public discourse. Understanding terrorism requires recognizing it as fundamentally a communication strategy designed to amplify certain narratives while suppressing others (Nacos, 2016).

The "war on terror" narrative that emerged after September 11, 2001, demonstrates both the power and limitations of security narratives. This framework successfully mobilized resources and public

support for counterterrorism efforts, but it also shaped responses in ways that may have exacerbated some security challenges while creating new ones (Jackson, 2005).

Narrative intelligence suggests that effective counterterrorism requires understanding and countering the stories that terrorist organizations tell about themselves, their enemies, and their goals. This involves recognizing how terrorist narratives exploit existing grievances, identity conflicts, and perceived injustices (Hoffman, 2006). It also means understanding how counterterrorism measures themselves generate narratives that may support or undermine security objectives.

The rise of online radicalization has intensified the narrative dimensions of terrorism, creating new battlegrounds for competing stories about identity, belonging, and political action. Social media platforms have become key sites for narrative contestation, where terrorist organizations, governments, civil society groups, and ordinary citizens compete to frame events and shape understanding (Conway, 2017).

Interconnected Narratives and Security

Perhaps most importantly, narrative intelligence reveals how climate change, migration, and terrorism are interconnected through overlapping story structures and causal relationships. These connections are not merely analytical abstractions but are actively constructed through narratives that link different phenomena and suggest particular policy responses.

The narrative of "climate refugees" connects environmental change with migration, suggesting that climate impacts will generate large-scale population movements with security implications (Myers, 2002). While this story has helped raise awareness of climate-migration linkages, it may also oversimplify complex mobility decisions and contribute to securitized responses to environmental migration (Bettini, 2013).

Similarly, narratives linking migration with terrorism—whether through stories about foreign fighters, radicalization in migrant communities, or border security failures—shape security policies in ways that affect both counterterrorism and migration management (Ibrahim, 2005). These narrative connections may not reflect empirical relationships, but they influence policy choices with real security consequences.

Practical Applications for Security Analysis

Implementing narrative intelligence in security analysis requires systematic attention to story structures, narrative actors, and the strategic dimensions of storytelling. Security analysts can develop narrative mapping techniques that identify dominant stories about particular challenges, trace their sources and transmission pathways, and assess their influence on different audiences (Antoniades et al., 2010).

This approach involves analyzing not just what stories are being told, but who is telling them, through what channels, to which audiences, and with what effects. It requires understanding how narratives compete, combine, and evolve over time, and how they interact with events, policies, and other narratives (Miskimmon et al., 2013).

Narrative intelligence also suggests the importance of reflexivity in security analysis, recognizing how analysts' own narrative frameworks shape their understanding of security challenges. The stories

that security institutions tell about themselves, their missions, and their methods influence their capacity to understand and respond to complex challenges (Weldes et al., 1999).

Strategic Communication and Narrative Engagement

Beyond analysis, narrative intelligence offers tools for strategic engagement with security challenges. This involves developing communication strategies that work with rather than against dominant narrative currents, finding ways to connect security objectives with stories that resonate with key audiences.

For climate security, this might mean connecting climate action with narratives of resilience, innovation, and economic opportunity rather than relying solely on threat-based framings (O'Neill & Nicholson-Cole, 2009). For migration, it could involve developing stories that acknowledge legitimate concerns about change while highlighting successful integration and mutual benefit (Zapata-Barrero et al., 2017). For counterterrorism, it might mean crafting counter-narratives that address underlying grievances while delegitimizing violent methods (Braddock & Horgan, 2016)

Narrative Intelligence Research

Research Methods

This article uses a qualitative research methodology to draw on narrative intelligence from open source intelligence (OSINT) geographically referenced to the Sahel. Using the Seerist© risk intelligence platform, we reviewed news outlets and social media posts throughout the region to identify patterns of reporting related to migration associated with the countries in the Sahel and Europe. The intent of this search is to capture current narratives relative to migration from the Sahel to Europe and combine those narratives with other contemporary literature to reflect the current narrative pertaining to the subject migratory flow.

A keyword search within Seerist© was performed using Boolean search methods. The terms "Sahel", "climate", "migration", or "Europe" were referenced using an AND operator against the terms "Senegal", "Gambia", "Mauritania", "Guinea," "Mali", "Burkina Faso", "Niger," "Chad," "Cameroon," "Nigeria", "Sudan", and "South Sudan". One hundred fifty eight results were given, including some duplication across the searches. After a review of abstracts on Seerist©, the author supplemented these narratives with notable papers and relevant grey literature relevant to this topic

Research Results

As noted previously, the author conducted a Boolean search. Figure 1 reflects a screen capture from the Seerist© platform, providing a snapshot of the reporting relevant to migration from the Sahel to Europe. Note the report on the bottom left relative to migrant deaths off the Tripoli coast of Libya. Also note the stability scores in the center of the figure, reflecting a risk analysis of specific nations based on platform reporting.

Figure 2 provides a country specific report for the nation of Mali. Note the commentary on conflicts between the Malian Army and Isis. Also note the daily sentiment scale in the center at the bottom of the figure. This sentiment scale reflects the emotions in the various publications and social media included in the analysis.

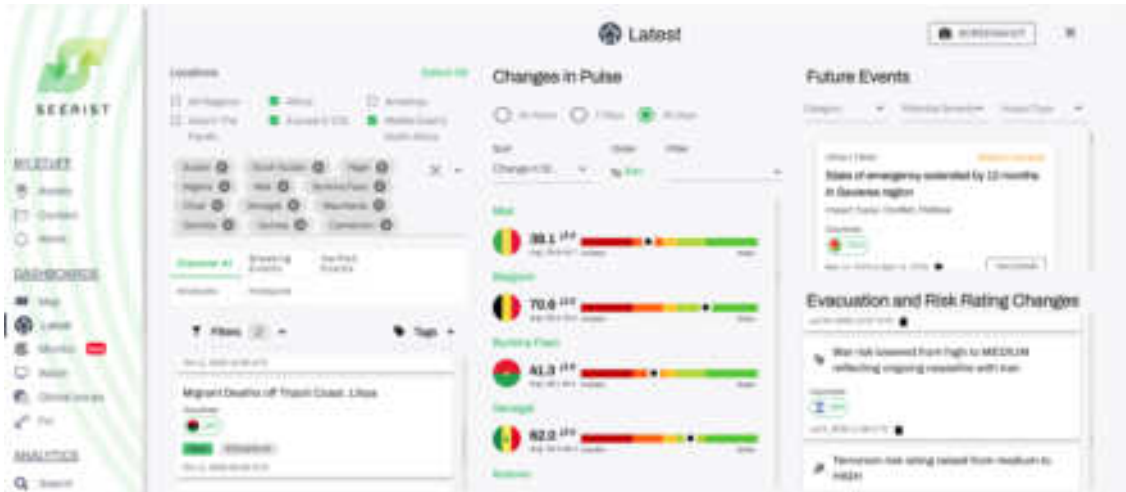


Figure 1 - Screen Capture Summarizing Reporting



Figure 2 - Mali Country Report

Reporting indicates that African migrants have become pawns in European countries' domestic political struggles, as center-right parties attempt to appease growing anti-migrant sentiment by adopting the rhetoric and policies of national-conservative and even far-right parties. Six EU member states currently have far-right leaders at their helm: Italy, Finland, Hungary, Slovakia, Croatia, and the Czech Republic Zarhloule, Y. (2025). National, xenophobic rhetoric is no longer contained to the fringes of the political spectrum across the European Union, with anti-immigrant sentiment today featuring dominantly in public debates after years of far-right populists amplifying cultural anxieties and accusing governments of having lost control of their sovereign borders (Varma, T., 2024).

The European Union has responded to unwanted arrivals with ever-stricter security measures, an approach that has both led to increased human rights violations and failed to stem the migratory tide. Framing migrants as a threat to national security or, worse yet, a country's national identity legitimizes violence against them and enables their exploitation, with the securitization of migration and its subsequent externalization to "partner" countries fueling this phenomenon (Zarhloule, Y., 2025). Despite criticism from human rights organizations denouncing systemic abuse against those trying to

cross the border, as well as the high costs and uncertain success of such policies, relocating migration control is still presented by the European Commission as the most effective method for managing migration flows European externalization and security outsourcing in North Africa (Pacciardi, A., n.d.)

European nations understand that climate change significantly impacts migration patterns, particularly in the Sahel Zone, West Africa, and the Maghreb, necessitating urgent policy responses. Climate change is not a future problem; it is currently affecting millions in the Sahel, Maghreb, and West Africa. The Sahel region's population relies heavily on climate-sensitive activities, making them particularly vulnerable to climate variations. The UNHCR estimates 1.2 billion people are at risk of climate-related displacement. Migration is often a last resort after other adaptation strategies fail.

The European Institute of the Mediterranean (IEMed) estimates that up to 13 million people in North Africa may be displaced by 2050, accounting for 6% of the population. In the Sahel and West Africa, projections suggest 86 million people could be forced to move within national borders by 2050. Climate-related environmental stressors are already the leading cause of internal displacement globally. Climate change is increasingly recognized as a significant driver of human displacement, particularly in vulnerable regions like North Africa and the Sahel (Bassou, A. 2019).

The European Union also understands that Russian hybrid warfare in the Sahel is also driving migration (Faleg 2022). Foreign information manipulation and interference (FIMI), a form of narrative intelligence, has significantly impacted the nations of the Sahel (Terren 2025). FIMI is a key tool in Russia's prosecution of hybrid warfare around the world, but especially in sub-Saharan Africa. Russian use of FIMI is of particular concern in Burkina Faso and Mali (Duarte 2024; Benkler, 2022).

Summary of Findings

The narrative reporting reveals a stark paradox: European governments acknowledge climate change and terrorism as drivers of African migration yet respond primarily with containment, externalization, and anti-immigrant politics rather than addressing root causes. The EU's strategy of outsourcing border control to often-authoritarian African governments has been widely criticized for human rights abuses, lack of accountability, and failure to provide sustainable solutions, while failing to address the fundamental drivers of migration including climate change, conflict, and economic inequality. This is particularly acute along the Atlantic route which is a longer voyage to Europe, fraught with danger.

Conclusion

The literature reviewed demonstrates that climate change, migration, and terrorism in the Sahel are interconnected phenomena with significant implications for regional and international security. While the relationships between these variables are complex and context-dependent, the evidence suggests that climate change acts as a "threat multiplier" that exacerbates existing vulnerabilities and creates new security challenges.

Climate change, migration, and terrorism represent security challenges that cannot be fully understood through traditional analytical frameworks focused on capabilities, intentions, and material factors. These challenges are fundamentally shaped by the stories that give them meaning and drive responses to them.

Narrative intelligence offers a framework for understanding how these challenges are constructed, communicated, and contested through storytelling. It reveals the interconnections between different security phenomena and suggests strategies for more effective analysis and response.

The application of narrative intelligence to security challenges requires developing new analytical skills, institutional capabilities, and strategic approaches. It demands attention to the temporal dimensions of storytelling, the multiplicity of narrative frameworks, and the reflexive dimensions of security analysis itself.

The implications for Europe, while not extensively detailed in the current literature, appear significant through both migration and security pathways. Climate-induced instability in the Sahel contributes to broader migration pressures and creates ungoverned spaces that can be exploited by extremist groups with international connections. Continued migration will inevitably provide pressure along the Atlantic coast of Africa, the Canary Islands, and the Iberian peninsula.

European migration and security policy perspectives, contemporary theoretical frameworks like Sherri Goodman's threat multiplier concept, and international migration governance developments reveal the increasingly global nature of climate security challenges. The EU's evolving migration policies, counter-terrorism strategies, and climate adaptation financing mechanisms represent attempts to address these interconnected challenges, though significant gaps remain in policy coordination and implementation.

Most importantly, narrative intelligence suggests that effective security strategies must engage with the fundamental human capacity for storytelling. Rather than viewing narratives as obstacles to rational analysis, this approach recognizes stories as essential tools for understanding complex challenges and building collective responses to them. In an era of interconnected, rapidly evolving security challenges, the ability to understand and strategically employ narrative intelligence may be essential for effective security governance.

Future research should focus on developing more sophisticated understanding of the causal mechanisms linking climate change to migration and terrorism, while paying greater attention to the regional and international dimensions of these relationships. Policy responses must adopt integrated approaches that address environmental, social, and security challenges simultaneously, recognizing that climate change in the Sahel requires coordinated international action.

The scholarly consensus emerging from this expanded literature suggests that addressing climate change in the Sahel is not merely an environmental imperative but a crucial component of regional and international security strategy. As climate change continues to intensify, understanding and addressing its security implications in vulnerable regions like the Sahel will become increasingly important for policymakers in Europe and beyond. The development of international frameworks like the Global Compact for Migration represents progress in recognizing climate displacement, but implementation challenges and political resistance highlight the ongoing difficulties in developing effective multilateral responses to climate-induced migration and security challenges.

References

- Abel, G. J., Brottrager, M., Crespo Cuaresma, J., & Muttarak, R. (2019). Climate, conflict and forced migration. *Global Environmental Change*, 54, 239-249. <https://doi.org/10.1016/j.gloenvcha.2018.12.003>
- Adger, W. N., Barnett, J., Brown, K., Marshall, N., & O'Brien, K. (2014). Human security and the well-being of people. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate change 2014: Impacts, adaptation, and vulnerability* (pp. 755-791). Cambridge University Press.
- Alessandrini, A., et al. (2021). Population dynamics, climate change and variability in Western Africa: the case of Sahel regions. European Commission, Joint Research Centre.
- Antoniades, A., Miskimmon, A., & O'Loughlin, B. (2010). Great power politics and strategic narratives. *The Centre for Global Political Economy Working Paper*, 7, 1-32.
- Aragall, X., Ouassif, A., Ferro, A., Ibáñez, M. (2021). Climate change and migration: Understanding factors, developing opportunities in the Sahel Zone, West Africa and the Maghreb. European Institute of the Mediterranean.
- Baldwin, A. (2013). Racialisation and the figure of the climate-change migrant. *Environment and Planning A*, 45(6), 1474-1490. <https://doi.org/10.1068/a45388>
- Bassou, A., Chmielewska, A., Ruiz-Campillo, X. (2019). *Climate security in the Sahel and the Mediterranean: Local and regional responses*. <https://www.iemed.org/publication/climate-security-in-the-sahel-and-the-mediterranean-local-and-regional-responses/>
- Benkler, M., Hansen, A. S., Reichert, L. (2022). *Protecting the truth: Peace operations and disinformation*. Center for International Peace Operations.
- Bettini, G. (2013). Climate barbarians at the gate? A critique of apocalyptic narratives on 'climate refugees'. *Geoforum*, 45, 63-72. <https://doi.org/10.1016/j.geoforum.2012.09.009>
- Bettini, G., Nash, S. L., & Whitfield, G. (2017). Relational climate politics: The European Union and the climate-migration nexus. In *Climate diplomacy* (pp. 219-235). Springer.
- Bigo, D. (2002). Security and immigration: Toward a critique of the governmentality of unease. *Alternatives*, 27(1), 63-92.
- Boas, I. (2015). Climate migration and security: Securitisation as a strategy in climate change politics. Routledge.
- Bourbeau, P. (2015). Migration, resilience and security: Responses to new inflows of asylum seekers and migrants. *Journal of Ethnic and Migration Studies*, 41(12), 1958-1977. <https://doi.org/10.1080/1369183X.2015.1047331>
- Braddock, K., & Horgan, J. (2016). Towards a guide for constructing and disseminating counternarratives to reduce support for terrorism. *Studies in Conflict & Terrorism*, 39(5), 381-404.

- Brown, K., & Westaway, E. (2011). Agency, capacity, and resilience to environmental change: Lessons from human development, well-being, and disasters. *Annual Review of Environment and Resources*, 36, 321-342. <https://doi.org/10.1146/annurev-environ-052610-092905>
- Bruner, J. (2004). Life as narrative. *Social Research*, 71(3), 691-710.
- Brzoska, M., & Fröhlich, C. (2016). Climate change, migration and violent conflict: Vulnerabilities, pathways and adaptation strategies. *Migration and Development*, 5(2), 190-210. <https://doi.org/10.1080/21632324.2015.1022973>
- Buhaug, H. (2015). Climate--conflict research: Some reflections on the way forward. *WIREs Climate Change*, 6(3), 269-275. <https://doi.org/10.1002/wcc.336>
- Burke, M., Hsiang, S. M., & Miguel, E. (2015). Global non-linear effect of temperature on economic production. *Nature*, 527(7577), 235-239. <https://doi.org/10.1038/nature15725>
- Busby, J. (2016). After Paris: How to make progress on climate and security. *Council on Foreign Relations Policy Brief*.
- Carius, A. (2009). Climate change and security in Africa: Challenges and international policy context. In *Climate change and security in Africa* (pp. 25-44). Nordic Africa Institute.
- Carrera, S., Luk, N. C., Allsopp, J., & Vosiylütë, L. (2019). The external dimensions of EU migration and asylum policies in times of crisis. In *Constructing and negotiating migration and asylum in Europe* (pp. 58-84). Springer.
- Castles, S. (2004). Why migration policies fail. *Ethnic and Racial Studies*, 27(2), 205-227.
- Center for Climate and Security. (2023). Climate change as a "threat multiplier": History, uses and future of the concept. <https://climateandsecurity.org/2023/01/briefer-climate-change-as-a-threat-multiplier-history-uses-and-future-of-the-concept/>
- Center for Strategic and International Studies. (2025). Peril in the desert: Irregular migration through the Sahel. <https://www.csis.org/analysis/peril-desert-irregular-migration-through-sahel>
- CNA Corporation. (2007). National security and the threat of climate change. CNA Corporation.
- CNA Military Advisory Board. (2014). National security and the accelerating risks of climate change. CNA Corporation.
- Conway, M. (2017). Determining the role of the internet in violent extremism and terrorism: Six suggestions for progressing research. *Studies in Conflict & Terrorism*, 40(1), 77-98.
- Detges, A. (2016). Local conditions of drought-related violence in sub-Saharan Africa: The role of road and water infrastructures. *Journal of Peace Research*, 53(5), 696-710. <https://doi.org/10.1177/0022343316651922>
- Dieng, A. (2021). The Sahel: Challenges and opportunities. *International Review of the Red Cross*, 103(918), 765-779. <https://doi.org/10.1017/S1816383122000339>
- Duarte, F.P. (2024). Information Disorder and Civil Unrest Russian Weaponization of Social Media Platforms in Mali and Burkina Faso – 2020–2022. *African Security* (17)(1-2)

- Eboreime, E., Anjorin, O., Obi-Jeff, C., Ojo, T., & Hertelendy, A. (2025). Climate, conflict and displacement in the Sahel. *Bulletin of the World Health Organization*, 103(4), 230-230. <https://doi.org/10.2471/BLT.24.292700>
- Eboreime, E., Anjorin, O., Obi-Jeff, C., Ojo, T. M., & Hertelendy, A. (2025). From drought to displacement: Assessing the impacts of climate change on conflict and forced migration in West Africa's Sahel region. *The Journal of Climate Change and Health*, 23, 100448. <https://doi.org/10.1016/j.joclim.2025.100448>
- European Council for Foreign Relations. (2020). Climate-driven migration in Africa. https://ecfr.eu/article/commentary_climate_driven_migration_in_africa/
- European Council. (2018). European Council conclusions on migration, security and defence. <https://www.consilium.europa.eu/en/policies/eu-africa/>
- European External Action Service. (2025). Migration & forced displacement. https://www.eeas.europa.eu/eeas/migration-forced-displacement_en
- European Parliament. (2020). Report on EU-African security cooperation in the Sahel region, West Africa and the Horn of Africa (2020/2002(INI)). https://www.europarl.europa.eu/doceo/document/A-9-2020-0129_EN.html
- European Parliament. (2021). Parliamentary question on climate change mitigation policies creating a breeding ground for terrorism (E-004838/2021). https://www.europarl.europa.eu/doceo/document/E-9-2021-004838_EN.html
- European Union Institute for Security Studies. (2020). Sahel climate conflicts? When (fighting) climate change fuels terrorism. <https://www.iss.europa.eu/content/sahel-climate-conflicts-when-fighting-climate-change-fuels-terrorism>
- Faleg, G. and Kovalčíková, N. (2022). *Rising Hybrid Threats in Africa: Challenges and implications for the EU*. European Union Institute for Security Studies.
- Farbotko, C., & McMichael, C. (2019). Voluntary immobility: Indigenous voices in the Pacific. *Forced Migration Review*, 61, 81-83.
- Forced Migration Review. (2025). Conflict, climate change and the shrinking mobility space in the Central Sahel. <https://www.fmreview.org/climate-crisis/morello-rizk/>
- Frontex (2023). Record arrivals on Western African route in October. <https://www.frontex.europa.eu/media-centre/news/news-release/record-arrivals-on-western-african-route-in-october-uNCHfO>
- Geddes, A., & Scholten, P. (2016). *The politics of migration and immigration in Europe* (2nd ed.). SAGE Publications.
- Gemenne, F., Barnett, J., Adger, W. N., & Dabelko, G. D. (2014). Climate and security: Evidence, emerging risks, and a new agenda. *Climatic Change*, 123(1), 1-9. <https://doi.org/10.1007/s10584-014-1074-7>
- Goodman, S. (2024). Threat multiplier: Climate, military leadership, and the fight for global security. Island Press.

- Hampshire, J. (2013). *The politics of immigration: Contradictions of the liberal state*. Polity Press.
- Hartmann, B. (2010). Rethinking climate refugees and climate conflict: Rhetoric, reality and the politics of policy discourse. *Journal of International Development*, 22(2), 233-246. <https://doi.org/10.1002/jid.1676>
- Hoffman, B. (2006). *Inside terrorism* (Rev. ed.). Columbia University Press.
- Hulme, M. (2009). *Why we disagree about climate change: Understanding controversy, inaction and opportunity*. Cambridge University Press.
- Hunter, L. M., Luna, J. K., & Norton, R. M. (2015). Environmental dimensions of migration. *Annual Review of Sociology*, 41, 377-397. <https://doi.org/10.1146/annurev-soc-073014-112223>
- Huysmans, J. (2000). The European Union and the securitization of migration. *Journal of Common Market Studies*, 38(5), 751-777.
- Ibrahim, M. (2005). The securitization of migration: A racial discourse. *International Migration*, 43(5), 163-187.
- Ide, T. (2018). Climate war in the Middle East? Drought, the Syrian civil war and the state of climate-conflict research. *Current Climate Change Reports*, 4(4), 347-354. <https://doi.org/10.1007/s40641-018-0115-0>
- Institute for Security Studies. (2024). Does climate change fuel terrorism in the Sahel? <https://issafrica.org/iss-today/does-climate-change-fuel-terrorism-in-the-sahel>
- International Organization for Migration. (2018). Global compact for safe, orderly and regular migration. <https://www.iom.int/global-compact-migration>
- International Organization for Migration. (2021). COP26 event: West Africa and the Sahel: Migration and displacement in the era of climate emergency. <https://environmentalmigration.iom.int/stories/cop26-event-west-africa-and-sahel-migration-and-displacement-era-climate-emergency>
- International Organization for Migration. (2023). Irregular Migration Routes to Europe: Western Africa – Atlantic Route. https://reliefweb.int/attachments/630b3920-876b-4dce-a48d-0d9686fc148a/2023.09%20-%20ENG%20-%20IOM%20-%20Flow%20From%20Western%20A_0.pdf
- Jackson, R. (2005). *Writing the war on terrorism: Language, politics and counter-terrorism*. Manchester University Press.
- Kassa, S. (2023). "Climate change as a threat multiplier": Security and communal implications for Iraq. *Community Change*, 4(2). <https://doi.org/10.21061/cc.v4i2.a.41>
- Knowledge for Policy (European Commission). (n.d.). Climate change induced migration (CLICIM). https://knowledge4policy.ec.europa.eu/migration-demography/climate-change-induced-migration-clicim-project_en
- Knowledge for Policy (European Commission). (n.d.). Population exposure and migrations linked to climate change in Africa. https://knowledge4policy.ec.europa.eu/publication/population-exposure-migrations-linked-climate-change-africa-0_en

- Koubi, V., Spilker, G., Böhmelt, T., & Bernauer, T. (2018). Do natural resources matter for interstate and intrastate armed conflict? *Journal of Peace Research*, 51(2), 227-243. <https://doi.org/10.1177/0022343313493455>
- Larémont, R. R. (2021). Climate change and conflict in the Western Sahel. *African Studies Review*, 64(4), 748-759. <https://doi.org/10.1017/asr.2021.114>
- Lazaridis, G., & Campani, G. (Eds.). (2017). Understanding the populist shift: Othering in a Europe in crisis. Routledge.
- Lazaridis, G., & Wadia, K. (Eds.). (2015). *The securitisation of migration in the EU: Debates since 9/11*. Palgrave Macmillan.
- Malet, D., & Hayes, M. (2021). Foreign fighter mobilization and persistence in a complex conflict: How ISIS survived the loss of territorial control. *Terrorism and Political Violence*, 33(1), 1-23. <https://doi.org/10.1080/09546553.2018.1518777>
- Mattern, J. B. (2005). Ordering international politics: Identity, crisis, and representational force. Routledge.
- McMichael, C., Barnett, J., & McMichael, A. J. (2012). An ill wind? Climate change, migration, and health. *Environmental Health Perspectives*, 120(5), 646-654. <https://doi.org/10.1289/ehp.1104375>
- Methmann, C., & Oels, A. (2015). From 'fearing' to 'empowering' climate refugees: Governing climate-induced migration in the name of resilience. *Security Dialogue*, 46(1), 51-68. <https://doi.org/10.1177/0967010614552548>
- Miskimmon, A., O'Loughlin, B., & Roselle, L. (2013). *Strategic narratives: Communication power and the new world order*. Routledge.
- Mortreux, C., & Barnett, J. (2017). Adaptive capacity: exploring the research frontier. *Wiley Interdisciplinary Reviews: Climate Change*, 8(4), e467. <https://doi.org/10.1002/wcc.467>
- Myers, N. (2002). Environmental refugees: A growing phenomenon of the 21st century. *Philosophical Transactions of the Royal Society B*, 357(1420), 609-613.
- Nacos, B. L. (2016). Mass-mediated terrorism: Mainstream and digital media in terrorism and counterterrorism (3rd ed.). Rowman & Littlefield.
- Nash, S. L. (2018). From borderlands to borderlines: Bordering practices in the UK Climate Change Risk Assessment. *Environment and Planning C: Politics and Space*, 36(7), 1235-1251. <https://doi.org/10.1177/2399654418767018>
- Naz, U., & Saleem, M. S. (2024). Climate-induced vulnerabilities: Conflict and migration patterns in the Sahel region of Africa. 8(2).
- Nelson, D. R., Adger, W. N., & Brown, K. (2007). Adaptation to environmental change: Contributions of a resilience framework. *Annual Review of Environment and Resources*, 32, 395-419.
- New Security Beat. (2020). It's time we think beyond "threat multiplier" to address climate and security. <https://www.newsecuritybeat.org/2020/01/its-time-threat-multiplier-address-climate-security/>

- O'Brien, K., & Barnett, J. (2013). Global environmental change and human security. *Annual Review of Environment and Resources*, 38, 373-400. <https://doi.org/10.1146/annurev-environ-032112-095830>
- O'Brien, K., Kristoffersen, B., Self, S., Hayward, B., Maxwell, J., & Sygna, L. (2018). *Climate change as a threat multiplier for human disaster and conflict*. Peace Research Institute Oslo.
- Oels, A. (2012). From 'securitization' of climate change to 'climatization' of the security field: Comparing three theoretical perspectives. In J. Scheffran, M. Brzoska, H. G. Brauch, P. M. Link, & J. Schilling (Eds.), *Climate change, human security and violent conflict* (pp. 185-205). Springer.
- Office of the High Commissioner for Human Rights. (2018). Global Compact for Safe, Orderly and Regular Migration (GCM). <https://www.ohchr.org/en/migration/global-compact-safe-orderly-and-regular-migration-gcm>
- O'Neill, S., & Nicholson-Cole, S. (2009). "Fear won't do it": Promoting positive engagement with climate change through visual and iconic representations. *Science Communication*, 30(3), 355-379.
- Overseas Development Institute. (2023). Changing climate, changing realities: migration in the Sahel. <https://odi.org/en/publications/changing-climate-changing-realities-migration-in-the-sahel/>
- Oxford Academic. (2024). Making a world of climate insecurity: The threat multiplier frame and the US national security community. *Global Studies Quarterly*, 4(4). <https://doi.org/10.1093/isagsq/ksae085>
- Pacciardi, A. and Berndtsson, J. (n.d.). European externalization and security outsourcing in North Africa. Externalizing Asylum. <https://externalizingasylum.info/european-externalization-and-security-outsourcing-in-north-africa/>
- PBS News. (2023). How climate change is contributing to migration out of North Africa. <https://www.pbs.org/newshour/world/how-climate-change-is-contributing-to-migration-out-of-north-africa>
- Pelling, M., & High, C. (2013). Understanding adaptation: What can social capital offer assessments of adaptive capacity? *Global Environmental Change*, 23(1), 308-318. <https://doi.org/10.1016/j.gloenvcha.2012.07.001>
- Policy Center for the New South. (2024). The migration dilemma: Europe and Africa's new compact—A realist pathway beyond fortress Europe. <https://www.policycenter.ma/publications/migration-dilemma-europe-and-africas-new-compact-realist>
- Raineri, L. (n.d.). When (fighting) climate change fuels terrorism.
- Reyer, C. P., Otto, I. M., Adams, S., Albrecht, T., Baarsch, F., Carlsburg, M., ... & Schleussner, C. F. (2017). Climate change impacts in Latin America and the Caribbean and their implications for development. *Regional Environmental Change*, 17(6), 1601-1621. <https://doi.org/10.1007/s10113-015-0854-6>
- Rüttinger, L., Smith, D., Stang, G., Tänzler, D., & Vivekananda, J. (2015). *A new climate for peace: Taking action on climate and fragility risks*. Adelphi.

- Sakellariou, A. (2017). Fear of small numbers? The security discourse on climate-induced migration in the EU policy arena. *European Security*, 26(2), 145-164. <https://doi.org/10.1080/09662839.2016.1238050>
- Sartori, N., & Fattibene, D. (n.d.). Human security and climate change: Vulnerabilities in the Sahel.
- Scheffran, J., Brzoska, M., Kominek, J., Link, P. M., & Schilling, J. (2012). Climate change and violent conflict. *Science*, 336(6083), 869-871. <https://doi.org/10.1126/science.1221339>
- Schleussner, C. F., Donges, J. F., Donner, R. V., & Schellnhuber, H. J. (2016). Armed-conflict risks enhanced by climate-related disasters in ethnically fractionalized countries. *Proceedings of the National Academy of Sciences*, 113(33), 9216-9221. <https://doi.org/10.1073/pnas.1601611113>
- Security Council Report. (2024). Group of Five for the Sahel Joint Force, May 2024 Monthly Forecast. <https://www.securitycouncilreport.org/monthly-forecast/2024-05/group-of-five-for-the-sahel-joint-force-9.php>
- Singer, L. (n.d.). Climate-induced migration: A threat to peace and security?
- Smith, A. B., & Jones, C. D. (2020). Environmental narratives and extremist recruitment in the Sahel. *Journal of Terrorism Studies*, 15(2), 45-67.
- Squire, V. (2009). *The exclusionary politics of asylum*. Palgrave Macmillan.
- Tacoli, C. (2009). Crisis or adaptation? Migration and climate change in a context of high mobility. *Environment and Urbanization*, 21(2), 513-525.
- Terren, L., Van Aelst, P., and Van Damme, T. (2025). The Last Line of Defence: Measuring resilience to foreign information manipulation and interference in West Africa. European Union Institute for Security Studies.
- Tesfaye, B. (n.d.). Climate change and conflict in the Sahel.
- The New Humanitarian. (2018). Briefing: The new global migration pact. <https://www.thenewhumanitarian.org/analysis/2018/12/12/briefing-new-global-migration-pact>
- The Tony Blair Institute for Global Change. (2024). From crisis to conflict: Climate change and violent extremism in the Sahel. <https://institute.global/insights/geopolitics-and-security/from-crisis-to-conflict-climate-change-and-violent-extremism-in-the-sahel>
- Torres, J. M., & Bergmann, J. (2019). Climate migration narratives and European solidarity: A discourse analysis of policy documents. *Migration Studies*, 7(3), 367-387. <https://doi.org/10.1093/migration/mny015>
- Torres, J. M., & Casey, J. A. (2017). The centrality of social ties to climate migration and mental health. *BMC Public Health*, 17(1), 600. <https://doi.org/10.1186/s12889-017-4508-0>
- Triandafyllidou, A. (2018). *Handbook of migration and globalisation*. Edward Elgar Publishing.
- United Nations. (2018). Global compact for migration. <https://refugeesmigrants.un.org/migration-compact>

- United Nations. (2022). Countering terrorism in Africa requires preventive approach including respect for human rights, law. <https://press.un.org/en/2022/sc15102.doc.htm>
- United Nations. (2024). Lack of coordinated regional responses in West Africa 'increases risk of further terrorist expansion in Central Sahel region', delegate tells Security Council. <https://press.un.org/en/2024/sc15764.doc.htm>
- United Nations. (2025). Efforts to address root causes of conflict, mitigate impact of climate change in West Africa, Sahel must be supported. <https://press.un.org/en/2025/sc16036.doc.htm>
- Van Ackern, P., & Detges, A. (n.d.). Climate change, vulnerability and security in the Sahel.
- Varma, T. and Roehse, S. (2024). *Understanding Europe's Turn on Migration*. Brookings Institution Press.
- Veron, P. (2010). Occidentalism as counter-hegemonic discourse: The case of post-apartheid South Africa. In *Occidentalisms in the Arab world* (pp. 165-187). I.B. Tauris.
- Vigil, S. (n.d.). Climate change and migration: Insights from the Sahel.
- Weldes, J., Laffey, M., Gusterson, H., & Duvall, R. (Eds.). (1999). *Cultures of insecurity: States, communities, and the production of danger*. University of Minnesota Press.
- Werrell, C. E., & Femia, F. (2018). Epicenters of climate and security: The new geostrategic landscape of the Anthropocene. Center for Climate and Security.
- Williams, J. M. (2015). From humanitarian exceptionalism to contingent care: Care ethics, cosmopolitan justice, and the politics of asylum. *American Political Science Review*, 109(4), 714-730.
- Williams, W. (2025). *African Migration Trends to Watch in 2025*. Africa Center for Strategic Studies. <https://africacenter.org/spotlight/migration-trends-2025/>
- Wilson Center. (2024). Threat multiplier: Climate change and national security. <https://www.wilsoncenter.org/video/threat-multiplier-climate-change-and-national-security>
- Wunderlich, D. (2012). Europeanization through the grapevine: Communication gaps and the role of international organizations in implementation networks of EU external migration policy. *Journal of European Integration*, 34(5), 485-503. <https://doi.org/10.1080/07036337.2011.611679>
- Zapata-Barrero, R., Caponio, T., & Scholten, P. (2017). Theorizing the 'local turn' in a multi-level governance framework of analysis: A case study in immigrant policies. *International Review of Administrative Sciences*, 83(2), 241-246.
- Zarhloule, Y. (2025). Migrants at the Gate: Europe Tries to Curb Undocumented Migration. *Carnegie Endowment for International Peace*. https://carnegie-production-assets.s3.amazonaws.com/static/files/Zarhloule_EU.pdf
- Zoubir, Y. H. (n.d.). Security challenges, migration, instability and violent extremism in the Sahel.

The Economic Impact of Climate Change on the Atlantic African Insular States: Cape Verde and São Tomé and Príncipe

Fahd Azaroual and Jamal Machrouh

Introduction

Climate change today represents one of the most critical challenges for Small Island Developing States (SIDS), particularly those of the Atlantic African region such as Cape Verde and São Tomé and Príncipe. Due to their geographical location, their dependence on fragile natural ecosystems, and their narrowly diversified economic structures, these two archipelagos find themselves on the front line of the physical, economic, and social impacts of climate disruption. Their vulnerability is exacerbated by intrinsic characteristics: limited natural resources, insularity marked by geographical isolation, and high exposure to external shocks.

These island territories are already experiencing tangible manifestations of climate change: sea-level rise, accelerated coastal erosion, worsening droughts, increased rainfall variability, ocean warming, and the growing frequency of extreme weather events. These physical disruptions undermine the foundations of their economic development, directly affecting key sectors such as tourism, fisheries, and agriculture. Yet these sectors, which are the main providers of employment and foreign exchange, are precisely the most sensitive to climate variability.

At the same time, environmental degradation is intensifying the dynamics of social and migratory precarity. Pressure on water resources, the loss of agricultural land, declining fishery yields, and damage to coastal infrastructure are exacerbating food insecurity, weakening rural incomes, and provoking both internal and external population displacements. The interaction between physical and socio-economic vulnerabilities thus tends to fuel a vicious cycle of poverty, rural exodus, and strains on health and education systems.

Moreover, the adaptive capacity of these two states remains constrained by structural factors: a high dependence on food and energy imports, elevated levels of public debt, limited budgetary resources, and a persistent reliance on external aid. Despite progress in developing national adaptation plans and initiatives aimed at building more resilient blue and green economies, financial, technical, and institutional means remain insufficient to address the magnitude of climatic and geophysical risks.

In this context, this chapter offers an in-depth analysis of the economic impact of climate change on Cape Verde and São Tomé and Príncipe. After examining the observed and projected physical impacts, it will highlight the socio-economic effects on key sectors, food security, poverty, and migration. The analysis will also focus on the limits of adaptation in these island states and will explore possible avenues for strengthening their resilience through integrated sustainable development policies, notably by leveraging regional and international cooperation.

Physical Impacts of Climate Change in Cape Verde and São Tomé and Príncipe

Cape Verde and São Tomé and Príncipe are island states particularly vulnerable to climate change due to their geographical position (transition between arid and humid zones) and their geography (volcanic islands with steep terrain and narrow coastlines) (Ministère des Ressources Naturelles et de l'Environnement, 2004; Monteiro et al., 2016). Recent observations and projections point to concrete

phenomena already detected: intensification of droughts, rising temperatures, decreasing rainfall and runoff, sea level rise, accelerated coastal erosion, soil degradation, and more frequent extreme weather events (Mycoo et al., 2022; Trisos et al., 2022). Each of these islands experiences these phenomena differently depending on its geographical, hydrological, and socio-economic specificities. The following paragraphs provide a detailed analysis of these dynamics within the respective contexts of Cape Verde and São Tomé and Príncipe.

Figure 1: Location of Cape Verde and São Tomé and Príncipe (Study Area)



Source: Author's elaboration

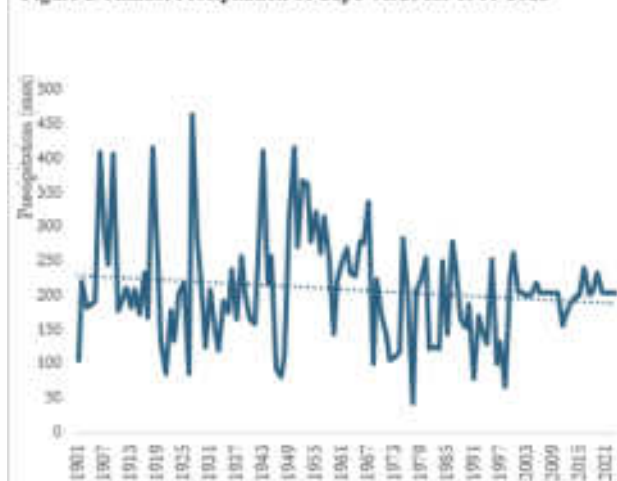
Drought

Both archipelagos experience recurrent droughts linked to rainfall variability. Cape Verde, located in the Sahelian zone, has very marked dry seasons and low average annual precipitation (around 250–350 mm). Drought episodes are cyclical; the country has endured several major historical droughts (for example, 1972–1977, 1984), resulting in documented famines and human losses (République du Cap-Vert, 1999; Monteiro et al., 2016). The current drought is particularly severe. According to the Cape Verdean government, the rainfall shortage since 2021 is "unprecedented compared to the critical situations of 1977 and 1947." In 2022, the largest dam (Poilão) dried up, and the FAO had to list Cape Verde among countries urgently requiring food aid (UNDP, 2022). A 2023 Afrobarometer survey confirms this experience: 80% of Cape Verdeans surveyed believe that droughts have become more severe over the past decade (Eduonoo, 2023). This perception is scientifically supported: climate models indicate a downward trend in average rainfall and an extension of dry seasons, which is linked to rising temperatures. For instance, a national study (Premier rapport national) indicates that under a "high sensitivity" scenario, the average annual temperature in São Tomé could rise by +2.84°C by 2100, along with a rainfall deficit of –830 mm/year (Ministère des Ressources Naturelles et de

l'Environnement, 2004). Similarly, the IPCC notes that climate change has increased the frequency and intensity of drought episodes in West Africa (Trisos et al., 2022).

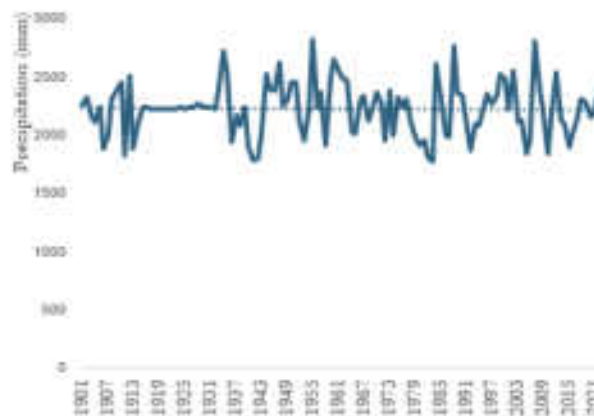
In practice, drought leads to the rapid depletion of surface water resources (reservoirs, dams) and vegetation degradation. In Cape Verde, farmers rely on limited rainwater reserves; once the rainy season ends, they must purchase water, often from desalination plants, which increases their production costs (FAO, 2024). High temperatures and chronic aridity favour soil desertification (wind and water erosion). São Tomé and Príncipe, although wetter (with an average of 900 mm/year), also experience significant seasonal droughts during the "Gravana" period (June–August) (World Bank). The extension of the dry season in both countries intensifies water stress on ecosystems and crops, jeopardizing local food security. Persistent severe droughts also weaken the economy; for example, the World Bank estimates that without adaptation measures, droughts and their effects could reduce Cape Verde's GDP by 3.6% by 2050.

Figure 2: Annual Precipitation of Cape Verde for 1901-2023



Source: World Bank, 2025

Figure 3: Annual Precipitation of São Tomé and Príncipe for 1901-2023



Source: World Bank, 2025

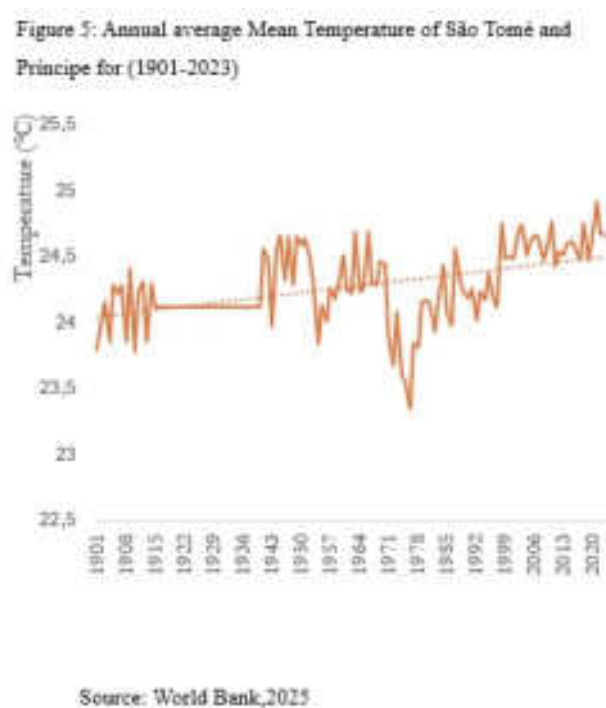
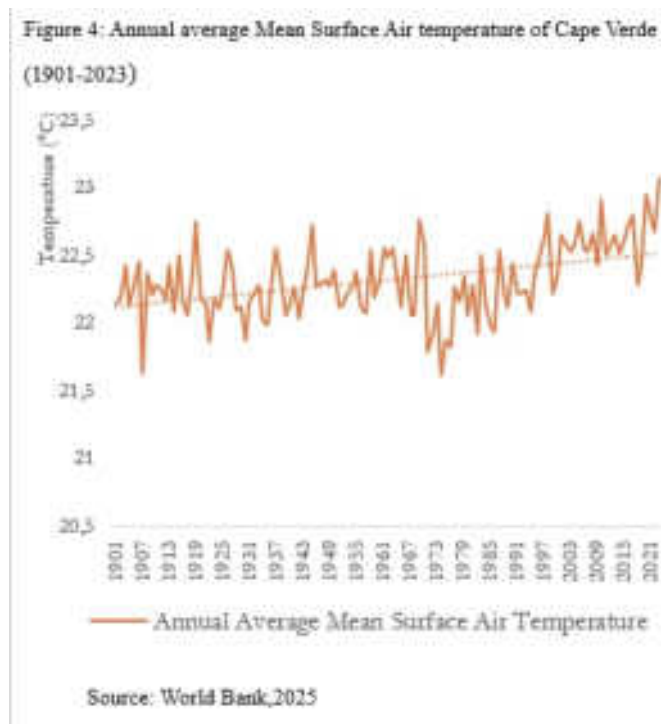
Rising Temperatures

Average temperatures are rising significantly across all African archipelagos. In Cape Verde, the trend is well-documented by both national and international meteorological services. The country's Sahelian climate is characterized by high annual temperatures (20–26°C depending on the islands), and recent years are among the hottest ever recorded. The national climate report highlights that current warming makes living conditions increasingly difficult. In São Tomé and Príncipe, average temperatures hover between 22–26°C, but a continuous rise has been observed since the 1970s (Ministère des Ressources Naturelles et de l'Environnement, 2004).

These trends are consistent with the broader pattern recognized by the IPCC: "average temperature increases have been detected throughout Africa, with several regions warming faster than the global average." (IPCC, AR6 WGI, Regional Fact Sheet – Africa, 2021, p. 1). The IPCC further notes that the frequency of heatwaves has already increased (very high confidence) and that current African

children will be exposed to four to ten times more heatwaves than in 1960 according to warming scenarios (Trisos et al., 2022). Although small Atlantic island states benefit from some maritime moderation, local studies still project significant temperature rises. São Tomé's national report (NDC) projects a temperature rise of +1.3 to +2.8°C by 2100, depending on the emission scenarios.

Rising temperatures exacerbate several physical processes: they increase evapotranspiration, intensify heat stress, and reduce water availability (greater soil and reservoir evaporation). They also increase the frequency of "hot days," affecting agricultural productivity and population well-being. Since the islands are small and heavily urbanized along their coasts (e.g., Praia, Mindelo, São Tomé city), even modest local thermal increases (urban heat island effect) can significantly amplify heatwave risks. The IPCC notes that with global warming, the duration and intensity of heatwaves across Africa will rise sharply (Trisos, 2022). In Cape Verde, this trend is evidenced by more frequent occurrences of extreme temperatures, with sensors regularly recording temperatures above 35–40°C during dry season peaks. Rising temperatures also contribute to the acidification and warming of coastal waters (affecting marine ecosystems) and, in São Tomé's case, diminishing algae growth and mangrove productivity.



Water Stress

Water stress—where water demand exceeds the available supply—is acute in Cape Verde and is increasing in São Tomé and Príncipe. Cape Verde is classified by the World Bank as a country facing absolute water scarcity (World Bank, 2025). Across the archipelago, only 50–70% of the population (mainly rural) has regular access to drinking water, and several islands import desalinated water for urban consumption. The World Bank highlights that climate change exacerbates water scarcity, as the country is experiencing longer and more intense droughts, while marine saline intrusion is degrading coastal aquifers, thereby reducing the availability of freshwater (World Bank, 2025). These phenomena particularly threaten the agricultural sector (the primary consumer of extracted water), leading to declining yields. The National Water Office reports structural deficits: reservoir and

groundwater recharge do not compensate for increased evaporation and withdrawals, resulting in recurrent seasonal water shortages during dry months.

In São Tomé and Príncipe, although the island is generally humid, water distribution is not uniform. The "Gravana" (dry season from June to August) puts pressure on supply, especially in elevated areas with poor water retention. National studies also highlight the influence of the "Gravanito" (shorter dry spells), which extend summer water shortages. The variability of the island climate leads to extreme fluctuations: years of abundance can be followed by several dry years. An IPCC analysis notes that tropical regions such as the Gulf of Guinea (near São Tomé) will experience extreme precipitation variability (–50% to +50%), with widespread multisectoral impacts (Trisos, 2022). Practically, the population of São Tomé has experienced occasional water shortages, sometimes requiring water rationing and rainwater harvesting.

This growing pressure translates into increasing stress on existing resources: falling groundwater levels, drying up of springs, water-use conflicts (agriculture vs. urbanization), and greater energy needs for pumping or desalination. Water stress also has cascading effects: it reduces agricultural production (unsatisfied irrigation needs), diminishes hydroelectric output (due to lower river flows), weakens sanitation systems, and can exacerbate social tensions. International indicators reflect this vulnerability: Cape Verde ranks among the countries least prepared to face climate shocks (76th out of 192 countries according to ND-GAIN) (Eduonoo, 2023), largely due to its critical water dependency.

Sea Level Rise

Sea level rise is one of the major threats facing these island states. It is a direct consequence of global warming (thermal expansion of oceans, melting of ice sheets) and has already been observed globally (+3.7 mm/year on average during the 20th century). For the Atlantic coasts of Africa, IPCC estimates suggest a relative rise of 0.3 to 1 meter by the end of the century, depending on the emissions scenario¹⁸. Sea level rise exacerbates several effects in Cape Verde and São Tomé and Príncipe:

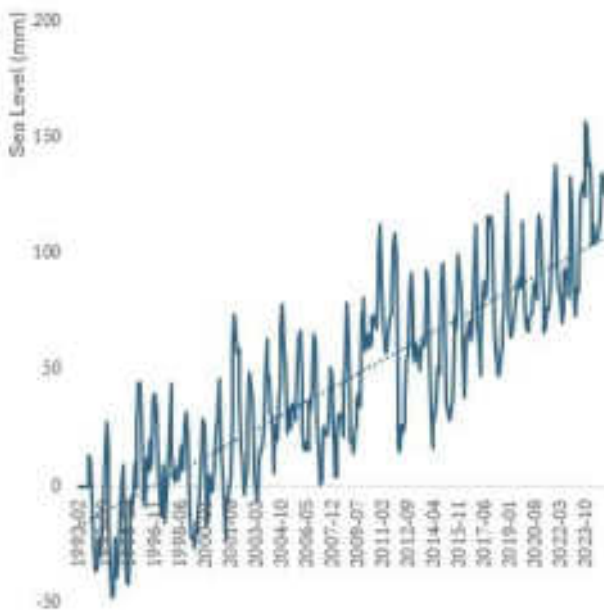
- **Coastal submersion and flooding:** Both archipelagos have low-lying coastal plains that are highly vulnerable. In Cape Verde, almost all cities (Praia, Mindelo, etc.) and infrastructures are located at low altitudes. A national study points out that even moderate sea level rise would flood a large share of socio-economic infrastructure and the rich coastal ecosystems (Ministère des Ressources Naturelles et de l'Environnement, 2004). The IPCC notes that small island states are already experiencing impacts linked to sea level rise. Each decade without adaptation measures sees progressive coastal erosion—some beaches in São Tomé have receded by several meters per year—threatening ports, homes, and mangroves.
- **Saline intrusion:** Rising marine water levels cause saltwater to infiltrate shallow soils and aquifers. This salinization affects drinking water quality and the fertility of coastal agricultural lands. In Cape Verde, hydrological services warn about declining water quality in coastal areas, necessitating deeper drilling or water treatment, which increases costs.
- **Accelerated coastal erosion:** The combination of rising waters, stronger wave events, and human pressures accelerates the erosion of beaches and coastal cliffs. As noted by the Green

¹⁸ Intergovernmental Panel on Climate Change (IPCC). Africa. In: Climate Change 2022 – Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press; 2023:1285-1456.

Climate Fund, "Cape Verde has already experienced extensive coastal erosion" (FAO, 2021). Similarly, São Tomé and Príncipe—volcanic islands with narrow sandy beaches—have recorded shoreline losses of about 5.2 meters per year in certain areas during the 1980–2000 period. Coastal ecosystems such as mangroves and coral reefs, which naturally buffered these impacts, are also under threat, further reducing coastal resilience.

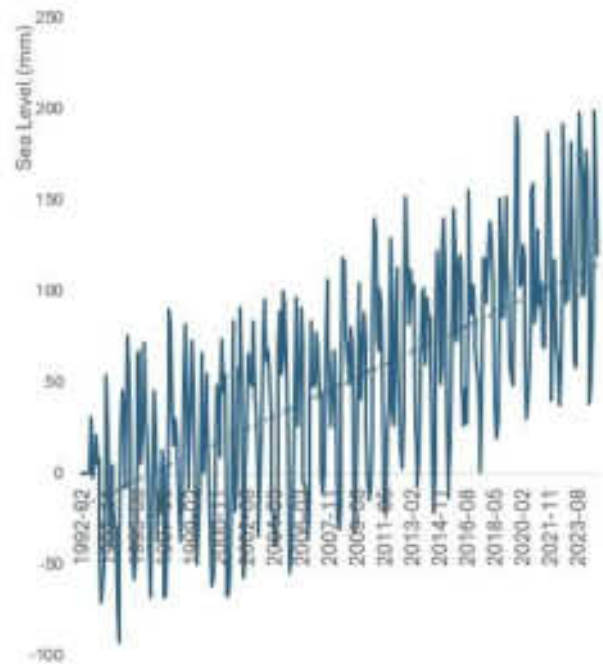
These combined impacts of sea level rise constitute a major challenge: they endanger beachfront tourist facilities, port infrastructures, housing, and cultivable coastal lands. According to a World Bank report, without adaptation measures, sea level rise could reduce Cape Verde's tourism revenues by approximately 10% (a pillar of the economy) and contribute to a 3.6% decrease in GDP by 2050 (World Bank, 2025). Similar assessments for São Tomé, given the concentration of populations and activities along the coasts, reveal comparable vulnerability (marine surges and flooding). In short, sea level rise intensifies coastal exposure to hazards: marine flooding, salinization, and erosion are jeopardizing the viability of inhabited and exploited coastal areas.

Figure 6: Total Sea level change by Month (1993-2024); Cape Verde Exclusive Economic Zone



Source: World Bank, 2025

Figure 7: Total Sea Level Change by Month (1993-2024); São Tomé and Príncipe Exclusive Economic Zone



Source: World Bank, 2025

Coastal Erosion

While sea level rise pushes the ocean further inland, other factors exacerbate coastal erosion in these archipelagos. Extreme weather events, particularly storms and occasional powerful cyclonic swells, batter the coasts and cause rapid shoreline retreat. In Cape Verde, beaches and river mouths ("ribeiras") are regularly eroded by heavy rains and secondary swells originating from distant tropical cyclones. São Tomé and Príncipe also experience Atlantic storms that sometimes strike the island—such as the December 2021 storm, which caused submersions and damages in the capital. These

events, combined with the slow rise in sea levels, produce a "coastal retreat" phenomenon, measured at several meters per year on some beaches.

Moreover, the overexploitation of construction materials (sand) and the loss of dune vegetation aggravate erosion. The natural coastal equilibrium is often disrupted by urbanization and port development. For example, on São Tomé Island, the deforestation of mangroves has weakened the southern coastline, leading to a retreat of more than 100 meters between 1980 and 2003 in some coastal areas (based on geotechnical measurements) (Ministère des Ressources Naturelles et de l'Environnement, 2004). In Cape Verde, coastal defense and reinforcement projects only cover a small fraction of the coastline, so many beaches shrink each year due to the combined effects of waves and tides.

In addition, the scientific community notes that coral reefs that once protected certain coastlines are weakened by ocean warming, thus reducing their wave-buffering capacity (Mycoo et al., 2022). Consequently, a widespread retreat of the coastline is observed across the Cape Verde archipelago and the islands of São Tomé. According to the Green Climate Fund, Cape Verde has already suffered extensive coastal erosion. This retreat directly threatens coastal fisheries (loss of spawning grounds), beach tourism (shrinking beaches), and the security of coastal infrastructure. Faced with this situation, both countries now consider coastal erosion a major risk to be addressed in spatial planning and climate change adaptation policies.

Soil Degradation

Soil degradation results from both climatic effects and local anthropogenic pressures. In Cape Verde, soil erosion is severe: the volcanic terrain and the absence of continuous vegetation cover facilitate surface runoff and the leaching of arable land during heavy rains (République du Cap-Vert, 1999). Poor rural areas, cleared for farming or livestock, also suffer from soil salinization (due to marine intrusion) and wind erosion (caused by dry Sahara winds). The national analysis notes that the scarcity and vulnerability of water resources—due to saline intrusion combined with low aquifer recharge—make Cape Verde one of the driest countries in the Sahelian region (République du Cap-Vert, 1999). In practice, this results in deteriorating soil fertility and progressive desertification: some abandoned lands become sterile, supporting only thorny plant cushions.

In São Tomé and Príncipe, the soil is naturally fertile (tropical ferrallitic soils under forest cover), but it is undergoing degradation due to several factors. Unsustainable exploitation of primary forests (for cocoa plantations and firewood) has weakened the root systems that stabilize hillside soils. Torrential rain runoff frequently causes landslides (especially on very steep slopes such as around Pico Cão Grande). Moreover, intensive plantation farming (cocoa, banana) on hillsides has led to localized topsoil erosion. Environmental experts warn that the "desertification process" could expand in some areas if the vegetation cover is not restored (Monteiro, 2016). Indeed, the IPCC highlights that in tropical ecosystems, rising temperatures and increased rainfall variability can accelerate soil degradation and reduce vegetative cover, ultimately affecting agricultural productivity (Trisos, 2022).

In short, in both Cape Verde and São Tomé and Príncipe, soil stability is undermined by worsening climatic conditions: the combination of heavy erosive rains and drought episodes leads to a loss of organic matter and the formation of gullies on slopes. Farmers have had to adapt with basic terracing, mulching, and the planting of windbreaks. Nevertheless, the national report stresses that irregular

rainfall variability causes significant soil losses during intense rain events (République du Cap-Vert, 1999), necessitating land management solutions to preserve the topsoil layer.

Extreme Events

Both countries are exposed to a range of extreme climatic events that tend to become more frequent or intense. The main extremes observed include flash floods, sudden storms, ocean swells, and, occasionally, rare hurricanes or tropical cyclones.

In Cape Verde, the rainy season (July–October) produces intense rainfall episodes each year. Torrential rains (sometimes 60–80% of annual precipitation concentrated in two or three downpours) regularly cause flash floods in rivers ("ribeiras") and mudslides. For example, national archives report deadly floods in 1938, 1950, 1961 (11 deaths), 1984 (48 deaths), 2009 (several deaths on São Nicolau), 2012 (bridge collapses on Boa Vista), and 2013 (several victims on Santiago and Boa Vista) (Monteiro, 2016). These episodes are amplified by the topography: short mountains channel water into narrow valleys where it rushes down violently. Each extreme event causes heavy damage: landslides on slopes, destruction of seasonal crops, damage to homes, and rural roads. The Afrobarometer report notes that 47% of Cape Verdeans surveyed believe that the severity of floods has increased since 2017 (Eduonoo, 2023), consistent with field observations (recent years having been marked by intensified rains).

São Tomé and Príncipe also experience violent rainfall episodes. The islands, influenced by the ITCZ (Intertropical Convergence Zone) and tropical waves, are particularly prone to "flash floods" at the end of the rainy season. In December 2021, a particularly violent low-pressure system caused torrential rains leading to major floods and landslides on the northern coast of São Tomé, forcing the government to declare a state of natural disaster. Such events expose densely populated coastal communities to heightened risks: flooded houses, cut-off roads, eroded riverbanks, and livestock losses. The local press also reports frequent cases of violent wind gusts ("ventos de monção") that damage tin roofs and uproot crops.

In terms of intensity, both countries can experience storm surges. In the Atlantic, tropical cyclones are rare at the latitudes of Cape Verde and São Tomé, but not impossible. The IPCC notes that globally, tropical cyclones will become less frequent but more intense (stronger winds and rainfall) in tropical regions with high temperatures, which could affect even these remote archipelagos. In practical terms, a cyclone striking Cape Verde or São Tomé would bring extreme rainfall and potentially destructive winds, even though the frequency remains low.

In summary, extreme events—whether climatic (rain-induced floods, sudden droughts, abnormal swells) or geophysical (rain-triggered landslides)—have already caused repeated local crises. They generate disproportionate human and economic losses for these developing countries. The projected rise in global temperatures and climatic variability suggests an increase in such events: more intense rains during the wet season, more severe off-season droughts, and potential concurrent marine storm surges with rising oceans.

Exposure to Geophysical Risks

Beyond climatic hazards, these two archipelagos, due to their geological origins, are also exposed to geophysical risks. The islands of Cape Verde and São Tomé and Príncipe are volcanic in origin, creating rugged topography and associated seismic and volcanic risks.

In Cape Verde, the entire archipelago is volcanic. Earthquakes are generally of low magnitude but are more frequent on certain islands (Brava, Fogo, Santo Antão). The main geophysical issue is volcanism: only the island of Fogo has an active volcano, with the 2014 eruption being the most recent among 26 recorded eruptions since the archipelago's discovery. Although recent eruptions have not caused human casualties, they have caused significant local destruction—for example, the village of Boca das Calderas was entirely buried, and fertile agricultural lands were lost. Moreover, the risk of volcanic flank collapse is real: geological studies have identified tsunami sediment deposits on Santiago's coast, evidencing a past flank collapse at Fogo that triggered giant waves reaching the main island. In other words, an underwater collapse or major eruption could trigger a tsunami affecting the entire archipelago. As a result, Cape Verdean authorities have invested in seismic and geodetic monitoring of Fogo and have developed volcanic risk management plans.

In São Tomé and Príncipe, the islands are also volcanic (the highest point, Pico de São Tomé, rises to 2024 meters), but no active volcano is currently known. However, the very steep terrain creates another significant geophysical risk: landslides and ravine collapses. Torrential rains can trigger landslides on steep slopes, cutting off roads and burying homes. Although no major earthquake has been recently recorded, any tremor could potentially trigger landslides on weakened slopes. Moreover, as in Cape Verde, São Tomé and Príncipe could theoretically be exposed to tsunamis generated by distant oceanic earthquakes or underwater volcanic collapses (a low but non-zero risk for any island region). Overall, these geophysical risks are considered "high" or "very high" due to the lack of natural shelters and the high coastal population density.

In conclusion, the unstable geological context—volcanoes, faults, and steep slopes—increases the exposure of both countries to disasters such as earthquakes, eruptions, or landslides. Combined with climate effects (e.g., extreme rains triggering landslides), they create an additional layer of geophysical vulnerability. Therefore, any adaptation policy to climate hazards must also take these risks into account: building in safe areas, alerting populations, and strengthening observation systems (seismographs, alert sirens, etc.) are strategies already underway (notably in Cape Verde) to reduce the combined geophysical and climatic threat.

Socio-economic impacts of climate change in Cape Verde and São Tomé and Príncipe

Coastal tourism:

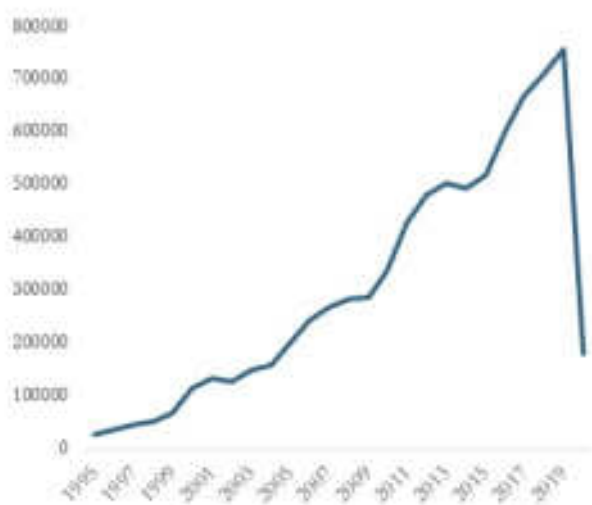
Tourism is a key driver of Cape Verde's economy, accounting for around 25% of GDP and a significant share of formal employment (US Department of state, 2023). The archipelago has built its appeal on its year-round sunshine, sandy beaches and volcanic landscapes. However, these natural assets are on the front line of climate impacts. Coastal erosion, caused by rising seas and wave action, is gradually eroding some of the beaches that visitors love. On the islands of Sal and Boa Vista in Cape Verde, for example, the shoreline of beachfront hotels is receding year by year, necessitating the construction of costly dikes and protective walls to safeguard tourist facilities. In the longer term, the chronic

submergence of low-lying areas could lead to the outright loss of stretches of coastline that were once popular with tourists. The Cape Verdean authorities are aware that climate change threatens coastal tourism, a crucial sector of the island's economy (Bpifrance, 2024; Banque Africaine de Développement BAD, 2024). According to the African Development Bank, Cape Verde's GDP growth remains volatile due to its dependence on tourism and vulnerability to climate-related shocks (BAD, 2024). Lasting damage to beaches or an increase in the frequency of storms could deter visitors and result in a substantial loss of foreign currency earnings.

In addition to erosion, water stress is another major challenge for tourism. As Cape Verde is naturally arid (with less than 250 mm of rainfall per year on average), freshwater supplies depend on irregular rainfall and costly seawater desalination processes. In periods of prolonged drought, hotels and resorts can face water shortages, affecting services offered to guests (swimming pools, showers, watering gardens, etc.). This situation often requires the import of water or investment in new desalination plants, which adds to operating costs. In addition, rising temperatures could intensify demand for electricity (for air conditioning) and water, putting further pressure on already limited resources. São Tomé and Príncipe, whose tourism industry is more modest but developing, is banking on its ecotourism image (tropical forest, diving, sport fishing). However, the degradation of coral reefs due to ocean warming and acidification is threatening diving sites, while rising sea levels and coastal storms can damage fledgling seaside infrastructures.

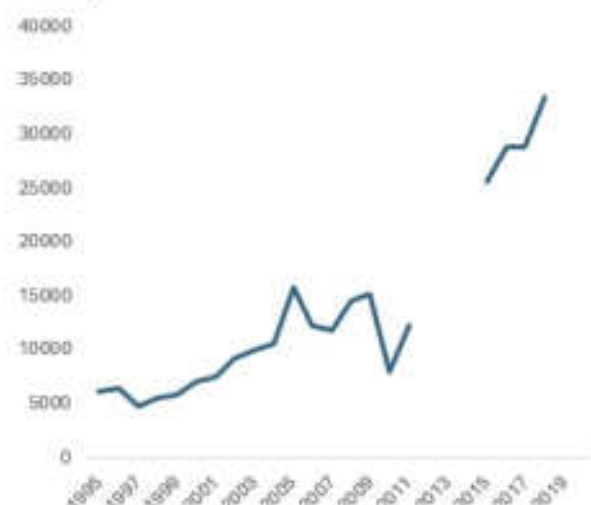
In short, coastal tourism on these Atlantic islands - the backbone of the Cape Verdean economy and an emerging sector in São Tomé - is highly dependent on the preservation of the coastal environment and the availability of natural resources. Climate change, by altering these conditions, exposes this economic pillar to unprecedented disruption. Potential losses are not limited to tourism revenues; they impact the economy as a whole through employment, tax revenues, and foreign currency inflows, hence the urgency of developing specific adaptation strategies for this sector.

Figure 8: International tourism, number of arrivals -Cape Verde



Source: World Bank, 2025

Figure 9: International tourism, number of arrivals – São Tomé and Príncipe



Source: World Bank, 2025

Fishing and marine resources

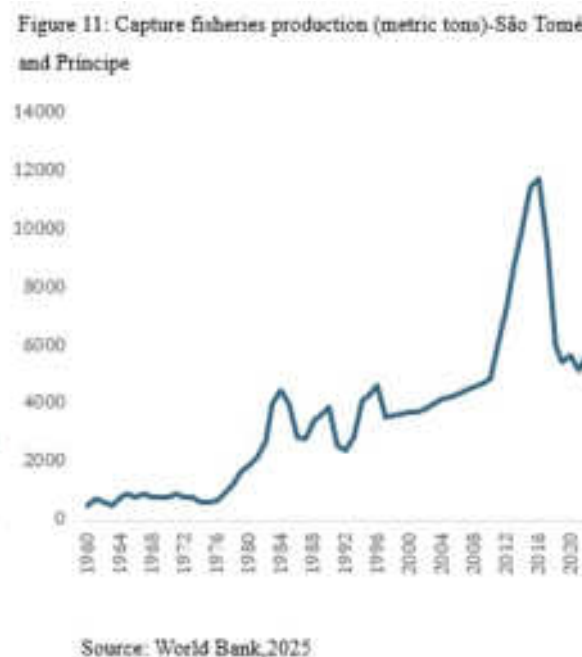
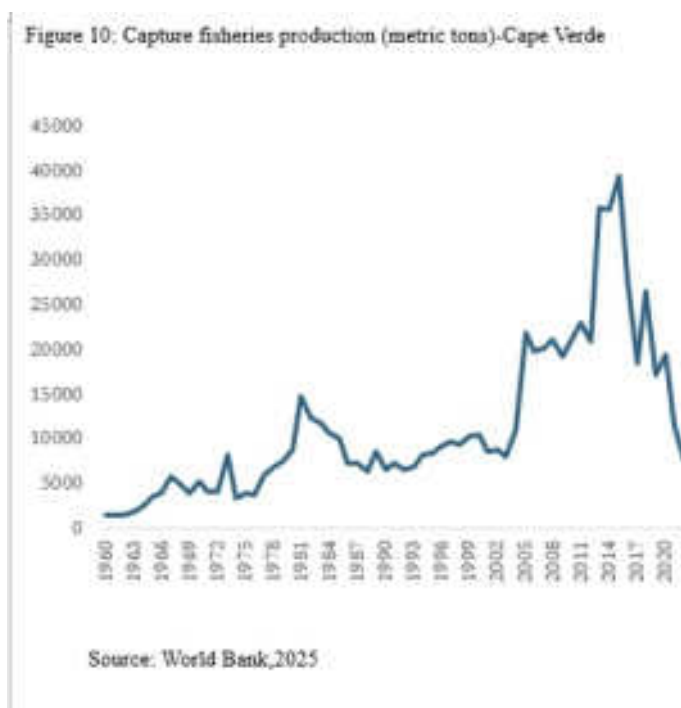
Artisanal and industrial fishing is a vital sector for both countries, providing nutrition, jobs and (for Cape Verde) exports. However, climate change is seriously disrupting the marine ecosystems on which these fisheries depend. In Cape Verde, the fishing industry provides around 6,000 jobs and is the mainstay of the population's diet (fish being a major source of protein) (Gorez, 2024). Seafood products also account for almost 80% of the country's exports, mainly in the form of processed tuna and mackerel. In recent years, however, local fishermen have observed worrying changes in catches. For example, catches of Atlantic mackerel - one of the most prized local fish - have fallen sharply, to the point where by 2022 this fish had all but disappeared from the industrial and artisanal fisheries. In the same year, the canning industry reported a drop in tuna catches and an absence of black mackerel, depriving canneries of a traditional raw material. These empirical observations are in line with scientific projections: according to preliminary UN estimates, by 2100 the biomass of large pelagic fish (such as yellowfin tuna) could fall by 45% in Cape Verdean waters if current trends continue. Such a reduction would have a profound impact on the island's economy, given the importance of fishing to employment and exports. In Cape Verde, the fishing industry is not only a direct source of income for thousands of coastal families, but also a vital source of foreign currency (fish exports to Europe and Asia) and a contributor to the balance of payments. Climate change - via ocean warming, altered ocean currents, acidification and deoxygenation of waters - is a clear threat to the future of fishing. The migration of certain species to colder or deeper waters, the decline in the reproductive rate of certain fish populations, and the degradation of habitats (e.g. coral bleaching, disappearance of seagrass beds) are all mechanisms likely to reduce the catches available to Cape Verdean fishermen.

São Tomé and Príncipe, on the other hand, has a coastal artisanal fishing industry, which is crucial to local food supply and employment. According to a recent FAO (Food and Agriculture Organization of the United Nations) report, after cocoa, artisanal fishing is the main source of income for low-income households, providing employment for around 30,000 people (over 10% of the population), including 4,000 active fishermen (Gorez, 2024). More than 50% of the animal protein consumed by Santomeans comes from fish, with an average consumption of around 29 kg per person per year - more than double the African average (Gorez, 2024). This underlines the extent to which a reduction in marine catches would have immediate consequences for the country's food security. As in Cape Verde, São Tomé's fishing communities are noticing changes: coastal fish are becoming rarer or smaller, forcing fishermen to venture further out to sea to catch enough to fill their nets. The need to go further out to sea, combined with changing marine weather conditions, makes fishing more dangerous for these craftsmen. Episodes of heavy seas, once rare, are becoming more frequent, exposing pirogue fishermen to greater risks. "From the beach, the sea may seem welcoming, but in deep waters it's dangerous and frightening", says a Santomean fisherman, who recounts having lost several colleagues at sea due to difficult conditions (Gorez, 2024). Coastal erosion also aggravates the situation, damaging fishing villages and infrastructure (pontoons, landing stages) and encroaching on areas formerly used for drying or selling fish.

In addition, the warming of the tropical Atlantic Ocean around the equator is undoubtedly modifying the distribution of certain species. Coastal pelagic fish (jacks, mackerel, sardines), which make up the bulk of artisanal catches in São Tomé and Príncipe, could see their abundance fluctuate according to variations in surface temperature and planktonic productivity. Studies indicate that many tropical Small Island Developing States could experience a decline of more than 50% in maximum fish catch

potential by 2100 as a result of climate change - an alarming statistic which, applied to São Tomé, would mean an unprecedented crisis for the country's fish supply (IPCC¹⁹, 2022). The FAO is already concerned about the sustainability of current practices: the recent increase in catches of coastal pelagic fish to feed the growing population, while reflecting the economic success of artisanal fishing, threatens the sustainability of resources and marine biodiversity in the medium term. In other words, the dual stresses of local overfishing and global climate change are jointly exerting pressure on island marine ecosystems (De Labra, G. et al , 2023; Gorez, 2024).

In response, a number of initiatives are emerging. In both Cape Verde and São Tomé and Príncipe, projects are promoting sustainable fisheries management and protection of marine ecosystems (creation of marine protected areas, ban on industrial fishing in coastal zones reserved for craftsmen, increased surveillance against illegal fishing, etc.). São Tomé and Príncipe has set aside a 12-nautical-mile zone exclusively for artisanal fishing. And as part of the regional WACA (West Africa Coastal Areas) program, supported by the World Bank, approximately 3,000 Santomean fishermen have received safety kits and training to help them cope with better sea conditions (Gorez, 2024). However, beyond these adaptation measures, the reality on the ground remains worrying: the nourishing sea that sustains these island nations is changing, becoming less predictable, less generous and more dangerous. Without greater resilience, fishing - the economic and social lifeblood of coastal areas - is likely to be one of the major victims of climate change in these countries.



Agriculture and food security

Agriculture in both archipelagos is both vulnerable and vital, although it accounts for only a modest share of GDP (especially in Cape Verde). In Cape Verde, around 11% of the country's total surface area is cultivated, representing 45,000 ha of which 42,000 ha is arable land and 3,000 ha permanent crops (FAO, 2005), and annual rainfall is among the lowest in West Africa (Varela-Lopes, G., Molion,

¹⁹ The Intergovernmental Panel on Climate Change

L., 2014). Agricultural production (essentially rain-fed) is therefore structurally limited and highly exposed to climatic hazards. Since the middle of the 20th century, Cape Verde has experienced numerous severe droughts, which have forced the country to import most of its foodstuffs and have historically led to food crises. For example, the exceptional drought of 2017-2018 decimated harvests, leading to a drop in income for thousands of farmers and breeders. More recently, the 2021-2022 cropping season has once again been marked by an almost total absence of rain, resulting in zero cereal production on the archipelago. This extreme inter-annual variability in rainfall - exacerbated by climate change - compromises the reliability of local supplies. Smallholders in Cape Verde see their yields fluctuate drastically from one year to the next, hampering any sustainable agricultural development. In addition, increased evaporation due to rising temperatures is exacerbating soil dryness and reducing the recharge of scarce groundwater. Eventually, the combination of warmer temperatures and lower rainfall could lead to increased aridification on some islands with already semi-desert climates, making traditional agriculture virtually impossible without irrigation.

São Tomé and Príncipe enjoys an equatorial climate with generous rainfall (over 1,000 mm per year in many areas, with a marked rainy season). The island of São Tomé has fertile volcanic soils, ideal for export farming (cocoa, coffee, palm oil) inherited from the colonial period. However, rainfall patterns are becoming increasingly unpredictable: some areas experience unusual dry spells or, on the contrary, extreme rainfall over short periods, resulting in floods that gully the soil. The lack of water in the north of the island of São Tomé in certain years makes it difficult to grow food crops (maize, tubers) without irrigation (World Food Programme, 2023). At the national level, agriculture contributes around 14% of Santomean GDP and accounts for a significant proportion of the working population (over 20% of men and 9% of women are involved in agricultural activity, according to the World Bank 2023²⁰). This is essentially small-scale agriculture, combining food crops and cash crop plantations. The majority of small-scale farmers have an average farm size of less than 3 hectares, and practice traditional mixed farming. They are among the poorest populations and the most vulnerable to climate shocks. Indeed, around 42% of households in São Tomé reported experiencing food shortages for some months of the year, illustrating chronic food insecurity in rural areas (World Food Programme, 2023).

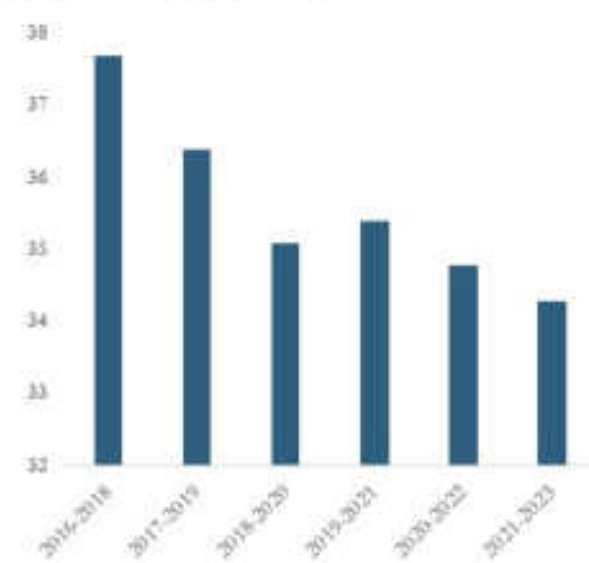
Climate change is likely to exacerbate these difficulties in agriculture through a number of mechanisms: increased water stress, new phytosanitary pressures and extreme weather events. On the one hand, rising temperatures and rainfall anomalies favour the appearance or proliferation of crop diseases and pests (insects, fungi) in areas previously spared, requiring more inputs and weakening yields (UNDP, 2025). In São Tomé, for example, there are reports of an upsurge in certain agricultural pests affecting food crops in abnormally dry years, as low rainfall can alter the biological cycle of pests and reduce the effectiveness of natural control methods. On the other hand, occasional torrential rains cause destructive flooding that can wipe out fields and gardens in a matter of hours (particularly in riverbank areas). In 2019, severe flooding in São Tomé devastated roads and isolated farming communities, ruining entire harvests and causing landslides in sloping plots (FAO, 2024). In Cape Verde, the major challenge is water management: to maintain viable agriculture, it is necessary to develop drip irrigation, store rainwater (cisterns, micro-dams) and use desalination, all costly solutions for a country with limited resources. Buying desalinated water significantly reduces Cape

²⁰ World Bank. 2023. Sao Tome and Principe Gender Landscape

Verde farmers' margins (FAO, 2024), making it sometimes more expensive than the market value of their produce.

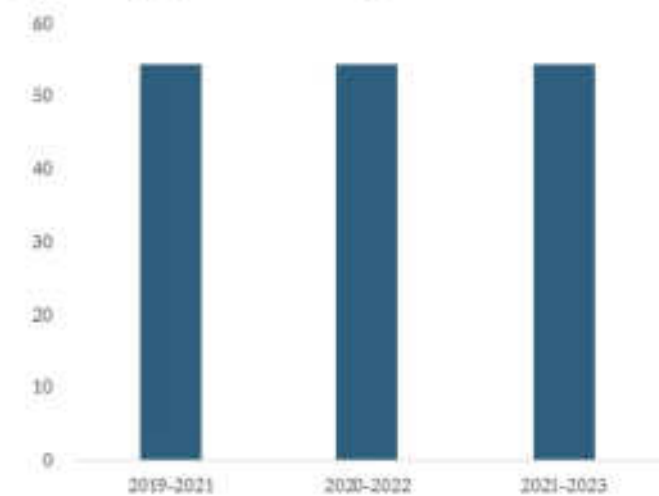
These structural vulnerabilities mean that these island states are highly dependent on external food supplies. Cape Verde imports between 80 and 90% of its food requirements (IMF, 2004) - cereals, rice, meat products, powdered milk, etc. - due to a lack of arable land and insufficient domestic production. Despite abundant rainfall, São Tomé and Príncipe also imports a significant proportion of its staple foods, notably rice and wheat, which are not grown locally, as well as a number of manufactured goods. This dependence on imports increases the country's vulnerability to exogenous shocks (rising world prices, supply disruptions). The global crisis of 2022 is a case in point: soaring food and sea freight prices, combined with the war in Ukraine, led to food inflation of almost 18% in São Tomé at the end of 2022 (Banque Africaine de Développement, 2024), exacerbating the food insecurity of poor households. In addition, Cape Verde and São Tomé have to mobilize foreign currency to pay for these costly imports, putting pressure on their balance of trade and foreign currency reserves. By December 2023, São Tomé and Príncipe had only the equivalent of one month's imports in foreign exchange reserves, mainly due to expensive energy imports - a critical situation jeopardizing its ability to pay for essential goods (Banque Africaine de Développement, 2024).

Figure 12: Prevalence of moderate and severe food insecurity (%) (3-year average) (Cape Verde)



Source: FAO, 2025

Figure 13: Prevalence of moderate and severe food insecurity (%) (3-year average) (São Tomé and Príncipe)



Source: FAO, 2025

Poverty and Health

The climatic and environmental disturbances described above have a direct impact on the socio-economic fabric of Cape Verde and São Tomé and Príncipe. One of the most worrying consequences is the exacerbation of poverty and inequality. In these countries, where a significant proportion of the population depends on subsistence farming or artisanal fishing, repeated climatic shocks are eroding livelihoods. Rural or coastal households with modest incomes often have no financial safety net to absorb the loss of a harvest or a missed fishing season. The result is greater economic insecurity,

increased food insecurity, and the need to resort to often precarious coping mechanisms (sale of livestock, indebtedness, reduced meals, etc.). In São Tomé and Príncipe, around 10% of households report severe food insecurity (with adults regularly skipping meals), and over 40% experience seasonal food shortages (World Food Programme, 2023). Climate change is likely to increase these proportions by multiplying the number of hazards. Similarly, the prevalence of malnutrition could increase if local food systems fail to compensate for production losses or rising costs.

The health sector is also at stake. Higher temperatures, for example, encourage the geographical spread of vector-borne diseases (such as dengue fever and malaria, although the latter has been declining in São Tomé in recent years). Extreme heat episodes can affect the elderly and vulnerable, particularly in poor urban areas where housing offers little protection against the heat. Unsafe water following floods or droughts (concentration of pollutants) increases the risk of water-borne diseases and diarrhea. In both islands, any destabilization of local food production coupled with a rise in the price of imported foodstuffs results in a less diversified, lower-quality diet for the poorest, which can exacerbate child malnutrition or micronutrient deficiencies. In this way, climate change threatens to cancel out or slow down the progress made in human development (poverty reduction, improved public health).

Migration

Another major social impact is the migration dynamics driven by environmental degradation. Historically, Cape Verde has experienced large waves of emigration, partly linked to the repeated droughts of the 20th century. The Cape Verdean diaspora — now estimated at around 700000 individuals living abroad (IOM)²¹, compared to approximately 524900 of the resident population (World Bank) — was notably shaped by the devastating droughts and famines of the 1940s, 1960s, and 1970s²². Today, it is feared that worsening rural climatic conditions will prompt a new generation of Cape Verdeans to leave the countryside for the cities, or from the country to abroad, in search of more viable livelihoods. There is already a significant rural exodus in Cape Verde: the urban population has risen from 17% in the 1960s to almost 68% in 2023(The globaleconomy , 2025). Climate change could accelerate this trend by making traditional rain-fed agriculture less and less tenable, prompting young people to abandon farming villages to try their luck in tourism or services in the city, or to emigrate. However, an uncontrolled influx into urban centers poses other challenges, notably in terms of housing, employment and access to basic services, potentially creating new areas of vulnerability (shanty towns in flood-prone areas, urban unemployment, etc.).

In São Tomé and Príncipe, international emigration remains relatively limited due to the country's geographic isolation and small population size. Nevertheless, a significant migratory flow has emerged in recent decades, primarily toward Portugal—the former colonial power—as well as toward Angola and Gabon. In 2020, the country recorded 39,608 emigrants, representing 18.1% of its total population, with women accounting for 52.5% of this group. The main destinations were Portugal (51.9%), Angola (17.3%), Gabon (16.5%), Cape Verde (4.6%), and Equatorial Guinea (4.5%)²³.

²¹ International Organization for Migration

²²World Bank (1993). Updating Economic Note: Opening up a Small Economy — An Agenda for the 1990s. Report No. 10594-CV, 11 juin 1993. Washington, DC : World Bank.

²³ Migrants & Refugees Section. (2022). Country profile: São Tomé and Príncipe. Integral Human Development.

Internal migration is also occurring. For example, residents of coastal fishing communities—particularly exposed to flooding and rising sea levels—may be forced to relocate inland or to the capital to escape the threat posed by the ocean. These displacements can be understood as small-scale climate-induced migrations. They may lead to the erosion of local traditions; when a fishing community disperses, the knowledge and skills that sustain it are at risk of being lost. In this context, the concept of a “climate migrant” becomes especially relevant: faced with the gradual erosion of their livelihoods due to climate change, some individuals have no alternative but to adopt migration as a last-resort adaptation strategy.

However, migration is not accessible to all - it requires resources and networks - and those who remain may be the most vulnerable (the elderly, households without means). As a result, the island's social fabric is likely to be profoundly transformed by these dynamics. On the one hand, diasporas can play a positive role by sending remittances that help families back home to cope with crises (BAD, 2012). On the other hand, if the exodus of vital forces accelerates, this could weaken the country's endogenous capacity to react (lack of agricultural manpower, fishermen, young entrepreneurs) and create a kind of dependence on external networks.

In summary, the socio-economic impacts of climate change on Cape Verde and São Tomé and Príncipe are multiple and intertwined: increased risk of poverty and food insecurity, pressure on the healthcare system, altered settlement patterns and increased migration. These phenomena pose major public policy challenges, as they require both emergency measures (food aid, rehousing) and long-term strategies (resilient job creation, training, urban planning) to prevent the consequences of climate leading to a setback in development.

Building resilience: challenges and opportunities for integrated sustainable development

Before examining the strategies available to Cabo Verde and São Tomé and Príncipe for building resilience, it is important to understand the structural constraints that currently limit their adaptive capacity. In the face of intensifying climatic threats, both countries' responses are hampered by economic and institutional fragilities. These include their heavy dependence on food and energy imports, limited budgetary margins, high levels of public debt, and underdeveloped technical and planning capacities.

Cape Verde imports most of its food and all of its fossil fuels to generate electricity and power transport, while São Tomé and Príncipe continues to rely largely on diesel-based electricity generation. This dependence not only weighs heavily on trade balances but also heightens vulnerability to international price fluctuations. When energy or food prices spike, fiscal space for adaptation shrinks accordingly. According to the African Development Bank (2024), Cape Verde's public debt reached around 120% of GDP in 2023, in part due to the legacy of previous investments and the COVID-19 crisis. São Tomé and Príncipe recorded public debt levels close to 100% of GDP, coupled with a chronic budget deficit financed by foreign aid. In 2023, nearly 97% of São Tomé's public investment budget was funded externally (World Food Programme, 2023), underscoring the countries' extreme reliance on international assistance for climate adaptation and development initiatives.

This fiscal pressure translates into underinvestment in critical areas such as meteorological services, disaster risk reduction, urban and coastal planning, and early warning systems. Many national

institutions lack the equipment, human resources, and expertise necessary to implement comprehensive climate policies. For instance, hydrometeorological services in both countries remain under-equipped and understaffed. Social protection mechanisms—such as contingency funds or insurance schemes tailored to climate risks—are still in their infancy.

Even though both governments have developed climate strategies and action plans (National Adaptation Plans, Nationally Determined Contributions), implementation depends overwhelmingly on access to external financing, such as Green Climate Fund (GCF) or Adaptation Fund resources. According to the UNDP (2025), Cape Verde has made progress in renewable energy—reaching nearly 20–25% renewable electricity—and aims to steadily increase this share. São Tomé and Príncipe, meanwhile, adopted a Blue Economy Transition Strategy in 2019 to preserve marine and coastal biodiversity. A regional program, supported by the GEF and UNDP, was also launched in 2021 to strengthen sustainable blue economies and coastal risk management in small islands (UNDP, 2025).

According to World Bank estimates, Cape Verde would need to invest an average of \$140 million annually between 2024 and 2030 to meet its climate and development challenges—an effort well beyond the reach of a small economy without significant external support (World Bank, 2024).

The compounded nature of their vulnerability—both economic and climatic—requires an integrated policy approach. Limited economic diversification, high unemployment, small domestic markets, and geographic isolation amplify exposure to shocks and restrict endogenous adaptation potential. As highlighted by the African Development Bank (2024), São Tomé and Príncipe's narrow production base severely limits its ability to respond to shocks or diversify its economy.

Under these constraints, public policy must balance urgent social needs (poverty reduction, education, health, infrastructure) with the long-term imperative of climate adaptation. Yet without scaled-up external support and innovations in climate finance, these dual goals often remain out of reach. The issue of climate justice also arises: these nations, which have contributed minimally to global emissions, are required to mobilize vast resources to confront their consequences—often at the risk of increasing their indebtedness.

In the subsections that follow, we examine how both countries can overcome these structural limitations and build climate resilience through integrated development strategies.

Integrating climate and development policies

A first challenge is to integrate the climate dimension into all sectoral policies. This means that economic development planning must systematically take into account future climate scenarios and current vulnerability. For example, land-use and urban development plans should avoid densifying flood-prone coastal areas, and include green buffer zones along the coastline. Resilient urban planning can involve gradually relocating certain critical infrastructures away from risk zones (hospitals, communication centers, etc.), improving building standards (raised housing in flood plains, roofs resistant to high winds) and building drainage systems in cities to cope with intense rainfall. In Cape Verde, the capital Praia began investing in drainage channels and retention basins to limit the flash flooding that affected certain districts during violent storms.

In the agricultural sector, integrated policies involve promoting climate-resilient agriculture: disseminating seed varieties that are more tolerant to drought or excess water, training farmers in soil conservation techniques (agroforestry, mulching, anti-erosion terracing), developing solar micro-

irrigation and rainwater harvesting. These measures increase productivity while reducing vulnerability to hazards. Cape Verde, for example, benefits from a South-South cooperation program with Brazil and the FAO to develop drip-irrigated vegetable gardens and improve soil management. For its part, São Tomé and Príncipe is working with IFAD (International Fund for Agricultural Development) on projects aimed at increasing rural incomes and food security through sustainable and diversified practices (FIDA,2023). The aim is to reduce dependence on a few vulnerable crops and strengthen local value chains.

For fisheries, integration means adopting an ecosystem-based approach to marine resource management, combining fishing regulation (quotas, marine protected areas) and conservation measures (mangrove restoration, installation of sustainable fish aggregation systems, combating coastal pollution). This can support the long-term productivity of fisheries while protecting biodiversity. São Tomé and Príncipe has identified agriculture and fisheries as among the most vulnerable sectors in its updated 2021 NDC, and is committed to focusing its adaptation efforts there (UNDP, 2025). For example, improving the treatment of agricultural and urban waste to prevent it from polluting coastal waters is an action that falls within the remit of agricultural, health and fisheries policies, demonstrating the need for cross-sectoral coordination.

Economic diversification and the blue/green economy

A key resilience strategy is economic diversification. By reducing dependence on a limited number of sectors, the country's overall sensitivity to specific shocks is reduced. Cape Verde is seeking to diversify its tourism (developing mountain ecotourism, cultural tourism, so as not to rely solely on the vulnerable beach resort), promote light industries and information technologies (thanks to its political stability and relatively well-trained human capital), and encourage the diaspora to invest in the country. São Tomé and Príncipe is banking on the development of the blue and green economies. Its “Blue Economy” strategy aims to develop marine resources in a sustainable way: sustainable aquaculture, marine biotechnologies, eco-responsible coastal tourism, etc., while protecting the ocean. At the same time, the green economy includes the expansion of renewable energies (the country plans to further develop hydroelectricity and solar power to reduce costly diesel imports), sustainable forest management (to prevent erosion and store carbon), and the valorization of niche organic agricultural products (coffee, high-end cocoa, pepper) that are less intensive in chemical inputs. These diversified orientations can create new jobs, reduce certain imports (for example, if more energy is produced locally, less fuel is imported) and potentially improve resilience to external shocks.

International financing opportunities exist to support this transition. Climate finance mechanisms - such as the Green Climate Fund (GCF) - offer grants or concessional loans for adaptation and mitigation projects in SIDS. For example, a project supported by the GCF aims to strengthen Cape Verde's capacity to cope with the effects of climate change in the fisheries, tourism and energy sectors (Green Climate Fund, 2021), explicitly recognizing that these are key areas of vulnerability. This project aims, in particular, to improve climate governance, train local players, and integrate climate risk into public investments. Similarly, São Tomé and Príncipe can benefit from initiatives such as the UNDP-FAO SCALA (Scaling up Climate Ambition on Land Use) program, which aims to step up adaptation actions in agriculture and land use. Accessing and effectively absorbing this funding remains a challenge (project development capacities, co-financing required, etc.), but it represents an opportunity to partially overcome the budgetary constraints mentioned above.

Another important element is institutional capacity building. This means training technicians, planners and engineers in climate issues, so that they can design and implement locally adapted solutions. It also means involving local communities in the design of measures, making the most of traditional knowledge (for example, indigenous knowledge of water management or climate forecasting can complement modern warning systems). Local ownership of projects ensures greater sustainability. In Cape Verde, some local NGOs (Nongovernmental Organization) are working with villages to introduce agroecology, reforest arid areas (the country has carried out extensive reforestation campaigns since the 1980s to combat desertification) and raise awareness of good water management practices. São Tomé and Príncipe, meanwhile, has the advantage of a small population, which can facilitate community mobilization on pilot projects (for example, the creation of fishermen's cooperatives equipped to process and preserve fish, in order to reduce post-harvest losses and diversify income).

Regional and international cooperation

Being small states, Cape Verde and São Tomé and Príncipe can also multiply partnerships to pool resources and knowledge. South-South cooperation between SIDS is particularly useful: exchanges of experience with other islands (for example, the sharing of expertise between Cape Verde and Mauritius or the Seychelles on sustainable tourism and marine conservation, or between São Tomé and Príncipe and Caribbean islands on the management of tropical watersheds). Platforms such as the Alliance of Small Island States (AOSIS) or the SIDS Network for Sustainable Development Solutions enable them to make their voices heard collectively, and to draw attention to their specific needs in terms of climate financing and the transfer of adaptation technologies (energy-efficient desalination, multi-hazard warning systems, etc.).

At the COP22 in Marrakech, AOSIS played a central role in advocating for increased access to climate finance, particularly for loss and damage mechanisms tailored to the needs of Small Island Developing States (SIDS). Cape Verde and São Tomé and Príncipe, as active members of AOSIS, have supported these initiatives, which aim to embed climate justice and equity in global climate governance frameworks.

At the regional level, both countries are also engaged in the African Atlantic States Process (AASP), initiated in 2022 to promote South-South cooperation among Atlantic African states. This intergovernmental initiative, led by Morocco, provides a platform to jointly address shared challenges—such as sustainable ocean governance, coastal resilience, blue economy development, and maritime security—through collective diplomatic and policy action. Cape Verde and São Tomé and Príncipe have participated in recent AASP ministerial meetings and supported its ambition to build a zone of peace and shared prosperity across the Atlantic façade of Africa.

At international conferences (climate COPs, UN forums), these countries advocate mechanisms such as disaster insurance facilities or funds dedicated to “loss and damage” caused by the climate, which could help them recover from extreme shocks without incurring heavy debt.

The Role of the United Nations in Strengthening Climate Resilience in Cape Verde and São Tomé and Príncipe

United Nations agencies have supported a range of targeted projects in Cape Verde and São Tomé and Príncipe to build resilience. For example, FAO (with GCF support) is funding a readiness project (≈US\$0.5 million) to mainstream climate change into Cape Verde’s “blue economy” sectors

(fisheries, tourism, energy), aligning the NDC (2017) and National Adaptation Programme of Action (NAPA) (2007) priorities with new investment plans (FAO, 2025). UNDP has implemented major adaptation programmes: notably a US\$3.0 million GEF-supported project (co-financed by Canada) to build climate-resilient water management in vulnerable municipalities of Cape Verde (drought mitigation, watershed reforestation, water recycling) (UNDP, 2025). In São Tomé and Príncipe, the UNDP-FAO SCALA project is engaging the private sector to develop climate-smart agriculture – it has delivered market studies on organic bio-inputs and is assisting government and entrepreneurs to scale up organic farming (reducing pesticides 25% by 2030) in line with the updated NDC (UNDP, 2025). Likewise, IFAD has financed transformative rural programmes: Cape Verde’s POSER (Rural Socio-Economic Opportunities) project (total cost ≈US\$47 million, IFAD loan US\$26.7 m) strengthens community associations, women’s and youth groups, and promotes diversified, climate-resilient farming to improve food security (IFAD, 2025). In São Tomé, the IFAD-funded COMPRAN (Commercialization, Agricultural Production and Nutrition) project (€19.2 m) targets 34,800 rural farmers (50% youth) with credit, irrigation, agroforestry and value-chain support to boost incomes, nutrition and climate resilience (IFAD, 2020). These and similar UN initiatives (often in partnership with GEF, GCF, World Bank and other donors) thus bring concrete financing and technical assistance to integrate climate adaptation, economic diversification and environmental protection in national programmes.

These programmes are beginning to be institutionalized in national policy. Cape Verde’s own planning documents now explicitly incorporate climate resilience and diversification. For example, the government’s 2006 NAPA and 2017 Climate Strategy already prioritized integrated management of water, agriculture, ecosystems, tourism, and coastal zones as key adaptation actions. Recent World Bank analyses note that Cape Verde’s national development plans (e.g. PEDS II and the “Ambition 2030” agenda) now incorporate economic diversification and climate shock resilience, aligning with the country’s NDC targets (World Bank, 2023). Indeed, under UNDP guidance, Cape Verde developed an Integrated National Financing Framework (INFF) linking budgeting to SDG and blue-economy goals: it launched the Blu-X platform (with UNDP and LuxDev) to finance sustainable blue-economy projects (issuance of a social bond and a US\$3.5 m blue bond for coastal SMEs) (UNDP, 2024). In São Tomé and Príncipe, climate goals have likewise been woven into policy: the 2019 Blue Economy Transition Strategy commits to preserving marine biodiversity and reducing agrochemical use, and the 2021 NDC specifically targets a 25% cut in pesticide/fertilizer use by 2030 (with a parallel increase in organic farming) (UNDP, 2025). In sum, the UN-supported pilots and projects have catalyzed stronger governance and planning for resilience – for example, water-saving technologies and ecosystem restoration demonstrated under UNDP projects are now informing broader national programmes, and environmental safeguards are being folded into tourism and fisheries strategies.

To sustain these gains over the long term, experts emphasize deeper integration and capacity-building. One priority is to fully align climate and development budgets. Cape Verde’s INFF process is a model here, but this should be extended: multilateral studies stress that “integration of climate and development strategies and their alignment with national budgets (including comprehensive INFFs) remains a work in progress in many SIDS” (UNOPS & Resident Coordinator’s Office for Barbados and the OECS, 2024). Thus, governments should continue to mainstream adaptation and mitigation across sectoral planning (water, agriculture, energy, tourism) and embed resilience indicators in public finance. Relatedly, accelerating direct access to climate finance (e.g. GCF accreditation) is key. UN

recommendations urge scaling up the capacity of national institutions to prepare bankable projects and meet GCF standards, so that countries can channel more climate funding through their own systems (UNOPS & Resident Coordinator's Office for Barbados and the OECS, 2024). Practically, this means reinforcing national climate funds or agencies (e.g. Cape Verde's MFA/GCF initiative) and investing in project preparation and monitoring units. Another strategy is to leverage private investment and innovation as demonstrated by Cape Verde's Blue Economy bonds and São Tomé's private-sector engagement under SCALA (UNDP, 2024).

Conclusion

The physical impacts of climate change on Cape Verde and São Tomé and Príncipe reveal the acute vulnerability of small island developing states (SIDS) at the intersection of environmental, geographical, and socio-economic fragilities. Both archipelagos, characterized by steep volcanic terrains, narrow coastal zones, and limited freshwater resources, are already experiencing tangible consequences: recurrent and intensified droughts, rising average temperatures, growing water scarcity, accelerated coastal erosion, sea level rise, soil degradation, and an increasing frequency of extreme climatic events. These phenomena, while globally recognized, manifest locally with particular severity due to the structural exposure and limited adaptive buffers of these insular environments.

In Cape Verde, the prolonged and worsening drought episodes, coupled with chronic water stress and soil desertification, threaten agricultural sustainability, rural livelihoods, and food security. São Tomé and Príncipe, despite higher average rainfall, faces increasing climatic variability leading to seasonal water shortages, land degradation, and coastal vulnerability. Sea level rise poses an existential threat to both countries' economic hubs and critical infrastructures concentrated in low-lying coastal areas, while coastal erosion and saline intrusion undermine ecosystems and productive lands. Rising temperatures amplify these pressures, reducing water availability, impacting marine and terrestrial ecosystems, and compounding health risks.

Moreover, geophysical vulnerabilities—such as volcanic risks in Cape Verde and landslide hazards in both archipelagos—add an additional layer of complexity to their climate exposure profiles. These compounded physical risks do not act in isolation: they interact with socio-economic factors such as rapid urbanization, poverty, dependence on climate-sensitive sectors (agriculture, fisheries, tourism), and limited public resources for adaptation, thereby magnifying the overall fragility of these states.

In sum, the physical impacts of climate change in Cape Verde and São Tomé and Príncipe are not distant or hypothetical threats: they are current realities, progressively eroding the ecological foundations and socio-economic stability of these nations. Without robust, integrated, and adequately financed adaptation strategies, the cascading effects of climatic and geophysical risks will increasingly jeopardize their development prospects. Recognizing the specificity and urgency of these challenges is thus essential for national policymakers, regional actors, and the international community alike to craft resilient and sustainable pathways for the future of these Atlantic island nations.

References

- Araújo, S. (2022, 17 octobre). *The Water Planter*. UNDP Accelerator Labs.
- Banque africaine de développement. (2011). *Cap-Vert : Un modèle de réussite*. Tunis : BAD.

- Banque africaine de développement. (2024). *Cabo Verde Economic Outlook*.
- Banque africaine de développement. (2024). *Perspectives économiques au Cabo Verde*.
- Banque africaine de développement. (2024). Perspectives économiques à Sao Tomé-et-Príncipe.
- Bpifrance. (2024). *Cabo Verde : Fiche Pays – Novembre 2024*. Direction de l'Évaluation, des Études et de la Prospective.
- De Labra, G., et al. (2023). The coastal pelagics value chain in Sao Tome and Príncipe: Summary report.
- Eduonoo, M. (2023). Climate change worsens life in Cabo Verde; citizens want collective action to combat it (Afrobarometer Dispatch No. 726). Afrobarometer.
- FAO. (2005). L'irrigation en Afrique en chiffres – Enquête AQUASTAT 2005 : Profil national – Cap-Vert. Organisation des Nations Unies pour l'alimentation et l'agriculture.
- FAO. (2024, 27 mai). *Un archipel en proie à la sécheresse*. Organisation des Nations Unies pour l'alimentation et l'agriculture.
- Food and Agriculture Organization of the United Nations (FAO). (2025). Enhance capacities of Cabo Verde in addressing the effects of climate change in key sectors of the blue economy.
- Fonds international de développement agricole (FIDA). (2023). Partenariat entre Sao Tomé-et-Príncipe et le FIDA pour améliorer la nutrition et les revenus face au changement climatique.
- Fonds monétaire international (FMI). (2024). Cabo Verde: Technical Assistance Report—Climate Public Investment Management Assessment (C-PIMA). Washington, DC : Fonds monétaire international.
- Gorez, B. (2024, 24 avril). Crise climatique à Sao Tomé-et-Príncipe : l'APPD favorisera-t-il l'essor de la pêche artisanale au large ? Coalition pour des accords de pêche équitables (CAPE).
- Green Climate Fund (GCF). (2021). Enhance capacities of Cabo Verde in addressing the effects of climate change in key sectors of the Blue Economy.
- IMF. (2004). Cape Verde: Poverty Reduction Strategy Paper. Report.
- Intergovernmental Panel on Climate Change (IPCC). (2023). Africa. In: *Climate Change 2022 – Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press; 2023:1285-1456.
- IPCC. (2022). Fact Sheet – Small Islands. Dans : *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*.
- Migrants & Refugees Section. (2022). *Country profile: São Tomé and Príncipe*. Integral Human Development.
- Ministère des Ressources Naturelles et de l'Environnement. (2004). *Première Communication Nationale sur les Changements Climatiques*. République Démocratique de São Tomé-et-Príncipe.
- Monteiro, S., Cunha, L., & Freire, G. S. (2016). Risques naturels, aléas, vulnérabilités : le cas de la ville de Praia sur l'île de Santiago (Cap-Vert). *Dynamiques Environnementales*.
- Mycoo, M., Wairiu, M., Campbell, D., Duvat, V., Golbuu, Y., Maharaj, S., Nalau, J., Pinnegar, J., & Warrick, O. (2022). *Small Islands*. Dans : *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the*

- Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 2043–2121.
- Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO). (2024, 27 mai). *Un archipel en proie à la sécheresse*. FAO.
 - République du Cap-Vert. (1999). *Communication nationale sur les changements climatiques*. Ministère de l'Agriculture, de l'Alimentation et de l'Environnement, Secrétariat Exécutif pour l'Environnement (SEPA), Projet CVI/97/G33/GEF - PNUD.
 - Tembe, J. (2023). *Cabo Verde (Cape Verde): Africa Housing Finance Yearbook 2023*. Centre for Affordable Housing Finance in Africa.
 - Trisos, C. H., Adelekan, I. O., Totin, E., Ayanlade, A., Efitre, J., Gameda, A., Kalaba, K., Lennard, C., Masao, C., Mgaya, Y., Ngaruiya, G., Olago, D., Simpson, N. P., & Zakieldeem, S. (2022). *Africa*. Dans : *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 1285–1455.
 - United Nations Development Programme (UNDP). (2024, 30 octobre). *Frontline of Climate Change: How Cabo Verde is Leveraging INFFs to Fund its NDC Targets*. Sustainable Finance Hub.
 - United Nations Development Programme (UNDP). (2025). Building adaptive capacity and resilience to climate change in the water sector in Cabo Verde.
 - United Nations Development Programme (UNDP). (2025). Enhance Adaptive Capacity to Floods and Water Security in São Tomé and Príncipe.
 - United Nations Development Programme (UNDP). (2025). *SCALA São Tomé and Príncipe*.
 - UNOPS & Resident Coordinator's Office for Barbados and the OECS. (2024). Making Climate Finance Work for SIDS: Building on the Outcomes of UNFCCC COP28 – Background Note for Interactive Dialogue 3, 4th International Conference on Small Island Developing States “Charting the Course Toward Resilient Prosperity”.
 - U.S. Department of State. (2023). *2023 Investment Climate Statements: Cabo Verde*. Washington, DC: U.S. Department of State.
 - Varela-Lopes, G., & Molion, L. C. B. (2014). Precipitation Patterns in Cape Verde Islands: Santiago Island Case Study. *Atmospheric and Climate Sciences*.
 - Vousdoukas, M. I., et al. (2023). Small Island Developing States under threat by rising seas even in a 1.5 °C warming world. *Nature Sustainability*.
 - World Bank. (2023, 14 juillet). Cabo Verde's Sustainable Growth Relies on Economic Diversification and Resilience to External Shocks. Communiqué de presse.
 - World Bank. (2025, 15 janvier). Ambitious climate action will reap large dividends for Cabo Verde.
 - World Food Programme (PAM). (2019). *Plan stratégique de pays – Sao Tomé-et-Príncipe (2019-2024)*. Rome : Programme alimentaire mondial.
 - World Food Programme (PAM). (2023). *Plan stratégique de pays – Sao Tomé-et-Príncipe (2024-2028)*. Rome : Programme alimentaire mondial.
 - World Bank. (2023). Sao Tome and Principe Gender Landscape.
 - World Bank.(1993). *Updating Economic Note: Opening up a Small Economy — An Agenda for the 1990s*. Report No. 10594-CV, 11 juin 1993. Washington, DC : World Bank

Climate Change as a Maritime Security Threat Multiplier in the Gulf of Guinea (GoG)

David Willima, Researcher

Introduction

In recent years, the Gulf of Guinea has taken centre stage in global maritime discussions, emerging as a pivotal region both strategically and in terms of security concerns. Stretching from Senegal to Angola and encompassing about 6,000 kilometres of coastline across 17 nations, the Gulf faces intensifying maritime security issues, including piracy, armed robbery at sea, transnational organised crime, and illegal, unreported, and unregulated (IUU) fishing. Chief among the contemporary challenges, however, is climate change, which increasingly acts as a threat multiplier, amplifying vulnerabilities and exacerbating existing risks in coastal and maritime domains. These environmental shifts have begun to undermine the development and human security of coastal communities, demanding urgent and multidisciplinary attention.

This paper aims to critically examine the intricate relationship between climate change and maritime security in the Gulf of Guinea, focusing particularly on how environmental transformations affect human well-being and the stability of maritime activities. Drawing on a multidisciplinary analytical approach combining oceanographic data, socio-economic indicators, and security incident reports, the study will map the cascading effects of climate change through the region's major urban and coastal hubs, such as Lagos, Abidjan, and Accra. Key areas of inquiry include how rising sea levels and warming oceans alter fish stock distributions and provoke competition over dwindling resources; how coastal erosion triggers population displacement and urbanisation in port cities; and how these combined processes intensify maritime threats, such as IUU fishing, trafficking, and piracy. The paper will also evaluate the capacity of governments and regional authorities to address these escalating challenges and the strain placed on enforcement agencies. Ultimately, the research seeks to propose an integrated framework for responding to climate-related maritime insecurity: recommending pathways for regional cooperation on fisheries management, community-based resilience strategies, and the full integration of climate considerations into maritime security policymaking, ensuring that policy responses promote both human security and long-term stability in this critical Atlantic region.

Figure 1 – The Context: Gulf of Guinea

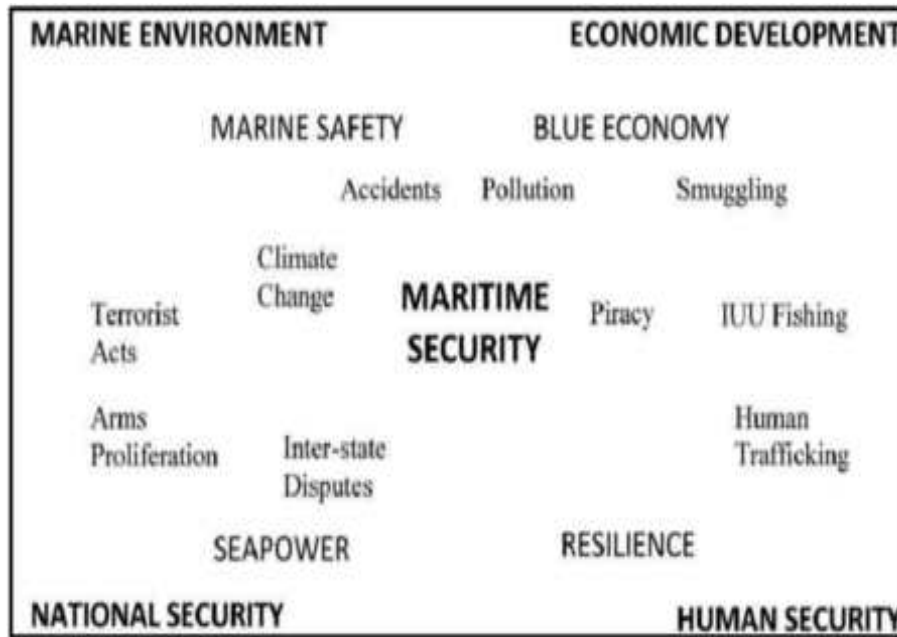


Source: Author

Maritime Security and Threats in the Gulf of Guinea

Maritime security in the Gulf of Guinea is best understood through the lens of its dynamic, interconnected threats. The issues facing the region are broad, cross-cutting, and frequently reinforce one another, forming what Christian Bueger terms the maritime security matrix, a conceptual framework that elucidates how diverse maritime risks, such as piracy, trafficking, IUU fishing, and climate impacts, interact within a systemic web. In this matrix, environmental stressors like climate change and coastal degradation are not isolated hazards; rather, they are tightly enmeshed with political, economic, and security factors. For example, diminishing fish stocks due to ocean warming and overexploitation drive local fishers toward alternative, often illicit, livelihoods, increasing piracy and organised crime (Bueger, 2015). Simultaneously, state capacity is challenged by rising demand for enforcement and governance at sea, while transnational criminal networks exploit these governance gaps, especially as climate shocks weaken social and economic resilience. This analytical approach highlights the indispensability of linking climate and environmental policy to maritime security strategies; integrated, multi-scalar action is critical to navigate the region's evolving threat landscape and to support long-term stability and development (Belhabib, Sumaila & Pauly, 2015).

Figure 2 - Maritime Security Matrix



Source: Bueger, C., 2015.

The onshore insecurity in West Africa compounds the offshore security environment in the Gulf of Guinea, which hosts a plethora of non-traditional maritime security challenges. These include piracy, armed robbery at sea, kidnapping seafarers, illegal fishing and transnational organised crime, namely smuggling and trafficking (European External Action Service 2021). As a consequence of the prevailing threats, countries in the Gulf of Guinea continue to have difficulty effectively harnessing and maximising the use of their marine resources. Beyond this, the lack of implementation of regional policies and the poor enforcement capability of the region's forces arguably exacerbate the situation.

Climate Change as a Threat Multiplier

Climate change, when compounded with persistent maritime insecurity and a host of terrestrial challenges, has become a defining threat multiplier for sustainable development in the Gulf of Guinea. The impacts of climate change in the region are diverse and far-reaching, including but not limited to ocean warming, acidification, sea-level rise, and fishery collapse. These environmental shifts are major stressors, undermining the health of marine ecosystems and threatening the viability and resilience of coastal communities that rely on the ocean for food, employment, and cultural identity. As global temperatures continue to climb, coastal populations face mounting risks to their security, nutrition, and livelihoods. These pressures are exacerbated by pollution, overfishing, and habitat loss, which further diminish marine resources and intensify human vulnerability.

Governments in the Gulf of Guinea increasingly struggle to respond to these ecological disasters, while maritime law enforcement capacities remain under strain due to limited resources, chronic underinvestment in maritime domain awareness (MDA), and persistent "sea blindness" at the highest levels of policymaking. This lack of coordinated investment and strategic vision leaves national waters vulnerable to exploitation by sophisticated criminal networks, creating additional complications for maritime security and regional stability. These cumulative stressors lay the groundwork for subsequent, more specific environmental threats such as ocean warming, shifts in

fish distribution, and intensifying coastal erosion, which are discussed in the next section as direct drivers of maritime insecurity and ecological fragility in the Gulf of Guinea.

Ocean Warming

The Gulf of Guinea's fisheries, once a cornerstone of local economies and essential for food security, are now facing existential risks due to intensifying climate change impacts. Ocean warming, which has absorbed roughly 90% of excess atmospheric heat, disrupts marine ecosystems by forcing many key fish species to migrate to cooler waters, outside the reach of traditional fishing communities. Scientific projections indicate that the region could see its maximum fish catch potential decrease by as much as 30% or more by 2050, even if overfishing is addressed. Already, local reports confirm sharp declines: in Ghana, the catch of small pelagic fish decreased by 59% between 1993 and 2019, and by nearly 40% in Côte d'Ivoire from 2003 to 2020. These dramatic reductions have heightened competition among fishers, pushing many toward riskier activities and inciting spikes in IUU fishing by both local and foreign actors, particularly distant-water industrial fleets operating with little oversight.

This confluence of stressors places extraordinary strain on regional coast guards and navies, already limited in resources and operational capacity. Security agencies are compelled to patrol vast maritime space more intensively, often facing well-armed transnational criminal networks that exploit depleted fish stocks and weakened surveillance to entrench their activities. The resulting maritime insecurity critically undermines state authority at sea, eroding legitimate governance and amplifying lawlessness. Onshore, these challenges reverberate through heightened food insecurity, as shrinking marine resources can no longer meet the dietary and economic needs of coastal populations.

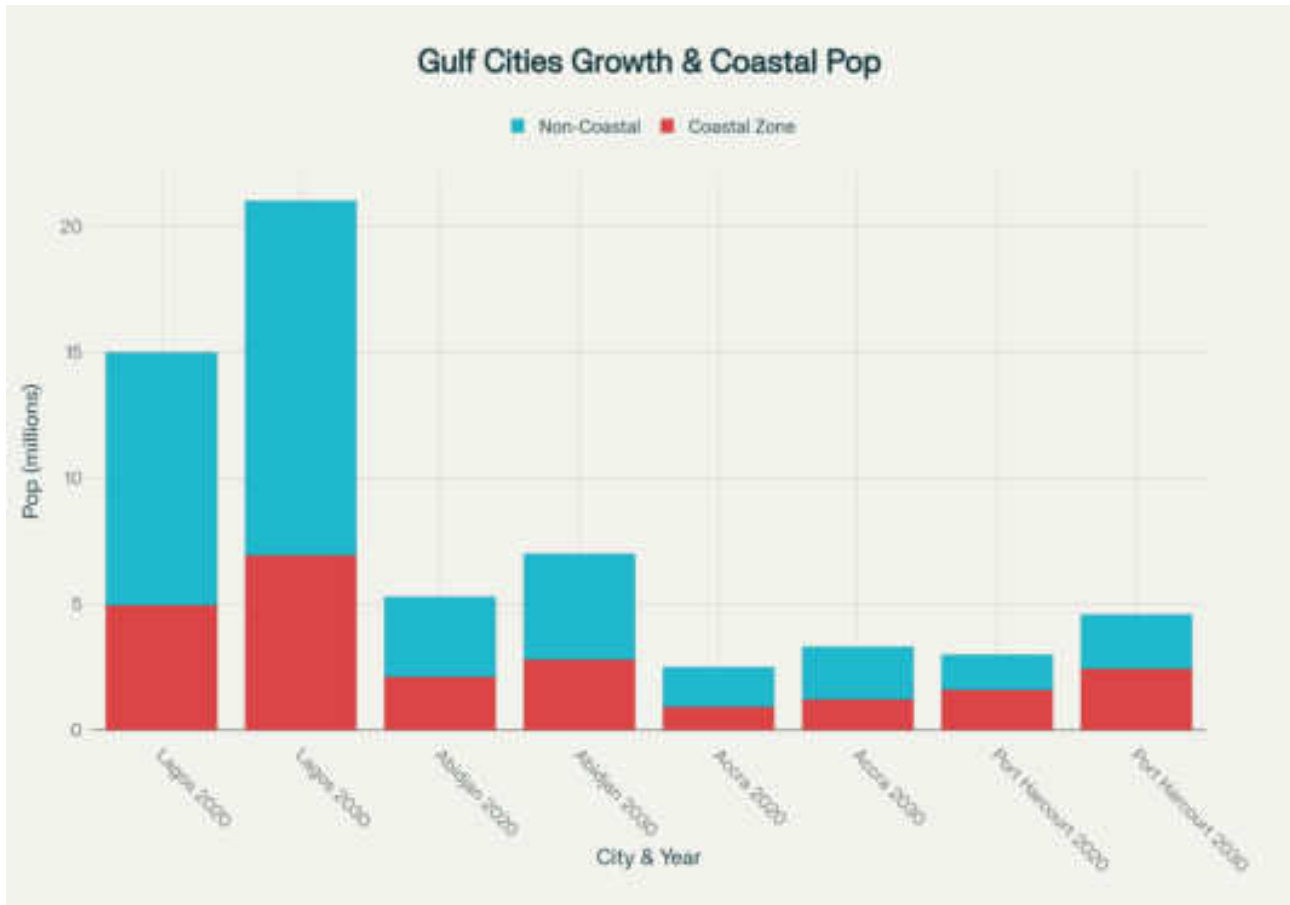
The region's experience thus demonstrates that climate-related ecological decline is inseparable from the escalation of maritime crime and criminality. Without robust, climate-adaptive management for fisheries, coupled with strengthened regional maritime coordination and effective enforcement, the Gulf of Guinea risks experiencing a vicious cycle: environmental degradation feeding into insecurity, and insecurity, in turn, exacerbating vulnerability and poverty at scale.

Sea Level Rise and Coastal Erosion

Rising sea levels directly threaten the physical and economic security of major Gulf of Guinea cities such as Lagos, Abidjan, Accra, and Port Harcourt by inundating coastal settlements, eroding shorelines, and damaging port infrastructure. Rapid subsidence and coastal erosion have already claimed tens of meters of land annually along parts of Togo, Ghana, and Nigeria, displacing entire communities and undermining confidence in state capacity. When vital choke points like ports and oil terminals are at risk, maritime trade is jeopardised, port operations are interrupted, and law enforcement mobility is reduced. Moreover, loss of land drives internal migration, creating vulnerability that can be exploited by criminal actors operating in the maritime domain. The evidence is clear: climate-induced sea level rise is pushing urban populations into deeper fragility while diminishing the security of maritime domains. Projections by the Africa Centre for Strategic Studies (2024) show that by 2030, West Africa is expected to account for over 85% of Africa's population living in low-elevation coastal zones, with Lagos alone projected to exceed 21 million people and up to 33% at risk of displacement. Accelerated coastal erosion, 2 meters per year in sections of Benin,

Côte d’Ivoire, Senegal, and Togo, compounds flooding and property loss. Infrastructure in these cities is acutely threatened, including critical ports and airports that serve as gateways for 90% of Africa’s import/export trade. Damage from erosion and flooding already costs West African countries \$3.8 billion annually, with projections for total damages as high as \$86.5 billion by 2050 if emissions remain high. Residents are forced to relocate, escalating pressure on urban centres ill-equipped to handle large-scale displacement.

Figure 3 - Projected population growth and coastal vulnerability in Gulf of Guinea cities (2020–2030)



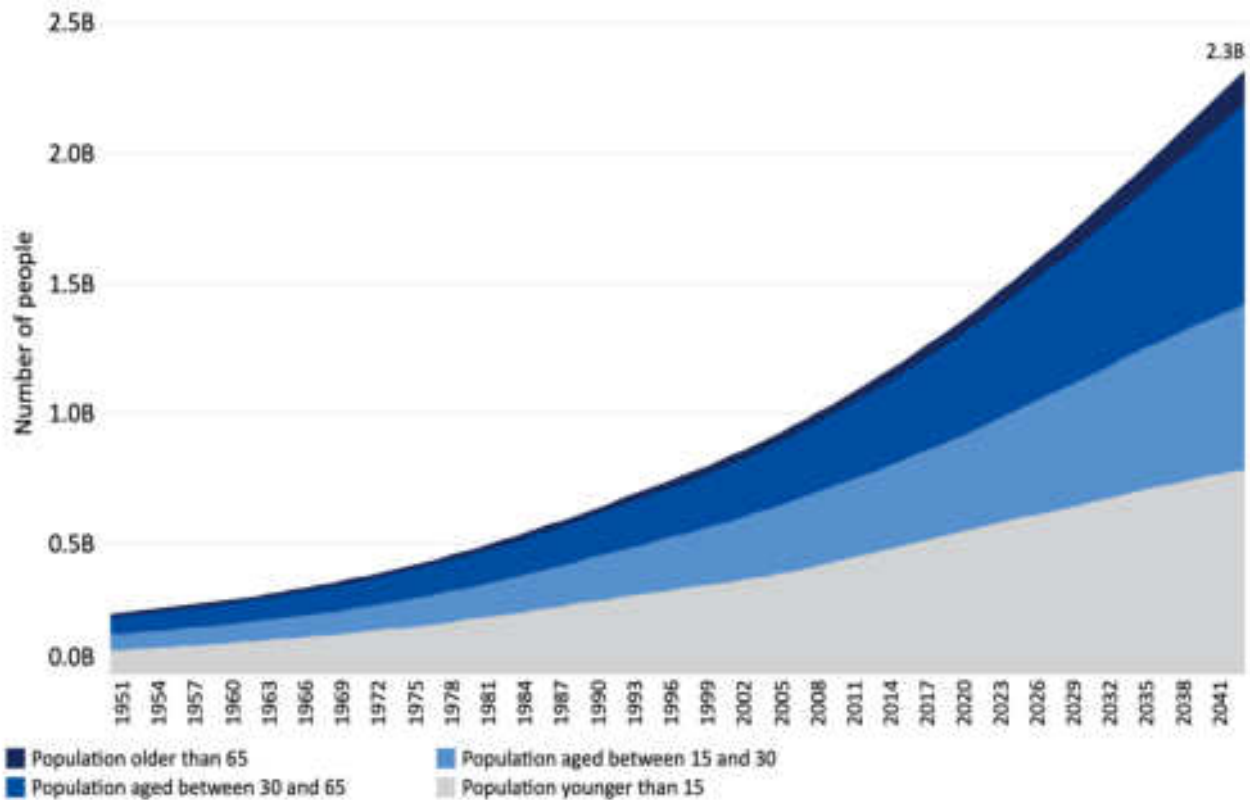
Source: Adapted from (Timidi et al, 2024)

Climate Change, a Growing Youth Population and Rapid Coastal Urbanisation

Against the background of the worsening effects of climate change, Africa is also experiencing a substantial demographic shift characterised by decreasing mortality rates, population growth, and a burgeoning youth population. Estimates show that this trend is projected to continue until 2074, with the continent reaching its demographic dividend between 2043 and 2050. The Youth dividend is a positive ratio between the working-age and elderly population, and holds the potential to stimulate economic growth and improve standards of living.²⁴

²⁴ A demographic dividend occurs when the ratio reaches and exceeds 1.7 working-age persons for every 1 dependent (those below 15 years and above 65).

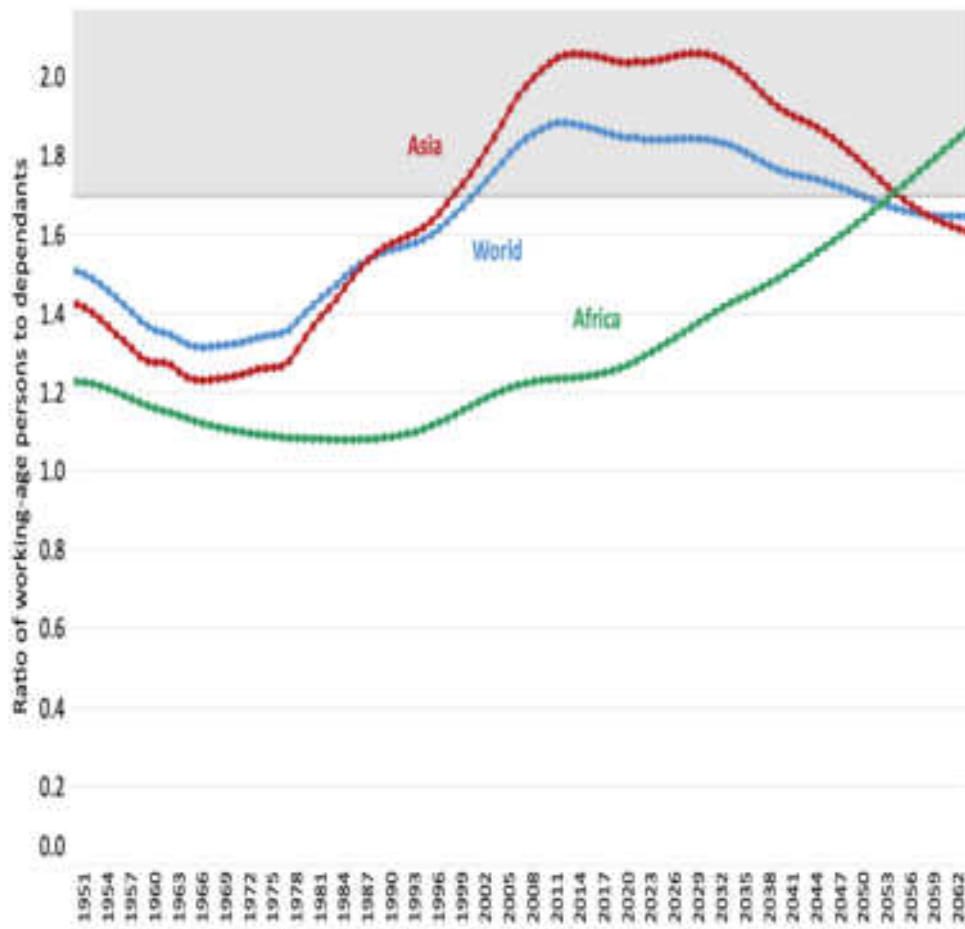
Figure 4 - Chart illustrating Africa's population from 1951 to 2041



Source: Reva, Willima and Liaga, 2024

With 60% of its 1.4 billion inhabitants below the age of 25 and a median age of 20, Africa already stands as the world's youngest continent, and this trend is set to continue. The potential is well recognised by the continent. However, without corresponding economic opportunities, the growing population could lead to increased competition, resulting in greater socioeconomic inequality, greater instability, resource scarcity, and social unrest.

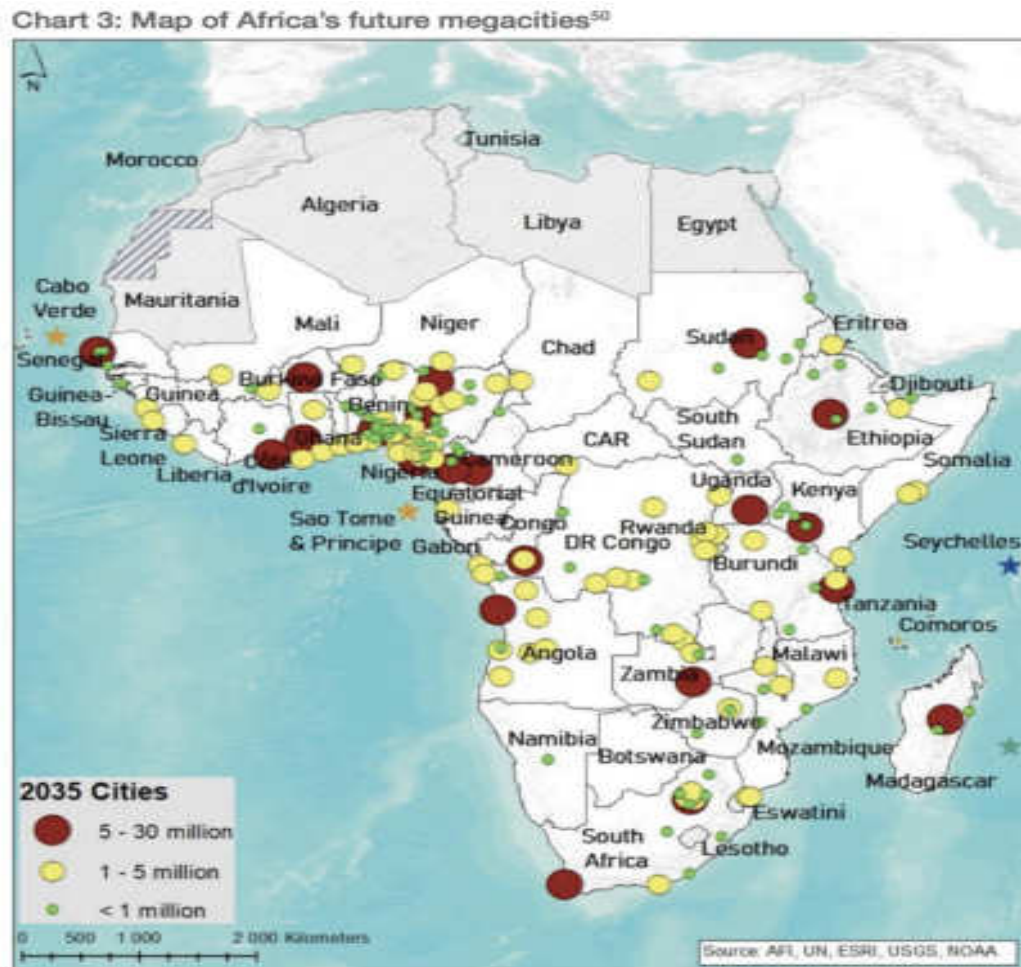
Figure 5 - Africa's working-age population in relation to Asia and the world at large



Source: Reva, Willima and Liaga, 2024

Ultimately, the interplay between climate change, a growing youth population and migration trends can be seen as a ‘fragility multiplier’, intensifying vulnerabilities and increasing the likelihood of conflict, violence and instability in already fragile regions. The coastal urban population in West Africa is expected to grow from 36 million in 2020 to over 80 million by 2050. This is expected to occur alongside a rural exodus as internal migration patterns spur the fast-paced expansion of coastal cities. Coastal cities are the economic engines of the Gulf of Guinea, generating over 50 per cent of the region’s gross domestic product (GDP). Consequently, spatial planning challenges have arisen. The rapid, often unplanned, expansion of these cities complicates spatial planning and increases exposure to climate risks. Economic development and population growth are accelerating land subsidence in these cities, compounding the effects of global sea-level rise and posing a significant hazard to urban infrastructure and economic assets.

Figure 6 - Climate and Africa's Mega Coastal Cities



Source: Reva, Willima and Liaga, 2024

Major coastal cities, Lagos, Abidjan, and Accra, face compounding urban vulnerabilities. Fluvial, pluvial, and tidal flooding in Lagos alone causes \$4 billion in annual economic loss, with future sea level rise poised to displace a third of its population by 2100. Public health crises, such as waterborne diseases (affecting 50% of Lagos hospital patients), will worsen with inundated infrastructure and contaminated groundwater. Emergency services face increasing operational complexity during extreme weather, further exposing residents to humanitarian crises during disasters (Willima and Dahir, 2023). The cumulative impact amplifies social fragility and pressure on housing, jobs, water supplies, and healthcare.

Sustainable development along the coast of West Africa faces mounting complexity due to a convergence of socioeconomic and environmental factors. Coastal population growth in the region is projected to outpace any other part of Africa, leading to rapid urbanisation, escalating demand for essential resources such as water and land, and intensified activities like sand extraction, all set against the backdrop of rising sea levels. According to the Intergovernmental Panel on Climate Change's Sixth Assessment Report, by 2030, up to 116 million Africans may be living in low-lying, densely populated coastal zones, with particularly acute vulnerability seen in major hub cities like Accra, Keta, and Takoradi in Ghana, and Saint-Louis, Dakar, and Ziguinchor in Senegal (IPCC, 2022).

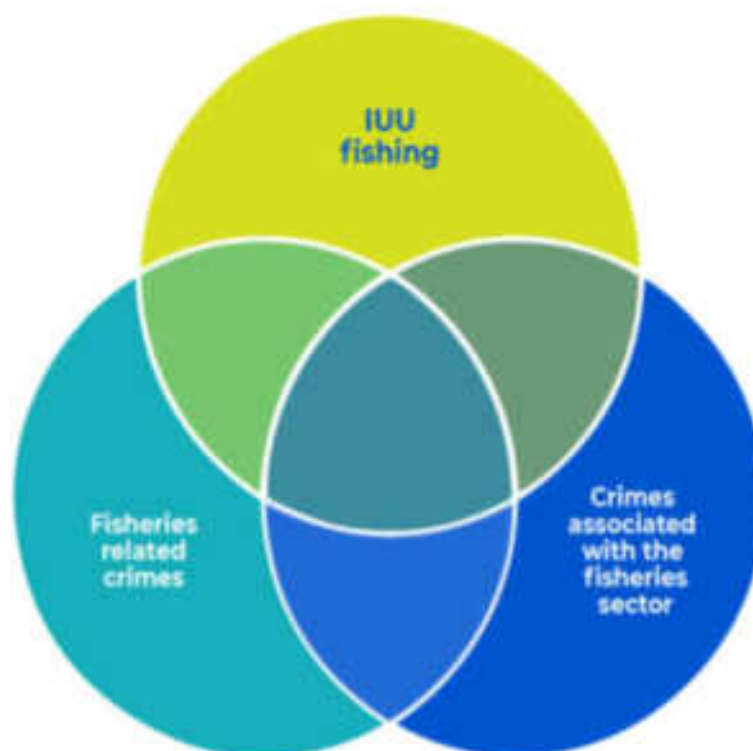
These communities, typically built close to the shoreline and lacking natural protective barriers, are increasingly exposed to coastal inundation and erosion. The consequences include loss of homes, critical infrastructure, and productive agricultural land, ultimately deepening existing socio-economic divides. Vulnerable populations also suffer public health risks, such as more frequent water-borne disease outbreaks, arising from damaged sewage and drainage systems. To safeguard these areas, it is imperative to prioritise forward-looking solutions such as resilient urban design, infrastructure investments, and, where necessary, managed relocation initiatives for adaptation to rising seas and associated hazards (Willima and Dahir, 2023).

Climate Change Fuelling IUU Fishing:

Fisheries constitute a significant component of Africa's maritime sector. The sector directly employs 12 million people and provides food and income security to 200 million people. The Gulf of Guinea's small pelagic fisheries, vital for food security and employment, have seen dramatic declines. Ocean warming, driven by climate change, is a primary cause, triggering fish migrations away from the Gulf of Guinea. However, another key contributor is illegal, unreported and unregulated (IUU) fishing. Marine heatwaves and warming ocean temperatures have already led to a poleward migration of key fish stocks, with West African fisheries expected to contract by up to 30% by 2050. In Ghana, fish population declines due to rising sea surface temperatures and salinity have threatened small-scale fisheries, with parallel observations in Nigeria's Eastern Niger Delta. Depleting fish stocks exacerbates food insecurity and undermines economic stability for millions dependent on fishing. The scarcity stimulates competition over marine resources, often leading to IUU fishing, heightened community conflict, and increased migration to cities (Timidi et al, 2024).

IUU constitutes one of the most pervasive maritime practices, serious crimes, of the 21st century. According to the Food and Agriculture Organisation (FAO), IUU fishing can constitute, lead to, or go hand in hand with other (associated) crimes in the fisheries sector (see fig. 7). These can be classified into two separate categories, namely 'fisheries-related crimes' and 'crimes associated with the fisheries sector'. The former refers to infractions such as money laundering, tax crimes, inappropriate working conditions, or document fraud, for example, forged fishing licenses. Whereas the latter, crimes associated with the fisheries sector, include violations such as piracy, narcotics, and arms trafficking, as well as human trafficking (FAO 2023).

Figure 7 - Intersections of IUU fishing, fisheries-related crimes, and crimes associated with the fisheries sector



Source: Food and Agriculture Organisation (2023)

Where these crimes intersect, the implications for the national and economic dimensions of maritime security as well as human security are wide-ranging. The persisting effects and subsequent implications are compounded by climate change.

Climate change is significantly compounding the challenge of IUU fishing in the Gulf of Guinea, making it harder to secure marine resources and the livelihoods that depend on them. While global summits increasingly highlight the urgent need for healthy oceans, the reality at sea is growing more precarious as environmental and criminal threats collide.

As the region's waters warm and sea levels rise, fish populations are dwindling and shifting their ranges, undermining the sustainability of local fisheries and weakening their ability to regenerate. This ecological stress creates new incentives for IUU fishing, particularly by well-equipped, large industrial vessels that exploit the lack of effective local enforcement. These foreign and subsidised fleets inflict the greatest harm on marine ecosystems, driving stocks toward collapse and making legal fisheries less viable for local communities.

The Gulf of Guinea's blue economy cannot thrive under current levels of illicit exploitation. Climate-driven losses and IUU fishing have already cost West African states billions in lost revenue, endangering food supplies and making communities more vulnerable to poverty and migration. For Mauritania, Senegal, The Gambia, Guinea Bissau, Guinea, and Sierra Leone alone, IUU fishing results in an estimated \$2.3 billion in annual losses.

Food insecurity is now further exacerbated by both declining climate conditions and rampant illegal fishing, leaving some communities with no alternative but to turn to illicit or desperate activities. The

erosion of trust in law enforcement and regulation, the inability of governments to protect coastal livelihoods, creates fertile ground for organised crime, piracy, and violence, compounding a climate-induced crisis of governance.

Instability resulting from unregulated fishing and climate migration raises tangible security threats. There is historical precedent for desperate fishers taking up arms, as occurred off Somalia, and the Gulf of Guinea's surge in piracy incidents up 30% in 2025 shows how criminality and climate risk feed off each other. As fish become scarcer, foreign fleets continue to encroach with impunity, often supported by opaque state subsidies, while weak national monitoring and the principle of "flag state" jurisdiction stymie local law enforcement.

Piracy, Trafficking, and Maritime Crime

Climate-driven economic hardship is a primary enabler of maritime insecurity in the Gulf of Guinea, amplifying threats posed by piracy and organised crime. As coastal ecosystems face mounting pressures, notably the depletion of fish stocks, local fishing communities experience tangible loss, evident in declining catch volumes, smaller fish sizes, and reduced seasonal yields. These shifts erode traditional livelihoods, pushing some individuals, especially youth and underemployed fishers, toward illicit alternatives such as piracy, marine smuggling, and trafficking, where perceived profits and survival outweigh risks.

IUU fishing, largely perpetrated by distant-water foreign fleets, has further compounded the crisis. Industrial-scale operations, often using sophisticated means to evade detection, strip local waters of valuable species. Small-scale fishers frequently report the intrusion of large vessels, sometimes operating at night or without licenses, which devastates stocks, damages artisanal gear, and provokes local migration in search of new resources. The collapse of nearshore fisheries increases competition, fuels community resentment, and heightens the risk of inter-community conflict as fishers travel further afield and encroach on neighbouring zones (Willima and Reva, 2021).

Climate change acts as a multiplier for these stressors. Rising ocean temperatures, altered currents, and destructive weather events reduce fish spawning grounds and coastal productivity, making local recovery almost impossible. This environmental degradation coincides with demographic pressures, growing coastal populations and urban drift, widening the chasm between available livelihoods and household needs.

Weak state capacity and the limited reach of security services further embolden maritime crime networks. National agencies and coast guards, stretched thin by resource constraints and lacking adaptive strategies that account for climate-induced change, struggle to maintain effective surveillance or enforcement. Transnational criminal organisations exploit these gaps, facilitating everything from fuel smuggling and armed robbery at sea to human trafficking and illicit bunkering. The environment of insecurity persists and expands in the absence of comprehensive, climate-aware governance, affording criminal enterprises space to operate with near impunity (Reva and Willima, 2021).

Ultimately, building resilient, legitimate livelihoods, closing governance gaps, and integrating climate adaptation into maritime security strategies are essential to disrupting the forceful nexus of climate stress and maritime crime in the Gulf of Guinea.

Policy and Regional Mitigation Frameworks

- **Regional cooperation:** Implement and expand regional frameworks, such as the African Union’s 2050 AIM Strategy, the Lomé Charter, and the West Africa Coastal Areas Management Program, to harmonise best practices, data sharing, and cross-border response to climate and security risks.
- **Climate-adaptive fisheries management:** Collaborative monitoring of fish stocks, enforcement against IUU fishing, and investment in climate-smart aquaculture.
- **Integrated coastal resilience:** Restore mangrove forests, wetlands, and dune systems to buffer against erosion and surge while providing new blue economy opportunities. Community-based adaptation and participatory urban planning are vital to protect vulnerable settlements.
 - **Earth Observation for marine monitoring:** Earth observation technologies can play a crucial role in monitoring the vast Gulf of Guinea maritime environment by supplying real-time, high-resolution data on ocean conditions, weather patterns, and coastal changes. Satellite-based remote sensing enables the tracking of sea level rise, temperature fluctuations, and the movement of fish stocks, all of which are essential indicators for understanding climate change impacts. These also help detect illegal fishing activities, coastal erosion, and environmental hazards, enhancing the capacity of regional authorities to respond to maritime threats and disasters.
 - **Green infrastructure:** Upgrade port and city infrastructure to withstand flooding, invest in efficient drainage, sanitation, and early warning systems, and prioritise affordable housing in safe areas.
- **Capacity building:** Expand training in climate risk analysis, adaptive policing, and emergency management for coastal security forces, integrating climate data with maritime surveillance.

Figure 8 - Comparative Table: Vulnerability and Impact in Selected Gulf of Guinea Coastal Cities

City	Pop. (2030 proj.)	% in Coastal Zone	Key Threats	Est. Economic Damages (2030–2050)
Lagos	21M	33%	Flooding, erosion, disease	\$4B/year flood loss
Abidjan	7M	40%	Port at risk, GDP loss	High (exact TBD)
Accra	3.3M	37%	Erosion, fishery decline	Substantial
Port Harcourt	4.6M	53%	Urban flooding, displacement	Major infrastructure damage

Source: Adapted from (Timidi et al, 2024)

Figure 9 - Diagram: Cascading Effects of Climate Change on Maritime Security in the Gulf of Guinea

- Rising sea levels → increased flooding/erosion → displacement, infrastructure loss
- Ocean warming → fish stock decline → food insecurity, resource conflict
- Displacement/urbanisation → pressure on cities → strained government capacity
- Livelihood loss → piracy/IUU fishing/trafficking increase
- Strained response resources → less effective maritime security, more criminality

The Way Forward: Cooperation and Climate Action

West African countries and regional institutions such as ECOWAS, the Sub-Regional Fisheries Commission, and the Fisheries Committee for the West Central Gulf of Guinea are strengthening monitoring, enforcement, and cooperation, but vast ocean areas and limited resources remain daunting obstacles. Mechanisms like the 2025 Yaoundé Declaration, which sets ambitious goals for ocean sustainability and conservation, reflect a growing regional commitment to holistic blue economy governance.

Further, robust implementation of the FAO Port State Measures Agreement is vital. Denying market access to illegal catch, ending harmful fishing subsidies, and international support for climate adaptation will be critical for sustainable security. Nigeria's ratification of key agreements would further boost deterrence.

Addressing IUU fishing in the Gulf of Guinea, therefore, means tackling the root causes and the climate consequences: enforcing the law, ending reckless subsidies, building coastal resilience, and mounting a united regional and global response.

Pathways to improve climate change integration into **maritime security** frameworks in the Gulf of Guinea require substantial action at both the national and regional levels. Coordinated responses must address the interconnected threats created by climate impacts such as coastal erosion, fish stock depletion, and extreme weather events, which compound existing maritime security challenges like piracy, illegal fishing, and trafficking. National strategies often lack the needed cross-sectoral planning, making it crucial for governments to intentionally mainstream climate risk analysis into maritime safety strategies.

National Level Planning

At the national level, countries in the Gulf of Guinea need to establish or strengthen inter-ministerial committees that include environmental, maritime, and security agencies. These structures can champion the integration of climate data into maritime threat assessments, guide policy on resilient coastal infrastructure, and facilitate local climate adaptation measures for vulnerable coastal communities. National blue economy and security plans must set clear objectives, identify measurable indicators related to both climate adaptation and security, and invest in early warning and response systems that reflect shifting climate patterns. Additionally, community engagement and inclusion in planning processes are critical for ensuring that policies achieve both security and sustainability outcomes, particularly for marginalised fishing and coastal populations.

Regional Coordination and Frameworks

Regionally, frameworks such as the Yaoundé Architecture, the Gulf of Guinea Commission, ECOWAS, and ECCAS must work towards harmonised, interoperable approaches. The establishment of permanent headquarters (such as the Combined Maritime Task Force, CMTF), joint operational protocols, and intelligence-sharing mechanisms is vital for regional coherence. There is a strong need for coordinated resource mobilisation strategies and costed implementation plans that target both security and resilience-building infrastructure. Furthermore, policy alignment with AU frameworks like AIMS 2050 and the Lomé Charter should be fostered, including the development of technical expert groups to support member states in mainstreaming climate considerations into their maritime security units and exercises.

Actionable Steps and Recommendations

- **Nationally:** Countries should mandate holistic risk assessments that combine environmental, climate, and security data to inform maritime law enforcement training, coastal policing, and disaster risk reduction programming.
- **Regionally:** Increased synchronisation of operational efforts, such as intelligence sharing, joint patrols, and regional exercises, is required to address the transboundary nature of both climate impacts and security threats.
- **Strategically:** Institutionalise reporting and monitoring mechanisms to ensure cross-sectoral progress, drawing on both national data sharing and regional coordination hubs
- **Partnerships:** Strengthen collaboration with international partners and the private sector for capacity building, technical innovation, and resource mobilisation targeting climate-resilient maritime infrastructure and coastal community resilience.

Delivering on these pathways requires sustained political will, adequate funding, and inclusive multi-stakeholder engagement at all levels of planning and decision-making.

Climate change is fundamentally reshaping the maritime security seascape in the Gulf of Guinea, compounding longstanding threats and creating new risks for coastal communities across West Africa. The region faces a complex web of challenges, from the depletion of fish stocks and the escalation of illegal fishing to the deepening impacts of sea level rise, coastal erosion, and rapid urbanisation. These urgent environmental pressures undermine livelihoods and governance capacity, intensify competition over resources, and fuel maritime crime, all while straining the ability of governments to protect their people and manage their marine assets. Addressing these intertwined vulnerabilities demands an integrated, forward-looking approach that brings together climate adaptation, regional cooperation, and enhanced maritime law enforcement. By investing in resilient coastal infrastructure, involving local communities in decision-making, and strengthening regional frameworks, the Gulf of Guinea can move towards greater stability and security in the face of mounting climate-related risks. Ultimately, the future of maritime security in the region will depend on the ability of states and stakeholders to work together in crafting holistic solutions that safeguard both human well-being and the ecological integrity of the ocean.

Key Findings

- **Maritime Security Threats:** Climate change-driven depletion of fish stocks and coastal degradation are exacerbating the risk of piracy, trafficking, and other maritime crimes as communities face loss of livelihoods and governance gaps.
- **Climate Change is a Threat Multiplier:** Ocean warming, acidification, and sea-level rise are amplifying fragility by undermining coastal ecosystems, food security, and the resilience of communities, fueling instability and resource conflicts.
- **Coastal Vulnerabilities:** Rapid coastal erosion, subsidence, and flooding are displacing populations, damaging infrastructure, and heightening socioeconomic risks in key West African cities, especially those lacking protective barriers and resilient planning.
- **Climate Impacts on Fisheries:** Ocean warming and illegal fishing have led to dramatic declines in local fish stocks, undermining food security, driving economic hardship, and pushing fishers toward illicit activities and migration.
- **Rising Sea Levels:** Accelerated sea-level rise and coastal erosion threaten the viability of major ports and urban centres, causing annual economic losses and increasing the displacement and vulnerability of millions.
- **Growing Youth Population:** Africa's demographic dividend offers economic promise but, without adequate job creation, risks exacerbating inequality, instability, and migration pressures, especially when compounded by climate impacts.
- **Rapid Coastal Urbanisation:** Urban population growth and unplanned coastal expansion are intensifying exposure to climate risks and resource scarcity, while compounding infrastructure, public health, and socioeconomic challenges in coastal cities.

Recommendations

- **Integrate Climate and Security Strategies:** National and regional maritime security strategies should explicitly incorporate climate adaptation, including early warning systems, climate-resilient infrastructure, and nature-based solutions
- **Community-Based Coastal Resilience:** Support for local adaptation initiatives, such as coastal protection, livelihood diversification, and ecosystem restoration, can build resilience and reduce displacement
- **Build State Capacity:** Invest in maritime domain awareness, law enforcement, and governance reforms to address both immediate security threats and underlying vulnerabilities
- **Inclusive Governance:** Engage local communities, especially women and youth, in decision-making and adaptation planning to ensure responses are grounded in local realities and priorities
- **Earth observation technologies:** utilising satellite-based remote sensing, significantly enhance maritime operations by providing real-time data on sea conditions, weather patterns, and environmental changes, improving efficiency, safety, and sustainability (GMES & Africa).

References

- Africa Centre for Strategic Studies. (2024). Rising Sea Levels Besieging Africa's Booming Coastal Cities: Lagos, Dakar, Alexandria, Maputo, Nile. Retrieved from africacenter.org.
- Belhabib, D., Sumaila, U. R., & Pauly, D. (2015). Feeding the poor: Contribution of West African fisheries to employment and food security. *Ocean & Coastal Management*. <https://www.sciencedirect.com/science/article/pii/S0308597X14003327>
- Bueger, C. (2015). What is maritime security? *Marine Policy*, 53, 159–164. <https://doi.org/10.1016/j.marpol.2014.12.005>
- European External Action Service (EEAS). (2021). The EU launches its Coordinated Maritime Presence concept in the Gulf of Guinea. https://www.eeas.europa.eu/eeas/eu-launches-its-coordinated-maritime-presences-concept-gulf-guinea_en
- Food and Agriculture Organisation (2001). International Plan of Action to Prevent, Deter, and Eliminate Illegal, Unreported and Unregulated Fishing. https://www.wto.org/english/tratop_e/rulesneg_e/fish_e/2001_ipoa_iuu.pdf
- Food and Agriculture Organisation of the United Nations. 2023. Illegal, Unreported and Unregulated Fishing. <https://www.fao.org/iuu-fishing/background/links-crimes/en/>
- Intergovernmental Panel on Climate Change. (2022). Chapter 9: Africa. In *Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. <https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-9/>
- Otto, L. (2020). *Global challenges in maritime security: an introduction*. Advanced Sciences and Technologies of Security Applications. Switzerland: Springer Nature.
- Ramachela, T. (2023). *African Maritime Security: A human security approach to maritime securitisation – The case for an alternative analytical framework* [Master Thesis, University of Pretoria].
- Reva, D., Willima, D., & Liaga, E. A. (2024). Charting Africa's blue future: Youth inclusion as a catalyst for peace and development. ISS Africa. <https://issafrica.org/research/africa-report/charting-africa-s-blue-future-youth-inclusion-as-a-catalyst-for-peace-and-development>
- Timidi, E. T., Daubiri, S. P., & Orusengha, P. E. (2024). Climate Change and Maritime Security: Implications for Africa's Regional Development. *The Root Journal*, 1(1), 1-26
- Willima, D., & Dahir, I. (2023, June 19). Rising tides threaten low-lying coastal West Africa. ISS Africa. <https://issafrica.org/iss-today/rising-tides-threaten-low-lying-coastal-west-africa>
- Willima, D., & Reva, D. (2021, November 18). Illegal fishing: another target in West Africa's maritime battleground. *ISS Today*. <https://issafrica.org/iss-today/illegal-fishing-another-target-in-west-africas-maritime-battleground>

A Comparative Study of the Effects of Climate Change on Maritime Security in Ghana and Nigeria

Juliet Afrah Obeng, Alberta Ama Sagoe, Kofi Amponsah Duodu and Lawrence Dogli

Introduction

The Gulf of Guinea has long been regarded as a maritime cornucopia. It feeds coastal communities, fuels national economies and knit together the fortunes of the West African coast through shared currents, shared fish stocks and shared peril as well. West Africa experiences climate change at rates exceeding the global average, with temperatures rising 1-3°C since the 1970s and unprecedented shifts projected by the 2040s (Khomsy et al., 2023). Rising sea-surface temperatures, increasingly erratic monsoonal patterns and accelerated coastal erosion have become measurable realities reshaping the littoral environments of West Africa's coast, including that of Ghana and Nigeria (Abija et al., 2020; Ankrah, 2024). These physical climatic transformations according to Goodman et al. (2023), act as "threat multipliers" that intensify pre-existing maritime security pressures on coastal populations, port infrastructures, fisheries and offshore energy installations, while simultaneously creating new vulnerabilities that state and non-state actors can exploit.

In Ghana, the erosion of the eastern seaboard from the Ada estuary to the Volta Delta threatens fishing settlements, inundates roads and undermines coastal activities (Brempong et al., 2023). Further, the harmattan-induced upwelling shifts pelagic species together with fishing activities farther offshore, beyond the reach of Ghana's limited patrol fleets (Amponsah, 2015; Cook et al., 2021). Nigeria, with a coastline six times longer, faces a more complex web of climate-linked maritime threats. Sea-level rise and extreme rainfall compound flooding and pollution in the Niger Delta, (Musa et al., 2014; Balogun, 2022), while plastic-laden runoffs disrupt navigation and pose as feed for aquatic life and catch for fishers. (Awode et al., 2025). The poleward migration of fish stocks like sardinella and mackerel (Kapstein, 2023) threatens fisheries relationships among fishing communities which if not handled properly could escalate to interstate fishing dispute. Not only is the climate changing, but the security consequences of those changes are also transcending borders and yet institutional silos are compounded by fragmented, state-centric policies ill-suited to managing compound coastal risks. The effects of climate change are evolving from a purely environmental threat to resource conflict which could threaten the cordial coexistence among coastal states. The West Africa coast is warming faster than policymakers can adapt, and the consequences are now measured not just in sea-level rise, but in lost coastline and displaced livelihoods. Ghana and Nigeria, though not immediate neighbors, share the same turbulent ocean and with it a misconceived perception of how climate stress translates into maritime insecurity. This calls for collective action beyond the current state centric approaches to climate induced risks and vulnerabilities in areas such as fisheries.

In recent years, climate change and maritime security have emerged as critical priorities on the global policy agenda with increasing recognition of their complex and interrelated impacts, particularly in vulnerable regions such as West Africa (Germond & Mazari, 2019; Siebels, 2020; Omotoso et al., 2023). There is growing evidence of the nexus between climate change and maritime security demonstrated by the intensification of existing threats by climate variability, creating new risks in the

maritime domain. The direct (Rubekie et al., 2022) and indirect effects (Ali et al., 2022) of climate change on marine and coastal ecosystems, maritime transport, tourism and the livelihoods of coastal communities have been extensively documented in both the natural and social sciences. Simultaneously, scholarly and policy literature extensively document the evolution of maritime crimes including illegal fishing, piracy, armed robbery at sea, drug smuggling, human trafficking and their intricate linkages to economic, social, political and geopolitical drivers. This evidence delineates a discernible trajectory in maritime security, framing these activities not as isolated occurrences but as manifestations of broader structural dynamics shaping the security landscape (Bueger & Edmunds, 2024).

Rising sea temperatures are altering fish migration, eroding shorelines and affecting catch volumes and patterns, forcing artisanal fishers to migrate. Additionally, piracy and armed robbery at sea adapt to altered seasonal windows when patrol craft are grounded by extreme weather (Jiang & LaFree, 2023; and displaced fishers feed into networks of smuggling and human trafficking (Otto & Jernberg, 2020). Coastal communities with their mangroves eroding and incomes collapsing are being driven into informal economies that further erode maritime order. As noted by the Intergovernmental Panel on Climate Change (IPCC) as early as 1990, climate change-induced displacement of coastal dwellers, including those in West Africa, has fueled the movement of “climate migrants” estimated to reach 200 million people in 2050 (IOM, 2008). The Atlantic Ocean countries continue to grapple with the perilous challenge of migrants primarily from West Africa who embark on perilous sea voyages to Spain’s Canary Islands and other destinations in Europe, driven by factors like poverty, conflict, climate change, and stricter land-based migration routes. Against this backdrop, the traditional security architecture of the region which is still largely framed around conventional notions of naval power, port policing and maritime domain awareness should recognize the security implications of a “warming ocean”.

Notwithstanding these converging realities, academic and policy discourses remain compartmentalized. Climate research often emphasizes terrestrial concerns agricultural yields, urban heat islands and inland flooding (Hemat et al., 2025) while maritime security studies continue to focus narrowly on human actors like pirates and smugglers (Song, 2023), treating the ocean as a passive backdrop. Even where climate-security links are explored, analyses are frequently global in scale (Timidi et al., 2024), obscuring the nuanced political and ecological differences between Ghana’s centralized governance and Nigeria’s fragmented federal structure. This disconnect means decision-makers lack grounded insights into how specific climate stressors translate into unique maritime security patterns within and across national boundaries. Despite the growing recognition of climate change as a driver of maritime insecurity, the specific linkages between the two remain underexplored, underscoring the need for this study to fill a critical knowledge gap.

This study, therefore, poses a single, urgent question: How exactly does environmental variability become security volatility in the maritime domains of Ghana and Nigeria and what can these countries do, individually and collectively, to get ahead of the curve? The justification is stark: without a precise, comparative understanding of the mechanisms that link climate stress to maritime crimes such as piracy, smuggling and IUU fishing, both states will continue chasing symptoms that evolve faster than their security responses. The study is built around three interconnected objectives. First, it will empirically trace the concrete pathways through which climate change currently heightens maritime threats and vulnerabilities in both countries. Second, it will analyze the institutional responses and policy frameworks addressing climate-related maritime security challenges in Ghana

and Nigeria. Finally, it will offer pragmatic yet forward-leaning recommendations that embed climate resilience at the core of a shared maritime-security paradigm, moving both nations from reactive crisis management to anticipatory and cooperative governance.

In addition, this inquiry explicitly situates its analysis within the broader Atlantic framework, recognizing that the Gulf of Guinea constitutes a vital sub-system of the wider Atlantic basin whose environmental and security dynamics are deeply interlinked. The study aligns with the Atlantic Centre's research and policy coordination framework, which seeks to advance a comprehensive Atlantic approach to security, governance, and sustainability. The study contributes to the Atlantic Centre's objective of improving collaborative, cross-regional solutions to shared maritime challenges, ensuring that insights from Ghana and Nigeria enrich a broader Atlantic dialogue on climate–security interdependence by engaging with this framework.

Conceptual framework

The conceptual framework for the study is structured around three core elements: climate change variables, maritime security dimensions and mediating factors. Climate change refers to persistent shifts in climatic patterns, including rising temperatures, shifting precipitation regimes, and sea-level rise largely caused by human activities (Trenberth, 2018). These changes significantly affect ocean systems through acidification, warming waters and more frequent and intense extreme weather events, threatening both ecosystems and human activity in maritime zones. Maritime security is frequently defined as a condition of a maritime environment that is free from various threats to territorial sovereignty and the enforcement of national and international laws aimed at ensuring the realization of a country's national interests. It encompasses both traditional state-based issues and non-traditional or transnational security threats, including piracy, armed robbery, environmental crime, and terrorism (Burger, 2015; Pratama et al., 2024). The study asserts that climate change compounds the rates and impacts of maritime crimes like piracy, illegal fishing, smuggling, and illicit migration on human wellbeing, environmental resources and blue economy sectors (Abdullah et.al, 2024). Mediating mechanisms established at local, national, and regional levels determine the degree to which the impacts can be mitigated.

In this framework, we argue that the nature and extent of global climate change impacts on maritime security are dependent on mediating factors, including a) governance and policy responses, b) institutional capacity, c) socioeconomic resilience of coastal communities and d) the degree of regional cooperation. This framework is comparative, applying the concept to cases in both Ghana and Nigeria to highlight similarities and differences in exposure, response and outcomes. This structure allows for a nuanced understanding of how climate-induced stressors interact with national and regional systems to shape maritime security in West Africa (Figure 1).

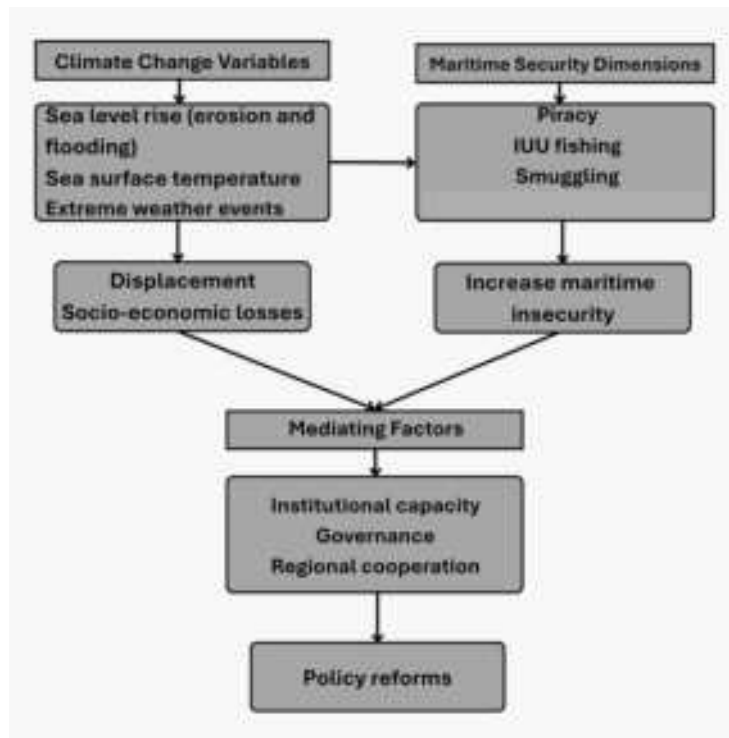
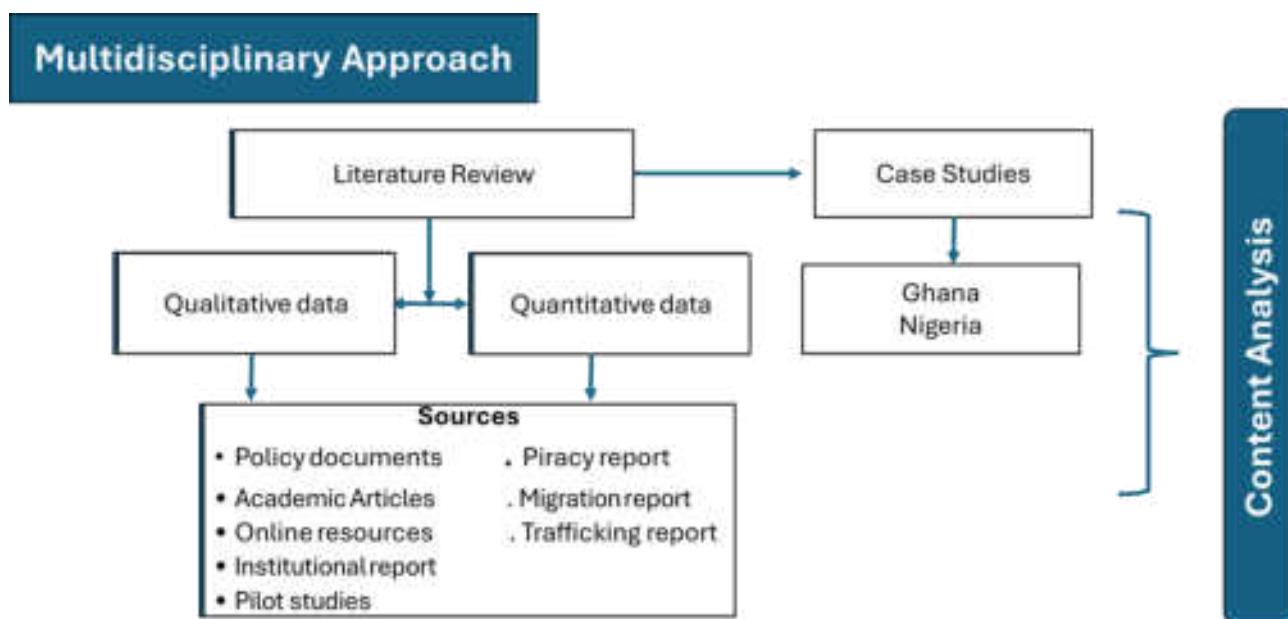


Figure 1: Conceptual framework for the Study. Source: Gulf of Guinea Maritime Institute, 2025.

Research Approach

The study was geographically focused on the coastal and maritime domains of Ghana and Nigeria, two West African countries with extensive coastlines and significant maritime interests. The research was designed as a comparative analysis that systematically compared and contrasted the experiences, responses and vulnerabilities of these two nations over a decade (2015-2025). Following a desktop research approach, the study conducted systematic collection, review and analysis of existing secondary data and literature including peer-reviewed academic articles, reports from international organizations, government publications, policy documents and reputable news sources. The analysis involved synthesizing information on climate change impacts, maritime security threats, institutional frameworks, and policy responses in both countries, following a comparative approach. The comparative approach highlighted similarities and differences and provided a nuanced understanding of the challenges and opportunities for enhancing climate resilience and maritime security in the Gulf of Guinea region. The study acknowledged the limitations of a desktop-based approach, such as reliance on available published information and the potential for rapidly evolving situations on the ground but aims to provide a robust foundational analysis for further research and policy action.



Strategic Importance of the West African Maritime Domain

The West African maritime domain, particularly the Gulf of Guinea, holds immense strategic significance, a status underscored by its role as a critical node in global maritime trade routes and a repository of vast natural resources (Mohammed & Dalaklis, 2024). This region facilitates the transit of a substantial volume of international commerce, including vital energy supplies from the Niger Delta and serves as a key fishing ground, supporting the livelihoods of millions of coastal inhabitants. The economic zones of Ghana and Nigeria within this broader domain, are rich in hydrocarbons and fisheries, making their stability crucial for national and regional economic development (Muhammed et al., 2024). Furthermore, the maritime environment supports a range of blue economy activities, from shipping and port operations to tourism and emerging offshore industries, all of which contribute to the GDP of coastal nations. The security and stability of this domain are therefore not only vital for the riparian states but also for international partners who rely on its waterways for trade and energy security. Disruptions in this area, whether from traditional security threats or climate-induced challenges, can have far-reaching consequences impacting global supply chains, regional food security and the socio-economic well-being of coastal communities (Marangio, 2025). The increasing global focus on maritime security in the Gulf of Guinea driven by concerns over piracy, illegal fishing and other illicit activities, further highlights its geopolitical importance and the need for robust governance structures to manage its resources and ensure its security.

The Maritime Security Landscape in Ghana and Nigeria (Pre-Climate Change Focus)

Prior to a detailed examination of climate change impacts, it is essential to understand the baseline of the maritime security landscape in Ghana and Nigeria. Both nations, while sharing the Gulf of Guinea, have historically faced different scales and types of maritime threats, shaped by their distinct geographical features, economic structures and governance capacities. The maritime environment in this region was already characterized by a range of security concerns, from petty crimes and illegal fishing to more organized and violent acts such as piracy and armed robbery at sea (Bueger & Edmunds, 2024). These pre-existing conditions form the backdrop against which the amplifying

effects of climate change must be assessed. Understanding this baseline is crucial for isolating the specific influence of climate change and for appreciating the compounded challenges faced by these nations. The security dynamics in the Gulf of Guinea have long been a concern for regional and international stakeholders, prompting various initiatives to enhance maritime domain awareness, improve law enforcement capabilities and promote regional cooperation. However, the underlying drivers of insecurity, often rooted in socio-economic deprivation, weak governance and political instability in coastal areas have proven persistence (Danso & Okyere, 2023). The scope of this analysis was defined by a 10-year timeframe from 2015 to 2025, allowing for an examination of the enduring maritime security challenges in Ghana and Nigeria prior to the Paris Agreement era to address the acceleration of climate change.

Ghana

Ghana's maritime domain was generally considered more stable and secure compared to its eastern neighbor, Nigeria (Asamoah & Agyekum, 2024; Amao et al., 2024). The country benefited from a relatively stable political environment and had made efforts to develop its maritime governance structures. The key maritime activities included fishing, which is a critical source of livelihood for coastal communities and a significant contributor to food security and the emerging oil and gas sector, with the Jubilee Field coming onstream. Port operations, particularly at Tema and Takoradi, also formed a vital part of the maritime economy. However, in the period under review, Ghana was not entirely free from maritime security challenges. Incidents of piracy and armed robbery at sea, though less frequent and often less violent than in the Niger Delta region, did occur (Figure 3/Appendix 1). Illegal, Unreported and Unregulated (IUU) fishing by foreign and domestic vessels was also a persistent problem, depleting fish stocks and undermining the livelihoods of local artisanal fishers (Figure 3/Appendix 1). Smuggling of goods, including petroleum products, and human trafficking also posed challenges to law enforcement agencies (Figure 3/Appendix 1). The Ghana Navy and Marine Police were the primary agencies responsible for maritime security, but their capacities, particularly in terms of surveillance, patrol assets and inter-agency coordination, were often stretched (Ali & Young-Adika, 2021). The discovery of offshore oil and gas reserves introduced new security considerations, requiring enhanced protection for critical infrastructure and a more robust response to potential environmental threats. While not facing the same level of acute insecurity as Nigeria, Ghana's maritime domain was characterized by underlying vulnerabilities and emerging threats that required ongoing attention and capacity building.

Nigeria

Nigeria's maritime domain, particularly the Niger Delta region and its environs, presented a far more complex and severe security landscape. The Gulf of Guinea had become a global hotspot for piracy and armed robbery at sea, with a significant proportion of incidents occurring in or near Nigerian waters (Lamptey, 2023). These attacks ranged from simple boardings and theft to sophisticated kidnappings for ransom targeting crew members and hijackings of vessels for cargo theft, especially petroleum products (Figure 3/Appendix 1). The roots of this insecurity were deeply intertwined with the socio-economic and political dynamics of the Niger Delta, including widespread poverty, environmental degradation from oil extraction, feelings of marginalization among local communities and the proliferation of armed groups (Elisha & Gbaranbiri, 2024). Beyond piracy, Nigeria faced rampant illegal bunkering (theft of crude oil), illegal refining and smuggling of stolen petroleum products, which not only caused significant economic losses but also fueled corruption and criminality (Beckley, 2024). IUU fishing was also a major concern, further straining local livelihoods.

The Nigerian Navy, despite being one of the largest in West Africa, faced considerable challenges in effectively policing its vast maritime territory due to resource constraints, logistical limitations and at times, allegations of complicity in illicit activities. The complexity of the security environment was compounded by the interconnectedness of maritime crime with onshore criminal networks and in some instances, with insurgent groups. Addressing maritime insecurity in Nigeria required a multi-faceted approach, encompassing not only robust law enforcement and naval presence but also efforts to address the root causes of conflict and criminality in the coastal regions. The international community, including organizations like the UNODC and regional bodies actively engaged with Nigeria to support its efforts to improve maritime security in the Gulf of Guinea (Lampitey, 2023). Research has indicated strong links between these criminal activities and the theft of crude oil, with criminal groups recruiting impoverished youths to hijack tankers and siphon oil (Beckley, 2024). The immense illicit profits from this oil theft, about \$23bn in oil revenue was lost in 2022 for Nigeria alone, potentially fueling arms trafficking, corruption and widespread lawlessness creating a vicious cycle that undermines development and security efforts (Mbah, 2024).

Despite both Ghana and Nigeria facing similar maritime threats, Nigeria's maritime security environment has historically been more severe and complex than Ghana's, driven by the Niger Delta's socio-economic challenges, environmental degradation and entrenched criminal networks. In contrast, Ghana has experienced comparatively fewer and less violent incidents, aided by a more stable political environment and relatively stronger governance structures, though its naval capacity remains limited. While Ghana's primary concerns include IUU fishing and emerging threats to offshore infrastructure, Nigeria must contend with a deeply entrenched cycle of criminality, oil theft and corruption, making its security challenges both broader in scope and more difficult to resolve.

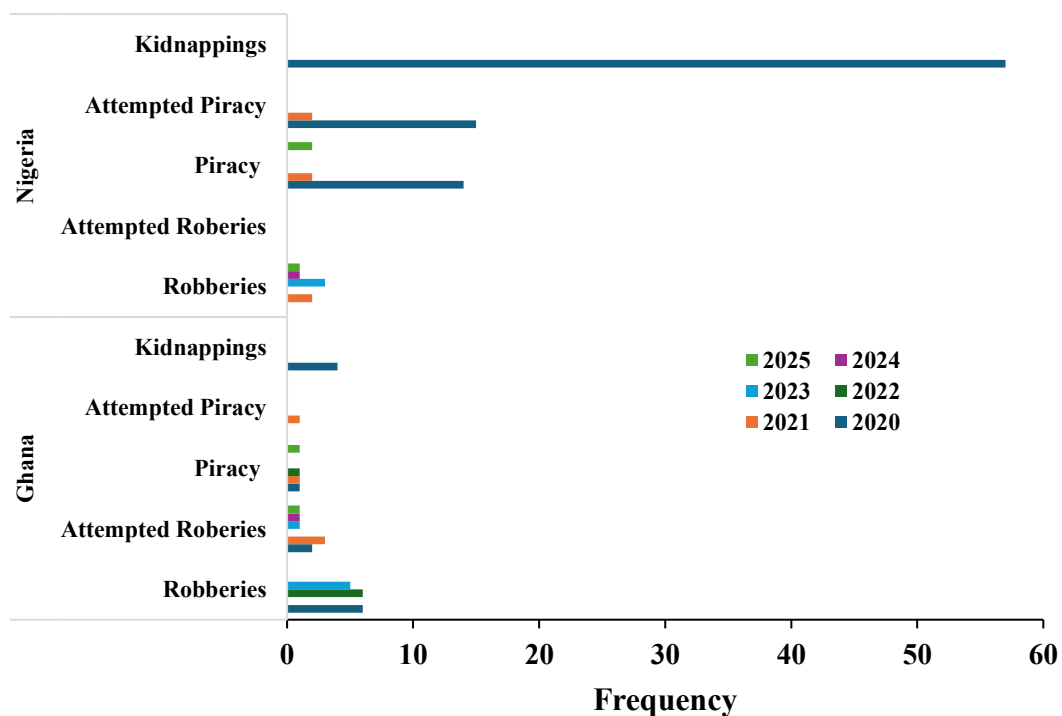


Figure 3: Piracy and Armed Robbery incidences for Ghana and Nigeria (2020- 2025) Source: Gulf of Guinea Maritime Institute, 2025/data from International Maritime Bureau

Observed and Projected Climate Change Effects in Coastal West Africa

Coastal West Africa is on the front lines of climate change, experiencing a range of observed and projected environmental shifts that have profound implications for its maritime security. Observations and projections of the different Climate change variables and their impacts on coastal West Africa are discussed below.

Rising Temperature and Rainfall Patterns

The region is warming at a faster rate than the global average, with temperatures having increased between 1°C and 3°C since the mid-1970s, particularly in the Sahelian zones that influence coastal hydrology and livelihoods (CDKN/ACDI, 2022). Rainfall patterns are becoming less predictable, complicating agricultural and water resource management far beyond the immediate coast, but with knock-on effects for migration and resource pressure in coastal zones (Mbaye et al., 2021). Unprecedented changes in temperature and precipitation are projected for the coming decades, with some scenarios indicating a potential temperature increase of +2.3°C by 2060 for West Africa, equating to a warming of +0.6°C per decade (Brandam, 2022). This accelerated warming contributes to more erratic precipitation, leading to an increase in the frequency and intensity of extreme weather events such as floods, droughts, coastal erosion and soil erosion in river basins that drain into the maritime domain (see: Box 2). These terrestrial impacts are intrinsically linked to the marine environment through sediment flows, nutrient cycles and freshwater input, affecting coastal ecosystems and fisheries (Hunt, 2024).

Warming sea temperatures, ocean acidification and changes in ocean currents are altering marine habitats and fish distribution, leading to a decline in fish stocks. This decline is not uniform, but the overall trend points towards reduced productivity in many traditional fishing grounds. For example, in Côte d'Ivoire, the total fish catch fell by nearly 40% between 2003 and 2020 (Paarlberg, 2024). Similarly, Ghana experienced a drastic 59% drop in landings of small fish between 1993 and 2019 (Paarlberg, 2024). Projections for Ghana, Nigeria and Côte d'Ivoire suggest that fish hauls could plummet by another 50% by 2050 if current trends continue (Paarlberg, 2024). This reduction in fishery resources directly translates into livelihood insecurity for coastal communities heavily reliant on fishing. As traditional income sources dwindle, communities face increased poverty and food insecurity, creating a desperate situation that can push individuals towards alternative, often illicit activities to survive.

Sea Level Rise and Coastal Erosion

A critical impact directly affecting the maritime domain is the rise in sea levels. Sea-level rise is already producing measurable harm to coastal communities along the Gulf of Guinea, accelerated coastal erosion and tidal inundation due to rising sea level have resulted in the displacement of entire settlements, as seen in Ghana's Anlo Beach and Nigeria's Ayetoro (World Bank, 2020). The encroaching sea also causes saltwater intrusion into freshwater aquifers, particularly in low-lying areas of Senegal, Gambia, and Benin, contaminating drinking water sources and reducing agricultural productivity (UNEP, 2023). In urban areas such as Lagos and Abidjan, recurrent coastal flooding disrupts transport, damages infrastructure, and elevates health risks through contamination of drainage systems (IPCC, 2023). Projections for sea-level rise in West Africa vary with some models suggesting an increase of 1.06 m by 2100, though these figures often do not fully account for the compounding effects of storm surges and increased wave action, which significantly exacerbate coastal erosion and flooding by 5,500 km² (WACA, 2019). According to Avornyo et al. (2023),

satellite observation data indicated a sea-level rise by about 5.3 cm from 1993 to 2014 at an annual trend of 2.52 ± 0.22 mm/yr, accounting for 31% of the observed annual coastal erosion rate (about 2 m/yr) in Ghana. However, according to Ikuemonisan et al. (2023), sea-level data from the Nigerian Institute of Oceanography and Marine Research indicated an accelerating rise of about 2.1 mm per year between 1986 and 2015, with projections suggesting an increase of 0.12 m by 2025 and 0.25 m by 2050 along the Lagos coast, highlighting a growing vulnerability of Nigeria's low-lying coastline to relative sea-level rise.

Coastal erosion is a major concern with vulnerable coastlines characterized by low relief, subsidence and high wave energy experiencing extensive shoreline erosion. For instance, a Coastal Vulnerability Index (CVI) developed for Accra - Ghana, depicted moderate vulnerability (Avornyo et al., 2023) (Figure 2). Furthermore, the Dynamic and Interactive Vulnerability Assessment model (DIVA model) application to the West African coast identified Nigeria, Guinea-Bissau, Guinea, Benin, Ghana, Sierra Leone, Gambia, Liberia and Cote d'Ivoire among the top 15 most vulnerable countries in Africa to sea-level rise (Dada et al., 2024). These physical changes are not occurring in isolation but are interacting with human systems, leading to loss of land, displacement of communities, and damage to coastal infrastructure, thereby increasing social vulnerability and potential for conflict over diminishing coastal resources. The UNESCO report highlights that Ghana has paid a price for its economic achievements over the past decade with substantial losses along its coastline and this erosion is expected to worsen with ongoing sea-level rise and climate change (UNESCO, 2024).

The scale and visibility of climate change impacts vary between both countries. In Ghana, documented shoreline retreat has been directly linked to sea-level rise, with coastal cities like Accra categorized as having moderate vulnerability and substantial economic losses already recorded. Nigeria's inclusion among the continent's top 15 most vulnerable nations reflects the extensive low-lying areas of the Niger Delta, where erosion, flooding and saltwater intrusion threaten densely populated and economically vital zones. While Ghana's climate challenges are often framed in terms of balancing economic gains with environmental costs, Nigeria's are compounded by the Delta's socio-economic fragility, meaning climate-induced losses there have an even greater potential to exacerbate instability and conflict.

Box 2: Case studies of the effect of climate change in Ghana and Nigeria

1. Coastal Erosion and Flooding (Ghana)

- Coastal flooding in Accra has intensified due to increased rainfall variability, urban sprawl and blocked drainage systems. There was frequent inundation of low-lying communities like Chorkor, James Town and La, leading to health risks and economic losses (Agyeman et. al., 2021)
- On 6 March 2025, an extreme tidal surge struck Agavedzi, erasing more than 50 homes, washing away 63 graves and flooding the local school. More than 300 residents lost shelter and the primary route to Aflao and Anloga was rendered impassable by sand and seawater (The Climate Insight, 2025).
- Accra coastal erosion and flooding mean sea-level rise of ~ 3 mm yr⁻¹, combined with more intense storm surges, has accelerated shoreline erosion on the Accra coast. Between 2005 and 2017 several hotels, roads and fish-landing sites near Jamestown and Keta were

lost to erosion, while the 2015 June 3rd twin disaster (flood and fire) that killed over 150 people was linked to higher rainfall extremes and blocked coastal drainage (UNESCO, 2024)

- Thirty-seven percent of the coastal land had been lost to erosion and flooding between 2005 and 2017.
- Cultural heritage sites such as Fort Kongensten (a historic Danish Fort constructed at Ada in 1783) and parts of Fort Prinsensten, built at Keta in 1734 have been completely washed away by coastal erosion. Increasing threats from coastal erosion was one of the factors that influenced the relocation of the office and residence of Ghana's President from the Christiansborg Castle to the Flagstaff House in Accra in 2013 (UNESCO, 2024).

2. Coastal Erosion and Flooding (Nigeria)

- From June to October 2022 Nigeria experienced its worst flood in more than a decade. About 612 deaths, 1.4 million people displaced, 2.4 million affected, 181 000 ha of farmland destroyed and critical roads cut in 34 of 36 states. Bayelsa and Kogi states became "inland seas" for weeks
- Southern Nigeria is losing between 30 to 40 meters of land to coastal erosion every year. In Akodo-Ise in Lagos, homes, livelihoods and even graves have been lost to ocean encroachment because of climate change (Salako, 2024).
- According to National Emergency Management Agency (NEMA), at least 320 persons were killed and over 1,346 others were affected by floods in 2024. Nigeria also witnessed severe flooding that led to the death of 30 persons and the displacement of over 400,000 in Maiduguri, the Borno state capital (Chibundu, 2024).
- Flooding events and related disasters have been frequent and severe in Lagos, with over 175,156 people affected by flooding incidents between 2022 and 2023 and property damage estimated at over \$262,500 (PUNCH, 2025).

Climate Change as an Accelerator of Maritime Security Challenges

The Intergovernmental Panel on Climate Change (IPCC) has consistently highlighted the vulnerability of coastal regions to phenomena such as sea-level rise, increased storm intensity, and ocean warming (Dada et al., 2024). These climatic shifts directly impact on the maritime environment leading to coastal erosion, loss of habitat and alterations in fish stock distribution and abundance (Belhabib et al., 2016). Such environmental changes can, in turn, exacerbate existing socio-economic vulnerabilities in coastal communities, particularly those reliant on fishing and agriculture. For instance, declining fish catches due to changing ocean conditions can undermine livelihoods, leading to increased poverty and food insecurity (Freeman, 2017).

Coastal vulnerability and Poverty dimensions

Coastal vulnerability across West Africa presents both shared patterns and distinctive national challenges, as seen in the cases of Ghana and Nigeria. In Ghana, recent assessments reveal that 15% of the coastline is classified as highly vulnerable. More alarmingly, Avornyo et al. (2023) report that 36% of the coast is considered very highly vulnerable based on a percentile based Coastal Vulnerability Index (CVI). These critical zones span the Jomoro District in the Western Region, Cape Coast in the Central Region and the eastern districts of Dangbe East, Keta and Ketu (Figure 2). Similarly, in Nigeria, coastal risks are compounded by widespread socioeconomic deprivation. Using the Multidimensional Poverty Index (MPI), Eteh et al. (2024) highlight stark disparities across coastal states. Lagos shows remarkable resilience with a low MPI score of 0.0044, while Ogun (0.0918), Cross River (0.0775) and Bayelsa (0.0644) struggle with significantly higher poverty burdens, despite being resource rich.

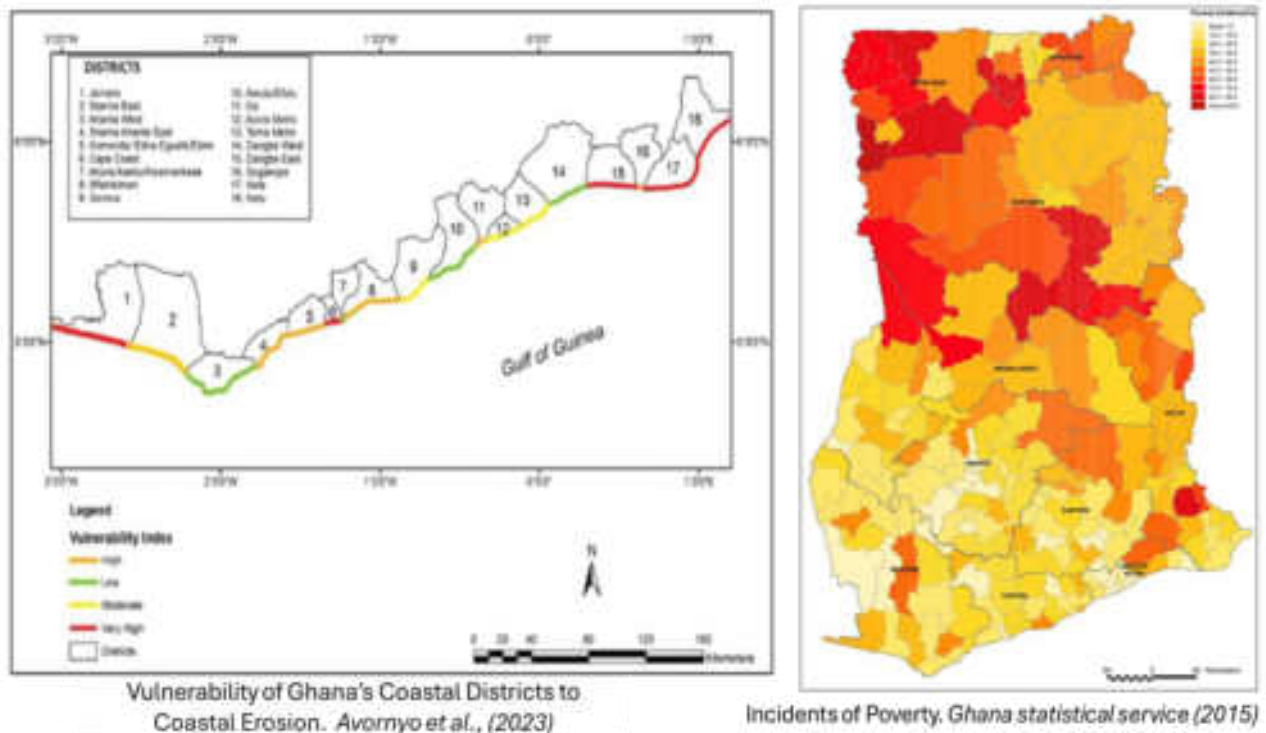


Figure 2: The Coastal vulnerability and poverty dimension of Ghana. Source:Avornyo et al. (2023)

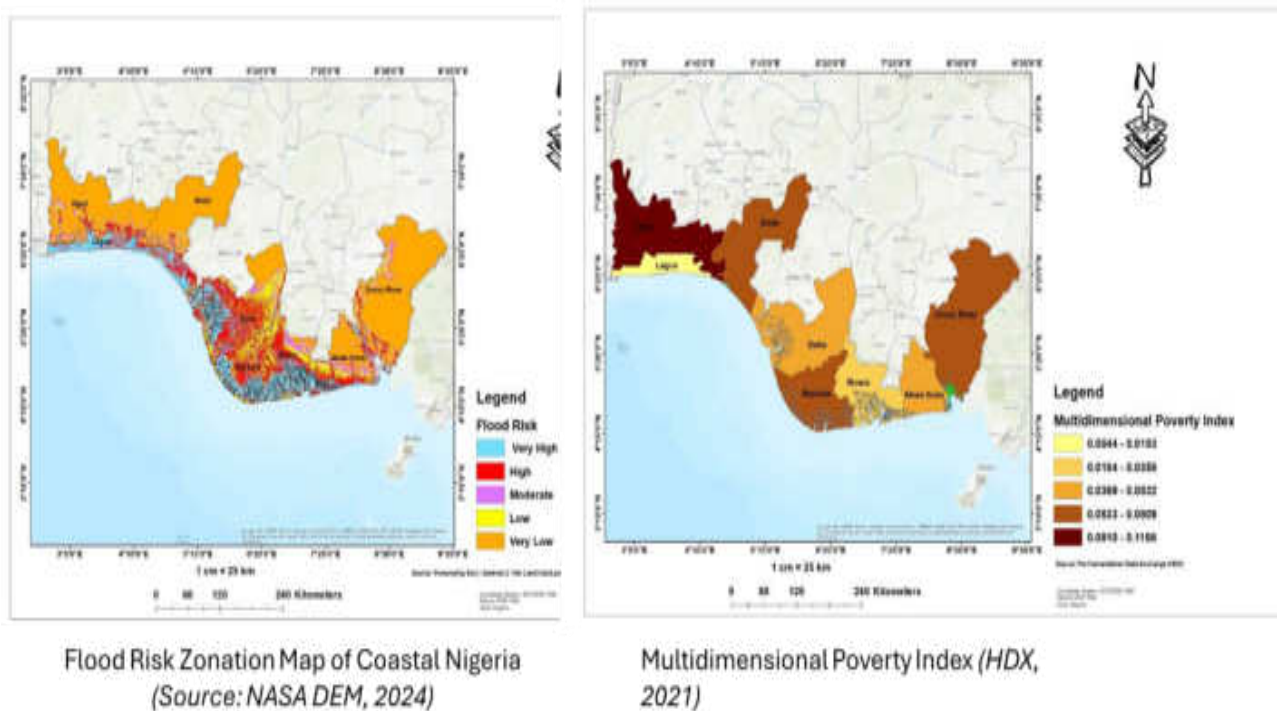


Figure 3: The Coastal vulnerability and poverty dimension of Nigeria. Source: Eteh et al. (2024)

Both countries illustrate how environmental stress is closely linked with economic fragility. In Ghana, highly vulnerable coastal areas often align with communities facing limited economic options. This desperation fosters conditions for illicit maritime activities such as IUU fishing, piracy and human trafficking (Danso & Okyere, 2023). In Nigeria, while poverty itself is a pressing concern, vulnerability to falling into poverty adds a second layer of risk. Cross River (34.7%), Ondo (32.4%), and Akwa Ibom (24.3%) have large portions of their populations hovering just above the poverty line, highlighting how socio-economic fragility is deeply embedded in the coastal space (Figure 3).

Environmental risk, particularly flooding, adds yet another dimension to these vulnerabilities. Nigeria's coastal topography, especially in deltaic states like Bayelsa, Rivers and Delta, is marked by flat terrain and poor drainage, placing over half of the land area at high or very high flood risk (Eteh et al., 2025). Even Lagos, despite its robust economy, is not spared: more than 56% of its land is categorized as highly flood prone. Ghana faces similar threats, particularly from sea level rise and coastal erosion. Ghomsi et al. (2024) note that across the Gulf of Guinea, such impacts are already taking a visible toll, damaging infrastructure and livelihoods.

Crucially, in both contexts, climate change does not operate in isolation. As Henrico and Doboš (2024) argue, it interacts with resource scarcity, political fragility and economic stress to act as a “threat multiplier.” This convergence of environmental and socio-economic pressures fuels instability, making maritime security more precarious. In both Ghana and Nigeria, the coastal landscape is thus shaped by overlapping stressors, poverty, environmental degradation, and weak governance, all of which demand coordinated and context specific responses.

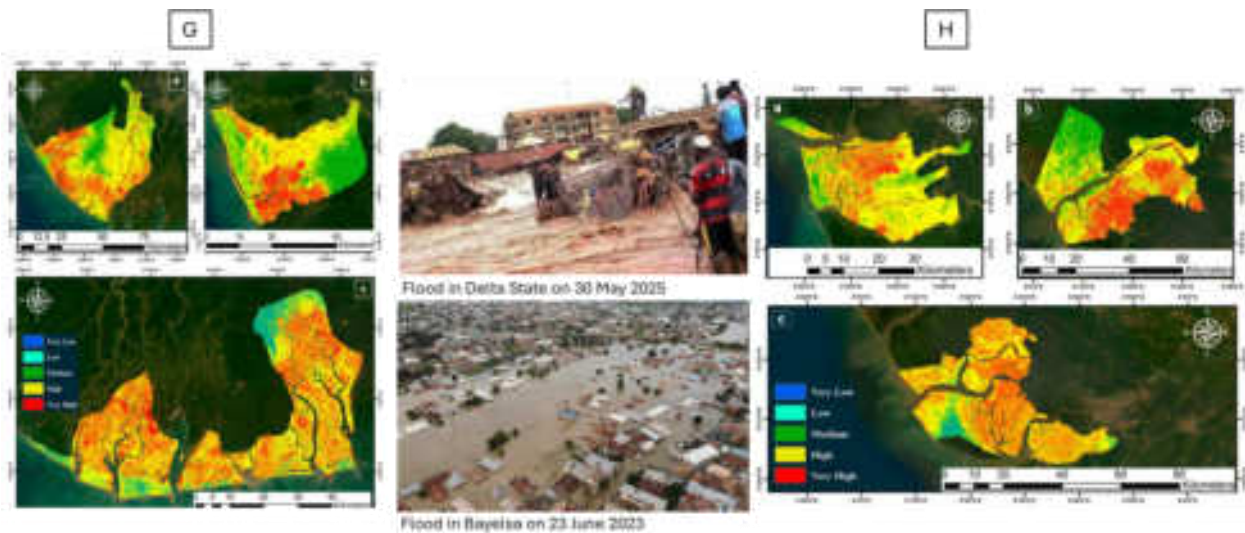


Figure 4: G-Bayelsa State (Flood susceptibility map of: (a) Southern Ijaw; (b) Ekeremor; (c) Brass) and H-Delta State (Flood susceptibility map of (a) Burutu; (b) Warri North; (c) Warri South). source Bello et al. (2024)

Livelihood Insecurity

This nexus of fisheries declines and livelihood insecurity is a potent driver of maritime threats, including piracy and other forms of maritime crime (Belhabib et al., 2019). The link is particularly evident when considering the experiences in other regions, such as East Africa, where climate change-induced devastation of coastal fisheries, coupled with prolonged drought and extreme weather exacerbating food insecurity and poverty on land, has been linked to some former fishermen turning to piracy in collaboration with militias and unemployed youth (Timidi et al, 2024). While the drivers of piracy in the Gulf of Guinea are complex and often tied to oil theft and organized crime, the decimation of local fisheries due to warming waters and rampant IUU fishing leaves coastal residents with few legitimate economic alternatives.

While both Ghana and Nigeria experience climate-driven livelihood insecurity in their coastal zones, the pathways into maritime insecurity diverge sharply. In Ghana, rising sea-surface temperatures (Paarlberg, 2024) and the persistent plunder by industrial trawlers (EJF, 2020) have cut small-pelagic catches by roughly three-fifths since the early 1990s, pushing canoe fishers into ever-smaller inshore grounds and ultimately, into the hands of pirate networks that exploit their seamanship for survival (Lazar et al., 2020). Thus, Ghana's insecurity manifests as a gradual, subsistence-driven slide into piracy, whereas Nigeria's is a lucrative, corruption-fuelled criminal economy that both feeds on and accelerates environmental collapse (Premium Times, 2024).

Institutional responses further expose the contrast. Ghana's government, constrained by limited fiscal space and inter-agency fragmentation, has relied on sporadic naval patrols and donor-funded surveillance projects to deter illegal fishing and piracy, yet these efforts rarely reach the artisanal landing sites where livelihoods are collapsing (Safty4Sea, 2018; EJF, 2020; Ali & Young-Adika, 2021). In Nigeria, vast security budgets anchored by the Deep Blue Project and multinational naval exercises coexist with entrenched oil-sector corruption, so while hardware and patrol days have increased, stolen crude still flows through creeks guarded by the same security forces tasked to stop it (Omeni, 2022). The result is that Ghana's fishers perceive state absence and turn to informal coping

mechanisms, whereas Nigerian coastal communities confront a predatory state–criminal nexus where violence is both a livelihood and a political currency.

The loss of livelihoods can make individuals more susceptible to recruitment by criminal gangs involved in piracy, oil bunkering and other illicit activities (Belhabib et al., 2019; Obeng & Sagoe, 2024). Therefore, climate change acts as a threat multiplier exacerbating the underlying socio-economic vulnerabilities that contribute to maritime insecurity (Obeng & Sagoe, 2024). Addressing these root causes, including the climate-driven decline in fisheries which is crucial for any long-term strategy aimed at enhancing maritime security in the region. The impacts on human livelihoods extend beyond direct fishing; women involved in fish processing and other ancillary industries also face reduced income and increased vulnerability with limited access to financial resources to adapt or transition to alternative sectors. The Geneva Centre for Security Sector Governance DCAF report on Guinea highlights that IUU Fishing and piracy contribute to poverty and food insecurity, generating problematic coping mechanisms and that a projected increase in demand on fisheries, coupled with governance challenges could lead to stock collapse and further insecurity (DCAF, 2023).

The main differences between Ghana and Nigeria in how climate change accelerates maritime security challenges lie in the scale, pathways and governance responses. In Ghana, vulnerability is concentrated in specific high-risk coastal zones such as Jomoro, Cape Coast, Dangbe East, Keta and Ketu, where sea-level rise, erosion and declining fisheries could push artisanal fishers toward subsistence-driven piracy or collaboration with illicit networks as a survival strategy. The drivers are primarily resource depletion, particularly the collapse of small-pelagic stocks by about 60% since the early 1990s and the economic desperation of communities with few alternatives. Institutional capacity is limited, with the state relying on sporadic naval patrols and donor-funded initiatives that rarely penetrate artisanal fishing hubs, leaving many communities feeling abandoned.

In Nigeria, climate impacts intersect with widespread poverty, deep socio-economic inequality, and a far more entrenched criminal economy. Vulnerability is dispersed across multiple coastal states, with poverty and flood risk particularly severe in deltaic areas such as Bayelsa and Delta. Here, environmental degradation exacerbates an already lucrative and corruption-fueled maritime crime system centered on oil theft, illegal bunkering and armed piracy. While Nigeria has invested heavily in security infrastructures and multinational naval operations, these measures coexist with corruption and complicity within security forces, allowing illicit trade to flourish. This creates a predatory environment where violence is an economic and political tool, contrasting with Ghana's slower, livelihood-driven drift into maritime crime.

Analysis of Institutional Responses and Policy Frameworks in Ghana and Nigeria

Policy Framework

Ghana and Nigeria have both made notable strides in establishing national frameworks to address climate change, yet they diverge in their approach to institutional coordination and the integration of maritime concerns into climate policy. Ghana's climate response is anchored in its National Climate Change Policy (NCCP), launched in 2013, which offers a broad framework for adaptation and mitigation across sectors (NCCP, 2013). More recently, the establishment of the Ministry of State for Climate Change and Sustainability reflects Ghana's growing political commitment to environmental issues. This ministry now leads climate governance, although this has created overlaps with the

Ministry of Environment, Science and Technology (MEST), which traditionally oversaw environmental policy and chaired the National Climate Change Committee (NCCC). These overlapping mandates have created confusion and policy fragmentation, with institutions like the Ghana Ports and Harbours Authority (GPHA) often left at the margins of relevant decision-making processes (MESTI, 2013; Adu Owusu, 2025; Climate Voice Global, 2025).

Similarly, Nigeria has introduced strong institutional structures, most notably through the Climate Change Act of 2021. This legislation established the National Council on Climate Change (NCCC) as the apex body for coordinating climate governance and requires coastal resilience planning and emissions caps for offshore oil and gas sectors. However, implementation has been sluggish, with ambiguities in the division of responsibilities between the Department of Climate Change (DCC), the National Council and the Nigerian Maritime Administration and Safety Agency (NIMASA) (Iwuchukwu, 2025). Like Ghana, Nigeria's institutions in the maritime and climate sectors suffer from overlapping mandates, which weaken accountability and delay effective integration of climate security in maritime governance. In both countries, national climate targets such as Ghana's updated Nationally Determined Contributions (NDCs) and Nigeria's Energy Transition Plan and Renewable Energy Master Plan highlight commitments to renewable energy, climate resilient agriculture, and sustainable land use (MESTI, 2021; IEA/IRENA, 2013). These targets carry indirect benefits for coastal and maritime sectors, including emission reductions in port operations and increased energy access in coastal communities. However, while Nigeria's draft National Adaptation Plan (2022) includes sections on oceans and the blue economy, it lacks robust indicators to assess vulnerability and progress in the port sector. Ghana stands out for its substantial investments in physical infrastructure, such as sea defense projects in Ada, Keta, and Axim, though only 38 percent of priority sites have received protection due to funding constraints. An estimated \$1.14 billion is needed to fortify vulnerable coastal zones (WACA, n.d). In contrast, Nigeria's emphasis has leaned more toward legal instruments and energy policy shifts, with fewer large scale coastal protection projects reported.

Institutional Framework

In Ghana, the Ghana Navy and the Ghana Maritime Authority (GMA) are the main institutions responsible for maritime governance. The GMA oversees maritime safety, security and environmental protection and Ghana is a signatory to multiple international conventions. It also engages in regional security initiatives aimed at enhancing cooperation among Gulf of Guinea states. However, while Ghana's National Climate Change Policy (NCCP) acknowledges the vulnerability of coastal zones, the explicit integration of climate change impacts into maritime security strategies remains limited. Emerging threats such as increased piracy driven by fisheries decline or displacement of coastal communities are not yet clearly addressed in national security planning. Compounding this are institutional capacity constraints, including limited resources for surveillance, patrol and weak coordination between agencies. According to the Climate Action Tracker (CAT, 2021), although coordination structures are in place, their effectiveness is inconsistent and funding for climate action remains a challenge.

Nigeria presents a more expansive and resource-intensive approach to maritime security. Its multi-agency structure is anchored by the NIMASA, which regulates maritime safety and environmental protection under the NIMASA Act of 2007. The Nigerian Navy plays a leading enforcement role, with significant assets dedicated to combating piracy, oil theft and other maritime threats. The Deep Blue Project, a large-scale initiative combining naval, aerial and land-based resources, reflects

Nigeria's commitment to securing its maritime domain. Like Ghana, Nigeria is an active participant in regional cooperation frameworks such as the Yaoundé Architecture (Mboob, 2022). However, despite these extensive efforts, Nigeria also faces difficulties in integrating climate change considerations into maritime security planning. NIMASA's environmental mandate has largely centered on pollution control, with less attention to broader climate-driven security issues such as sea-level rise or declining marine ecosystems. According to Amao et al. (2024), challenges such as the vastness of Nigeria's maritime territory, inter-agency rivalries and limited resources hinder a coordinated response to climate-related risks.

What ties the two countries together is the common gap between climate policy and maritime security practice. Both have the institutional foundations and regional partnerships to tackle maritime threats, but neither has fully articulated how climate change factors into those threats. Strengthening the link between environmental agencies and maritime security institutions such as between Ghana's EPA and GMA or Nigeria's NIMASA and Navy will be key to bridging this gap. Developing climate-informed security planning and ensuring that risk assessments are systematically incorporated into operations is essential.

Table 1: Summary analysis of Policy Frameworks and Institutional Responses in Ghana and Nigeria

	Ghana	Nigeria
Policy Framework	Similarities	
	Both countries have strong national climate policy frameworks but face overlapping mandates and weak integration of climate change into maritime security strategies.	
	Differences	
	Anchored in National Climate Change Policy (2013).	Anchored in Climate Change Act (2021)
	Coastal protection emphasis with sea defense projects in Ada, Keta, Axim (only 38% coverage due to \$1.14B funding gap).	Emphasis on legal instruments and energy policy (e.g., Energy Transition Plan, Renewable Energy Master Plan).
Institutional Capacities	Similarities	
	Both have capable core maritime institutions and participate in regional cooperation (e.g., Yaoundé Architecture).	
	Both lack systematic integration of climate change into maritime security strategies.	
	Both face coordination issues and resource constraints (though Nigeria's capacity is larger).	
	Differences	
	Maritime governance led by Ghana Maritime Authority (GMA) and Ghana Navy.	Maritime governance led by NIMASA and Nigerian Navy under NIMASA Act (2007).
	Under-resourced for surveillance and patrols.	Large-scale enforcement capacity via Deep Blue Project (naval, aerial, land assets).

Regional Cooperation for Addressing Maritime Security Threats and Climate Change

Regional cooperation, primarily through the Economic Community of West African States (ECOWAS) and the Yaoundé Architecture, plays a crucial role in addressing maritime security in the Gulf of Guinea and increasingly, the impacts of climate change are being recognized within these frameworks (Marangio, 2025). The Yaoundé Architecture, established in 2013, provides a structure for inter-regional cooperation (ECOWAS and ECCAS) on maritime safety and security, including information sharing, coordinated patrols and capacity building. Both Ghana and Nigeria are active participants. However, the effectiveness of these regional mechanisms is often hampered by factors such as varying national capacities, funding constraints, and differing political priorities among member states (Mboob, 2022). The DCAF – Geneva Centre for Security Sector Governance report notes that while the Yaoundé Architecture provides a good framework, funding remains an impediment and the original intention to upgrade the Yaoundé Code of Conduct (YCoC) into a binding multilateral agreement is yet to be achieved (DCAF, 2023). The extent to which climate change considerations are systematically integrated into the operational plans of these regional bodies is still developing. While there is an increasing awareness of how climate impacts like fisheries decline can exacerbate insecurity, translating this awareness into concrete, coordinated regional actions remain a work in progress. Strengthening regional cooperation requires not only addressing these institutional and financial challenges but also ensuring that climate change is explicitly factored into joint risk assessments, early warning systems and response strategies for maritime security in the Gulf of Guinea.

While both Ghana and Nigeria are active participants in regional maritime security frameworks like ECOWAS and the Yaoundé Architecture, their engagement reflects different national capacities and priorities. Ghana's contributions tend to align with its relatively smaller naval and institutional capacity, focusing on information sharing, joint patrol participation and targeted capacity-building efforts. Its role in regional cooperation is often shaped by resource limitations, meaning it leans on multilateral mechanisms to bolster its maritime security and integrate climate considerations, albeit gradually. Climate-related threats such as fisheries decline are acknowledged, but Ghana relies heavily on these frameworks to supplement domestic shortfalls in surveillance, enforcement and climate adaptation in its maritime domain.

Nigeria, by contrast, engages in regional cooperation from a position of greater enforcement capacity and geopolitical influence in the Gulf of Guinea. With a larger navy, the Deep Blue Project and broader security infrastructure, Nigeria plays a more dominant operational role in joint patrols and maritime crime suppression. However, despite its stronger military presence, Nigeria's integration of climate change into regional security planning remains limited, with priorities still weighted toward combating piracy and oil theft over environmental threat mitigation. In effect, Ghana approaches regional cooperation as a strategic necessity to compensate for domestic constraints, while Nigeria participates as a leading security actor but has yet to leverage its influence to embed climate change considerations systematically into regional maritime security strategies.

Theoretical Framework on Climate Change and Maritime Security: Application to the Ghanaian and Nigerian Contexts

This study applies the Climate Maritime Security Theory (CMST) to examine the intricate relationship between climate change and maritime security. It highlights how environmental

transformations primarily driven by climate change, increasingly shape geopolitical stability, governance and security dynamics across maritime zones. As climate-related disruptions intensify, the maritime domain becomes a focal point where environmental, economic and security interests intersect, creating both challenges and opportunities for coastal nations and global actors. The intersection of climate change and maritime security is best understood through a multidisciplinary lens that draws from both traditional and contemporary security theories (Germond & Mazaris, 2019). Historically, maritime security has been grounded in classical geopolitical thought, where the sea is viewed as a strategic domain for projecting power, securing trade routes and defending national sovereignty (Germond, 2015). This traditional framework emphasizes state-centric threats such as piracy, naval conflict, and maritime terrorism, often focusing on the role of navies and coast guards in maintaining order and control over territorial waters and exclusive economic zones. A holistic framework acknowledges that environmental changes are deeply intertwined with security concerns in the realm of the maritime. The maritime domain in the face of climate change requires moving beyond narrow, militaristic interpretations and embracing a comprehensive, multi-sectoral approach that prioritizes sustainability, human well-being and ecological resilience. The CMST frames climate change as a threat multiplier that exacerbates existing vulnerabilities and creates new security challenges in the maritime domain (Germond & Mazaris, 2019). This study examined the CMST under four theoretical foundations namely: Human Security Theory, Security Studies Theories, Environmental Security Theory and Complexity and Systems Theory.

Human Security Theory (HST)

HST reorients the locus of security from the state to the individual, insisting that threats to life, livelihood and dignity be treated as core security concerns. The theory illuminates how climate shocks cascade into personal and communal risk and why some groups become perpetrators while others are victimized by foregrounding the everyday insecurities of coastal populations (Brennan & Germond, 2024). It further demands that maritime law-enforcement agencies integrate human-rights defense into their operations protecting migrants encountered at sea, avoiding abuses during interdictions and balancing enforcement with humanitarian imperatives. Finally, it reveals the porous boundary between onshore instability and offshore threats: poverty, governance failures and environmental degradation on land readily morph into piracy, trafficking and irregular migration at sea. Consequently, any effective response must weave together economic development, environmental sustainability and social justice, replacing narrow militarized approaches with inclusive strategies that strengthen the resilience of both people and the marine ecosystems they inhabit (McCabe, 2023).

In Ghana and Nigeria, climate-driven depletion of fish stocks, salinization of freshwater lenses and the progressive loss of coastal housing erode the economic, food and environmental pillars upon which millions of artisanal fishers and port communities depend (Pabi et al., 2015). These accumulating deprivations do not merely heighten vulnerability; they actively channel people into illicit fishing, piracy and fuel smuggling making maritime crime an expression of human insecurity rather than a conventional law-and-order issue (Phayal et al., 2024).

Following the HST, Ghana and Nigeria should anchor their climate-sensitive maritime security strategies in safeguarding the livelihoods, rights and dignity of coastal populations, moving beyond narrow, state-centric and militarized responses. This requires embedding human rights protection into maritime law enforcement, ensuring humane treatment of migrants and artisanal fishers, preventing abuses during interdictions and balancing enforcement with humanitarian obligations. Both countries

should address the structural drivers of maritime crime by confronting climate-induced livelihood erosion, including overfishing, saltwater intrusion and coastal erosion, through sustainable fisheries management, community-led adaptation and marine ecosystem restoration. Policies must integrate economic development, environmental stewardship and social equity, offering alternative livelihoods, enhancing coastal governance, and expanding access to essential services. By linking onshore stability with offshore security, Ghana and Nigeria can transform maritime security into a resilience-building instrument that reduces incentives for piracy, trafficking and illegal fishing, rather than relying on repression alone.

Security Studies Theories (SST) - Securitization

Traditional security theories emphasize state sovereignty and defense against military threats, while the Human Security Framework shifts focus on safeguarding individuals and communities from non-traditional threats, including environmental degradation. In the maritime context, human security is endangered by climate-driven disruptions to food sources, livelihoods and infrastructure. Securitization theory, developed by the Copenhagen School, provides a critical lens through which to analyze how climate change is framed as a security issue (Stepka, 2022). According to this theory, an issue becomes a matter of security not because of its inherent characteristics, but because it is presented as an existential threat by influential actors. In the case of climate change, this has led to the increasing involvement of military and security institutions in climate adaptation and disaster response, raising important questions about the militarization of environmental governance and the potential marginalization of civil society. Critical and postcolonial security studies challenge dominant narratives by interrogating the power dynamics and historical legacies that shape contemporary maritime governance (Aning et al., 2021; DCAF, 2023). These perspectives question whose security is prioritized in climate-security discourses and advocate for more equitable and decolonized approaches that center the voices and experiences of marginalized coastal and island communities.

Ghana's acquisition of offshore patrol vessels or Nigeria's Deep Blue Project are classic moves to secure sea-lanes, deter pirates and defend sovereign resources (Lionel, 2025; NIMASA, 2020). Constructivism, by contrast, shows that what counts as a "threat" is socially made. In Ghana, rising coastal erosion was long framed as an environmental nuisance until civil-society actors, journalists (Joynews, 2025) and fishers successfully re-labelled it a national-security risk, drawing navies into coastal-protection roles. Nigeria's Niger Delta offers a sharper securitization moment. For example, where militant attacks on oil platforms were narrated as existential threats to state revenue, legitimizing joint-task-force deployments and more recently, the militarization of climate-adaptation funds in the region (Oluyemi, 2020). Critical and post-colonial perspectives then ask whose security is actually being secured. While Ghanaian naval patrols protect tuna-export corridors, small-scale fishers complain of harassment and exclusion from traditional grounds. In Nigeria, counter-piracy campaigns secure oil infrastructure but rarely address the loss of mangroves and fishing livelihoods that originally fueled local grievances. This theory reminds us that maritime governance continues to echo colonial patterns: powerful actors define risks, allocate resources and deploy force, often marginalizing the very coastal communities whose daily survival is most at stake.

Applying the securitization theory, Ghana and Nigeria can strengthen climate-sensitive maritime security initiatives by deliberately reframing climate change impacts as existential security threats that demand urgent, coordinated action. In Ghana, this means expanding beyond the naval protection

of export corridors to integrate coastal community voices into security planning, ensuring patrols and enforcement measures also safeguard small-scale fishers' livelihoods and climate resilience. In Nigeria, securitization should move past narrowly protecting oil infrastructure to address climate-driven root causes of insecurity in the Niger Delta, such as mangrove loss, flooding and livelihood collapse, thereby reducing tensions that fuel maritime crime. Both states should avoid the pitfalls of over-militarization by pairing naval capabilities with inclusive governance, civil-society participation and locally grounded adaptation strategies, shifting the definition of "security" from elite or economic assets to the long-term survival and wellbeing of vulnerable coastal populations. This balanced approach would make securitization a tool for resilience rather than exclusion.

Environmental Security Theory (EST)

EST reframes security by locating its foundation in the stability of ecosystems rather than in the strength of armies (McCabe, 2023). The theory predicts that three stressors in particular- resource depletion, habitat loss and climate-driven migration will translate into crime, civil unrest and interstate friction unless preventive governance is in place. It argues that when environmental systems degrade through fish-stock collapse, coastal erosion, or climate-driven displacement the resulting scarcities and uncertainties erode livelihoods, weaken governance and incentivize conflict. Maritime spaces are particularly sensitive: warming seas redistribute resources, storms destroy protective infrastructure and displaced communities crowd into ports, creating conditions in which piracy, smuggling and illegal fishing flourish (Cook et al., 2021; Mbaye et al., 2021; Pal et al., 2023). The theory insists that sustainable resource management, equitable adaptation and cross-border cooperation are not environmental luxuries but core security imperatives by treating ecological integrity as a prerequisite for social order.

Ghana's western coastline illustrates a resource-depletion pathway. Since the early 2000s, sardinella stocks have shifted northward in response to warmer surface waters. Small-scale fishers from Sekondi and Axim now travel farther, crossing into Ivorian and at times Togolese waters (Asiedu et al., 2022). Increased operating costs, declining catches and rising debt have pushed some crews into light-arms smuggling and the transshipment of cocaine at sea (Witbooi et al., 2020). Some arrests indicate the same vessels once flagged for illegal fishing are now implicated in narcotics cases, showing how ecological scarcity escalates directly into multidimensional maritime crime (Obeng & Sagoe, 2024). On the other hand, the Niger Delta demonstrates the habitat-loss trajectory. Accelerated coastal erosion and salt-water intrusion have destroyed more than 1,000 km² of mangroves since 1985 (Ogbeibu & Oribhabor, 2023). The loss of these nurseries has collapsed local crab and shrimp fisheries, depriving riverine villages of both protein and income. With legitimate livelihoods gone, young men gravitate to refining stolen crude in makeshift creeks and selling the product to tankers waiting beyond the nine-mile limit (Onje, 2025). Environmental degradation thus undercuts state authority and turns the delta's creeks into a logistics hub for transnational oil theft.

Again, Ghana's eastern Volta Delta and Nigeria's Badagry coast reveal the climate-migration linkage. Seasonal flooding now renders parts of Keta and Aflao uninhabitable for months each year, while Badagry's shoreline erode up to 30 m annually (Adeaga et al., 2021; Awuah, 2023). Displaced farmers and fishers converge on urban waterfronts (Tema & Lagos) where competition for informal dock work and scarce housing fuels local gang formation. These groups, in turn, extort protection money from incoming fishing crews and have been implicated in the hijacking of fuel barges, illustrating how environmentally induced migration reshapes the geography of maritime violence.

Across these cases, environmental security's core insight holds ecological breakdown is not a backdrop to insecurity, it is its engine.

According to the EST, environmental protection should be treated as a core security function rather than a peripheral development issue. For Ghana, this means prioritizing sustainable fishery management to counter resource depletion along the western coast such as enforcing science-based catch limits, expanding joint patrols with Côte d'Ivoire and Togo and supporting alternative livelihoods for fishers to reduce incentives for smuggling and drug transshipment. In Nigeria's Niger Delta, addressing habitat loss should involve large-scale mangrove restoration, stricter controls on coastal erosion drivers and targeted economic programs for communities displaced from collapsed crab and shrimp fisheries, reducing the draw into oil theft networks. For both countries, climate-driven migration hotspots require proactive relocation planning, investment in flood-resilient housing and coordinated port-city management to prevent urban overcrowding from feeding maritime gang activity. Jointly, Ghana and Nigeria should strengthen cross-border environmental monitoring, share early-warning data on fish stock shifts and shoreline retreat and embed ecological restoration targets into Gulf of Guinea maritime security agreements, ensuring that ecological integrity is recognized as a prerequisite for long-term stability at sea.

Complexity and Systems Theory

The climate-security nexus is embedded in complex adaptive systems where climate variables interact dynamically with social, political and economic factors. These interactions produce non-linear outcomes, such as cascading risks from a single climate event, underscoring the importance of integrated systemic responses. More recent approaches draw on systems thinking and resilience theory to address the complexity and interconnectedness of climate and maritime systems (Zięcina et al., 2022). These frameworks recognize that the impacts of climate change are often non-linear and unpredictable, requiring adaptive and flexible governance structures. Resilience theory, in particular, emphasizes the capacity of communities, institutions and ecosystems to absorb shocks, adapt to change and transform in response to long-term stressors (Germond & Ha, 2019). In the maritime domain, this translates into policies that support sustainable fisheries, climate-resilient infrastructure and inclusive governance mechanisms that engage local stakeholders.

CST views maritime security as a complex adaptive system composed of multiple independent but interrelated actors such as states, non-state groups, international organizations, private sector entities and local communities whose interactions produce emergent behaviors that cannot be fully predicted by analyzing components in isolation. This approach recognizes that maritime security issues are embedded in a web of ecological, social, economic, political, and technological factors that continuously evolve and influence each other in nonlinear ways. At its core, CST emphasizes the self-organizing and adaptive nature of maritime security environments. For example, modern maritime piracy organizations operate as decentralized networks that adapt rapidly to enforcement efforts, exploiting vulnerabilities in governance and economic conditions. Understanding such groups through the lens of complex adaptive systems reveals patterns and behaviors that traditional linear or hierarchical models fail to capture, enabling more effective, flexible and anticipatory responses.

In applying the CST, Ghana and Nigeria are encouraged to move away from rigid, one-size-fits-all strategies toward approaches that are responsive to changing conditions and capable of evolving over time. In practical terms, this should translate into leveraging advanced technologies such as satellite surveillance, data analytics and network modeling to map and understand complex patterns of

maritime activities. It also entails improving institutional learning and collaboration to share information, harmonize regulations, and building capacity among both countries and international partners.

Strategic Recommendations for Enhancing Climate Resilience and Maritime Security

Strengthening National Institutional Capacities and Policy Coherence

Ghana and Nigeria should strengthen national institutional capacities and ensure policy coherence by integrating climate change considerations into maritime security strategies and vice versa. In Ghana, this entails fostering coordination between environmental agencies and maritime bodies, using climate risk and fisheries data to guide naval patrols, and developing joint adaptation–security projects in erosion-prone areas, supported by the planned climate change hub for capacity building and early warning systems. Nigeria should harmonize the work of the National Council on Climate Change with maritime institutions like the Navy, NIMASA and GMAs, embed climate-security priorities into enforcement and create cross-sector task forces to address climate-driven disputes and IUU fishing. Both countries need to invest in specialized training in climate science, maritime law and disaster response; improve resource allocation, with Ghana focusing on sea defense infrastructure in Keta, Ada, Axim and Nigeria targeting Niger Delta coastal rehabilitation and mangrove restoration; and enhance transparency through unified data-sharing systems, public reporting and independent audits to ensure accountability in climate-maritime security initiatives.

Improving Regional Collaboration and Integrated Approaches

Regional collaboration backed by tailored integrated approaches is key to tackling climate change and maritime security threats in the Gulf of Guinea. Both countries should promote joint patrols, harmonize legal frameworks, develop early warning systems, invest in capacity building on climate–maritime security skills and secure sustainable funding, with Nigeria leveraging its monitoring and surveillance capacity and Ghana capitalizing on its planned climate change hub to attract climate finance.

Specifically, Ghana should focus on upgrading its monitoring, control and surveillance (MCS) systems to integrate satellite-based coastal monitoring, fisheries data and security reports to enhance climate-driven solutions to maritime security. Additionally, efforts should be made to expand Navy offshore patrol capacity; include climate hazard forecasts in regular maritime security bulletins; and establish a dedicated climate–maritime security fund supported by regional and international finance. Nigeria, meanwhile, should enhance NIMASA’s data analytics to merge environmental and security indicators, embed climate-security objectives into patrol missions, integrate meteorological and hydrological data with maritime threat assessments, expand erosion-prone coastal monitoring and ring-fence oil and gas revenues for climate-resilient maritime infrastructure.

Promoting Sustainable Blue Economy Initiatives and Community Resilience

Ghana and Nigeria should strengthen climate resilience and maritime security by advancing sustainable blue economy initiatives tailored to their national contexts. Diversifying coastal livelihoods is critical: Ghana should expand climate-resilient aquaculture training, microfinance for eco-tourism, value-added seafood processing and women-led marine biotech, while Nigeria supports community-based aquaculture, coastal heritage tourism, green start-ups and youth-led renewable

marine industries. Investment in resilient infrastructure is also essential—Ghana prioritizing flood defenses, upgraded landing sites, early warning systems and port retrofits and Nigeria reinforcing sea walls, deploying automated flood warnings and restoring mangroves. Finally, community empowerment must underpin these efforts, with Ghana fostering structured youth and women-led adaptation projects and localized education campaigns and Nigeria creating community monitoring committees, grassroots shoreline restoration projects, conflict resolution training, and targeted awareness programs for deltaic and island populations.

Conclusion

The comparative analysis of Ghana and Nigeria reveals that climate change is undeniably acting as a significant accelerator of maritime security challenges in both nations, albeit with distinct manifestations and intensities. Rising sea levels, coastal erosion, ocean warming and the resultant decline in fisheries are not just environmental concerns but are increasingly recognized as critical factors influencing human security, economic stability and the prevalence of maritime threats such as piracy, IUU fishing and illicit trafficking. While both countries have established policy frameworks and institutional mechanisms to address climate change and maritime security separately, the integration of these two domains remains a critical gap. Ghana, with its relative stability, faces emerging threats amplified by climate impacts, particularly on its fisheries and coastal infrastructure. Nigeria, grappling with more entrenched maritime insecurity, particularly in the Niger Delta, sees climate change exacerbating existing vulnerabilities and complicating efforts to maintain maritime order.

Achieving a secure and climate-resilient maritime future for Ghana and Nigeria requires a paradigm shift towards integrated and proactive strategies. This involves strengthening national institutional capacities to understand and respond to the climate-maritime security nexus, improving deeper regional collaboration within frameworks like ECOWAS and the Yaoundé Architecture and promoting sustainable blue economy initiatives that build community resilience and reduce dependence on vulnerable resources. The strategic recommendations outlined focusing on policy coherence, regional cooperation and sustainable development provide a roadmap for action. Addressing these interconnected challenges is not merely an option but an imperative for the socio-economic well-being of coastal populations, the stability of the Gulf of Guinea and the broader security interests of the West African region and its international partners. The next decade will be crucial in determining whether Ghana and Nigeria can effectively navigate these turbulent waters and build a future where their maritime domains are both secure and sustainable.

References

- Abdullah, Ali, F., & Ali, R. (2024). Impact of Climate Change on Maritime Security. *International Journal of Human and Society (IJHS)*. 3(4). 644-653.
- Abija, F. A., Abam, T. K. S., Teme, S. C., & Eze, C. L. (2020). Relative sea level rise, coastline variability and coastal erosion in the Niger Delta, Nigeria: implications for climate change adaptation and coastal zone management. *Earth Science Climatic Change*, 11, 9.

- Addo, K. A., & Adeyemi, M. (2013). Assessing the impact of sea-level rise on a vulnerable coastal community in Accra, Ghana. *Jàmhá: Journal of Disaster Risk Studies*, 5(1), 1-8.
- Adeaga, O., Folorunsho, R., Foli, B. A. K., & Akinbaloye, O. (2021). Assessment of shoreline change along the coast of Lagos, Nigeria. *Remote Sensing in Earth Systems Sciences*, 4(3), 186-198.
- Adu-Owusu, P. (2025). Climate Change office at presidency to coordinate national response to climate – Technical Advisor. <https://www.myjoyonline.com/climate-change-office-at-presidency-to-coordinate-national-response-to-climate-technical-advisor/>
- Agyeman, K. O., & Ofori-Danson, P. K. (2021). Urban flooding and climate change in Ghana: A case study of Accra. *Journal of Environmental Planning and Management*.
- Ali, I., Shaik, R., Azman, A., Singh, P., Bala, J. D., AO, A., ... & Hossain, K. (2022). Impacts of climate change on coastal communities. In *Research Anthology on Environmental and Societal Impacts of Climate Change* (pp. 1659-1671). IGI Global Scientific Publishing.
- Ali, K. & Young-Adika, S. (2021). Simplifying Complexities: Interagency Coordination in Ghana's Maritime Security Governance. *CEMLAW*. 1-8
- Amao, F., Ola, A. A., Afolabi, M. B., & Gbadeyan, O. J. (2024). The effect of maritime security on national development in Nigeria. *Journal of Transportation Security*, 17(1), 20.
- Amponsah, S. K. K. (2015). Assessment of the Security of Coastal Fishing Operations in Ghana from the Perspectives of Safety Poverty and Catches (Doctoral dissertation, University of Ghana).
- Aning, K., Albrecht, P., & Blaabjerg Nielsen, A. (2021). West Africa security perspectives: Kwesi Aning explains (No. 2021: 03). DIIS Report.
- Ankrah, J. (2024). Shoreline change and coastal erosion: an analysis of long-term change and adaptation strategies in coastal Ghana. *Geo-Marine Letters*, 44(3), 12.
- Asamoah Agyekum, H. (2024). Tackling maritime security in the Gulf of Guinea: Interactions between global shipping and Ghanaian state agents. *African Security*, 17(1-2), 115-140.
- Asiedu, B., Failler, P., Amponsah, S. K., Okpei, P., Setufe, S. B., & Annan, A. (2022). Fishers' migration in the small pelagic fishery of Ghana: a case of small-scale fisheries management. *Ocean & Coastal Management*, 229, 106305.
- Avorinyo, S. Y., Addo, K. A., Teatini, P., Minderhoud, P., Woillez, M. N., Jayson-Quashigah, P. N., & Mahu, E. (2023). A scoping review of coastal vulnerability, subsidence and sea level rise in Ghana: Assessments, knowledge gaps and management implications. *Quaternary Science Advances*, 12, 100108.
- Awode, A. E., Adewumi, J. R., Obiora-Okeke, O., & Komolafe, A. A. (2025). Analysis of rainfall variability and extreme events in South-Western Nigeria: implications for water resource management and climate resilience. *Bulletin of the National Research Centre*, 49(1), 31.
- Awuah, R. (2023). Climate Change: Beware! Sea washing away Keta, Ada, let's explore what we can do. *The Fourth Estate*. Accessed on 19.07.2025. <https://thefourthstategh.com/2023/10/climate-change-beware-sea-washing-away-keta-ada-lets-explore-what-we-can-do/>

- Balogun, W. A. (2022). In the shadows: Maritime crime, illicit operational chain and informal economy in West Africa. *LASU Journal of African Studies*, 10.
- Beckley, E. O. (2024). Maritime Security in Nigeria: Perspective for a Comprehensive Approach. In *Understanding Contemporary Security Challenges in Nigeria* (pp. 67-89). Singapore: Springer Nature Singapore.
- Belhabib, D., Lam, V. W., & Cheung, W. W. (2016). Overview of West African fisheries under climate change: Impacts, vulnerabilities and adaptive responses of the artisanal and industrial sectors. *Marine Policy*, 71, 15-28.
- Belhabib, D., Lam, V. W., & Cheung, W. W. (2016). Overview of West African fisheries under climate change: Impacts, vulnerabilities and adaptive responses of the artisanal and industrial sectors. *Marine Policy*, 71, 15-28.
- Belhabib, D., Sumaila, U. R., & Le Billon, P. (2019). The fisheries of Africa: Exploitation, policy, and maritime security trends. *Marine Policy*, 101, 80-92.
- Bello, M., Singh, S., Singh, S. K., Pandey, V., Kumar, P., Meraj, G., ... & Sajan, B. (2024). Geospatial analysis of flood susceptibility in Nigeria's vulnerable coastal states: A detailed assessment and mitigation strategy proposal. *Climate*, 12(7), 93.
- Brandam, H. (2022). ECOWAS Regional Climate Strategy and Action Plan. Accessed on 17.07.2025. <https://disasterdisplacement.org/resource/ecowas-regional-climate-strategy-and-action-plan/#:~:text=However%2C%20the%20African%20continent%20is%20at%20the,a%20warming%20of%200.6%20%C2%B0C%20per%20decade>.
- Brempong, E. K., Almar, R., Angnuureng, D. B., Mattah, P. A. D., Avornyo, S. Y., Jayson-Quashigah, P. N., ... & Teatini, P. (2023). Future flooding of the Volta Delta caused by sea level rise and land subsidence. *Journal of Coastal Conservation*, 27(3), 24.
- Brennan, J., & Germond, B. (2024). A methodology for analysing the impacts of climate change on maritime security. *Climatic Change*, 177(1), 15.
- Bueger, C. (2015). What is maritime security? *Marine policy*, 53, 159-164.
- Bueger, C., & Edmunds, T. (2024). *Understanding maritime security*. Oxford University Press.
- CAT, (2021). *Climate Governance: Ghana*. CAT Climate governance series. 1-24
- CDKN/ACDI, (2022). *THE IPCC'S SIXTH ASSESSMENT REPORT Impacts, adaptation options and investment areas for a climate-resilient West Africa*. 1-20.
- CEMLAWS (2023). *Analyzing Maritime Security In Ghana (AMARIS) Project*. Accessed on 16.07.2025. <https://cemlawsafrica.org/analyzing-maritime-security-in-ghana-amaris-project/>
- Chibundu, J. (2024). Report: Floods disrupted education of 2.2m Nigerian students in 2024. Accessed on 08/08/2025. <https://www.thecable.ng/report-floods-disrupted-education-of-2-2m-nigerian-students-in-2024/>
- Climate Voice Global (2025). Stakeholders call for stronger climate governance, political action to address climate challenges. <https://www.ghanaweb.com/GhanaHomePage/NewsArchive/>

Cook, R., Nyarko, B. K., Aggrey-Fynn, J., Acheampong, E., & Asiedu, G. (2021). Assessment of small pelagic fish stocks in Ghanaian and adjacent waters. Available at SSRN 3956447.

Dada, O. A., Almar, R., & Morand, P. (2024). Coastal vulnerability assessment of the West African coast to flooding and erosion. *Scientific Reports*, 14(1), 890.

Danso, K & Okyere, O. F., (2023). Thinking Beyond Borders: Understanding the Domestic and External Sources of Maritime Insecurity in the Gulf of Guinea. KAIPTC Occasional Paper 60. 1-14

DCAF (2023). Context and stakeholder analysis of Maritime Security and Justice in the Gulf of Guinea. Final Report. 1-53

EJF (2020). The “people’s” fishery on the brink of collapse. Small pelagics in landings of Ghana’s industrial trawl fleet.

Elisha, O. D., & Gbaranbiri, I. (2024). The Struggle of the Niger Delta Region of Nigeria: The Duality of Liquid Gold and Poverty. *Journal of Economics and Trade*, 9(2), 1-14.

Eteh, D. R., Egobueze, F. E., Paar, M., Otutu, A., & Osondu, I. (2024). The impact of dam management and rainfall patterns on flooding in the Niger Delta: using Sentinel-1 SAR data. *Discover Water*, 4(1), 123.

Eteh, D. R., Japheth, B. R., Akajiaku, C. U., Osondu, I., Mene-Ejegi, O. O., Nwachukwu, E. M., & Ayo-Bali, A. E. (2025). Assessing the impact of climate change on flood patterns in downstream Nigeria using machine learning and geospatial techniques (2018-2024).

Freeman, O. E. (2017). Impact of climate change on aquaculture and fisheries in Nigeria; A review. *International Journal of Multidisciplinary Research and Development*, 4(1), 53-59.

Germond, B. (2015). The geopolitical dimension of maritime security. *Marine Policy*, 54, 137-142.

Germond, B., & Ha, F. W. (2019). Climate change and maritime security narrative: the case of the international maritime organisation. *Journal of environmental studies and sciences*, 9(1), 1-12.

Germond, B., & Mazari, A. D. (2019). Climate change and maritime security. *Marine Policy*, 99, 262-266.

Ghoms, F. E. K., Nyberg, B., Raj, R. P., Bonaduce, A., Abiodun, B. J., & Johannessen, O. M. (2024). Sea level rise and coastal flooding risks in the Gulf of Guinea. *Scientific Reports*, 14(1), 29551.

Goodman, S., Baudu, P., & Fleishman, R. (2023). Maritime response to climate change. In *Climate Change, Conflict and (In) Security* (pp. 213-240). Routledge.

Hemat, F. R., Hassan, M. Z. U., Khalid, M. U., Fatima, A., Hayat, M. K., Subhan, M., ... & Islam, R. N. (2025). The Urban Nexus: Intertwined Impacts of Urbanization on Climate Change and Agriculture. *International Journal of Agriculture Innovations and Cutting-Edge Research (HEC Recognised)*, 3(2), 54-77.

Henrico, I., & Doboš, B. (2024). Shifting sands: the geopolitical impact of climate change on Africa’s resource conflicts. *South African Geographical Journal*, 1-27.

Hunt, B. P., Alin, S., Bidlack, A., Diefenderfer, H. L., Jackson, J. M., Kellogg, C. T., ... & Vargas, C. A. (2024). Advancing an integrated understanding of land–ocean connections in shaping the marine ecosystems of coastal temperate rainforest ecoregions. *Limnology and Oceanography*, 69(12), 3061-3096.

IEA/IRENA, (2013). Nigeria Renewable Energy Master Plan. <https://www.iea.org/policies/4974-nigeria-renewable-energy-master-plan>

Ikuemonisan, F. E., Ozebo, V. C., Minderhoud, P. S. J., Teatini, P., & Woillez, M.-N. (2023). A scoping review of the vulnerability of Nigeria's coastland to sea-level rise and the contribution of land subsidence (AFD Research Paper No. 284). Agence Française de Développement (AFD)

International Organization for Migration (2008). Migration and Climate Change. ISSN 1607-338X. https://publications.iom.int/system/files/pdf/mrs-31_en.pdf

Iwuchukwu, S. (2025). Implementation And Challenges of the CCA 2021. Accessed on 17.07.2025. <https://www.mondaq.com/nigeria/climate-change/1602016/implementation-and-challenges-of-the-cca-2021>

Jiang, B., & LaFree, G. (2023). Climate change, fish production, and maritime piracy. *Weather, Climate, and Society*, 15(2), 289-306.

Joynews. (2025). Coastal erosion: Devastation is a national security threat; interventions needed to curb destruction. Accessed on 16.07.2025. <https://web.facebook.com/watch/?v=3069872289843921>

Kapstein, (2023). The Fish That Ate an Agreement: How Migrating Mackerel Undermine International Fisheries Cooperation. Accessed: 16.7, 2025

Khomsi, K., El Wakil, R., Nwaigwe, C. O., Mateyisi, M., & Nangombe, S. S. (2023). Current and Projected Climate Changes in African Subregions. In *Impact of Climate Change on Health in Africa: A Focus on Liver and Gastrointestinal Tract* (pp. 21-52). Cham: Springer International Publishing.

Kismartini, K., Yusuf, I. M., Sabilla, K. R., & Roziqin, A. (2024). A bibliometric analysis of maritime security policy: Research trends and future agenda. *Heliyon*, 10(8).

Lamptey, A. (2023). Securing the Gulf of Guinea: Evaluating Nigeria's Anti-Piracy Initiatives for Enhanced Maritime Governance. KAIPTC. 1-18

Lazar, N., Yankson K., Blay, J., Ofori-Danson, P., Markwei, P., Agbogah, K., Bannerman, P., Sotor, M., Yamoah, K. K., Bilisini, W. B. (2020). Status of the small pelagic stocks in Ghana in 2019. Scientific and Technical Working Group. USAID/Ghana Sustainable Fisheries Management Project (SFMP). Narragansett, RI: Coastal Resources Center, Graduate School of Oceanography, University of Rhode Island. GH2014_SCI083_CRC. 17 pp.

Lionel, E. (2025). Ghana builds naval base, acquires largest naval vessel from Japan. *Military Africa*. Accessed on 16.07.2025

Marangio Rossella (2025), Deep waters: the maritime security landscape in the Gulf of Guinea. Accessed on 19.07.2025 <https://www.iss.europa.eu/publications/briefs/deep-waters-maritime-security-landscape-gulf>

[guinea#:~:text=Navigating%20maritime%20security%20threats%20The%20Yaound%C3%A9%20architecture,Economic%20Community%20of%20Central%20African%20States%20\(ECCAS\)](#)

Marangio, R. (2025). The maritime security landscape in the Gulf of Guinea. Deep waters. Brief 1. <https://www.iss.europa.eu/publications/briefs/deep-waters-maritime-security-landscape-gulf-guinea>

Mbah, F. (2024). In Nigeria's crude capital, a plan to win the war against oil theft. Aljazeera Accessed on 16.07.2025. <https://www.aljazeera.com/news/2024/12/19/in-nigerias-crude-capital-a-plan-to-win-the-war-against-oil-theft#:~:text=Nigeria%20is%20one%20of%20Africa's,the%20highest%20in%20recent%20years>

Mbaye, A. A., Gueye, A., Gueye, F., Sarr, K. Y., & Gueye, F. (2021). Climate Change and Migration in West African Coastal Zones. Working Paper Series: CC-008. The African Economic Research Consortium. 1-41

Mboob, M. (2022). An Evaluation of the Yaounde Architecture. GoGMI. 1-22

McCabe, R. (2023). Environmental drivers of maritime insecurity: Governance, enforcement and resilience in the western Indian Ocean. *Conflict, Security & Development*, 23(3), 237-265.

MESTI (2013). Ghana National Climate Change Policy

Mohammed, L. A., & Dalaklis, D. (2024). The Current Status of Maritime Security in the Gulf of Guinea. *Journal of Maritime Research*, 21(2), 78-86.

Muhammed, A., Aminu, B. M., Musa, I. O., Abdulsalam, M., Isma'il, R., Gimba, Y. M., ... & Moses, E. O. (2024). Blue economy in Nigeria and the African Continent. In *Marine Bioprospecting for Sustainable Blue-bioeconomy* (pp. 355-370). Cham: Springer Nature Switzerland.

Musa, Z. N., Popescu, I., & Mynett, A. (2014). The Niger Delta's vulnerability to river floods due to sea level rise. *Natural Hazards and Earth System Sciences*, 14(12), 3317-3329.

NIMASA (2020). Deep Blue Project; Facing Maritime Security Head-On. *The Voyage*. 4(8). 1-60

Nwilo, P. C. (1995). Sea level variations and the impacts along the coastal areas of Nigeria (Doctoral dissertation).

Obeng, J.A & Sagoe, A. A. (2024). Is the Fight against IUU Fishing in the Gulf of Guinea a Futile Endeavor? Assessing the Effectiveness of IUU Fishing Interventions within the Gulf of Guinea. Atlantic Center. Centre. https://www.defesa.gov.pt/pt/pdefesa/ac/pub/acpubs/Documents/20241107_Atlantic-Centre_Report_04.pdf

Ogbeibu, A. E., & Oribhabor, B. J. (2023). The niger delta mangrove ecosystem and its conservation challenges. *Mangrove biology, ecosystem, and conservation*, 19.

Oloko, A., Dahmouni, I., Le Billon, P., Teh, L., Cheung, W., Sánchez-Jiménez, A., ... & Sumaila, U. R. (2025). Gender dynamics, climate change threats and illegal, unreported, and unregulated fishing. *Discover Sustainability*, 6(1), 494.

- Oluyemi, O. A. (2020). The military dimension of Niger delta crisis and its implications on Nigeria national security. *Sage Open*, 10(2), 2158244020922895.
- Omeni, A. (2022). Beyond African Pride: Corruption mechanisms in the Nigerian Navy and maritime sector. *Scientia Militaria: South African Journal of Military Studies*, 50(1), 45-64.
- Omotoso, A. B., Letsoalo, S., Olagunju, K. O., Tshwene, C. S., & Omotayo, A. O. (2023). Climate change and variability in sub-Saharan Africa: A systematic review of trends and impacts on agriculture. *Journal of Cleaner Production*, 414, 137487.
- Onje. O (2025). Troops seize 30,000 litres of stolen oil, arrest 46 thieves, dismantle 23 illegal refineries. Accessed on 16.07.2025. <https://businessday.ng/news/article/troops-seize-30000-litres-of-stolen-oil-arrest-46-thieves-dismantle-23-illegal-refineries/>
- Osei, I.W., (2025). Government to establish National Climate Change and Sustainability Hub to support climate action. Accessed on 08/08/2025. <https://www.modernghana.com/news/1420272/government-to-establish-national-climate-change.html>
- Otto, L. (2020). Introducing maritime security: the sea as a geostrategic space. In *Global challenges in maritime security: An introduction* (pp. 1-11). Cham: Springer International Publishing.
- Otto, L., & Jernberg, L. (2020). Maritime piracy and armed robbery at sea. In *Global challenges in maritime security: An introduction* (pp. 95-110). Cham: Springer International Publishing.
- Paarlberg, R. (2024). West Africa's falling fish stocks: illegal Chinese trawlers, climate change and artisanal fishing fleets to blame. *The Conversation*. Accessed on 16.07.2024. https://theconversation.com/west-africas-falling-fish-stocks-illegal-chinese-trawlers-climate-change-and-artisanal-fishing-fleets-to-blame-226819?utm_medium=email&utm_campaign=Latest%20from%20The%20Conversation%20for%20April%209%202024%20-%202932229788&utm_content=Latest%20from%20The%20Conversation%20for%20April%209%202024%20-%202932229788+CID_3f29d87c54c46f75dd5b707a8881a784&utm_source=campaign_monitor_africa&utm_term=West%20Africas%20falling%20fish%20stocks%20illegal%20Chinese%20trawlers%20climate%20change%20and%20artisanal%20fishing%20fleets%20to%20blame
- Pabi, O., Codjoe, S. N. A., Sah, N. A., & Appeaning Addo, I. (2015). Climate change linked to failing fisheries in coastal Ghana. *Brief reports*. 1-5
- Pal, I., Kumar, A., & Mukhopadhyay, A. (2023). Risks to coastal critical infrastructure from climate change. *Annual review of environment and resources*, 48(1), 681-712.
- Phayal, A., Gold, A., Maharani, C., Palomares, M. L. D., Pauly, D., Prins, B., & Riyadi, S. (2024). All maritime crimes are local: Understanding the causal link between illegal fishing and maritime piracy. *Political Geography*, 109, 103069.
- Premium Times (2024). Nigeria: Massive Oil Theft: Calling for Greater Maritime Security. Accessed on 17.07.2025. <https://allafrica.com/stories/202405130113.html>
- PUNCH (2024). Climate change erodes 84% of Lagos coastline – Report. Accessed on 08/08/2025. <https://healthwise.punchng.com/climate-change-erodes-84-of-lagos-coastline-report/>

Rubekie, A. P., Pauline, N. M., & Kaaya, L. T. (2022). Coastal communities' responses to climate change and variability impacts: a threat to coastal and marine resources?. *Climate and Development*, 14(9), 842-856.

Safty4Sea (2018). Ghana steps up efforts against illegal fishing. Accessed on 18.07.2025. <https://safety4sea.com/ghana-steps-up-efforts-against-illegal-fishing/>

Salako, P. (2024). Lost homes and rising seas: A Nigerian coastal community fears extinction. *Ajazeera*. Accessed on 16.07.2025. <https://www.aljazeera.com/features/2024/11/24/lost-homes-and-rising-seas-a-nigerian-coastal-community-fears-extinction>

Siebels, D. I. R. K. (2020). *Maritime Security in East and West Africa* (Vol. 13). Springer International Publishing.

Song, A. M. (2023). Civilian at sea: understanding fisheries' entanglement with maritime border security. *Geopolitics*, 28(3), 1161-1185.

Stępką, M. (2022). The Copenhagen school and beyond. A closer look at securitisation theory. In *Identifying Security Logics in the EU Policy Discourse: The "Migration Crisis" and the EU* (pp. 17-31). Cham: Springer International Publishing.

Tarif, K. (2022). Climate change and violent conflict in West Africa: Assessing the evidence. *SIPRI Insights on Peace and Security*. 1-24

The Climate Insight. (2025, March 7). *Tidal waves destroy 51 houses, displace over 300 in Agavedzi*. <https://theclimateinsight.com/2025/03/07/tidal-waves-destroy-51-houses-displace-over-300-in-agavedzi/>

Timidi, E. T., Pere, D. S., Enebraye, O. P., (2024). Climate Change and Maritime Security: Implications For Africa's Regional Development. *figshare*. Journal contribution. <https://doi.org/10.6084/m9.figshare.27643308.v1>

Trenberth, K. E. (2018). Climate change caused by human activities is happening and it already has major consequences. *Journal of energy & natural resources law*, 36(4), 463-481.

UNESCO (2024). Ghana's coastline, swallowed by the sea. Accessed on 17.07.2025. <https://courier.unesco.org/en/articles/ghanas-coastline-swallowed-sea#:~:text=The%20phenomenon%20is%20all%20the,erosion%20in%20a%20single%20year>

WACA, (2019). Rising Tide: Protecting Vulnerable Coastal Communities in West Africa. Accessed on 17.07.2025. <https://www.wacaprogram.org/article/rising-tide-protecting-vulnerable-coastal-communities-west-africa#:~:text=By%20100%2C%20West%20Africa%20is%20expected%20to,solutions%20are%20needed%20to%20protect%20coastal%20livelihoods>

Witbooi, E., Deen-Ali, K., Santos, M. A., Hurley, G., Husein, Y., Maharaj, S., ... & Salas, O. (2020). Organised crime in the fisheries sector.

Zięcina, M., Sokołowski, W., & Ficoń, K. (2022). Maritime safety in the approach of L. von Bertalanffy's general system theory. *Systemy Logistyczne Wojsk*, 57(2), 101-126

Appendix 1: Maritime Security Challenges of Ghana and Nigeria (2020- 2025)

	Ghana	Nigeria	References
Piracy, robberies and kidnappings	2020 - 6 robberies, 2 attempted robberies, 1 piracy attack & 4 kidnappings 2021 - 1 piracy, 1 attempted piracy, 3 attempted robberies 2022 - 6 robberies & 1 piracy 2023 - 5 robberies & 1 attempted robbery 2024 - 1 attempted robbery 2025 - 1 piracy attack & 1 attempted robbery.	2020 - 14 piracy, 15 attempted piracy, 2 robberies, 4 attempted robberies & 57 kidnappings 2021 - 2 piracy, 2 attempted piracy & 2 robberies 2023 - 2 robberies 2024 - 1 robbery attack 2025 - 1 robbery & 2 piracy attacks	ICC-IMB (2020). ICC-IMB Piracy and Armed Robbery Against Ships Report – 01 January – 31 December 2020. https://www.icc-ccs.org/reports/2020_Annual_Piracy_Report.pdf ICC-IMB (2021). ICC-IMB Piracy and Armed Robbery Against Ships Report – 01 January – 31 December 2021. https://www.icc-ccs.org/reports/2021_Annual_IMB_Piracy_Report.pdf ICC-IMB (2022). ICC-IMB Piracy and Armed Robbery Against Ships Report – 01 January – 31 December 2022. https://www.icc-ccs.org/reports/2022%20Annual%20IMB%20Piracy%20and%20Armed%20Robbery%20Report.pdf ICC-IMB (2023). ICC-IMB Piracy and Armed Robbery Against Ships Report – 01 January – 31 December 2023. https://www.icc-ccs.org/reports/2023_Annual_IMB_Piracy_and_Armed_Robbery_Report_live.pdf ICC-IMB (2024). ICC-IMB Piracy and Armed Robbery Against Ships Report – 01 January – 31 December 2024. https://icc-ccs.org/piracy-map-2024/ ICC-IMB (2025). ICC-IMB Piracy and Armed Robbery Against Ships Report map.

			Accessed on 13/10/2025. https://icc-ccs.org/map/
Oil Theft & Illegal Bunkering	2020 - 8 people and 6 illegal bunkering boats arrested in Takoradi during routine sea patrols by the Ghana Maritime Authority (GMA) with Western Naval Command & Marine Police. A wooden bunkering boat (a “dendey”) — reported to hold ~55,000–60,000 litres — was seized (Quansah, 2020). 2022 - GMA destroys 20 wooden boats used for illegal bunkering (Aklorbortu, 2022).	2020 - The Nigerian Navy seized a vessel and 6 suspect on January 9, 2020 for conveying illegal/poorly refined diesel (from artisanal refining) (Guardian News, 2020). 2020 - The Nigerian Navy publicly handed over crew members from multiple vessels to the EFCC for prosecution — specifically seven Sri Lankans, 46 Nigerians and two Ghanaians — tied to arrests of vessels alleged to be involved in illegal bunkering (EFCC, 2020). 2020 - NNS Jubilee seizes bunkering vessel; 5 suspects arrested (Akwa Ibom) (Vanguard Nigeria News, 2020) 2020 - the Navy also deactivated 982 illegal local refineries/refining sites with about 487 suspects arrested (Usman, 2021). 2021 - EFCC Arrests Six Suspected Illegal Oil Bunkerers in Port Harcourt (EFCC, 2021). 2021 - EFCC Arrests 11 Suspected Illegal Oil Bunkerers In Port Harcourt (EFCC, 2021).	Abia, D. (2021). EFCC, Nigerian Navy Collaborate To Combat Oil Bunkering In Niger Delta. https://independent.ng/efcc-nigerian-navy-collaborate-to-combat-oil-bunkering-in-niger-delta Abisola, S. (2023). NSCDC Arrests Five For Oil Bunkering In Bauchi. https://independent.ng/nscdc-arrests-five-for-oil-bunkering-in-bauchi/ Aklorbortu, D. K. (2022). GMA destroys 20 wooden boats used for illegal bunkering. https://www.graphic.com.gh/news/general-news/gma-destroys-20-wooden-boats-used-for-illegal-bunkering.html Chibundu, J. (2024). Navy arrests 10 persons for ‘oil bunkering’, seizes 7k barrels of crude in Akwa Ibom. Cable. https://www.thecable.ng/navy-arrests-10-persons-for-oil-bunkering-seizes-7k-barrels-of-crude-in-akwa-ibom Eboh, C. (2025). Nigerian Navy cracks down on oil theft, arrests 76 vessels in two years. https://www.reuters.com/business/energy/nigerian-navy-cracks-down-oil-theft-arrests-76-vessels-two-years-2025-06-19 Eboh, C. (2025). Nigerian troops arrest dozens in week-long oil theft crackdown. https://www.reuters.com/world/africa/nigerian-troops-arrest-dozens-week-long-oil-theft-crackdown-2025-04-07/ EFCC (2020). Oil Theft: Navy Hands over Seven Sri-Lakans, Two Ghanaians to EFCC for

		2021 - Five people (plus Tugboat DP28, MV Nazarene, transshipping ~261,000 litres of AGO without license) arraigned for alleged oil theft (EFCC, 2021). 2021 - Two vessels (MT Bright Hope and MV Johanna II) arrested. MT Bright Hope (Togolese flag) had 13 crew (12 Nigerians and 1 Ghanaian), and was carrying ~1,371,256 litres of allegedly stolen crude plus ~62,431 litres of refined AGO; MV Johanna II had ~394,000 litres of AGO (Abia, 2021). 2021 - 18 suspected illegal oil bunkerers arrested (29 Nov 2021) in G.R.A., Port Harcourt (EFCC, 2021). 2021 - The Nigerian Navy impounded 25 vessels used in illegal oil bunkering over the year (Guardian Nigeria, 2021). 2021 - Five suspects arrested after uncovering illegal bunkering sites (TVCNews, 2021). 2022 - 120 suspects arrested for illegal oil bunkering. Seized were eight vehicles and pumping machines (Omolaoye, 2022). 2022 - 19 suspects arrested in one batch for engagement in illegal	Prosecution. https://www.efcc.gov.ng/efcc/news-and-information/news-release/5467-oil-theft-navy-hands-over-seven-sri-lakans-two-ghanaians-to-efcc-for-prosecution EFCC (2021). EFCC Arrests 11 Suspected Illegal Oil Bunkerers In Port Harcourt. https://www.efcc.gov.ng/efcc/news-and-information/news-release/6774-efcc-arrests-11-suspected-illegal-oil-bunkerers-in-port-harcourt EFCC (2021). EFCC Arrests 18 Suspected Illegal Oil Bunkerers In Port Harcourt. https://www.efccnigeria.org/efcc/news-and-information/news-release/7502-efcc-arrests-18-suspected-illegal-oil-bunkerers-in-port-harcourt EFCC (2021). EFCC Arrests Six Suspected Illegal Oil Bunkerers In Port Harcourt. https://www.efcc.gov.ng/efcc/news-and-information/news-release/6760-efcc-arrests-six-suspected-illegal-oil-bunkerers-in-port-harcourt EFCC (2021). EFCC Docks Five for Alleged Oil Theft. https://www.efcc.gov.ng/efcc/news-and-information/news-release/6619-efcc-docks-five-for-alleged-oil-theft Guardian (2024). Army dismantles 43 illegal refineries in Niger Delta, arrests suspects. https://guardian.ng/news/army-dismantles-43-illegal-refineries-in-niger-delta-arrests-suspects/ Guardian News (2020). Navy hands over arrested oil vessel, six suspects to EFCC. https://www.legalnigeria.com/navy-hands-over-arrested-oil-vessel-six-suspects-to-efcc/
--	--	---	--

		bunkering. The NSCDC also reported that since January 2022, they had arrested 69 suspects in Rivers State for oil bunkering (TVCNews, 2022). 2023 - NSCDC (Nigeria Security and Civil Defence Corps) arrested 292 suspected oil thieves in several raids and operations. Convicted 40 out of them. Also made 176 arrests for vandalism, illegal oil bunkering (Vanguard, 2023). 2023 - Nigerian Navy (NNS Beecroft) Arrested 8 suspects. Wooden boat with 8-member crew caught with >300 drums, pumping machines and other illegal equipment, prevented from transporting product (Vanguard, 2023). 2023 - Nigerian Navy (NNS Beecroft) Seized a fibre boat abandoned by the perpetrators, containing 205 drums of substance suspected to be Premium Motor Spirit (PMS) (Vanguard, 2023). 2023 - Motor Tanker Queen Hansal vessel seized; 10 persons arrested (1 captain and 9 crew, Nigerians). Vessel had capacity ~1,022 tonnes (~7,000 barrels of crude) (Chibundu, 2024).	Guardian Nigeria (2021). Navy impounds 25 vessels used in illegal bunkering. https://guardian.ng/news/navy-impounds-25-vessels-used-in-illegal-bunkering/ Nwaoku, O. (2024). Oil theft: Troops dismantle 63 bunkering sites, arrest seven suspects. https://guardian.ng/news/nigeria/metro/oil-theft-troops-dismantle-63-bunkering-sites-arrest-seven-suspects/ Olekanma, F. (2024). Navy deactivates 124 illegal refining sites, arrests oil thieves in Niger Delta. https://dailypost.ng/2024/10/10/navy-deactivates-124-illegal-refining-sites-arrests-oil-thieves-in-niger-delta/ Omolaoye, S. (2022). EFCC, army arrest 120 oil theft suspects in Port Harcourt. https://guardian.ng/news/efcc-army-arrest-120-oil-theft-suspects-in-port-harcourt/ Quansah, I (2020). Six illegal bunkering boats arrested in Takoradi. https://www.myjoyonline.com/six-illegal-bunkering-boats-arrested-in-takoradi/?utm_ Shotayo, N. (2023). NSCDC apprehends 5 suspects involved in illegal oil bunkering, impounds vehicles in Imo. https://www.pulse.ng/articles/news/local/nscdc-apprehends-5-suspects-involved-in-illegal-oil-bunkering-2024072621430383523 The Nigerian Observer, (2025). Troops foil attempts to re-establish illegal bunkering sites, arrest 28. https://nigerianobservernews.com/2025/04/troops-foil-attempts-to-
--	--	--	---

		2023 - 5 suspects arrested at scene of illegal bunkering, with jerry cans full of stolen oil (Abisola, 2023). 2023 - 5 suspects arrested; 4 vehicles impounded; about 30,000 litres of oil recovered (Shotayo, 2023). 2024 - Nigerian Navy arrested 3 suspects with a wooden boat carrying ~60,000 litres of suspected stolen crude oil (Product value ~N32 million) (Vanguard, 2024). 2024 - Over ~4 months: 124 illegal refining sites deactivated, 55 suspected oil thieves / illegal refinery operators arrested. Also ~116 wooden boats, 543 dugout pits, 64 storage tanks were deactivated; 6 vessels arrested (Olekanma, 2024). 2024 - Nigerian Army dismantled 43 illegal oil bunkering / refining hubs, arrested 19 suspects, seized ~260,000 litres of stolen product during operations in those states (Guardian, 2024). 2024 - Nigerian Army dismantled 63 bunkering sites, arrested 7 suspects, seized 280,000 litres of stolen crude oil; intercepted a wooden boat illegally siphoning oil from barge (Rivers	<u>re-establish-illegal-bunkering-sites-arrest-28/</u> TVCNews (2021). Navy Arrests 5 Suspects for bunkering, Confiscates Products In Delta. https://www.tvcnews.tv/navy-arrests-5-suspects-for-bunkering-confiscates-products-in-delta/ TVCNews (2022). NSCDC arrests 19 for Oil Bunkering, 69 since January in Rivers. https://www.tvcnews.tv/nscdc-arrests-19-for-oil-bunkering-69-since-january-in-rivers/ Usman, E. (2021). Nigerian Navy Score card 2020: Arrests 87 vessels, 43 barges, 57speed boats, 393 others. FCWC. https://fcwc-fish.org/nigerian-navy-score-card-2020-arrests-87-vessels-43-barges-57speed-boats-393-others/ Vanguard (2023). Navy arrests 8, halts illegal bunkering activities. https://www.vanguardngr.com/2023/10/navy-arrests-8-halts-illegal-bunkering-activities/ Vanguard (2023). Navy seizes boat engaged in illegal bunkering. https://www.vanguardngr.com/2023/10/navy-seizes-boat-engaged-in-illegal-bunkering/ Vanguard (2023). NSCDC arrests 292 oil thieves, convicts 40 in 2023 – Commandant. https://www.vanguardngr.com/2023/12/nscdc-arrests-292-oil-thieves-convicts-40-in-2023-commandant/ Vanguard (2024). Navy arrests 3 suspects with stolen crude oil in A’Ibom. https://www.vanguardngr.com/2024/11/navy-arrests-3-suspects-with-stolen-crude-oil-in-aibom/ Vanguard (2025). Army uncovers 27 illegal oil bunkering sites in Niger Delta. https://www.vanguardngr.com/2025/06/army-uncovers-27-illegal-
--	--	--	---

		State) with ~198,000 litres (Nwaoku, 2024). 2025 - Navy reported it had arrested 76 vessels and at least 242 suspects in anti-oil-theft operations (two-year figure reported in June 2025) and destroyed more than 800 illegal refining sites. This is Navy's reported enforcement tally over a period that covers 2024–2025 activity (Eboh, 2025). 2025 - Troops arrested 43 suspected oil thieves in a week-long crackdown and seized >254,000 litres of stolen fuel during coordinated operations across the Niger Delta (Eboh, 2025). 2025 - Army announced operations that uncovered 27 illegal bunkering sites and reported the arrest of 43 suspected oil thieves (reporting on operations conducted late May–early June 2025) (Vanguard, 2025). 2025 - Troops said they foiled attempts to re-establish illegal bunkering hubs and arrested 28 suspects in coordinated raids to prevent re-establishment of sites (The Nigerian Observer, 2025).	<u>oil-bunkering-sites-in-niger-delta/</u> Vanguard Nigeria News (2020). Illegal bunkering: Navy siezes vessel, arrests 5 suspects in Akwa Ibom. <u>https://www.vanguardngr.com/2020/07/illegal-bunkering-navy-siezes-vessel-arrests-5-suspects-in-akwa-ibom</u>
Drug & Arms Trafficking	2020 - 152 kilograms (15 slabs) of a substance suspected to be cocaine	2021 - ≈43.11 kg cocaine seized at Tin Can Seaport (NDLEA's 2021 activity	Obokoh, A. (2025). NDLEA intercepts N3.4 billion worth of opioids, codeine in Lagos and

were intercepted concealed inside a shipment of sugar arriving in containers from Brazil (Myjoyonline, 2020). 2020 - Customs flagged a container (arrived by sea) on the red channel and after examination discovered a concealed consignment of pistols and ammunition (reports cite 436 pistols and multiple packs of ammunition) (GRA, 2020). 2021 - Officers intercepted two containers transiting Tema Port in the first half of 2021: one container held ~1,000,000 tramadol tablets, the other ~1,500,000 tapentadol capsules (total $\approx$ 2.5 million capsules) (DL News, 2021). 2021 - Ghana Revenue Authority (Customs) preventive / counter-terrorism teams discovered concealed weapons during physical examination of a 40-foot container at the Golden Jubilee Terminal. Published inventory included 9 pistols (side-arms), 8 assault rifles and ~219 pieces of live ammunition (Oclo, 2021). 2023 - Ghana Navy Riverine Command, in collaboration with NACOC and Police seized 81 sacks of suspected	summary cites the Feb seizure) (newslive, 2022). 2021 - Multiple crew and associated suspects arrested after vessels were intercepted with cocaine on board — high-profile cases included the arrest of a vessel and crew at Apapa in October 2021 (NDLEA, 2021). 2021 - 12 Apapa dock workers arrested reportedly linked to a large seized cocaine consignment (Olugbode, 2021). 2022 - NDLEA intercepted 40,250 kg of codeine (in two 40-ft containers from India) at Apapa Port (Port Express Bonded Terminal, Berger-Apapa). There was also a related seizure of 14,080 kg codeine syrup + 4,352.43 kg of “cold caps” used to conceal the codeine-laden syrups in another container (Sunday, 2022). 2022 - NDLEA intercepted consignments including “Colorado” (a strain of cannabis) and cannabis juice at Tincan seaport (Apapa) and MMIA. Several dock workers and a consignee/wine seller were arrested (Sahara Reporters, 2022).	Port Harcourt. https://nairametrics.com/2025/05/04/ndlea-intercepts-n3-4-billion-worth-of-opioids-codeine-in-lagos-and-port-harcourt Onyenucheya, A. (2025). Customs seize 16 containers of illicit drugs, ammunition worth N10b at Apapa port. https://guardian.ng/news/nigeria/metro/customs-seize-16-containers-of-illicit-drugs-ammunition-worth-n10b-at-apapa-port/ Obokoh, A. (2025). NDLEA arrests Delta drug kingpin, seizes N7.8billion worth of opioids at Onne Port. https://nairametrics.com/2025/08/17/ndlea-arrests-delta-drug-kingpin-seizes-n7-8billion-worth-of-opioids-at-onne-port/ Opanuga, J. (2025). NDLEA seizes N6.5b worth of illicit drugs, arrests four over cannabis. https://guardian.ng/news/nigeria/metro/ndlea-seizes-n6-5b-worth-of-illicit-drugs-arrests-four-over-cannabis/ Olugbode, M. (2024). NDLEA Intercepts over N7bn Worth of Opioids at Apapa, Onne Seaports. https://www.thisdaylive.com/2024/10/21/ndlea-intercepts-over-n7bn-worth-of-opioids-at-apapa-onne-seaports/ Owolabi, T. (2024). Nigerian customs agents seize weapons, cough syrup in twin busts. https://www.reuters.com/world/africa/nigerian-customs-agents-seize-weapons-cough-syrup-twin-busts-2024-07-01/ Vanguard (2023). Customs intercepts 31 arms in Lagos ports. https://www.vanguardngr.com/2023/07/customs-intercepts-seizes-31-arms-in-lagos-ports/
--	--	--

	marijuana; 6 suspects arrested (GNA, 2023). 2024 - The Narcotics Control Commission (NACOC) intercepted 1,035,000 tramadol tablets/capsules (net weight reported ~4,734.38 kg) during container examinations at Tema Port (Daily Graphic, 2024). 2024 - Officers from NACOC (at Swiss Port, Tema) uncovered 73 slabs (approx. 89.74 kg) of a substance suspected to be cocaine concealed in outbound cargo. four individuals were reported arrested in connection with that attempted shipment (Otchere, 2024). 2024 - During a routine examination of a 40-foot container (arrived 4 Nov 2024) at the Golden Jubilee Terminal, Customs discovered 53 pistols, 74 magazines and 65 live rounds concealed inside suitcases. the declarant/agent and the consignee's representative were arrested (Duodu, 2024). 2025 - NACOC and Customs intercepted a 20-foot container at Tema Port (unstuffed ~99 cartons of TRAMAL-X120 — tramadol and carisoprodol, 120mg) in a coordinated raid in Atimpoku on 7 May 2025 (Modern Ghana, 2025).	2023 - A 40-ft container examined during a joint operation uncovered arms & ammunition concealed in plastic drums: includes pump action rifles, pistols (various makes), magazines, live rounds. Two suspects (clearing agents) arrested in relation to the container (Vanguard, 2023). 2024 - Customs intercepted a shipping container (loaded in Turkey) containing more than 800 rifles and ~100,000 rounds of ammunition hidden among furniture and other goods (Owolabi, 2024). 2024 - Customs / NDLEA jointly intercepted large consignments of codeine-based cough syrup and millions of opioid tablets (tramadol / tapentadol / related products) in multiple containers at Apapa (Lagos) and Onne (Port Harcourt). Reports describe more than a million bottles/ millions of pills in combined operations (Olugbode, 2024). 2025 - Seizure of six million opioid pills (including tamol, tapentadol, carisoprodol 225mg) and 332,000 bottles of codeine-based	Daily Graphic (2024). NACOC intercepts 1m capsules of tramadol. https://www.graphic.com.gh/news/general-news/ghana-news-nacoc-intercepts-1m-capsules-of-tramadol.html DL News (2021). 2 million capsules of Tramadol, Tapentadol intercepted at Tema Port. https://dennislawnnews.com/article/2-million-capsules-of-tramadol--tapentadol-intercepted-at-tema-port Duodu, S. (2024). Customs seizes firearms at Tema Port. https://www.graphic.com.gh/news/general-news/ghana-news-customs-seizes-firearms-at-tema-port.html Glover, B. X (2025). GHC20million worth of opioid drugs intercepted at Tema Port. https://www.graphic.com.gh/news/general-news/customs-seizes-40-foot-container-of-undeclared-opioid-pharmaceuticals-at-tema-port.html GNA (2023). Navy seizes 81 sacks of suspected marijuana, arrests six suspects. https://gna.org.gh/2023/12/navy-seizes-81-sacks-of-suspected-marijuana-arrests-six-suspects/ GRA (2020). Press Release - Seizure Of Arms And Ammunition At The Tema Port. https://citinewsroom.com/wp-content/uploads/2020/10/RELEA-SE-SEIZURE-OF-ARMS-AMMUNITION-AT-THE-TEMA-POST-11-OCT-2020-final.pdf Modern Ghana (2025). NACOC, Customs intercept Tramadol shipment at Tema Port; drug trafficking ring busted in Eastern Region. https://www.modernghana.com/n
--	---	--	---

	2025 - Joint inspection at Tema Port uncovered large consignments of Tapentadol / Tafradol / Timaking and other opioid pharmaceuticals (reported value ~GH¢20 million) (Glover, 2025).	cough syrup via containers at both ports (Opanuga, 2025). 2025 - Seizure of opioids worth ~₦7.8 billion: 875,000 bottles of codeine syrup and 3.5 million pills of “trodol benzhexol” (or similar) from five containers. Arrests: 36-year-old drug kingpin Sunday Ibide and one aide arrested, among others (Obokoh, 2025). 2025 - Seizure of 16 containers holding contraband including arms, ammunition, fake/expired drugs, military gear, etc. Arrests: five suspects arrested, three charged and remanded, two on administrative bail (Onyenuchey, 2025). Seizure of over 3.5 million opioid pills + ~163,000 bottles of codeine syrup in a container at Onne; plus follow-up arrests of a syndicate (including one “kingpin” associated with a previous tramadol shipment) in Lagos (Obokoh, 2025).	ews/1404105/nacoc-customs-intercept-tramadol-shipment-at-tema.html Myjoyonline (2020). 152kgs of cocaine concealed as sugar intercepted at Tema Port. https://www.myjoyonline.com/152kgs-of-cocaine-concealed-as-sugar-intercepted-at-tema-port/ NDLEA (2021). 32.9kg cocaine trafficking: 10 Thai sailors, ship convicted, fined \$4.3million. https://web.facebook.com/ndlea01/posts/329kg-cocaine-trafficking-10-thai-sailors-ship-convicted-fined-43million-convict/1001867538794013/ newslive (2022). NDLEA arrests 12,306 suspects over N130bn drug in 2021 – Marwa. https://newslive.com.ng/ndlea-arrests-12306-suspects-over-n130bn-drug-in-2021-marwa/ Oclo, D. R. (2021). Cache of arms seized at Tema Port. https://www.graphic.com.gh/news/general-news/cache-of-arms-seized-at-tema-port.html Olugbode, M. (2021). NDLEA Arrests 12 Apapa Dock Workers over Link to Seized N9.5bn Cocaine. https://www.thisdaylive.com/2021/11/14/ndlea-arrests-12-apapa-dock-workers-over-link-to-seized-n9-5bn-cocaine/ Otchere, A. (2024). NACOC intercepts 73 slabs of suspected cocaine at Swiss Port; 4 arrested. https://citinewsroom.com/2025/04/nacoc-intercepts-73-slabs-of-suspected-cocaine-at-swiss-port-4-arrested Sahara Reporters (2022). Nigerian Anti-Narcotics Agency, NDLEA Intercepts 'Colorado', Cannabis Juice At Lagos Airport, Seaport; Arrests Dock Workers, Others.
--	---	---	--

			https://saharareporters.com/2022/12/25/nigerian-anti-narcotics-agency-ndlea-intercepts-colorado-cannabis-juice-lagos-airport Sunday, O. (2022). NDLEA seizes 40,250 kg of Codeine worth N2b at Lagos port. https://guardian.ng/news/ndlea-seizes-40250-kg-of-codeine-worth-n2b-at-lagos-port/
Human Trafficking & Migrant Smuggling	2020 - IJM and Ghanaian partners rescued four boys (ages ~11–16) exploited in a Lake Volta fishing business; the operation also resulted in four suspected traffickers arrested (IJM, 2020). 2020 - The Tema Regional Command of Ghana Immigration Service (GIS) disembarked four Ghanaians who had stowed away on the MV Kota Samba which called at Tema harbour anchorage, after a voyage from Walvis Bay, Namibia. They were discovered on board while the ship was in transit (Ghana News Agency, 2020). 2020 - Three Nigerian nationals were found hiding (behind the vessel's propeller housing) on a vessel from Apapa (Nigeria) that called at Tema. They had hoped to get to Spain (Zancy, 2020). 2021 - 36 trafficked persons rescued through lake patrol / marine police	2020 - NAPTIP announced rescue of 132 victims in Akwa Ibom in August 2020; the operation related to trafficking networks using coastal corridors (Nwosu, 2020). 2023 - Five stowaways arrested on MSC Martha vessel near Lagos anchorage by Nigerian Navy (NNS Beecroft patrol) (Aworinde, 2023) 2023 - Eight stowaways inside Europe-bound Charminar Panama ship arrested by Nigerian Navy in Lagos Anchorage (Vanguard, 2023) 2023 - Eight stowaways aboard container vessel NATAL heading to Abidjan, arrested by Navy at Lagos Anchorage (Egobiambu, 2023). 2023 - Four stowaways aboard "TEME EXPRESS" (container vessel to Dubai) arrested by Nigerian Navy (Jubril, 2023).	Aworinde, O. (2023). Navy Arrests Five Stowaways Near Lagos Anchorage. https://www.channelstv.com/2023/08/30/navy-arrests-five-stowaways-near-lagos-anchorage/ Darko, S. (2024). GPHA security manager grabs three stowaways at Tema Port. https://www.ghanaweb.com/GhanaHomePage/NewsArchive/GPHA-security-manager-grabs-three-stowaways-at-Tema-Port-1964522 Egobiambu, E. (2023). Navy Arrests Eight Stowaways At Lagos Anchorage. https://www.channelstv.com/2023/11/06/navy-arrests-eight-stowaways-at-lagos-anchorage/ Ehigiator, S. (2024). Nigerian Navy Extracts, Arrests Nine Stowaways from Spain-bound Vessel. https://www.thisdaylive.com/2024/02/06/nigerian-navy-extracts-arrests-nine-stowaways-from-spain-bound-vessel/ Ghana News Agency (2020). Ghana Immigration Service disembarks four Ghanaian stowaways. https://gna.org.gh/2020/10/ghana-immigration-service-disembarks-four-ghanaian-stowaways

	/ IJM collaboration. 8 trafficking cases recorded in 2021; 4 persons sent to court; 1 convicted; 3 still on trial (The Herald Ghana, 2022). 2021 - Six children rescued (four minors 10-16 yrs, two adults) being trafficked from Yeji (Ghana) to Togo; victims were handed over to Social Welfare (Ghana News Agency, 2021). 2021 - 13 child survivors of trafficking (boys aged 9-19) returned to their home country (Côte d'Ivoire). They had been trafficked into exploitative labour in farming in Ghana (IMO, 2021). 2021 - Stowaway from Guinea-Bissau (28-year-old) disembarked at Tema Port after being found at high seas aboard MV Aurora (boarded in Bissau via a mooring rope) (Ghana News Agency, 2021) 2022 - Ghana Police and Department of Social Welfare (with support from IJM) carried out a rescue operation that freed nine suspected victims of trafficking who were being exploited in the fishing sector (IJM, 2022). 2022 - IJM led two coordinated rescue operations with the Dambai Police and	2023 - Naval operations arresting stowaways on various vessels (multiple ships: Charminar, MSC Martha, Natal, etc.) totalling ~75 stowaways across different months in Lagos waters/launched vessels (Olowofoyeku, 2023). 2024 - Navy extracts/arrests nine stowaways from the rudder compartment of the Spain-bound motor tanker LYSIAS VALETTA near Lagos (Ehigiator, 2024). 2024 - "Japa: Navy arrested 75 Nigerians hidden under rudder of cargo ships" — from August 2023 through April 2024, 75 stowaways in various vessels (rudder compartments etc.) were apprehended by Nigerian Navy (Omonobi, 2024). 2024 - Navy intercepts 19 suspected stowaways aboard two Europe-bound vessels (MT KRITI RUBY, MT MCC YANBU) at Lagos (I think Atlas Cove or Fairway Buoy / Lagos waterways) (Usman, 2024).	Ghana News Agency (2021). Guinea-Bissau stowaway disembarks at Tema Port. https://gna.org.gh/2021/10/guinea-bissau-stowaway-disembarks-at-tema-port/ Ghana News Agency (2021). PAORP-VWC rescues trafficked children in Tatale. https://gna.org.gh/2021/01/paorp-vwc-rescues-trafficked-children-in-tatale/ GIS (2022). Ghana Immigration Service 2022 Annual Report. IJM (2020). Four Boys Free, Four Suspects Arrested. https://ijm.org.au/news/four-boys-free-four-suspects-arrested IJM (2022). 10 Boys Rescued from Lake Volta in Ghana. https://ijm.org.au/news/10-boys-rescued-from-lake-volta-in-ghana? IJM (2022). Nine rescued from extreme abuse on Lake Volta, some suffering for two decades. https://ijm.org.au/news/nine-rescued-from-extreme-abuse-on-lake-volta-some-suffering-for-two-decades IMO (2021). Child Survivors of Trafficking Rescued in Ghana Return to Côte d'Ivoire. https://www.iom.int/news/child-survivors-trafficking-rescued-ghana-return-cote-divoire? Jubril, A. (2023). Nigeria Navy arrests four stowaways aboard Dubai vessel. https://telegraph.ng/news/2023/11/16/nigeria-navy-arrests-four-stowaways-aboard-dubai-vessel/ Nwosu, A. (2020). MetroNAPTIP rescues 132 victims of human trafficking in Akwa Ibom. https://dailypost.ng/2020/08/27/naptip-rescues-132-victims-of-human-trafficking-in-akwa-ibom/
--	--	---	--

	Department of Social Welfare that freed 10 boys who had been trafficked into forced fishing labour (IJM, 2022). 2022 - In the 2022 GIS Annual Report, under “Stowaway”, Ghanaians/foreign nationals who attempted stowaway to various destinations: 41 attempts in 2022, up from 26 in 2021. These are “persons who attempted to stowaway to various destinations” (GIS, 2022). 2024 - Ghana Ports & Harbours Authority security staff at Tema Port intercepted three stowaways who had boarded a ship clandestinely and were discovered while the vessel was in port (Darko, 2024).	Olowofoyeku, S. (2023). Navy decries menace of stowaways, arrests 75 in Lagos. https://maritimetodayonline.com/navy-decries-menace-of-stowaways-arrests-75-in-lagos/ Omonobi, K. (2024). Japa: Navy arrested 75 Nigerians hidden under rudder of cargo ships. https://www.vanguardngr.com/2024/04/japa-navy-arrested-75-nigerians-hidden-under-rudder-of-cargo-ships/ The Herald Ghana (2022). Oti: 36 trafficked persons rescued on Volta lake in 2021. https://theheraldghana.com/oti-36-trafficked-persons-rescued-on-volta-lake-in-2021/ Usman, E. (2024). Navy arrests 19 stowaways aboard two Europe bound vessels. https://www.vanguardngr.com/2024/12/navy-arrests-19-stowaways-aboard-two-europe-bound-vessels/ Vanguard (2023). Navy arrests eight stowaways inside Europe-bound ship. https://www.vanguardngr.com/2023/09/navy-arrests-eight-stowaways-inside-europe-bound-ship/ Zancy (2020). 3 Nigerian stowaways who thought they were going to Spain, land in Ghana instead. https://www1.illuminaija.com/entertainment-news/3-nigerian-stowaways-who-thought-they-were-going-to-spain-land-in-ghana-instead/
--	---	---

Climate Change and Resource Exploitation in the Gulf of Guinea: A Looming Crisis for Environmental and Economic Security in Cameroon

Edouard Epiphane Yogo²⁵

General Introduction

Context of the Study

This study is conducted within the framework of the Atlantic Centre, an institution dedicated to fostering research and policy development on maritime security, climate change, and regional resilience across the Atlantic basin. It explains how far the 21st century is increasingly defined by major climatic upheavals, whose consequences are already palpable across many regions of the world. Among these, the Gulf of Guinea, a strategic maritime space bordering Central and West Africa, has emerged as an epicenter of environmental, economic, and security vulnerability (Ellison, 2012). Cameroon, by virtue of its geographic location and natural wealth, stands as a poignant illustration of how climate change and intensified natural resource exploitation converge to threaten human and ecological systems alike.

Rising sea levels, ocean acidification, changing temperature patterns, and the growing frequency of extreme weather events are profoundly altering coastal ecosystems. These transformations directly impact artisanal fishing and subsistence agriculture, two sectors that are not only central to the livelihoods of millions but also vital to local food security and national economic stability (IFRI, 2009). In this context, the interactions between climate change and natural resource exploitation must be understood not only as environmental concerns but also as strategic threats to social cohesion, economic development, and national security.

This research situates Cameroon's climate and security challenges within the broader Atlantic context, recognizing the interconnectedness of coastal ecosystems, economic activities, and migration patterns across the Atlantic basin. By engaging with the Atlantic Centre framework, the study benefits from a trans-regional perspective that links local vulnerabilities to wider Atlantic security and environmental dynamics.

Rationale of the Study

In a global context where political and strategic initiatives increasingly aim to reconcile economic development with environmental sustainability, it becomes imperative to assess how local dynamics are shaped by the dual forces of climate change and resource extraction. Cameroon, as a coastal nation within the Gulf of Guinea, faces a double burden. On one hand, its coastal communities, particularly in the Littoral and South-West regions, rely heavily on artisanal fisheries and subsistence farming (Ellison, 2012). On the other, the state has oriented its development strategy around the exploitation of hydrocarbons as a core engine for national growth.

²⁵ Lecturer at the University of Yaoundé II. Senior Researcher at the Bureau of Strategic Studies (BESTRAT). email: edouardyogo@yahoo.fr

This duality creates significant tensions and raises critical questions regarding the long-term viability of natural resources, the resilience of local populations, and the broader trajectory of socio-economic stability in the country. Moreover, it invites reflection on the adequacy of current governance frameworks in addressing climate-related risks, especially those affecting the poorest and most exposed communities.

Justification for the Research Topic

By engaging with the Atlantic Centre's mandate, this research links Cameroon's climate challenges to broader Atlantic security and environmental concerns. This study is justified by the need to offer both scientific insight and practical policy guidance regarding the nexus between food security and environmental governance in the context of accelerating climate degradation. By focusing on Cameroon, a country that encapsulates many of the challenges faced by coastal African nations, this study seeks to contribute to a better understanding of structural vulnerabilities, aggravating factors, and potential pathways for sustainable and inclusive resource governance.

In addition to providing an empirical examination of local realities, the study aims to engage with broader theoretical debates on the securitization of environmental risks, the political economy of natural resource management, and the prospects for climate adaptation in fragile contexts.

This approach ensures that local findings inform trans-regional strategies, promoting resilience and cooperative solutions across the Atlantic basin.

Research Problem, Hypothesis, and Objectives

The central research question guiding this study is as follows: how does the interplay between climate change and natural resource exploitation affect food and economic security in coastal communities in Cameroon? The core hypothesis posited is that the intersection of climate change effects and unsustainable resource exploitation, particularly in relation to oil, gas, and fisheries, is accelerating environmental degradation. This degradation, in turn, undermines both local food security and the broader economic resilience of the country.

The study is guided by the following specific objectives:

- To describe the tangible impacts of climate change on fisheries and agricultural resources in Cameroon's coastal regions;
- To analyze the economic consequences of the depletion of these critical resources for local livelihoods;
- To evaluate the relationship between hydrocarbon exploitation and environmental degradation in marine and terrestrial ecosystems;
- To formulate actionable policy recommendations for sustainable and inclusive governance of natural resources in Cameroon.

Methodology and Analytical Framework

This study adopts a qualitative and interpretative approach, grounded in both empirical data and theoretical reflection. At the theoretical level, the research is anchored in Keith Krause's theory of

security constructivism, which frames security not as an objective condition but as a social construct shaped by perceptions, narratives, and political processes (Krause, 1998). This lens is particularly useful in understanding how environmental risks, such as food insecurity and ecological degradation, are framed as threats to human security and national stability.

Methodologically, the study employs François Thual's geopolitical approach, which emphasizes the importance of spatial, political, and historical dimensions in the analysis of power struggles over territory and resources (Thual, 1996). This approach allows for a nuanced understanding of how climate change, resource extraction, and governance intersect in specific geographies such as the Gulf of Guinea.

Data will be collected through a combination of documentary analysis (including reports from institutions such as the FAO, UNEP, and national policy documents), field case studies in the Littoral and South-West regions, and semi-structured interviews with local actors, including fishermen, farmers, and environmental officials. This methodological framework aims to provide both a macro-level understanding of structural challenges and a micro-level insight into the lived experiences and strategies of local communities.

Geographical, Temporal, and Conceptual Scope

Geographically, the study concentrates on Cameroon's coastal regions, particularly the Littoral and South-West areas, which are the most exposed to climatic and industrial pressures. These regions are both economically vital and environmentally vulnerable, making them ideal case studies for analyzing the nexus between climate change and resource exploitation.

Temporally, the research spans the period from 2000 to 2025, enabling a diachronic analysis of trends in environmental degradation, policy evolution, and livelihood transformations. This temporal frame also captures the intensification of climate-related impacts and the expansion of oil and gas activities in the country.

Conceptually, the study draws on and interrogates key notions such as food security, environmental degradation, natural resource exploitation, and community resilience. It treats these not merely as descriptive terms but as dynamic and contested categories that reflect deeper socio-political realities and governance challenges.

Structure of the Paper

This study is structured into two main parts:

- Part I analyzes the impact of climate change on the local economies of Cameroon's coastal zones, with a specific focus on the fishing and agricultural sectors. It examines how rising sea temperatures, coastal erosion, and changing rainfall patterns affect both ecosystems and livelihoods, thereby exacerbating vulnerabilities related to food security and income generation.
- Part II investigates the broader economic and environmental implications of resource exploitation, particularly oil and gas, and its interaction with food security. This section explores how pollution from extraction activities compounds environmental degradation, and how this in turn threatens both biodiversity and the socio-economic fabric of coastal

communities. It also engages with governance challenges and offers a critical reflection on the need for integrated and adaptive policies.

Each section incorporates empirical case studies, theoretical insights, and concrete policy proposals. Ultimately, the research seeks to contribute to a deeper understanding of the looming crisis of environmental and economic insecurity in Cameroon and to offer pathways for more sustainable and equitable governance of natural resources in the face of climate change.

The Impact of Climate Change on Local Economies in Coastal Cameroon

The coastal regions of Cameroon, particularly the Littoral and South-West, are at the frontline of the country's exposure to the adverse effects of climate change. In these zones, where livelihoods are largely dependent on artisanal fishing and subsistence agriculture, the ecological shifts caused by climate variability are generating socio-economic vulnerabilities that threaten both household resilience and national food security (NIS, 2019). This section examines how climate change-induced stressors, rising sea temperatures, erratic weather patterns, and sea-level rise are undermining the productivity of marine and agricultural resources. By focusing on the erosion of local economic structures and livelihood systems, it highlights the complex interactions between environmental degradation and economic fragility at the community level.

Marine Resources and Fisheries

Marine ecosystems along Cameroon's coastline are experiencing an unprecedented decline in biodiversity and biomass, largely due to warming waters, acidification, and overfishing. These transformations have direct consequences for the artisanal fishing sector, which employs thousands of coastal dwellers and represents a primary source of protein for the population. This subsection explores the ecological drivers behind fish stock depletion, the resulting economic hardships for fishing communities, and the broader implications for nutritional security and coastal stability.

Depletion of Fish Stocks: Exploration of how rising sea temperatures and overfishing are reducing fish populations, affecting local livelihoods.

One of the most pressing consequences of climate change in the Gulf of Guinea, and particularly in Cameroon's coastal regions, is the alarming depletion of fish stocks (Chiambeng, 2006). This phenomenon is driven by two intersecting forces: rising sea surface temperatures and unsustainable fishing practices. Together, these dynamics are not only destabilizing marine ecosystems but also eroding the socioeconomic foundations of communities whose livelihoods depend heavily on artisanal fisheries (Djama, 1992).

Rising sea temperatures are disrupting the delicate ecological balance of marine life. As ocean waters warm, the distribution and behavior of fish species are changing. Many fish populations are migrating to cooler, deeper waters or shifting away from the coastal zones where fishing communities traditionally operate (Ellison, 2012). This migration reduces the availability of fish in areas historically known for their abundance, forcing fishermen to travel farther into the sea, often beyond their technical and financial capacities. Moreover, warmer waters affect the reproductive cycles and growth rates of key species such as sardines, tilapia, and mackerel, species that constitute the

backbone of local diets and commerce (Djama, 1992). This decline in fish populations is not gradual; in some zones, it has reached critical thresholds that threaten the very viability of small-scale fishing.

Parallel to these climatic effects, overfishing has accelerated the depletion of fish stocks. Artisanal fishers, under increasing pressure to sustain their income in the face of scarcity, are resorting to intensified fishing efforts using less selective and often illegal gear (ENVIREP-CAM, 2011). Additionally, industrial fishing vessels, sometimes foreign-flagged, operate with little regulation or oversight, contributing significantly to resource exhaustion. These vessels employ sophisticated technology that allows them to sweep large swathes of the ocean floor, catching fish indiscriminately, including juveniles and non-target species (Ahmadou, 2022). The lack of effective surveillance and enforcement of fishing quotas has turned Cameroon's maritime zones into open-access resources, leading to what Garrett Hardin (1968) famously termed "the tragedy of the commons" (p.1243).

The consequences of this depletion on local livelihoods are far-reaching. Fishing is not merely an economic activity in Cameroon's Littoral and South-West regions; it is a way of life, a cultural identity, and a pillar of community cohesion (Djama, 1992). As catches decline, so do incomes, pushing already vulnerable households into deeper poverty. Many small-scale fishers report needing to spend longer hours at sea, burn more fuel, and still return with smaller harvests. This economic strain is compounded by rising costs of fishing equipment and boat maintenance, making artisanal fishing increasingly unviable as a livelihood (ENVIREP-CAM, 2011). For many families, especially those with limited access to land or other employment opportunities, there is no alternative.

The ripple effects of fish stock depletion extend beyond individual incomes. Local fish markets are seeing reduced supply, which drives up prices and limits access to affordable protein for poor households (NDC, 2021). Given that fish contributes significantly to dietary protein intake in Cameroon, particularly in coastal regions, the decline in fish availability directly threatens food security and public health. Children and pregnant women, who are especially dependent on nutrient-rich foods, are at heightened risk of malnutrition in areas where fish used to be a dietary staple (Achu, 2009). In a country already grappling with food insecurity and underemployment, the collapse of the artisanal fishing sector could trigger broader social instability.

Moreover, the environmental consequences of fish stock depletion cannot be overlooked. As predator-prey dynamics shift and biodiversity diminishes, marine ecosystems lose their resilience. Coral reefs and seagrass beds, which serve as breeding and feeding grounds for many fish species, are also being degraded, further reducing the regenerative capacity of fish populations (Ahmadou, 2022). In this context, climate change and overfishing do not operate as isolated stressors but as mutually reinforcing drivers of marine ecological collapse.

Addressing this crisis requires a holistic and multisectoral approach. Strengthening the monitoring and regulation of both artisanal and industrial fishing is essential. Establishing marine protected areas, enforcing seasonal bans, and promoting community-led fisheries management can allow fish populations to recover while empowering local stakeholders. At the same time, investment in alternative livelihoods, such as aquaculture or sustainable agriculture, can reduce the economic pressure on coastal populations and promote long-term resilience.

In sum, the depletion of fish stocks in Cameroon's coastal regions illustrates the intricate link between environmental change and human vulnerability. It is a vivid example of how the impacts of global warming, when combined with weak governance and economic dependency on natural resources, can

undermine local economies and deepen social inequalities. Without urgent intervention, these communities risk losing not only their primary source of income and nutrition but also their cultural heritage and future prospects.

Economic Impact on Coastal Communities: Analysis of how the decline in fish stocks directly influences local economies, with a focus on fishermen's income and job losses.

The economic vitality of coastal communities in Cameroon is intricately tied to the health and productivity of marine ecosystems, particularly the availability of fish stocks (IRAD Limbe, 2010). As these stocks continue to decline due to rising sea temperatures and overexploitation, the consequences are being felt most acutely by those who rely on fishing for their livelihoods. This environmental deterioration is not only a biological concern; it is a socioeconomic crisis that is unraveling the economic fabric of coastal societies in the Littoral and South-West regions of the country (IRAD Limbe, 2010).

Fishing, particularly artisanal fishing, is one of the main sources of employment and income for thousands of households along the Cameroonian coast. Small-scale fishermen, fish processors, traders, and those involved in the transport and marketing of fish all form part of a vast informal economy that has thrived for generations (Djama, 1992). However, the ongoing depletion of fish stocks is dramatically undermining this system. As catches diminish, fishermen are forced to go out to sea more frequently and for longer periods, often using more fuel and resources without a corresponding increase in returns (Chiambeng, 2010). This imbalance results in a sharp decline in profitability. Many fishermen now find themselves spending more than they earn, with their activities becoming financially unsustainable.

The economic pressure also extends beyond the boats. Women, who traditionally dominate fish processing and trade in many coastal communities, are facing a shortage of raw products to sustain their businesses. As fish become scarcer and more expensive, many are being priced out of the market, unable to maintain their livelihoods (Koane, 2007). This has cascading effects on household incomes, particularly in female-headed households where fishing-related activities are the primary source of sustenance (NIS, 2019). Local markets that once thrived on abundant fish supplies are now shrinking, reducing the flow of money and weakening community economies.

Moreover, job losses in the fishing sector are not limited to the fishermen alone. Boat builders, net weavers, ice suppliers, market porters, and other auxiliary services that revolve around the fishing economy are also witnessing a slowdown (Koane, 2007). The interconnected nature of this sector means that any disruption has multiplier effects throughout the community. Youth unemployment, already a serious issue in coastal Cameroon, is being exacerbated as fewer job opportunities remain in what was once a thriving sector. With limited alternatives for income generation, some individuals turn to risky coping mechanisms, including migration to urban slums or engagement in illegal activities such as piracy or smuggling along the Gulf of Guinea (Ngo Likeng, 2006).

The socio-economic impacts of this environmental degradation are further intensified by the lack of a robust safety net or inclusive development policies. In the absence of insurance schemes, access to affordable credit, or state subsidies, many affected households are trapped in cycles of poverty. The informal nature of artisanal fishing makes it difficult for these actors to access institutional support or economic stimulus packages (Njamen, 2005). Even initiatives meant to diversify the local

economy, such as encouraging aquaculture or small-scale agriculture, often fail due to lack of infrastructure, technical knowledge, and investment.

At the macroeconomic level, the decline in fish stocks also affects national food security and trade. Cameroon's coastal fisheries not only feed local communities but also supply regional markets and contribute to export revenues (Ssentongo, 1987). As these stocks dwindle, the country risks becoming increasingly dependent on imported fish to meet domestic demand, weakening its trade balance and exposing it to international market fluctuations. This dependency undermines the country's economic sovereignty and places an additional burden on state resources already stretched by other developmental challenges.

The situation is further compounded by inadequate policy responses and weak enforcement of marine governance. Illegal, unreported, and unregulated (IUU) fishing, particularly by foreign industrial fleets, continues to strip the ocean of its wealth without contributing meaningfully to local economies. This unfair competition, combined with the effects of climate change, leaves coastal communities in a precarious position, fighting for survival in an increasingly hostile economic environment (ENVIREP-CAM, 2011).

The decline in fish stocks is not merely an environmental or ecological issue but a profound economic disruption for Cameroon's coastal populations. The erosion of income, the collapse of small-scale enterprises, the loss of jobs, and the weakening of local markets all point to a looming socio-economic crisis that must be addressed with urgency. Without targeted interventions that combine environmental restoration, economic support, and inclusive governance, these communities face a future of deepening poverty, instability, and marginalization in a region already burdened by vulnerability. Addressing the economic impacts of fish stock depletion is thus essential not only for preserving livelihoods but also for safeguarding national cohesion and long-term development.

The Role of Fish in Food Security: Examining how fish, as a major source of protein for coastal populations, impacts food security in the region.

Fish plays an indispensable role in the food security of coastal populations in Cameroon and across the Gulf of Guinea region. For millions of people living along these shores, fish is not merely a dietary preference but a fundamental source of nutrition and sustenance that underpins daily life. Its importance transcends cultural practices and economic activities, reaching into the very core of health, wellbeing, and social stability (Ahmadou, 2022). In these coastal communities, fish provides a primary source of high-quality animal protein, essential fatty acids, vitamins, and minerals that are often scarce or unaffordable in other forms of food. This nutritional contribution is particularly vital in contexts where poverty and limited access to diverse food sources heighten vulnerability to malnutrition and related health issues.

The significance of fish in food security is further magnified by the demographic realities of coastal Cameroon, where population growth and urbanization are placing ever-increasing pressure on local food systems (Chiambeng, 2010). As traditional agricultural lands face challenges such as soil degradation, erratic rainfall, and land competition (IFRI, 2009), fisheries have remained one of the few accessible and reliable sources of protein for many households. Fish consumption tends to be higher in these regions compared to inland areas precisely because it is locally available and affordable. It sustains not only individual dietary needs but also communal food practices and social

cohesion. The preparation and sharing of fish are deeply embedded in cultural identities, celebrations, and daily meals, reinforcing its role beyond simple nutrition.

However, the precarious state of fish stocks, driven by climate change and overfishing, poses a direct threat to this vital pillar of food security. As fish populations dwindle and fishing yields decline, the availability of fresh, affordable fish in local markets is decreasing. This scarcity drives up prices, pushing fish out of reach for many of the poorest families who rely on it as a staple food (OECD, 2010). When access to fish becomes limited, households often substitute it with cheaper, less nutritious alternatives, which undermines dietary quality and increases risks of malnutrition, particularly among children and vulnerable groups such as pregnant women and the elderly. The nutritional consequences of reduced fish consumption are profound and can exacerbate existing public health challenges, including stunted growth, weakened immune systems, and increased susceptibility to disease.

Moreover, the decline in fish availability has a ripple effect on the broader food system and local economies. Fish not only contributes to daily meals but also supports local livelihoods, which in turn enables households to afford other food items and basic needs. When fishing incomes shrink, purchasing power diminishes, and food security is jeopardized not only by reduced direct consumption but also by an overall decline in household food access (ENVIREP-CAM, 2011). In this sense, fish acts as both a direct source of nutrition and an economic resource that enables food security through income generation.

The role of fish in food security is intricately linked to governance and resource management practices. Inadequate regulation, illegal fishing, and weak enforcement exacerbate the depletion of fish stocks, making it difficult to sustain the supply needed for local consumption. The lack of effective policies to protect coastal fisheries undermines the capacity of communities to maintain their food security over the long term (OECD, 2010). Efforts to enhance sustainable fisheries management, including community-based resource stewardship and the establishment of marine protected areas, are therefore critical to safeguarding fish as a key food resource. Without such measures, the erosion of fish stocks risks tipping many coastal communities into chronic food insecurity and nutritional deficits (Satia, 2011).

In addition, fish's role in food security must be considered in the context of environmental change. Rising sea temperatures and ocean acidification not only reduce fish populations but also alter the quality and safety of seafood (Hanna, 2010). Contaminants and changes in fish physiology linked to environmental stressors can impact nutritional value and pose health risks. This intersection between environmental degradation and food safety highlights the complex challenges faced by coastal populations relying on fish for sustenance.

Fish remains a cornerstone of food security for coastal populations in Cameroon, providing essential nutrition and supporting livelihoods in regions where alternatives are limited. The ongoing decline in fish stocks threatens to undermine this vital role, jeopardizing the health and wellbeing of millions. Addressing this challenge requires integrated approaches that combine environmental conservation, sustainable fisheries management, and social policies aimed at protecting vulnerable populations. Ensuring the continued availability of fish as a nutritious and accessible food source is not only a matter of ecological stewardship but also a fundamental component of human security and development in coastal Africa.

Agriculture and Food Security

As the sea encroaches further inland and rainfall patterns become more erratic, fertile agricultural land in coastal Cameroon is steadily shrinking. Crops such as cassava, maize, and plantains, vital to food sovereignty and rural subsistence (IPCC, 2007), are increasingly vulnerable to climate variability and saline intrusion. This subsection investigates the impact of climate-induced coastal erosion on arable land and agricultural yields, drawing links between ecological change, crop productivity, and household food insecurity. It also highlights the mounting pressure on rural communities to adapt to environmental stress without sufficient institutional support.

Coastal Erosion and Rising Sea Levels: Understanding how climate change-induced coastal erosion threatens agricultural land and reduces arable areas.

Coastal erosion and rising sea levels represent some of the most visible and devastating consequences of climate change, particularly in vulnerable regions like Cameroon's coastal zones. These phenomena are not isolated environmental events; they are deeply interconnected processes that pose a profound threat to agricultural lands and, by extension, to the food security and livelihoods of local populations (Tataw, 2021). Coastal erosion refers to the gradual loss of land along shorelines, driven by the relentless action of waves, tides, and currents, which is exacerbated by the rising sea levels caused by global warming. The encroachment of the sea onto previously fertile agricultural zones transforms productive land into barren or saline wastelands, diminishing the area available for crop cultivation and threatening the very basis of subsistence farming for many communities.

The impacts of this land loss are multifaceted and ripple through the socio-economic fabric of coastal regions. Agricultural lands in areas like the Littoral and South-West regions of Cameroon have historically supported staple crops such as cassava, maize, and plantains, crops that form the dietary backbone of local populations. As sea levels rise, saltwater intrusion into the soil becomes increasingly common, altering the chemical composition of the earth and rendering it unsuitable for traditional farming practices (Alves, 2020). This salinization stunts crop growth, reduces yields, and in many cases, causes total crop failure. The gradual but persistent advance of seawater not only diminishes the quantity of arable land but also degrades the quality of the remaining land, undermining its productivity and threatening the food sovereignty of communities reliant on these agricultural outputs.

Beyond the direct effects on soil and crops, coastal erosion disrupts the delicate balance of local ecosystems that support agriculture. Mangrove forests, which act as natural buffers against storm surges and coastal erosion, are being lost or degraded due to changing sea patterns and human pressures (Ellison, 2012). The destruction of these natural barriers accelerates land degradation and exposes agricultural zones to the full force of coastal hazards. This ecological imbalance reduces the resilience of the coastal environment, making recovery from erosion events more difficult and increasing the vulnerability of farming communities. Moreover, as fertile lands shrink, farmers are often forced to clear inland forests or marginal lands to compensate, leading to deforestation and loss of biodiversity, which in turn aggravates environmental instability and climate vulnerability.

The socio-economic consequences of these environmental changes are severe. Coastal communities, many of which depend almost exclusively on agriculture for their livelihoods, face declining crop productivity and increased uncertainty in food production. The loss of agricultural land translates directly into reduced income and food availability, forcing households to seek alternative, often less

sustainable, sources of income or food (Bardach, 1989). In the absence of viable options, many rural inhabitants are compelled to migrate to urban centers, fueling urbanization challenges and straining infrastructure and services. The destabilization of rural economies thus has far-reaching implications, contributing to cycles of poverty and food insecurity that are difficult to break.

Furthermore, the issue of coastal erosion and rising sea levels intersects with broader challenges related to governance, policy, and adaptation capacity. Despite the clear and growing risks, many affected communities lack access to adequate resources, technical knowledge, or institutional support to implement effective mitigation and adaptation strategies. There is often a gap between national-level climate policies and the realities on the ground, where local actors struggle to respond to increasingly frequent and intense coastal hazards (Warrick, 1993). This disconnect hinders the development of sustainable land management practices and coastal protection measures such as seawalls, reforestation of mangroves, and improved drainage systems. Without concerted efforts to bridge these gaps, the degradation of agricultural land will likely accelerate, deepening food insecurity and economic instability.

The temporal dimension also highlights the urgency of addressing coastal erosion. The slow but steady rise of sea levels, combined with episodic extreme weather events like storms and flooding, creates a compounding effect that intensifies land loss over time (Warrick, 1993). This gradual erosion often goes unnoticed until it reaches a critical threshold, making it difficult for communities to plan and adapt effectively. The window for intervention is closing rapidly, and delayed action risks irreversible damage to coastal agricultural systems that are essential for local food production.

In addition, the cultural and social dimensions of coastal land loss must not be overlooked. For many coastal communities in Cameroon, agricultural land is not only a source of food and income but also a repository of cultural identity and ancestral heritage. The disappearance of these lands represents a loss of tradition, social cohesion, and collective memory, compounding the trauma of environmental change with social dislocation. This aspect underscores the need for adaptation strategies that are not only technically sound but also socially inclusive and sensitive to the cultural context of affected populations (Nicholls, 2007).

Coastal erosion and rising sea levels driven by climate change present an existential threat to agricultural land in Cameroon's coastal regions. This environmental degradation reduces arable land, undermines crop productivity, disrupts ecosystems, and destabilizes the livelihoods and food security of vulnerable communities. The complexity of this challenge demands integrated responses that combine environmental conservation, community engagement, and strong governance. Protecting and restoring coastal lands, enhancing adaptive capacities, and aligning policy frameworks with local needs are critical steps toward safeguarding the agricultural foundation of food security in coastal Cameroon. Without urgent and sustained action, the intertwined crises of land loss, food insecurity, and socio-economic vulnerability will deepen, imperilling the future of these communities and the region as a whole.

Impact on Staple Crops: Exploration of how climate change affects the production of staple crops such as cassava, maize, and plantains.

Staple crops such as cassava, maize, and plantains form the backbone of food systems in Cameroon, particularly in the coastal regions where subsistence agriculture is not only a way of life but also a crucial pillar of local economies and food security (NEPAD, 2013). However, climate change is

increasingly destabilizing the delicate environmental conditions under which these crops have traditionally flourished. Erratic rainfall patterns, prolonged droughts, rising temperatures, and the intensification of extreme weather events are now combining to undermine crop productivity, disrupt farming cycles, and endanger the livelihoods of millions who rely on these staple foods for sustenance and income (IPCC, 2007).

Cassava, known for its resilience and adaptability to poor soils, has long been regarded as a safeguard against hunger in times of environmental stress (NEPAD, 2013). Yet, even this hardy crop is now vulnerable to the shifting climatic conditions affecting the region. Prolonged dry spells during critical growing periods reduce tuber size and delay harvests, while excess rainfall can lead to root rot and increased susceptibility to pests and diseases. In coastal zones where soil salinity is rising due to seawater intrusion, cassava cultivation becomes even more difficult, leading to significant yield losses and threatening the availability of one of the region's most reliable sources of carbohydrates.

Similarly, maize production is being heavily disrupted by the unpredictability of the rainy seasons. Once relatively stable, these seasons now begin later or end earlier than expected, creating uncertainty for farmers who rely on consistent weather cycles for planting and harvesting. Maize is particularly sensitive to temperature changes; increased heat during the pollination phase significantly lowers grain yield. In addition, rising temperatures also favor the proliferation of pests such as the fall armyworm, whose outbreaks in recent years have devastated maize fields across parts of Cameroon (Adom, 2024). The compounded effect of climatic stress and pest invasions is leading to smaller harvests, which not only reduces food availability but also pushes prices beyond the reach of low-income households, deepening food insecurity.

Plantains, which serve as a dietary staple for millions and are central to local markets and culinary traditions, are similarly imperiled. This crop thrives under specific temperature and humidity conditions, both of which are being altered by climate change. Higher average temperatures are speeding up maturation cycles, leading to smaller fruit size and diminished quality. Unseasonal heavy rains often trigger fungal diseases such as Black Sigatoka, which reduces both yield and the commercial value of plantains (Adom, 2024). For smallholder farmers who depend on plantains not only for home consumption but also for income generation in local markets, these changes are catastrophic. Declining yields translate into reduced revenue, weaker purchasing power, and diminished capacity to invest in improved seeds, fertilizers, or farming tools.

What compounds the vulnerability of staple crop production in Cameroon is the limited adaptive capacity of the agricultural system. Most farmers in the affected coastal regions still depend on traditional methods, rain-fed agriculture, and lack access to climate-resilient technologies or formal irrigation systems. The absence of adequate agricultural extension services means that critical information about changing weather patterns, new pests, and suitable seed varieties often fails to reach the people who need it most. Consequently, farmers are left to confront the vagaries of climate change on their own, often relying on guesswork and outdated practices in a context that demands innovation and flexibility.

Moreover, the degradation of the environmental landscape due to deforestation, unregulated land use, and resource extraction further exacerbates the pressure on arable land and crop production. As forests are cleared to compensate for lost agricultural lands or to make way for oil and gas exploitation, soil fertility declines and the microclimates that support crop health are destabilized (World Bank, 2022). The loss of vegetative cover also leads to increased erosion and runoff, particularly during intense

rainfall events, stripping the soil of nutrients and leaving behind degraded plots that struggle to support even the most basic food crops.

These transformations are not just technical or agricultural issues, they are deeply socio-political. The decline in staple crop production has direct implications for social stability and equity. As yields fall and food becomes scarcer, competition for land and resources intensifies (Adom, 2024). The burden falls disproportionately on women, who make up the majority of smallholder farmers in Cameroon, and on children, who suffer from malnutrition when staple foods become inaccessible. In this context, climate change becomes a multiplier of existing vulnerabilities, driving wedges through already fragile communities and threatening the cohesion and sustainability of rural life.

In essence, the impact of climate change on cassava, maize, and plantains is emblematic of a broader crisis facing Cameroon's food systems. It is a crisis that links environmental degradation with economic precarity, and agricultural decline with human insecurity. Without decisive and coordinated interventions, including investment in climate-resilient agriculture, early warning systems, farmer education, and sustainable land management, the production of staple crops will continue to decline. The consequences will not be limited to hunger or poverty alone but will ripple across generations, undermining development, weakening resilience, and threatening the very foundation of food sovereignty in Cameroon.

Increased Food Insecurity: Evaluating how disruptions in both marine and agricultural sectors contribute to food insecurity in vulnerable coastal communities.

In the vulnerable coastal regions of Cameroon, the convergence of marine and agricultural disruptions has triggered a steady and alarming rise in food insecurity. These communities, historically sustained by the dual reliance on artisanal fishing and subsistence farming, now face an existential threat as climate change and unsustainable resource exploitation erode the foundations of their food systems. This disruption is not merely a seasonal fluctuation; it represents a deep structural crisis that undermines livelihoods, weakens nutritional health, and challenges the social cohesion of entire populations (Tataw, 2021).

The degradation of marine ecosystems, marked by declining fish stocks, coastal erosion, and pollution from offshore oil operations, has drastically reduced the availability of fish, a primary source of protein and income for many coastal households. Once-abundant fishing zones have become less productive due to rising sea temperatures, acidification, and overexploitation (Warrick, 1993). Traditional fishing techniques, passed down through generations, are increasingly ineffective against the ecological upheavals taking place beneath the waves. As catches dwindle, fishermen are forced to venture further offshore at greater cost and risk, only to return with smaller hauls. The direct outcome is a fall in fish availability for both household consumption and local markets, leading to increased food scarcity and rising prices.

Simultaneously, the agricultural sector in coastal areas is experiencing a parallel collapse. Climate variability has destabilized rainfall patterns, intensified droughts, and increased the frequency of flooding events, all of which undermine the production of key staple crops such as cassava, maize, and plantains. Coastal erosion and saltwater intrusion into freshwater sources further compound the crisis by rendering farmland infertile and destroying crops (Bardach, 1989). Smallholder farmers, who form the majority of agricultural producers in these regions, often lack the resources, knowledge,

and infrastructure to adapt to these new challenges. Consequently, many are trapped in a cycle of diminishing yields and food shortages that exposes entire communities to chronic food insecurity.

This dual-sector disruption deepens inequalities within already fragile communities. As access to food becomes more erratic and costly, vulnerable populations, particularly women, children, and the elderly, bear the brunt of the crisis. Malnutrition rates rise as protein and nutrient-rich foods become scarce or unaffordable. Households are forced to reduce meal portions, skip meals entirely, or substitute traditional, nutritious diets with cheaper, less healthy alternatives. Over time, these coping strategies not only degrade health and productivity but also limit the ability of communities to recover or build resilience. The food insecurity experienced is not just about quantity, but quality, and the loss of dietary diversity further entrenches public health vulnerabilities.

Moreover, the socio-economic implications are far-reaching. As fishing and farming incomes decline, families lose their main sources of livelihood, pushing many into informal or precarious work, and accelerating rural-urban migration (Parry, 2004). Young people, disillusioned by the collapse of traditional economic models, increasingly abandon agricultural and fishing activities, thereby weakening community continuity and traditional knowledge systems. This demographic shift reduces the labor force available for local food production and amplifies the cycle of food dependence and economic vulnerability.

The crisis is further aggravated by weak governance structures and limited institutional support. Despite the growing evidence of climate-induced food insecurity, national and local policies often lack coherence, coordination, and enforcement. Investment in climate-resilient infrastructure, sustainable agriculture, and fisheries management remains insufficient (Satia, 2011). Early warning systems, social safety nets, and community-based adaptation strategies are either poorly funded or absent, leaving populations exposed to the full force of environmental shocks without meaningful support. In such a context, food insecurity evolves from an environmental issue into a political one, a test of state legitimacy and responsiveness.

Increased food insecurity in coastal Cameroon, therefore, is not an isolated outcome but the cumulative result of interlinked environmental, economic, and institutional breakdowns. The collapse of marine and agricultural productivity undermines not just the physical availability of food, but also the economic and social access to it. It threatens the dignity and survival of populations that have historically contributed to the nation's food economy. Addressing this issue demands more than humanitarian interventions; it calls for transformative approaches to governance, sustainability, and justice.

What is at stake is not only the nourishment of bodies, but the preservation of entire ways of life. If left unaddressed, this escalating food insecurity could lead to broader instability, fueling local conflicts over resources, undermining public trust, and eroding national development gains. Ensuring food security in the face of climate disruption is not merely a policy objective; it is a moral imperative that demands urgent, integrated, and inclusive action.

Broader Economic Implications of Climate Change in the Gulf of Guinea

While Cameroon continues to invest heavily in the exploration and extraction of its offshore oil and gas reserves, hoping to secure macroeconomic stability and national development, this economic

strategy carries severe environmental costs. In a paradoxical twist, the very industries that promise national wealth are accelerating the degradation of ecosystems vital to food security and sustainable livelihoods. This second section analyzes the broader economic and ecological implications of natural resource exploitation in the Gulf of Guinea. It evaluates the long-term risks posed by hydrocarbon activities to marine health, explores their feedback effects on food systems, and interrogates the viability of current governance frameworks in reconciling economic development with environmental stewardship.

Oil and Gas Exploitation

Cameroon's dependence on oil and gas revenues makes hydrocarbon extraction a critical pillar of national economic planning. However, offshore drilling operations contribute to marine pollution, disrupt coastal ecosystems, and intensify environmental risks that disproportionately affect fishing communities. This subsection evaluates the dual role of the oil and gas sector, as a source of economic opportunity and environmental degradation. It assesses the environmental externalities of the extractive industry and examines how insufficient environmental regulations deepen the fragility of coastal ecosystems.

Economic Dependence on Oil and Gas: Assessing the significance of oil and gas extraction in Cameroon's economy and the role it plays in national income.

Cameroon's economic landscape is significantly shaped by its dependence on oil and gas, industries that have, for decades, constituted a crucial pillar of national income and macroeconomic stability. The hydrocarbon sector, particularly offshore oil extraction in the Gulf of Guinea, plays a central role in the country's export earnings, government revenue, and infrastructural investments (Gauthier, 2009). This reliance, while economically advantageous in the short term, presents a complex matrix of vulnerabilities, particularly when considered alongside the ecological fragility of the coastal regions and the broader challenges posed by climate change.

Oil and gas account for a substantial portion of Cameroon's GDP, with revenues from petroleum exports financing key sectors such as infrastructure, education, health, and defense. The national budget is inextricably linked to fluctuations in global oil prices, making the economy susceptible to external shocks (ITIE, 2018). A dip in prices, as seen in recent global energy crises, can translate into budgetary shortfalls, currency depreciation, and rising debt burdens. In this context, the country's economic health is not only determined by its internal governance but also by the volatility of international commodity markets, an inherently precarious foundation for sustainable development.

The centralization of oil and gas revenues also perpetuates a form of economic imbalance, where growth is driven by extractive activities concentrated in specific regions, often disconnected from local development outcomes. In coastal zones like the South-West and Littoral regions, offshore oil platforms and associated infrastructure generate immense profits, yet local communities rarely benefit directly. Employment opportunities in the sector are limited and highly technical, often excluding local labor forces. Meanwhile, the influx of capital and corporate interests contributes little to the diversification of local economies, which remain largely reliant on small-scale fishing and farming. This disconnect fuels resentment and highlights the paradox of resource wealth: communities living atop immense natural wealth often experience poverty, exclusion, and environmental degradation.

Moreover, Cameroon's heavy reliance on hydrocarbons presents a double-edged sword. While oil and gas revenues are vital to the state, the industry's operations contribute to environmental

degradation that undermines other critical sectors, particularly agriculture and fisheries. Oil spills, gas flaring, and marine pollution degrade ecosystems and threaten the very livelihoods of the communities that have historically relied on the sea and land for sustenance (CSIR, 2002). This environmental cost often goes unaccounted for in national economic metrics, creating a distorted view of progress that ignores the depletion of natural capital.

This economic dependence also affects national policy priorities. The strategic importance of oil and gas has historically directed public attention and investment toward sustaining the extractive sector, often at the expense of renewable energy development, climate adaptation strategies, and food system resilience. The dominance of hydrocarbons in the national discourse has marginalized urgent environmental issues, particularly in policy circles where short-term fiscal concerns outweigh long-term ecological sustainability (ITIE, 2018). This orientation reinforces a cycle where oil becomes not just a resource, but a constraint, limiting policy innovation and locking the country into a carbon-intensive development path.

As the global energy landscape shifts toward decarbonization and sustainability, Cameroon's reliance on oil and gas places it at a strategic crossroads. While hydrocarbons may continue to serve as a revenue backbone in the short to medium term, the long-term prospects of the sector are increasingly uncertain. International climate commitments, emerging green technologies, and shifts in global energy demand will inevitably reduce the economic viability of fossil fuels. If Cameroon fails to anticipate and prepare for this transition, the nation risks being stranded economically, with outdated infrastructure, a declining resource base, and a populace unprepared for the industries of the future (Adom, 2024).

In sum, while oil and gas extraction has undeniably contributed to Cameroon's fiscal base and economic modernization, this dependency is fraught with structural vulnerabilities. It exposes the country to global market volatility, reinforces regional and social inequalities, and contributes to environmental degradation that threatens broader food security and sustainable development goals. The challenge, therefore, is not merely to harness oil wealth, but to strategically manage it, investing in diversification, building resilience in climate-sensitive sectors, and redefining development through a more inclusive and environmentally responsible lens. Only through such a transformation can Cameroon move beyond dependence and toward a future of balanced, sustainable prosperity.

Environmental Impact of Resource Extraction: Investigating how offshore oil and gas exploitation contributes to marine pollution, negatively impacting fisheries.

The environmental impact of resource extraction, particularly offshore oil and gas exploitation, has emerged as a critical issue in Cameroon's coastal regions. As the country continues to rely heavily on hydrocarbon revenues to support its economy, the ecological toll of these activities on marine ecosystems becomes increasingly difficult to ignore. Offshore drilling operations in the Gulf of Guinea, a maritime zone already vulnerable to the effects of climate change, are introducing a new dimension of environmental stress that threatens biodiversity, food security, and the long-term sustainability of coastal livelihoods (Amoasah, 2010).

Oil exploration and production involve a series of activities that directly and indirectly degrade marine environments. From seismic surveys that disturb aquatic life to the routine discharges of drilling mud, heavy metals, and hydrocarbons, the cumulative impact on marine ecosystems is

substantial. Most alarming are the oil spills and gas leaks that occur with relative frequency, either through pipeline ruptures, blowouts, or tanker accidents (Amoasah, 2010). Even when not large-scale disasters, chronic, low-level leaks can be just as damaging, slowly saturating marine habitats with pollutants that poison fish stocks, disrupt reproductive cycles, and destroy breeding grounds such as mangroves and coral reefs.

Cameroon's fisheries, particularly the artisanal fishing sector that sustains thousands of coastal households, are among the first casualties of such environmental degradation. As toxic substances accumulate in coastal waters, fish populations decline both in number and diversity. Species that once formed the bedrock of local diets and commerce become harder to find, pushing fishers further offshore, where costs and risks increase (Djama, 1992). Those who cannot afford the transition to deep-sea fishing are left with dwindling catches, plunging incomes, and growing food insecurity. In this way, the contamination of marine habitats translates directly into socioeconomic instability in communities that are already grappling with poverty, marginalization, and climate-induced pressures.

Beyond the immediate ecological impact, oil and gas operations disrupt the delicate balance of marine ecosystems in more subtle but far-reaching ways. Increased sedimentation, noise pollution from drilling equipment, and thermal discharges alter water quality and stress marine organisms. The destruction of sensitive ecosystems such as estuaries and lagoons, which serve as nurseries for many commercially important fish species, undermines the natural regeneration of fish stocks, further compounding the decline in productivity (Boesch, 1987). These disruptions weaken the resilience of marine ecosystems, reducing their capacity to recover from shocks and adapt to broader climate variability.

Moreover, the absence of robust environmental governance exacerbates the problem. In many instances, oil companies operate under lax regulatory oversight, with insufficient environmental impact assessments and weak enforcement of mitigation measures (UNEP IE, 1997). Local communities are rarely consulted, and when environmental degradation occurs, compensation is often delayed or inadequate. This impunity not only perpetuates environmental harm but also breeds social discontent, fueling perceptions of injustice and exclusion in regions where state presence is already limited. The perceived prioritization of oil revenues over ecological protection erodes public trust and deepens the legitimacy crisis of state institutions in the affected areas.

The pollution resulting from offshore resource extraction also poses long-term public health risks. Contaminants such as polycyclic aromatic hydrocarbons and heavy metals enter the food chain through contaminated seafood, posing dangers not only to the coastal populations that depend on fish for nutrition but also to broader consumer markets (Patin, 1999). Repeated exposure to these toxins can lead to severe health outcomes, including cancer, neurological disorders, and reproductive issues. These impacts place additional strain on already fragile health systems and increase the human cost of unchecked environmental degradation.

Furthermore, the environmental damage associated with offshore drilling creates a contradiction at the heart of Cameroon's development agenda. While the government promotes blue economy initiatives and fisheries modernization programs, its simultaneous expansion of offshore oil exploitation undermines these goals (Adom, 2024). The result is a policy incoherence that hinders integrated coastal zone management and weakens national resilience in the face of climate change. If sustainable development is to be more than a rhetorical objective, Cameroon must reconcile its economic ambitions with its ecological responsibilities.

Offshore oil and gas extraction in Cameroon is not merely an economic activity; it is a force reshaping the marine environment with profound consequences for biodiversity, livelihoods, and food security. The degradation of coastal ecosystems due to pollution threatens the viability of artisanal fisheries and disrupts the socioecological equilibrium of entire communities. Without urgent reforms in environmental governance, stricter regulation of extractive activities, and a commitment to sustainable resource use, the ecological costs of offshore drilling will continue to mount, eroding the very foundations upon which coastal resilience and national prosperity depend.

Tension Between Economic Growth and Environmental Degradation: Analyzing the paradox of economic growth driven by oil exploitation versus the long-term damage to coastal ecosystems and livelihoods.

The pursuit of economic growth through oil exploitation in Cameroon exemplifies one of the most striking paradoxes of contemporary development: the tension between short-term economic gains and long-term environmental sustainability. In a context marked by poverty, unemployment, and an urgent need for infrastructure and public services, the extraction of hydrocarbons appears as a powerful engine of growth and a gateway to increased national revenue. Yet, the ecological costs associated with this model of development are profound and potentially irreversible, especially for coastal ecosystems and the communities that depend on them for their survival (Ndubuisi, 2018).

Oil exploitation has undeniably contributed to Cameroon's gross domestic product, attracted foreign investment, and provided the state with significant fiscal revenues. These financial inflows have allowed the government to finance development programs, build roads, expand public services, and assert its strategic importance in the Gulf of Guinea (MINEPAT, 2024). However, these benefits often remain concentrated among elites and in urban centers, while the environmental externalities of extraction are borne disproportionately by rural and coastal populations. The communities along the Atlantic coastline, particularly in the Littoral and South-West regions, find themselves at the intersection of ecological vulnerability and economic exclusion. Their mangroves are degraded, their fishing zones are polluted, and their agricultural land is encroached upon by rising seas and industrial expansion—often without sufficient compensation or viable alternatives.

This dynamic exposes the fundamental contradiction of growth fueled by resource extraction: while it offers immediate economic benefits, it gradually undermines the very environmental foundations upon which long-term prosperity depends. The degradation of coastal ecosystems caused by oil spills, chemical discharges, and gas flaring erodes marine biodiversity and disrupts ecological balance. Fish stocks dwindle, water quality deteriorates, and fragile wetlands are lost (Akpan, 2011). These changes translate into a decline in food security, loss of livelihoods, and increased vulnerability to climate shocks such as flooding and storms. In effect, the country's economic growth becomes an engine of environmental degradation, setting into motion a cycle of vulnerability that threatens to cancel out the very gains it seeks to achieve.

Moreover, this contradiction is sustained by a development model that prioritizes extractive industries over sustainable alternatives. Investments in oil and gas often crowd out support for renewable energy, sustainable fisheries, or climate-resilient agriculture. The regulatory frameworks in place, often weakened by corruption or political inertia, fail to enforce environmental standards or to ensure equitable benefit sharing (Amoasah, 2010). The resulting governance vacuum allows the exploitation of natural resources with minimal regard for ecological limits or social justice. As extractive operations expand offshore and onshore, they increase competition over land and water, displace

traditional livelihoods, and heighten socio-political tensions, particularly in marginalized or conflict-prone areas.

The environmental degradation driven by oil exploitation also presents a long-term risk to national economic stability. As coastal ecosystems collapse and fisheries decline, entire local economies are destabilized. The loss of biodiversity reduces nature's capacity to provide essential services such as carbon sequestration, storm protection, and clean water, making the country more vulnerable to the cascading effects of climate change (NRC, 1985). In addition, dependence on volatile oil markets exposes Cameroon to price shocks and revenue fluctuations, as seen in global downturns that have triggered budget crises and forced austerity measures. In such scenarios, the supposed economic advantages of oil exploitation quickly evaporate, while the environmental damages remain.

This paradox is further intensified by the lack of meaningful inclusion of local voices in decision-making processes related to resource management. Coastal communities often have little say in how their land and waters are used, and their traditional knowledge is rarely integrated into environmental planning. This exclusion undermines trust, weakens social cohesion, and reduces the legitimacy of state interventions. By sidelining those who are most affected by environmental degradation, the state limits its ability to implement adaptive and inclusive responses that could mitigate the negative impacts of extraction.

Ultimately, Cameroon stands at a critical crossroads. The country can continue to pursue a path of extractive growth that sacrifices its ecological capital for immediate financial returns, or it can embrace a new paradigm that prioritizes environmental integrity, community resilience, and long-term sustainability (ITIE, 2018). This will require bold political choices, including a reorientation of national development strategies, stricter environmental regulation, and a commitment to participatory governance. Only by resolving the tension between economic ambition and ecological responsibility can Cameroon hope to secure a future in which prosperity does not come at the expense of its people or its environment.

Interconnectedness of Resource Exploitation and Food Security

Beyond immediate ecological damage, the exploitation of natural resources, both terrestrial and marine, poses a structural threat to long-term food security in Cameroon. Oil spills, waste discharge, and coastal industrialization reduce biodiversity and contaminate both water and soil, limiting access to clean fishing grounds and fertile land. This subsection explores the interconnections between extractive activities and deteriorating food systems, highlighting how the pursuit of short-term economic gains undermines the basic subsistence of coastal populations. It calls attention to the need for a holistic and integrated approach to sustainable resource governance.

Environmental Degradation and Food Insecurity: Exploring how both marine and terrestrial resource exploitation leads to broader environmental degradation, further exacerbating food insecurity.

Environmental degradation and food insecurity are increasingly interlinked phenomena, particularly in fragile ecosystems such as Cameroon's coastal zones. In the Gulf of Guinea, the unsustainable exploitation of both marine and terrestrial resources is not only accelerating environmental deterioration but also destabilizing food systems that are vital to the survival of millions. The ecological damage caused by industrial fishing, oil extraction, deforestation, and agricultural

expansion is reaching critical levels, and its ripple effects are most painfully felt in the declining capacity of ecosystems to sustain the production of food (Ehiomogue, 2022). For Cameroon, where large swaths of the population depend directly on nature for nourishment and income, this confluence of environmental and nutritional stress is rapidly becoming a silent emergency.

Marine environments are among the most visibly affected. The overexploitation of fisheries, often by foreign industrial fleets operating with limited oversight, has led to the collapse of local fish stocks. Coupled with pollution from offshore oil drilling, including oil spills, discharge of untreated wastewater, and the dumping of toxic drilling muds, these practices devastate marine biodiversity (Ehiomogue, 2022). Fish, a primary source of protein for coastal communities, becomes scarcer and more expensive. The nutritional intake of these populations weakens, forcing households to turn to less diverse and less nutritious alternatives, thereby triggering a deterioration in public health. Moreover, as local fishermen struggle with shrinking catches, their incomes decline, and their ability to purchase food or invest in alternative livelihoods is severely compromised.

Terrestrial ecosystems are not spared. The expansion of extractive industries such as logging and mining in forested and agricultural areas leads to large-scale deforestation, soil erosion, and contamination of freshwater systems. Toxic runoff from mining sites poisons rivers and water tables, affecting both crop irrigation and drinking water quality. This environmental destruction reduces the fertility of arable land and exposes farmlands to flooding, desertification, or landslides (Voundi, 2021). The consequences are stark: yields of key staples like cassava, plantains, and maize are in decline, and rural communities are increasingly unable to meet their food needs. Additionally, the destruction of vegetation and tree cover alters microclimates, further destabilizing the delicate balance necessary for stable agricultural production.

This environmental degradation is not merely the result of isolated incidents but stems from a broader pattern of weak governance and poorly regulated development. Concessions for oil, gas, and mining operations are often granted without adequate environmental impact assessments or proper consultation with affected communities. In many cases, compensation is either delayed, insufficient, or nonexistent, leaving local populations to bear the brunt of ecological decline (Voundi, 2021). These structural weaknesses are exacerbated by a lack of investment in sustainable practices and a failure to prioritize environmental protection in national development planning. The result is a form of development that extracts maximum short-term economic value while leaving long-term ecological and social scars.

The nexus between environmental degradation and food insecurity is further complicated by the limited adaptive capacity of vulnerable populations. In many coastal and rural areas, access to technology, credit, and information is minimal. Climate-smart agriculture, sustainable fishing techniques, or ecosystem restoration projects remain out of reach for most local actors. Instead, communities often fall into a vicious cycle: as resources degrade, people overexploit what remains in an effort to survive, which in turn accelerates the degradation. This feedback loop not only deepens poverty but also heightens the risk of conflict over scarce resources, as communities compete over shrinking fishing grounds, arable land, or clean water sources.

The broader implications are profound. Food insecurity contributes to malnutrition, poor educational outcomes, weakened labor productivity, and increased dependency on humanitarian aid. In a country like Cameroon, with growing demographic pressure and multiple socio-political tensions, such conditions create fertile ground for instability (Osano, 2022). Young people, lacking economic

opportunities and food security, may be drawn to illicit activities or armed groups, especially in regions already marked by insecurity.

In light of these realities, the link between environmental degradation and food insecurity in Cameroon is not simply a matter of ecological concern, it is a question of human security. Protecting ecosystems must therefore be seen as integral to protecting livelihoods, health, and social stability. Breaking the cycle of environmental damage and nutritional decline requires a multidimensional strategy: reforming governance frameworks, enforcing environmental laws, promoting sustainable resource management, and investing in the resilience of vulnerable communities. Without urgent and sustained action, the degradation of Cameroon's natural capital will continue to erode its capacity to feed its people, thus threatening its long-term development and peace.

Link Between Oil Exploitation and Food Security: Analyzing the indirect effects of the oil industry, such as oil spills and pollution, on food sources like fish and crops.

The link between oil exploitation and food security in coastal Cameroon reveals a complex and increasingly alarming dynamic, where economic pursuits undermine the very ecological foundations necessary for community survival. While oil exploitation remains a cornerstone of national economic planning, its indirect consequences on food systems, particularly fish and crop production, have profound implications for local livelihoods and public health (Ehiomogue, 2022). As this exploitation intensifies, so do its environmental byproducts: oil spills, toxic emissions, water contamination, and land degradation. These ecological side effects disrupt natural ecosystems and, in turn, compromise food availability, accessibility, and quality for coastal populations that already face significant socio-economic challenges.

Offshore oil operations in the Gulf of Guinea, notably along Cameroon's coastline, have led to recurrent incidents of marine pollution. Oil spills, whether from routine extraction, accidental leaks, or poorly regulated transportation, create slicks that spread across the ocean surface, suffocating marine life and destroying habitats. Mangroves, which serve as breeding grounds for many fish species and as buffers against coastal erosion, are especially vulnerable to hydrocarbon contamination (Valiela, 2001). The degradation of these ecosystems results in diminished fish populations and the collapse of artisanal fisheries. For communities that rely on fish not only as a primary source of protein but also as a critical source of income, the impacts are devastating. Families are forced to spend more on alternative proteins, face rising food prices due to scarcity, and contend with a general decline in dietary diversity and nutrition.

Beyond the sea, the contamination caused by oil extraction also reaches inland food systems through groundwater and soil pollution. Wastewater discharges, pipeline leaks, and flaring byproducts often find their way into rivers, wetlands, and farming zones. The chemical composition of oil residues and associated heavy metals, such as lead, mercury, and cadmium, not only alters soil fertility but also accumulates in crops grown on contaminated land. Cassava, maize, and plantains, which are dietary staples in Cameroon's coastal regions, are particularly affected. When cultivated in polluted environments, these crops yield poorly and may carry harmful substances that pose risks to human health. Ingestion of such toxins over time can lead to chronic illnesses, further straining community health systems and reducing labor productivity, an indirect but critical blow to food security.

The economic fallout of these disruptions extends the food crisis beyond the immediate environmental degradation. As farming and fishing become less productive, households lose income

sources, and food becomes both scarcer and more expensive. Markets in urban and peri-urban areas suffer from supply shortfalls, especially in fresh fish and local produce (Achu, 2009). The reduced purchasing power of affected communities means that even when food is available, it may not be accessible to those who need it most. This has far-reaching consequences for nutrition levels among vulnerable groups, particularly children and pregnant women, who require consistent intake of protein and micronutrients to support growth and health. Consequently, malnutrition becomes a secondary but potent effect of oil-driven environmental decline.

Compounding these challenges is the lack of robust regulatory oversight and environmental accountability in the oil sector. Despite existing legislation aimed at environmental protection, enforcement remains weak due to institutional inertia, corruption, and limited technical capacity. Communities affected by pollution are often left without adequate compensation or remediation efforts (ITIE, 2018). Environmental impact assessments, when conducted, tend to underestimate the long-term food security consequences of oil activities. Moreover, public participation in decisions about oil exploration zones is minimal, leaving local populations with little say in the management of their own environmental futures. This democratic deficit deepens the vulnerability of already marginalized groups and contributes to growing resentment and mistrust of both government institutions and private sector actors.

The intersection of oil exploitation and food insecurity is therefore emblematic of a broader development paradox in Cameroon. Economic growth, narrowly defined by extractive output and export revenues, comes at the expense of ecological sustainability and human well-being. The country finds itself trapped in a resource curse dynamic, where natural wealth generates short-term gains but leads to long-term environmental degradation and social harm. For coastal populations, this trade-off is especially stark: they must navigate the consequences of national economic strategies that simultaneously undermine their access to clean water, fertile land, and nutritious food.

Addressing this imbalance requires a fundamental shift in how resource exploitation is governed. Policies must prioritize environmental safeguards, ensure that oil companies adopt and enforce international pollution control standards, and establish transparent compensation mechanisms for communities affected by oil-related damage (Alves, 2020). Equally important is the promotion of economic diversification strategies that reduce dependency on oil revenues and reinvest in sustainable agriculture and fisheries. Empowering local populations through environmental education, participatory governance, and support for ecological restoration initiatives can also strengthen community resilience against food insecurity.

In sum, the indirect effects of oil exploitation on food security in Cameroon are both deep and multifaceted. Pollution from oil activities contaminates the very resources that communities rely on to survive, leading to a cascade of economic, nutritional, and social vulnerabilities. Without decisive intervention, the gap between national economic ambitions and grassroots food realities will only widen, placing both environmental integrity and human development at grave risk.

Challenges for Sustainable Resource Management: Discussing the need for integrated policies that address both the environmental and socio-economic challenges posed by climate change.

Sustainable resource management in the context of climate change is among the most urgent challenges confronting coastal countries like Cameroon. The environmental pressures generated by

rising temperatures, sea-level rise, erratic rainfall, and extreme weather events converge with socio-economic vulnerabilities to create a complex web of risks. In regions such as the Littoral and South-West, where communities rely heavily on fragile ecosystems for their food and livelihoods, the consequences are already deeply felt. Yet despite mounting evidence of the need for sustainable practices, current approaches to resource governance often remain fragmented, reactive, and short-term in focus, unable to effectively address the intertwined threats posed by environmental degradation and economic instability.

One of the principal obstacles to sustainable resource management in Cameroon is the lack of coordination between environmental, agricultural, fisheries, and energy policies. Each of these sectors operates within its own institutional silo, with limited cross-sectoral dialogue and planning. For example, while national environmental strategies acknowledge the impacts of climate change, they are often disconnected from agricultural extension services or fisheries governance frameworks that deal with the day-to-day realities of food production (Mondal, 2022). The result is a policy landscape where critical synergies are missed and opportunities for integrated responses are squandered. This fragmentation leads to inconsistent regulations, overlapping mandates, and the inefficient use of scarce public resources.

Moreover, there is often a disconnect between national development priorities, largely centered around economic growth through resource extraction, and the environmental imperatives required to ensure long-term sustainability (Raj, 2018). Oil and gas exploitation, for instance, continues to receive significant political and financial backing, despite its contribution to pollution, ecosystem destruction, and displacement of coastal livelihoods. The pursuit of short-term economic returns through unsustainable extraction not only exacerbates environmental degradation but also undermines the adaptive capacity of local communities, pushing them deeper into cycles of poverty and food insecurity. The absence of robust environmental safeguards and the failure to integrate climate risk assessments into development planning only deepen the vulnerability of these communities.

Additionally, socio-economic challenges such as poverty, limited infrastructure, weak land tenure systems, and inadequate education constrain the ability of populations to adopt sustainable practices (Winter, 2001). Farmers and fishers operating at subsistence levels cannot be expected to prioritize environmental protection when their immediate survival is at stake. Without access to climate-resilient technologies, affordable credit, secure land rights, or market incentives for sustainable production, they remain trapped in exploitative cycles that degrade natural resources. Policy responses must therefore recognize that sustainability is not only a technical issue but also a deeply social one, requiring the empowerment of communities through inclusive governance, capacity-building, and equitable access to resources.

Climate change further compounds these difficulties by introducing new uncertainties and increasing the urgency of action. Unpredictable rainfall patterns affect planting cycles and harvests, while coastal erosion and saltwater intrusion reduce the amount of arable land. These changes demand adaptive governance structures capable of responding to evolving environmental conditions (Raj, 2018). Yet in many cases, existing institutional frameworks are too rigid or under-resourced to implement effective adaptation strategies. Local authorities often lack the training, funding, or political backing needed to coordinate resilience-building initiatives or enforce environmental regulations. This leaves a vacuum where unsustainable practices flourish, and long-term planning is sacrificed for immediate gain.

To overcome these challenges, there is a pressing need for integrated policy approaches that align environmental sustainability with socio-economic development. This means breaking down institutional silos and promoting cross-sectoral collaboration among government ministries, civil society, local communities, and private actors. Climate resilience must be embedded within all aspects of planning, from infrastructure development and natural resource management to education and public health (Fath, 2022). In particular, investing in climate-smart agriculture, sustainable fisheries management, and renewable energy can offer co-benefits that reduce environmental impact while supporting livelihoods.

Effective resource management also requires inclusive participation, where local communities are not only consulted but actively involved in designing, implementing, and monitoring policies. Traditional knowledge systems, often dismissed or marginalized, should be integrated with scientific approaches to create culturally relevant and context-specific solutions. Mechanisms for transparency and accountability are also essential to ensure that environmental regulations are enforced and that the benefits of sustainable practices are equitably shared.

In sum, the challenges of sustainable resource management in Cameroon cannot be addressed through piecemeal interventions or sector-specific reforms. What is needed is a holistic vision, one that understands environmental protection, economic development, and social equity as interconnected pillars of national resilience. Only through integrated and inclusive policies can Cameroon hope to build a sustainable future where both people and ecosystems thrive in the face of climate change.

Conclusion Générale: Confronting a double crisis through integrated and inclusive governance

Cameroon's coastal regions are navigating the compounded effects of two converging crises: the escalating impacts of climate change and the unsustainable exploitation of natural resources. As demonstrated throughout this study, rising sea levels, coastal erosion, ocean acidification, and extreme weather events are not merely environmental phenomena; they are profound threats to food security, economic stability, and community resilience. These ecological disruptions are further intensified by extractive activities, especially in the oil and gas sectors, which while contributing to national economic growth, exacerbate the vulnerability of marine and agricultural ecosystems.

This dual vulnerability is particularly acute in the Littoral and South-West regions, where local economies are deeply interwoven with artisanal fishing and small-scale farming. The depletion of fish stocks and the degradation of arable land are already reducing income, increasing food scarcity, and threatening social cohesion. In this context, food insecurity emerges not as an isolated humanitarian issue but as a systemic risk that intersects with environmental injustice, economic inequality, and weak governance structures.

The findings of this research underscore a critical need for a paradigm shift in the governance of natural resources and climate adaptation in Cameroon. Sustainable development in the Gulf of Guinea cannot be achieved without rethinking the current extractive economic model, prioritizing ecological integrity, and reinforcing the agency of local communities. There is an urgent call for national and regional policy frameworks that are inclusive, ecologically responsible, and security-informed.

Key policy recommendations include:

- Developing adaptive and climate-resilient fisheries management systems;
- Investing in sustainable agricultural practices that mitigate land degradation;
- Enforcing stricter environmental regulations on extractive industries;
- Integrating local knowledge and participation into environmental governance;
- Promoting economic diversification to reduce dependency on hydrocarbons.

At the international level, Cameroon must also position itself within global climate and ocean governance agendas, leveraging multilateral cooperation and South-South partnerships to mobilize funding, expertise, and technology for resilience building.

Ultimately, this study has demonstrated that the intersection of climate change and resource exploitation in Cameroon is not only an environmental issue, but a matter of national security and survival. The challenge is clear: either the state and society act now to build a sustainable and inclusive future, or they risk entrenching a cycle of ecological degradation, economic fragility, and human insecurity in one of Africa's most strategic coastal zones.

References

BOOKS

1. Amoasah, G. (2010). The potential impacts of oil and gas exploration and production on the coastal zone of Ghana. Thesis in Environmental Sciences. Wageningen University.
2. Boesch, D.F. & Rabalais, N.N. Long-term environmental effects of offshore oil and gas development. Elsevier, New York.
3. Chiambeng, G.Y. (2006). *Cameroon National Report on Marine and Coastal Biodiversity*. Research Station for Fisheries and Oceanography, Cameroon.
4. Djama, T. (1992). Interaction between the artisanal and the industrial fisheries of Cameroon. Ph.D thesis, University of Wales, Uk.
5. Gauthier, B. & Zeufack, A. (2009). Governance and oil revenues in Cameroon. Revenue Watch Project, OxCARRE, Oxford University.
6. IPCC & al. (2007). *Climate change 2007: Impacts, adaptation and vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press.
7. Mondala, S. & Palit, D. (2022). Challenges in natural resource management for ecological sustainability. *Natural Resources Conservation and Advances for Sustainability*. <https://doi.org/10.1016/B978-0-12-822976-7.00004-1>.
8. Ngo, Likeng, J.L. (2006). Migrations de pêche côtière au Cameroun : Essai d'approche pour l'intégration des communautés à l'aménagement des ressources.
9. NRC (National Research Council). (1985). Oil in the sea: inputs, fates, and effects. National Academy Press, Washington, D.C.
10. Thual, F. (1996). La Méthode géopolitique : apprendre à déchiffrer l'actualité. Ellipses.
11. Warrick, R. A, Barrow, E. M and Wigley, T. M. L (1993). *Climate and Sea Level Change: Observations, Projections and Implications*. Cambridge: Cambridge University Press.
12. Winter, G. (2001), Inégalités et politiques publiques en Afrique, paris, Karthala.

SCIENTIFIC ARTICLE :

1. Achu, C.C. (2009). Fish marketing in Cameroon: A case study of Yaounde markets. *Conference paper presented at Tropentag*, 6th to 8th, October, 2009, Hamburg.
2. Ahmadou, A. & al. (2022). Biodiversity of bottom trawl fishery and left-over marine resources along the Cameroonian coast. *Journal of Fisheries and Aquatic Science* · doi: 10.22271/fish.2022.v10.i6a.2749
3. Akpan, U. F., & Chuku, A. (2011). Economic growth and environmental degradation in Nigeria: beyond the environmental kuznets curve. *Munich Personal RePEc Archive*. Online at <http://mpira.ub.uni-muenchen.de/31241/>.
4. Alves, B., Angnuureng, D.B., Mrand, P. et al. (2020). A review of coastal erosion and flooding risk and best management practices in West Africa: What has been done and should be done. *Journal of Coastal Conservation*, 24(38).
5. Bardach, J. E, (1989). Global Warming and the Coastal Zone. *Climatic Change*, 15 : 117-150.
6. Ehiomogue, O. & al. (2022). Effect of crude oil exploration on global food security: a review. *Annals of Faculty Engineering Hunedoara – International Journal of Engineering*, Tome XX.
7. Ellison, J. & Zouh, I. (2012). Vulnerability to Climate Change of Mangroves: Assessment from Cameroon, Central Africa. *Biology*, 1, 617-638. doi:10.3390/biology1030617
8. Fath, B. (2022). Challenges in sustainable resource management. *Frontiers in Sustainable Resource Management*. doi: 10.3389/fsrma.2022.943359.
9. Hanna, S. (2010). Economic and policy issues related to the impact of climate change on fisheries. OECD. (2010). *The Economics of Adapting Fisheries to Climate Change*. OECD Publishing. <http://dx.doi.org/10.1787/9789264090415-en>.
10. Hardin, G. (1968). The Tragedy of the Commons. *Sciences News Series*, 162(3859), 1243-1248.
11. Krause, K. (1998). A Critical Theory and Security Studies: The Research Program of Critical Security Studies. *Cooperation and Conflict*, 33(3), 299-334.
12. Ndubuisi, J. (2018). Analysis of the Relationship Between Environmental Degradation of Oil Companies and Economic Growth of Nigeria. *International Journal of Finance and Banking Research*, 4(4): 67-78. doi: 10.11648/j.ijfbr.20180404.11.
13. Nicholls, R.J. & al. (2007). Coastal systems and low-lying areas. *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press: Cambridge, UK, 315-356.
14. Njamen & Njifonjou, O. (2005). Contribution de la pêche artisanale maritime sur l'économie nationale et contraintes liées à son développement : cas du Cameroun. COPACE : Troisième session du groupe de travail des pêches artisanales. Accra, GHANA : 7 – 9 juin 2005.
15. Osano, P. (2022). Climate change amplifies the risks for violent conflicts in Africa.
16. Parry, M. L., C. Rosenzweig, Iglesias, A. Livermore, M. & Fischer, G. (2004). Effects of climate change on global food production under SRES emissions and socio-economic scenarios. *Global Environmental Change*, 14(1), 53–67.
17. Patin, S. A. (1999). Environmental Impact of the Offshore Oil & Gas Industry. *Eco Monitor Publishing, East Northport*. New York. ISBN 0-967 1836-0-X.
18. Raj, A., Jhariya, M.K., Harne, S.S. (2018). Threats to biodiversity and conservation strategies. In: Sood, K.K., Mahajan, V. (Eds.), *Forests, Climate Change and Biodiversity*. Kalyani Publisher, India, 304-320.

19. Satia, B. (2011). Improving Fisheries Policy and management Systems in Cameroon. *Workshop document ACPFISH-II*, Seme Beach Limbe, 26-29th januray 2011.
20. Ssentongo, G.W. & Njock, J.C., (1987). Marine fishery Resources of Cameroon: A review of exploited fish stocks. *CECAF/ECAF*, SERIES 87/44.
21. Tataw, O. A. & al. (2021). Coastal Dynamics and Implication for Development of the Fishing Communities Along the Shoreline Region of Toubé, Cameroon. *Landscape Architecture and Regional Planning*. doi: 10.11648/j.larp.20210602.13.
22. Valiela, I & al. (2001). Mangrove forests, one of the world threatened major tropical environments. *BioScience*, 51, 807-815.
23. Voundi, E. (2021). Mining extractivism in East Cameroon and socio-environmental controversies: what prospects for peaceful development of local communities? *Belgeo*, 2. doi: 10.4000/belgeo.48699.

INTERNATIONAL ORGANIZATION REPORT:

1. Adom, I. & al. (2024). Climate change in Cameroon: key challenges and reform priorities. International Monetary Fund.
2. Chiambeng. G. Y. (2010). *Socio-economic survey of the Ngosso North Permit Fishery*. Consultation report submitted to ADAX petroleum. Southwest Cameroon.
3. CSIR. (2002). Environmental Impact Assessment of Exploration Drilling: Ebodge, PH:69. CSIR Report 2002(118). Prepared for Perenco Cameroon S A.
4. ENVIREP-CAM. (2011). Overview of Management and Exploitation of the Fisheries Resources of Cameroon, Central West Africa. IRAD, Yaoundé.
5. ITIE. (2018). Initiative pour la Transparence dans les Industries Extractives au Cameroun. ITIE Cameroun. Rapport ITIE 2018.
6. International Food Policy Research Institute. (2009). *Climate change: Impact on agriculture and costs of adaptation*. Food Policy Report 21. Washington, D.C.
7. IRAD Limbe. (2010). Annual report of activities, Research Station for Fisheries and Oceanography. Limbe, Cameroon.
8. Koane, M. (2007). The importance and challenges of Fisheries in Cameroon. Workshop report for MINEF, Limbe.
9. MINEPAT. (2024). Measures to adapt the Cameroonian economy to shocks and changes.
10. Nationally determined contribution- updated. (2021). Republic of Cameroon.
11. National Institute of Statistics. (2019). *Cameroun statistical yearbook*. 209-219.
12. NEPAD. (2013). Les agricultures africaines : Transformations et perspectives.
13. OECD. (2010). *The Economics of Adapting Fisheries to Climate Change*. OECD Publishing. <http://dx.doi.org/10.1787/9789264090415-en>.
14. UNEP. (1997). *Environmental management in oil and gas exploration and production*. An overview of issues and management approaches. UNEP IE/PAC Technical Report 37. Oxford. UK.
15. World Bank. (2022). Cameroon Country Climate and Development Report. CCDD Series.

Climate Change, Human Mobility, and Regional Security: Perspectives from Brazil

Bruno Magalhães, PhD, Senior Researcher of the Sovereignty
and Climate Center and of the Amsterdam University.

Mariana Nascimento Plum, PhD candidate (PUC-Rio), Executive Director
of the Sovereignty and Climate Center.

Introduction: Ground Moving Under Our Feet

In Brazil today, climate-induced mobility is no longer a distant risk. It is a lived reality. Droughts empty the Sertão; floods transform the South; fires drive Amazonian communities from ancestral lands; rising seas displace families along the coast. These movements—internal and cross-border, temporary and permanent, visible and invisible—are reshaping Brazil’s social fabric and altering the country’s security landscape. Yet public policy remains dangerously out of step with these changes. Brazil continues to approach climate mobility as a peripheral humanitarian issue, neglecting its growing scale, complexity, and strategic implications.

Over the last decade, Brazil has gained recognition as an active participant in international climate diplomacy. It has signed key agreements—the Paris Agreement, the Sendai Framework, the Global Compact on Refugees—and positioned itself as a leader in South–South cooperation (Itamaraty, 2023). Brazilian negotiators have consistently highlighted the links between climate change, mobility, and social vulnerability. They have advocated for the recognition of Loss and Damage, equitable climate finance, and the inclusion of human mobility in global adaptation frameworks (IISD, 2023; CIDH, 2021). On the international stage, Brazil speaks the language of integrated, human-centred solutions.

At home, however, a deep disconnect remains between this foreign policy discourse and domestic governance. National climate policy continues to focus overwhelmingly on mitigation—on reducing deforestation, expanding renewables, and leveraging carbon markets to attract international finance (IISD 2023). Adaptation, by contrast, is chronically underfunded, fragmented across ministries, and politically marginal. Even where adaptation is discussed, its link to human mobility remains largely invisible. The 2016 National Adaptation Plan remains only partially implemented, with no central agency empowered to coordinate across sectors (CIDH, 2024). The majority of Brazilian municipalities—those closest to the frontline of climate impacts—still lack the capacity to develop their own adaptation strategies.

The absence of an integrated mobility strategy is especially stark. Brazil’s 2017 Migration Law, hailed for its human rights provisions, remains silent on climate-induced displacement (Moretti & Bicalho 2020). The National Policy on Civil Protection and Defence, inspired by the Sendai Framework, offers no pathways for planned relocation or durable solutions for climate-displaced persons (UNDRR, 2022). Ministries and agencies operate in silos. Coordination is weak. In 2023, a proposed Interministerial Commission on Climate Mobility collapsed amid bureaucratic disputes (Chatham House, 2022). No dedicated agency holds responsibility for anticipating or managing mobility as an adaptation pathway.

This institutional vacuum persists even as the scale of displacement accelerates. In 2024 alone, over 200,000 people left drought-stricken rural zones of the Northeast (IBGE, 2024). Similar movements are unfolding in the South, the Amazon, and the Centre-West. Across Brazil's northern borders, cross-border flows from Peru and Colombia are rising, driven by glacier retreat, drought, and environmental degradation (IOM, 2023; Vuille et al., 2018). Yet those displaced—internally and across borders—remain trapped in a legal and policy void. They fall outside the categories recognized in current migration frameworks. They receive little structured support. Their mobility is neither anticipated nor governed.

As these patterns deepen, they are producing new pressures on urban centres, local governance, and public security. Displaced rural populations concentrate in fragile urban peripheries, straining housing, services, and social cohesion (Rigaud et al., 2018). Informal settlements expand into flood-prone zones. Health impacts rise. In border regions, frontier towns face compounding pressures from internal and cross-border mobility, with limited federal support (Chatham House, 2022). In the Amazon, Indigenous communities face cultural dislocation and growing precarity. Across the country, mobility is increasingly linked to inequality, exclusion, and injustice.

At the same time, the security framing of climate mobility is gaining ground. Brazilian armed forces—once reluctant to engage in migration governance—now play growing roles in border management and disaster response (Chatham House, 2022). Military doctrines remain rooted in territorial defence, but climate risks are entering strategic thinking, shaped in part by evolving Atlantic dynamics. European and North American militaries are already integrating climate risks into force planning and joint exercises (Brutschin et al., 2023). The Atlantic basin is emerging as a space where climate pressures, mobility, and geopolitical competition converge (Van Schaik & Staeger, 2021). Brazil, as the largest Atlantic actor in the South, cannot afford to remain unprepared.

Globally, legal and normative debates are also accelerating. Small Island Developing States—Cape Verde, Caribbean states—are leading efforts to evolve international law on climate displacement and state responsibility (ITLOS, 2024). The recent advisory opinion by the International Tribunal for the Law of the Sea underscores the growing weight of these debates. Brazil has supported Loss and Damage discussions and championed human mobility in international fora (Itamaraty, 2023). Yet domestically, legal frameworks and governance remain out of step. Aligning internal policies with emerging international norms is increasingly urgent—not only for protecting affected populations, but for preserving Brazil's diplomatic credibility.

Meanwhile, the Atlantic region itself is becoming more vulnerable. Climate-driven shifts in agriculture, fisheries, and oceanic conditions are disrupting trade flows and food security (Pal et al., 2023). Brazil's coastal infrastructure—ports, energy terminals, shipping routes—faces growing risks from rising seas and extreme weather (Pal et al., 2023). These pressures affect Brazil's economic security and its regional influence. Building Atlantic partnerships on infrastructure resilience, food security, and adaptation is vital. Yet such regional engagement will ring hollow if Brazil's internal policies continue to lag behind its diplomatic rhetoric.

The stakes are clear. Without a strategic shift, Brazil risks deepening cycles of reactive crisis management—where displacement is addressed only after it occurs, and affected populations are left in prolonged precarity. By contrast, a proactive, mobility-centred approach to adaptation could reduce harm, ease pressures on vulnerable communities, and contribute to sustainable development. It could also strengthen Brazil's leadership in emerging Atlantic debates on climate security.

This article argues for such a shift. It begins by mapping the changing geography of climate-driven mobility across Brazil's diverse regions. Drawing on ethnographic evidence and recent data, it examines how drought, flood, fire, and ecosystem collapse are driving new patterns of displacement—and immobility. It shows how these dynamics intersect with inequality, legal gaps, and governance failures. The article then situates Brazil's experience within the wider Atlantic context, analysing how regional and transatlantic dynamics are evolving. It concludes by identifying opportunities—and risks—for Brazil's future strategy. At a time when climate-induced mobility is reshaping the security landscape of South America and the Atlantic, the choices Brazil makes now will shape its role for decades to come.

A Country on the Move, a State Standing Still

The semi-arid hinterland of Northeast Brazil — the Sertão — has long known hardship. Yet over the last two decades, the pattern of droughts has changed. They persist longer, arrive less predictably, and increasingly stretch beyond historic cycles (Marengo et al., 2020). Rainfall is erratic, groundwater depletion severe, and desertification now affects vast areas of Ceará, Pernambuco, Paraíba, and Bahia (Gutiérrez et al., 2021).

For rural families like Dona Bernadete's in Bahia, these changes bring daily suffering. During the 2017 drought, her cistern yielded only foul-smelling, green water. "It tastes like animal feet," she said (S&C, 2025:12). Crops failed, livestock starved, and household water became scarce (S&C, 2025:12). For Seu Antônio, a cattle farmer in Feira de Santana, the drought left one option: feeding his herd mandacaru cactus. "When the drought comes, everything ends," he lamented (S&C, 2025:12).

Across the Sertão, worsening conditions have forced thousands to migrate. In 2024 alone, over 200,000 people left rural zones of the Northeast (IBGE, 2024). Municipalities in Ceará, Pernambuco, and Bahia have lost up to 20% of their populations within a decade (S&C, 2025). The young migrate first, seeking precarious city work; the elderly remain on desiccated lands (S&C, 2025).

Upon arrival in Fortaleza, Recife, or Salvador, migrants face new hazards. In Fortaleza's Bom Jardim and Jangurussu neighborhoods, rural newcomers fill informal settlements. Many live on flood-prone land or hillsides. Public services buckle under the influx. In these densely populated favelas, migrants face new climate-related risks, including floods, landslides, and extreme heat (S&C, 2025).

Many families adopt pendular migration. Young men labor seasonally in São Paulo's or Minas Gerais's cane, coffee, and fruit sectors, while women work as domestics. Remittances sustain relatives back home, but this migration cycle erodes knowledge and weakens community ties (S&C, 2025).

These dynamics fuel further degradation. Desertification accelerates where labor disappears. Farming knowledge wanes. Water scarcity deepens the crisis. Without adaptation, the rural exodus will likely intensify. The World Bank's Groundswell report projects that Brazil could see 5 to 10 million internal climate migrants by 2050, with the Northeast as a key source (World Bank, 2021).

In the South, water — not drought — drives displacement. Torrential rains, floods, and landslides displace tens of thousands annually (S&C, 2025). In 2023, severe floods in Rio Grande do Sul's Taquari Valley displaced over 40,000 people. Towns like Estrela and Lajeado were inundated; vineyards in the Serra Gaúcha lost entire harvests (S&C, 2025). Porto Alegre saw homes and businesses wrecked, with billions of reais in damage (S&C, 2025).

Human costs were high. In Petrópolis, 2022 landslides killed dozens in hillside settlements. For residents like Cristiane Gross, disaster struck fast. “The water came so fast we didn’t even grab our documents,” she recalled (S&C, 2025:12).

Such tragedies are no longer rare. Since 2000, floods and landslides have claimed over 5,000 lives in Brazil (S&C, 2025). For each fatality, many more are displaced. Urban centers like Porto Alegre and Curitiba absorb growing numbers of rural migrants and disaster survivors (S&C, 2025).

But municipal infrastructure can’t keep pace. Outdated drainage systems fail under extreme rainfall (S&C, 2025). Migrants often lack legal tenure or services, and many are forced to rebuild in equally risky sites (S&C, 2025). Repeat displacement drains savings, fractures networks, and deepens trauma. Healthcare services report rising respiratory disease, leptospirosis, and mental health impacts linked to climate disasters (S&C, 2025).

Poverty compounds risk. Informal settlements expand into vulnerable flood zones, as safer areas remain unaffordable. Women-headed households and migrants from poorer regions — especially the Northeast — are over-represented among those displaced (S&C, 2025). Public housing and building codes lag behind. Without major adaptation and social investment, these displacement cycles will escalate (S&C, 2025).

In the Centre-West, climate impacts reshape landscapes and mobility. The Cerrado’s fertile savannas and the Pantanal’s wetlands are both in crisis (S&C, 2025). The Pantanal remains scarred from the record drought and fires of 2019–2021, which burned over 26% of its area (Silva et al., 2022). Recovery is slow. Water cycles remain disrupted. Fishing and ecotourism continue to suffer (S&C, 2025).

In the Cerrado, deforestation and land conversion now exceed 50% (S&C, 2025). But rising heat, erratic rains, and land degradation now threaten agricultural viability. In 2024, soy yields in Mato Grosso fell up to 30% in Sorriso and Lucas do Rio Verde (S&C, 2025). Goiás maize crops suffered similar declines, compounded by pest outbreaks (S&C, 2025).

Small and mid-size farmers, lacking irrigation or climate-resilient tools, fell into debt. Cooperatives in Mato Grosso reported losing 15% of members during 2023–2024 (S&C, 2025). Livestock ranchers, facing degraded pastures and rising feed costs, sold herds or abandoned ranching (S&C, 2025).

These rural losses triggered migration toward Cuiabá, Goiânia, and Brasília (S&C, 2025). Fast-growing cities now struggle with stretched infrastructure, overburdened transport, and weak services (S&C, 2025). Displaced farmers often settle in irregular peripheries, expanding informal zones and deepening vulnerabilities (S&C, 2025).

Climate-driven mobility now reshapes the Centre-West’s social geography, emptying parts of the countryside while increasing urban inequality. Without urgent rural adaptation and inclusive urban policies, these patterns will worsen (S&C, 2025).

In the Amazon, climate-induced migration is multifaceted. Deforestation, illegal mining, and hydropower intersect with extreme climate impacts — record droughts, fires, collapsing river systems — to drive displacement (S&C, 2025).

In 2023–2024, the Rio Negro hit record lows: 13.59 meters. Navigation across major rivers — Solimões, Madeira, Tapajós — was severely disrupted (S&C, 2025). Remote villages along the Rio Madeira endured weeks of isolation, relying on emergency aid (S&C, 2025).

Fishing collapsed. On the Japurá, catches fell 40% in 2024; on the Tapajós, Munduruku communities reported major losses due to mining (S&C, 2025). Many fishers abandoned riverside homes, migrating toward Manaus or smaller cities like Santarém and Altamira (S&C, 2025). Informal urban settlements expanded.

Fires worsened the crisis. In 2024, Amazon fires rose 51% year-on-year; Smoke in Manaus spiked respiratory illnesses by 25%; Mercury contamination from illegal mining caused a health emergency in Yanomami lands, forcing families to flee to Boa Vista or Altamira (S&C, 2025).

Urban life offered little refuge. Indigenous migrants live in precarious shelters in Boa Vista, lacking sanitation, exposed to new risks (S&C, 2025). Cultural dislocation grows. Subsistence knowledge erodes. Languages fade (S&C, 2025).

Cross-border migration is rising. Displaced Peruvians increasingly enter Brazil through Acre. In 2024, flows through Rio Branco rose 22% (S&C, 2025). These migrants face language barriers, poor services, and precarious work.

Amazonian mobility is complex — internal and cross-border, temporary and permanent — and will intensify without urgent intervention (S&C, 2025).

Along Brazil's coast, climate risks accelerate. Sea-level rise, tidal flooding, erosion, and extreme heat reshape cities and mobility patterns (S&C, 2025). In Recife, Salvador, Rio, and Santos, tidal floods now regularly displace families (S&C, 2025). Rising seas redraw urban maps. Coastal erosion eats away floodwalls and beaches (S&C, 2025).

In addition to land-based impacts, climate change is reshaping Brazil's marine ecosystems. Rising sea temperatures, ocean acidification, and altered currents are disrupting marine biodiversity in the South Atlantic, with major implications for coastal economies. Coral bleaching, declining fish stocks, and shifts in species distribution increasingly undermine artisanal fisheries, particularly in Northeastern and Amazon coastal zones. These disruptions not only erode livelihoods but also drive displacement and reconfigure traditional coastal communities. As part of the wider Atlantic system, Brazilian waters face linked pressures with other Atlantic littoral states — pointing to the need for cooperative approaches to marine adaptation.

Gradual displacement often escapes official notice. Families leave after repeated losses — furniture, homes, livelihoods (S&C, 2025). Climate gentrification follows. In Rio, wealthier households tend to cluster in cooler zones or gated hilltop condominiums. In Ipanema and Leblon, rising real estate prices reflect heat refuge demand (S&C, 2025). Poorer residents are pushed outward — to hotter, drier, more flood-prone peripheries (S&C, 2025).

In Complexo do Alemão, summer heat regularly exceeds 40°C. Poor infrastructure traps heat; water rationing worsens hardship. In 2023's record summer, many fled temporarily to relatives in cooler areas (S&C, 2025).

Saltwater intrusion affects drinking water in Santos. Failing infrastructure drives some middle-class families inland (S&C, 2025).

Fisheries collapse deepens displacement. Warming, acidification, and shifting currents have cut artisanal fish catches by 50% in Pará and Pernambuco (S&C, 2025). Fishers turn to precarious city jobs, swelling informal settlements — like Salvador’s mangrove favelas (S&C, 2025).

Sea-level rise will intensify these trends. IPCC projections warn Brazil’s coast could see up to one meter of rise by 2100 (IPCC, 2023). Without major adaptation, cycles of displacement and inequality will deepen (S&C, 2025).

Not all Brazilians can move. Many are trapped. In the rural Northeast, prolonged droughts have hollowed out villages. Since 2012, 31 million people suffered extreme drought (S&C, 2025). The poorest — elderly farmers, widows — remain on degraded lands. Cattle gone, fields barren, they survive on irregular water deliveries (S&C, 2025).

In the Amazon, many Indigenous elders refuse to abandon ancestral lands, despite dropping river levels, collapsing fisheries, and mercury contamination (S&C, 2025). For them, leaving would mean cultural erasure.

Urban immobility is stark. In Recife, Salvador, Fortaleza, migrants fleeing rural crises land in favelas. Without jobs or legal housing, they become trapped again ((S&C, 2025). In Salvador’s Fazenda Coutos, a 12% population surge occurred in 2024 — mostly from drought-hit interiors (S&C, 2025). Few can afford further relocation. In Recife’s Ibura, tidal floods now regularly inundate homes. But residents have no path to safer ground (S&C, 2025).

Forced immobility harms health, increases stress, and deepens poverty. It hits the elderly, women, Indigenous peoples, and the disabled hardest ((S&C, 2025). Overcrowded schools, strained clinics, and unsafe housing worsen risks (S&C, 2025).

Policy responses remain blind to the trapped. Brazil’s climate and migration frameworks emphasize disaster response, neglecting the slow degradations that immobilize millions. Without targeted aid, local adaptation, and community-driven risk reduction, immobility will become an ever-greater injustice of Brazil’s climate crisis (S&C, 2025).

Global Talk, Local Gaps

Over the last decade, Brazil has positioned itself as a visible and active player in international climate diplomacy. The country participates in key global frameworks, including the Paris Agreement (2015), the Sendai Framework for Disaster Risk Reduction (2015–2030), the Global Compact on Refugees (2018), and the Global Compact for Safe, Orderly, and Regular Migration (2018). In these arenas, Brazilian diplomats have consistently underscored the links between climate change, mobility, and social vulnerability — advocating for integrated approaches that address the cascading human impacts of environmental stress (CIDH, 2021; IOM, 2022; IDMC, 2023; IISD, 2023). Brazil has also championed the inclusion of food security, water governance, social protection, and the recognition of Loss and Damage as critical pillars of international climate action. In the context of South–South diplomacy, Brazilian negotiators frequently position the country as a bridge between the global North and South, advocating for equitable climate finance and protections for vulnerable populations.

Framing Brazil’s experience within an Atlantic perspective is crucial. The Atlantic basin — spanning South and North America, West Africa, and Europe — forms a deeply interconnected space where climate change impacts travel through oceanic, ecological, economic, and human mobility linkages.

Migration pressures along Brazil's northern borders and coastal cities increasingly reflect broader Atlantic dynamics: sea-level rise, extreme weather, and livelihood crises from the Caribbean to West Africa drive complex flows across the Atlantic space. Recognizing climate-induced mobility as a shared Atlantic challenge — a transnational issue within a global common — would enable more effective cooperation between Brazil and Atlantic partners, moving beyond narrow national responses.

Yet behind this progressive international discourse lies a deep disjunction between foreign commitments and domestic realities. While Brazil speaks of holistic, human-centred solutions abroad, its climate policy at home remains fragmented, mitigation-centred, and institutionally unprepared to address the human consequences of climate change — particularly climate-induced migration.

This imbalance begins with the framing of the climate agenda itself. National debates remain dominated by mitigation goals: reducing deforestation, expanding renewables, and positioning Brazil as a “green” leader in global carbon markets (IISD, 2023). These efforts attract international finance and bolster Brazil's diplomatic image. In contrast, adaptation remains chronically underfunded, institutionally marginal, and lacks political visibility. When adaptation is mentioned, it is typically in vague terms and disconnected from the realities of human mobility.

Brazil's National Adaptation Plan (PNA), launched in 2016, laid out an ambitious roadmap for preparing the country for worsening climate impacts. Yet eight years on, implementation is partial and slow. No central agency holds the mandate or political weight to coordinate adaptation across sectors. Funding is inconsistent and dwarfed by mitigation budgets. While substantial funds flow toward carbon market projects and mitigation efforts, adaptation expenditures remain low and largely non-transparent (CIDH, 2024). At municipal level, 65% of Brazilian cities lack the technical capacity or resources to develop their own adaptation plans — a severe gap in a country where local governments are on the frontlines of responding to climate impacts.

Emerging technologies offer new tools for addressing these gaps. Satellite monitoring, AI-based early warning systems, and big-data analytics can vastly improve risk assessment, disaster anticipation, and mobility tracking. Building capacity to leverage these innovations — particularly through partnerships with Atlantic allies — could enhance anticipatory governance and strengthen responses to climate-induced mobility. However, Brazil's use of such technologies remains fragmented, with limited integration across ministries and sectors.

The consequences of this neglect are becoming stark. In the drought-stricken Northeast, rural exodus is accelerating as agriculture collapses and water insecurity deepens. The semi-arid Sertão is seeing entire communities move to urban peripheries in search of basic survival, as in the case of Dona Bernadete in Bahia, who was forced to consume unsafe water during the 2017 drought (G1, 2017). In the South, extreme floods — such as those that devastated Rio Grande do Sul in 2023 — have displaced thousands. Survivors like Maria Antônia Ferreira and her family were left homeless, relying on donations and sheltering in gymnasiums, with no clear prospects for return or relocation (G1, 2023b).

In the Amazon, intensified wildfires and prolonged droughts are devastating traditional riverine communities, as in the case of Rosely dos Santos Bastos, whose livelihood was destroyed when flames consumed the forests around her home in Mato Grosso do Sul (O Globo, 2024a). Fishermen

along the Rio Negro have seen their mobility and subsistence shattered as historic droughts dry up once navigable waters (O Globo, 2023).

In each case, the displaced face similar realities: there is no anticipatory planning, no structured support for mobility as an adaptation pathway, and no recognition of their rights as climate-displaced persons. Responses remain reactive, centred on emergency relief, with little capacity for long-term solutions.

The legal frameworks in place are equally inadequate. Brazil's 2017 Migration Law (Lei 13.445/2017), celebrated for embedding human rights principles, does not mention climate-induced mobility. Nor does the National Policy on Civil Protection and Defense (PNPDEC, Lei 12.608/2012), despite being inspired by the Sendai Framework. No provisions exist for planned relocation, durable integration, or socioeconomic reconstruction for those displaced by environmental degradation.

Those displaced are thus left to navigate a fragmented patchwork of responses: temporary shelters, ad hoc humanitarian aid, local improvisation. No dedicated agency holds responsibility for climate mobility. The 2023 proposal to create an Interministerial Commission on Climate Mobility — which could have begun bridging this gap — collapsed amid bureaucratic disputes and lack of political consensus.

Coordination across ministries remains weak. The Ministry of Environment, the Ministry of Justice (which oversees CONARE), the Ministry of Social Development, and the National Civil Protection System all operate in relative isolation. The PNA and the PNPDEC barely interact. CONARE's criteria remain outdated, providing no pathway for recognising climate-displaced persons in asylum or residency decisions.

Meanwhile, patterns of displacement are accelerating. In 2024, more than 200,000 people left rural areas of the Northeast alone due to droughts and agricultural collapse (IBGE, 2024). Similar movements are reported in the Amazon basin and in the Pantanal. Cross-border flows are also growing: in Acre, for example, Peruvian migrants displaced by glacier loss and desertification in the Andes now make up an increasing share of irregular crossings into Brazil.

Yet these internal and cross-border migrants find themselves in a legal vacuum. They do not qualify for humanitarian residence under current Brazilian law. No mechanism exists for planned relocation. No national strategy supports the reconstruction of livelihoods for displaced communities. In cities like Manaus, Boa Vista, and Rio Branco, urban peripheries are swelling with climate migrants — often in precarious conditions, without public policy for integration.

Ironically, while this domestic paralysis persists, Brazil continues to champion the inclusion of climate mobility in international mechanisms. International legal norms are evolving. The recent advisory opinion by the International Tribunal for the Law of the Sea (ITLOS) on climate change and international law, initiated by the Commission of Small Island States on Climate Change and International Law (COSIS), underscores emerging state responsibilities for loss and damage. In the Atlantic, legal debates increasingly link provisions of the United Nations Convention on the Law of the Sea (UNCLOS) to climate impacts on maritime zones. Brazil has so far remained cautious in these debates — yet stronger engagement could inform domestic reforms and contribute to developing legal protections for climate-displaced persons, both internally and in cross-border contexts.

Brazilian negotiators have been more active in discussions under the Warsaw International Mechanism on Loss and Damage and the new Loss and Damage Fund. They argue that these mechanisms should finance adaptation, social protection, and planned relocation. Yet at home, no equivalent funding or institutional framework exists. Adaptation budgets remain small and often unexecuted. No national financial instrument is in place to support local governments in preparing for or managing climate-driven displacement.

Coastal infrastructure faces particular risks. Ports, oil terminals, power plants, and transport hubs along Brazil's Atlantic seaboard are increasingly exposed to storm surges, tidal flooding, and erosion. Yet there is little systematic planning for the protection or relocation of critical infrastructure. In the wider Atlantic region, countries face similar challenges. Coordinated assessments of infrastructure vulnerabilities would allow Brazil to align its strategies with emerging Atlantic-wide adaptation agendas. But that is not what we see.

This widening gap between foreign policy and domestic governance is more than a problem of diplomatic inconsistency. It actively undermines Brazil's own development goals and humanitarian capacities. Without coherence between international commitments and domestic policies, Brazil is unable to fully access or deploy the climate finance it champions abroad. More seriously, displaced populations — internal and cross-border alike — remain in prolonged precarity. Their vulnerability deepens social inequalities, fuels tensions in receiving communities, and risks creating cycles of marginalisation and exclusion.

At a deeper level, Brazil's overemphasis on mitigation reflects structural flaws in climate governance. Mitigation alone cannot protect vulnerable Brazilians from worsening climate impacts. Nor can Brazil deliver on its international commitments while its domestic governance remains so fragmented. What is needed is a strategic shift: toward an integrated approach that centres adaptation, mobility governance, and social protection. Without such a shift, Brazil will continue to rely on reactive crisis management, leaving millions exposed to harm.

Bridging this gap is not merely about diplomatic credibility. It is about human dignity. As climate risks accelerate, mobility will become an increasingly central dimension of adaptation. If well managed, mobility can reduce harm, distribute population pressures, and contribute to sustainable development. But if neglected, it will exacerbate social injustice and deepen the vulnerabilities of those least responsible for the climate crisis.

Guns, Floods, and Displaced People

In Brazil, climate-induced mobility has long been treated primarily as a humanitarian and development issue. The dominant framing conceptualizes these displacements as temporary, reactive, and manageable through disaster response, poverty alleviation, and human rights-based development (IPCC, 2019b, 2021b; Clement et al., 2021). Brazil's National Civil Protection and Defence System (SINPDEC), which structures the country's disaster risk reduction architecture, remains largely focused on emergency interventions (UNDRR, 2022). While Brazil endorsed the Sendai Framework in 2015 — with its emphasis on reducing disaster risks through prevention — in practice, the operational emphasis remains reactive, aimed at managing crises after they occur rather than addressing underlying drivers of vulnerability and displacement (UNDRR, 2022; IDMC, 2025).

For decades, Brazil's climate and security agendas evolved on parallel tracks. National security remained centered on sovereignty, organized crime, drug trafficking, and conventional border control (Chatham House, 2022). Meanwhile, climate policy — concentrated within the Ministry of the Environment and the Ministry of Foreign Affairs — focused primarily on mitigation and environmental diplomacy, with limited attention to the human consequences of climate impacts (IISD, 2023). Even as Brazil gained a strong international profile in climate diplomacy, domestic policy failed to integrate climate change into national security planning (Chatham House, 2022; IISD, 2023).

This separation is now eroding, as converging trends force climate-induced mobility into the security field. First, the scale of displacement is growing. In 2024 alone, over 200,000 people migrated from drought-affected rural areas of Northeast Brazil (IBGE, 2024). Recurrent floods in the South and catastrophic wildfires in the Amazon and Pantanal are displacing thousands each year (World Bank, 2023b). The World Bank's Groundswell report warns that Brazil may face millions of new internal climate migrants by 2050 (Clement et al., 2021).

Second, the impacts of mobility are cascading. Displaced rural populations, unable to return to degraded lands, are concentrating in fragile urban peripheries (Rigaud et al., 2018). In cities such as Fortaleza, Manaus, Boa Vista, Porto Alegre, and Salvador, informal settlements are growing, stressing housing markets, public services, and social cohesion (Rigaud et al., 2018; IPCC, 2023a).

Third, cross-border migration linked to climate impacts is rising. In Acre, new flows of Peruvian migrants displaced by Amazonian drought, fires, and deforestation have been recorded (Cesario, Fabriani e Cesario, 2015). Venezuelan migration into Roraima — initially driven by political collapse — is increasingly shaped by environmental factors, such as drought and degraded livelihoods in Venezuela (Cesario et al., 2015; Clement et al., 2021). Border municipalities such as Pacaraima and Assis Brasil face the compounding pressures of cross-border and internal mobility with little capacity for coordinated response (IOM, 2022).

As a result, climate mobility is now reframed as a security issue in Brazilian policy and practice. Agencies such as the Ministry of Defence, the Armed Forces, and public security bodies increasingly view extreme weather events and mobility flows through a security lens (Chatham House, 2022). Military involvement in disaster response has expanded sharply: the Armed Forces regularly assist in wildfire suppression (2020–2024), drought relief operations in the Northeast, and flood evacuations in the South (Agência Brasil, 2024b; Chatham House, 2022).

At the discursive level, new security language is entering the political mainstream. Terms such as “threats to social order,” “border security,” and “critical infrastructure protection” are now linked to climate crises and mobility in public debates (Chatham House, 2022). State security plans increasingly list climate-related risks as triggers for instability (IISD, 2023; Chatham House, 2022).

This securitization reflects real challenges. Urban infrastructures are strained. Housing deficits, water insecurity, and social tensions are rising in migration hotspots (Rigaud et al., 2018). In Pacaraima and Assis Brasil, local authorities have requested military assistance to manage cross-border inflows (Cesario et al., 2015). In Boa Vista and Manaus, public discourse often portrays migrants as sources of insecurity — despite the humanitarian nature of their displacement (Agência Brasil, 2024b).

Beyond immediate disaster response, climate change is now shaping the strategic thinking of armed forces across the Atlantic. European and North American powers are adapting procurement priorities

to address Arctic melting, maritime insecurity, and new logistical demands. In contrast, Brazil's military doctrine remains more reactive, focused on territorial defence. Greater engagement with Atlantic partners on climate-related security transformations — particularly through joint training and force modernization — could position Brazil more strategically in the shifting Atlantic security landscape.

At the same time, the turn toward security framing carries serious risks. One is the potential criminalization of migrants and displaced persons. When public narratives shift from recognizing climate mobility as a humanitarian need to treating it as a “threat,” displaced people face stigmatization, discrimination, and restrictive policy responses (Chatham House, 2022). This dynamic is already visible in Brazilian media, where discourses of “overloaded cities” and “out-of-control borders” are gaining traction (Agência Brasil, 2024b; Chatham House, 2022).

A second risk is that militarized responses could overshadow human rights and development-based approaches. While military participation in disaster response may sometimes be necessary, it can entrench a logic of containment and deterrence — marginalizing holistic solutions (UNDRR, 2022; Chatham House, 2022). Comparative evidence suggests that once climate migration is securitized, space for rights-based interventions shrinks, and displaced populations face greater vulnerability (Chatham House, 2022).

Finally, securitization may deepen governance fragmentation. Brazilian policy on climate, migration, and security remains siloed (IISD, 2023). Ministries of Environment, Justice, Defence, and Regional Development operate with limited coordination (UNDRR, 2022). A security-first framing risks further marginalizing efforts to build integrated, human-centered responses to climate mobility (Chatham House, 2022).

Brazil now faces a crossroads. It can adopt coordinated, human-rights-centered responses — aligning adaptation planning, migration policy, urban development, and accountable security interventions (Rigaud et al., 2018). Or it can drift into a narrow security approach that treats climate-induced migration as a threat to be managed through militarization and containment (Chatham House, 2022).

Civil society actors — from universities to community networks and NGOs — can emerge as key players in adaptation, especially in regions neglected by federal policy, or they can continue to be ignored. In the Amazon, Indigenous organizations document climate impacts and propose community-driven solutions. In urban centers, grassroots movements advocate for housing rights and climate justice. The private sector, particularly in energy, insurance, and finance, is also beginning to account for climate mobility risks. Yet these efforts remain poorly integrated into national policy. A more participatory governance model, engaging civil society and private actors, would enrich Brazil's capacity to manage climate-induced mobility.

The stakes are clear. Climate-driven mobility in Brazil is accelerating. The ways in which the state frames and manages this phenomenon will shape humanitarian outcomes — and national and regional security dynamics — for decades to come (Clement et al., 2021; World Bank, 2023b).

Be as it may, climate-induced migration and displacement are already reshaping — and will increasingly reshape — the regional security landscape in South America (Machado et al., 2021; Obermaier et al., 2022). The emerging patterns of cross-border movement expose the inadequacy of traditional, state-centric paradigms of security still dominant in the region (Briceño Ruiz & Ribeiro Hoffmann, 2015), and highlight the lack of institutional capacity to govern human mobility driven by

environmental change (Mijares & Nolte, 2018; IOM 2023). While Brazilian diplomacy has become active in framing these issues in international forums (Itamaraty, 2023), the country's fragmented domestic responses are producing spillover effects that risk undermining regional cooperation (Chatham House, 2022). The result is an unstable and fast-evolving context in which Brazil's choices — or inaction — will shape whether this transition produces collaboration or fragmentation across the continent.

In the Amazon, cross-border migration flows from Peru and Colombia into Brazil are accelerating (IOM, 2023; INPE, 2022). Peru's Andean glaciers are retreating rapidly (Vuille et al., 2018), producing severe water shortages and displacing rural and Indigenous populations toward the frontier with Acre (CARE Peru, 2021). The combined effects of ecosystem degradation, declining agricultural viability, and the collapse of traditional livelihoods are driving new movements into Brazilian border towns (Fraser, 2023). In Colombia, similar dynamics are unfolding in the Amazonian departments, where decades of deforestation, mining, and extractive development intersect with post-conflict fragilities (Salazar & Valencia, 2020) and increasingly severe floods and droughts (IDEAM, 2022). Communities from Caquetá, Guaviare, and Amazonas departments now appear in growing numbers in towns like Tabatinga (IOM, 2023).

In Bolivia, glacial retreat in the Andes (Rabatel et al., 2013), prolonged droughts in the highlands (UNDP Bolivia 2022), and increasing flood events in Amazonian provinces (CONARA, 2022) are producing both internal displacement and transboundary migration (IOM, 2023). Urban centres like La Paz and Cochabamba now host growing populations of displaced rural migrants (CENDA, 2023), while cross-border movements into Brazil are emerging, particularly among Indigenous groups and rural families from Pando and Beni (Chatham House, 2022).

In the Triple Border region between Argentina, Paraguay, and Brazil, drought-driven migration has accelerated (IOM, 2023). The Pampas region of Argentina — the country's agricultural heartland — has experienced repeated crop failures due to severe drought (FAO, 2023), forcing small and medium farmers, rural workers, and Indigenous communities to seek employment in Brazil's southern states (UNHCR, 2023). In Paraguay's Chaco, desertification and water scarcity are undermining local economies and contributing to growing migration toward Mato Grosso do Sul and Paraná (WWF Paraguay, 2023). Many of these flows are informal, difficult to monitor, and challenge Brazil's already stretched border management capacity (Chatham House, 2022).

Meanwhile, Venezuelan displacement — still the largest source of regional migration — increasingly reflects climate pressures alongside political and economic collapse (IOM, 2023; Sequera & Pinheiro 2021). Water scarcity, food insecurity, and ecosystem degradation in Venezuela are pushing secondary migration into northern Brazil, particularly Roraima (UNHCR, 2023). Pacaraima and Boa Vista now face chronic pressures on housing, public services, and local governance (Chatham House, 2022).

These converging dynamics are destabilizing the inherited security paradigms of the region. For decades, South American security thinking was rooted in a state-centric model, focused on sovereignty, territorial integrity, and the management of interstate conflict (Briceño Ruiz & Ribeiro Hoffmann 2015). The emergence of the South American Defence Council under UNASUR reflected a cooperative vision of security — but one that remained wedded to traditional notions of military defence (Briceño Ruiz & Ribeiro Hoffmann, 2015). Environmental risks were classified as development challenges, not security threats. Migration, when considered at all, was viewed as a humanitarian or social issue, external to the security sphere (Mijares & Nolte, 2018).

Brazil's own military doctrine still reflects this approach. The 2020 National Defence Strategy emphasizes territorial defence and the safeguarding of Amazonian sovereignty (Ministério da Defesa, 2020). Environmental security is defined primarily in terms of preventing foreign influence in the Amazon basin (Ministério da Defesa, 2020). In this framework, climate-induced migration is not conceptualized as a security issue. Rather, it remains treated through fragmented, largely reactive public policy channels (Chatham House, 2022).

Yet the pressures of climate migration are forcing a shift (IOM, 2023). Ministries of defence, public security, and federal police increasingly play a role in migration governance, particularly in frontier regions (Chatham House, 2022). In Brazil, the New Migration Law (Lei 13.445/2017) articulated strong rights-based principles, but in practice migration governance has become securitized, with a growing role for public security actors in screening, monitoring, and managing mobility (Moretti & Bicalho, 2020).

Regionally, security thinking in South America is also in a state of flux. The collapse of UNASUR as an active regional institution and the paralysis of the South American Defence Council have left a significant vacuum in cooperative security frameworks (Mijares & Nolte, 2018). Although Brazil helped to champion a cooperative vision of regional security in earlier years (Briceño Ruiz & Ribeiro Hoffmann, 2015), these institutional mechanisms are now defunct. What remains is MERCOSUR's residence agreements, which continue to function as a key legal tool for facilitating regional mobility (OAS, 2022). Yet these agreements were not designed with irregular or climate-induced migration in mind. They offer residence and mobility rights to nationals of MERCOSUR member states but provide no clear pathways or protections for climate-displaced persons (IOM, 2023).

The Quito Process — originally created in 2018 to coordinate regional responses to Venezuelan displacement — has begun to evolve in recognition of the growing role of climate drivers in regional mobility dynamics (IOM, 2023). Discussions under this platform have started to acknowledge that adverse environmental conditions now exacerbate migrant vulnerabilities. However, the institutional capacity of the Process remains limited (IOM, 2023).

In Brazil's northern and western frontier zones — particularly in municipalities such as Pacaraima, Tabatinga, and Assis Brasil — local governance structures are under acute strain (Chatham House, 2022). These border towns were already characterized by limited fiscal resources, fragile infrastructure, and thinly stretched municipal services. The new influxes of migrants and displaced persons, driven both by Venezuela's complex crisis and by mounting climate pressures across the Amazon and Andean regions (IOM, 2023), are pushing these capacities beyond their limits. Local officials, unable to provide housing, healthcare, or adequate social services to new arrivals, are increasingly requesting federal intervention — often in the form of military or security deployments (Chatham House, 2022).

The Brazilian armed forces, long reluctant to engage directly in migration governance (Ministério da Defesa, 2020), are now being drawn into this domain. This reflects a broader erosion of doctrinal boundaries between defence, public security, and migration management (Chatham House, 2022). The military's growing operational role in efforts such as Operação Acolhida in Roraima illustrates this shift (Moretti & Bicalho, 2020).

The absence of a coherent regional framework for climate-induced mobility exacerbates these tensions (IOM, 2023). National security agendas remain highly divergent across the region (Chatham

House, 2022). Colombia continues to prioritize counter-narcotics and organized crime operations (MinDefensa, 2022). Bolivia focuses on securing control over extractive resources and territory (MinDefensa Bolivia, 2022). Brazil's military doctrine remains anchored in the defence of territorial sovereignty and the safeguarding of the Amazon against perceived foreign threats (Ministério da Defesa, 2020). These doctrinal divergences impede the development of shared operational concepts or coordinated responses (Chatham House, 2022).

Yet there are also opportunities for more integrated and cooperative approaches (Itamaraty, 2023). Brazil has taken an active role in several regional forums where mobility and climate are increasingly linked: the Pan-Amazon Cooperation Treaty, MERCOSUR's Citizenship Agreement, the Cartagena+30 process, and the 2023 Declaration of Nassau (Itamaraty, 2023). In these settings, Brazilian diplomacy has promoted joint risk assessments, early warning systems, and shared agendas for climate adaptation and mobility governance (Itamaraty, 2023).

Brazil's leadership in the Quito Process further reflects this potential (IOM, 2023). The country has proposed mapping climate-vulnerable zones, promoting cross-border corridors for adaptation, and creating integrated policies that combine migration management with climate resilience (Itamaraty, 2023). Its advocacy in the 2023–2030 Plan of Action demonstrates an ambition to situate climate mobility within broader sustainable development strategies (Itamaraty, 2023).

For Brazil to lead credibly on these issues, it must address persistent domestic gaps (Chatham House, 2022). A deep disjunction remains between its strong foreign policy discourse and fragmented internal responses (Moretti & Bicalho, 2020). Without urgent action to bridge this gap, Brazil risks drifting into a reactive posture (Chatham House, 2022). As climate-induced migration transforms the security environment of South America, the choice is clear.

These trends do not unfold in isolation. As climate-induced migration reshapes Brazil's internal dynamics and regional security relationships, wider transformations are occurring across the Atlantic space. Climate change is intensifying mobility, economic disruption, and geopolitical competition across the basin — from the Caribbean to West Africa and Europe (Brutschin et al., 2023; Van Schaik & Staeger, 2021). The Atlantic is emerging as a key arena where environmental risks, strategic interests, and humanitarian challenges intersect. For Brazil, understanding these shifts — and positioning itself accordingly — will be crucial to advancing national interests, strengthening cooperation, and shaping more coherent responses to the security risks of climate change.

Swim or Sink: Brazil's Atlantic Choice

The evidence is clear: climate-driven mobility is no longer a peripheral issue for Brazil. It is reshaping patterns of displacement, altering regional security dynamics, and challenging existing legal and governance frameworks. As droughts, floods, fires, and ecosystem collapse accelerate, mobility pressures will only grow. Yet Brazil's domestic responses remain fragmented, reactive, and poorly aligned with its international commitments. To close this gap, the country must move beyond siloed approaches and adopt an integrated strategy—one that treats mobility as a central element of climate adaptation and security planning. Doing so will not only improve outcomes for displaced populations but also strengthen Brazil's position in emerging regional and Atlantic debates on climate security.

Geopolitical dynamics are shifting. As Arctic ice retreats, new maritime routes are opening, and competition over mineral resources, hydrocarbons, and fisheries is intensifying (Dmitrieva & Solovyova, 2024). European and North American powers are integrating climate risks into force planning, procurement strategies, and joint exercises (Brutschin et al., 2023; NATO, 2023). The Atlantic basin is no longer simply a space of trade—it is becoming a contested strategic arena shaped by climate pressures. Brazil's military doctrine remains more reactive and defensive (Ministério da Defesa, 2020). Yet greater engagement with Atlantic partners—through joint training, maritime domain awareness, and climate-focused security cooperation—would allow Brazil to adapt to this changing environment and protect its strategic interests.

Legal and normative debates are also accelerating. Small Island Developing States (SIDS) from Cape Verde to the Caribbean are leading efforts to reshape international law on climate harm and state responsibility. The recent advisory opinion by the International Tribunal for the Law of the Sea (ITLOS, 2024), initiated by the Commission of Small Island States on Climate Change and International Law (COSIS), marks a turning point in how UNCLOS provisions are being interpreted in light of climate impacts. These legal innovations resonate across the Atlantic and align with Brazilian diplomatic priorities around loss and damage (Itamaraty, 2023). Closer alignment with SIDS could help Brazil advance its interests in global climate governance while contributing to more robust legal frameworks for protecting climate-displaced persons.

Meanwhile, the risks to Atlantic food security and critical infrastructure are mounting. Climate-driven shifts in agricultural yields, fishery stocks, and ocean currents are disrupting trade patterns (Pal et al., 2023). Brazil's agricultural exports—soy, beef, poultry, and fisheries—are key to food security across Atlantic markets, while the country also depends on Atlantic maritime routes for energy imports and industrial supplies (Brutschin et al., 2023). Yet, port infrastructure and coastal energy terminals remain vulnerable to rising seas, storm surges, and extreme weather events (Pal et al., 2023). Coordinated Atlantic action is needed on port resilience, secure trade corridors, and shared food security planning. Brazil's active engagement in regional dialogues—whether through the Pan-Amazon Cooperation Treaty, the Cartagena+30 process, or EU–African Union–South America initiatives—would help position the country as a constructive actor in building Atlantic resilience (Itamaraty, 2023).

Climate change is transforming the Atlantic basin into a space of converging humanitarian, legal, and security risks. For Brazil, the choice is clear. Remaining focused on fragmented domestic responses and a narrow regional posture will leave the country exposed and diplomatically isolated. Embracing a more integrated, Atlantic-facing strategy—one that strengthens cooperation with SIDS, deepens engagement with European and African partners, and addresses vulnerabilities in food systems, infrastructure, and mobility governance—can allow Brazil not only to safeguard its own national interests, but to contribute meaningfully to a more stable and just Atlantic order. As climate-induced mobility accelerates and the Atlantic space becomes a key frontier in climate security, Brazil's response in the coming years will shape its role for decades to come.

References

Agência Brasil. 2024b. Cobertura especial: impactos das mudanças climáticas no Brasil. Brasília: Agência Brasil.

- Briceño Ruiz, J. & Ribeiro Hoffmann, A. 2015. *Post-Hegemonic Regionalism in the Americas: Toward a Pacific-Atlantic Divide?* London: Routledge.
- Brutschin, E., Dzebisashvili, S., Ferraro, M., Keohane, D. & Wolf, S. 2023. *Climate Change and European Security: A Strategic Outlook*. Paris: EUISS.
- CARE Peru. 2021. *Glacier Retreat and Water Scarcity in the Peruvian Andes*. Lima: CARE.
- Castro, F.R. (2025) *Stowaway journeys and Protection & Indemnity Clubs in Brazil*. *Forced Migration Review*, 75 (Dangerous journeys: Saving lives and responding to missing migrants and refugees), May, pp.61-64.
- CENDA. 2023. *Informe sobre Migración Interna en Bolivia: Desplazamientos por cambio climático*. La Paz: CENDA.
- Cesario, R., Fabriani, T. & Cesario, P. 2015. *Migração e Fronteiras na Amazônia Brasileira: Dinâmicas e desafios*. Brasília: IPEA.
- Chatham House. 2022. *Climate Change, Migration, and Security in Latin America*. London: Chatham House.
- CIDH. 2021. *Movilidad Humana y Cambio Climático: Informe temático de la Comisión Interamericana de Derechos Humanos*. Washington, DC: OAS.
- CIDH. 2024. *Balance de Políticas de Adaptación Climática en América Latina*. Washington, DC: OAS.
- Clement, V. et al. 2021. *Groundswell Part 2: Acting on Internal Climate Migration*. Washington, DC: World Bank.
- CONARA. 2022. *Informe sobre Desplazamiento Climático en Bolivia: Perspectivas y datos recientes*. La Paz: CONARA.
- Dmitrieva, E. & Solovyova, Y. 2024. *New Geopolitical Dynamics in the Arctic and Atlantic*. Moscow: IMEMO RAN.
- FAO. 2023. *Drought Impacts on Agriculture in the Southern Cone*. Rome: FAO.
- Fraser, B. 2023. *Climate Migration in the Amazon: New Flows, New Risks*. Washington, DC: Wilson Center.
- G1. 2017. *Sertão enfrenta crise hídrica histórica*. G1 Nordeste.
- G1.2023b. *Enchentes no Sul do Brasil: desabrigados e respostas emergenciais*. G1 Sul.
- Grotti, V., Malighetti, R. & Notar, B. 2021. *Borders, Biopolitics and Mobility: The European Union and the Atlantic*. London: Routledge.

- Gutiérrez, A. P. A. et al. 2021. “Projected changes in precipitation and drought patterns over northeastern Brazil.” *Climate Dynamics* 57: 3891–3907.
- IBGE. 2024. Fluxos migratórios internos no Brasil: Impactos das mudanças climáticas. Rio de Janeiro: IBGE.
- IDEAM. 2022. Informe sobre Clima Extremo e Impactos no Sul da Colômbia. Bogotá: IDEAM.
- IDMC. 2023. Global Report on Internal Displacement. Geneva: IDMC.
- IDMC. 2025. Displacement in the Context of Disasters and Climate Change: Latin America Regional Report. Geneva: IDMC.
- IISD. 2023. Brazil’s Climate Diplomacy and Governance: Strengths and Gaps. Winnipeg: IISD.
- INPE. 2022. Relatório Anual: Mudanças Climáticas e Mobilidade na Amazônia. São José dos Campos: INPE.
- International Tribunal for the Law of the Sea (ITLOS). 2024. *Advisory Opinion: Climate Change and International Law*. Hamburg: ITLOS.
- IOM. 2022. Cross-Border Human Mobility Trends in the Amazon Basin. Geneva: IOM.
- IOM. 2023. Climate-Induced Mobility in Latin America and the Caribbean: Regional Trends and Policy Gaps. Geneva: IOM.
- IPCC. 2019b. Special Report on Climate Change and Land. Geneva: IPCC.
- IPCC. 2021b. Sixth Assessment Report: Impacts, Adaptation and Vulnerability. Geneva: IPCC.
- IPCC. 2023. Climate Change 2023: Synthesis Report. Geneva: IPCC.
- Itamaraty. 2023. *Diplomacia Climática Brasileira: Relatório Anual*. Brasília: Ministério das Relações Exteriores.
- Magalhães, B. 2025. “Delayed Technological Discrimination: Biometric Borders and Temporal Exclusion in Brazil’s Asylum Governance.” *Mobilities* (forthcoming, accepted May 2025).
- Magalhães, B. 2024. Mudanças climáticas, defesa e migração: uma agenda emergente no Norte Global. v. 29 n. 3 (2023): *Revista da Escola de Guerra Naval*, Marinha do Brasil, EGN.
- Machado, C. V., Dutra, R. & Oliveira, A. R. 2021. *Segurança Climática na América do Sul: desafios emergentes*. Rio de Janeiro: IUPERJ.
- Marengo, J. A. et al. 2020. “Projected climate change impacts in the Brazilian Northeast.” *Climate Services* 17: 100134.

- Mijares, V. & Nolte, D. 2018. "Latin America and the Caribbean: Security regionalism in hard times." *Global Society* 32(2): 117–136.
- MinDefensa Bolivia. 2022. *Estrategia Nacional de Defensa 2022–2030*. La Paz: MinDefensa Bolivia.
- MinDefensa. 2022. Plan Estratégico del Ministerio de Defensa Nacional de Colombia 2022–2030. Bogotá: MINDEFENSA.
- Ministério da Defesa. 2020. *Estratégia Nacional de Defesa do Brasil 2020*. Brasília: Ministério da Defesa.
- Moretti, B. & Bicalho, C. 2020. Lei de Migração e Política de Segurança: desafios da implementação. São Paulo: USP.
- NATO. 2023. Climate Change and Security Impact Assessment Report. Brussels: NATO.
- OAS. 2022. MERCOSUR Residence Agreements: Regional Integration and Human Mobility. Washington, DC: OAS.
- Obermaier, A., Rathgeb, P. & Schaefer, D. 2022. *Climate Security in Latin America: Risks and Responses*. Berlin: SWP.
- O Globo. 2023. Rio Negro em seca recorde afeta comunidades ribeirinhas. O Globo Amazônia.
- O Globo. 2024a. Incêndios florestais atingem comunidades tradicionais no Centro-Oeste. O Globo Nacional.
- Pal, I. et al. 2023. "Climate change, trade, and food security across the Atlantic basin." *Nature Food* 4: 122–130.
- Rabatel, A. et al. 2013. "Current state of glaciers in the tropical Andes: A multi-century perspective on glacier evolution and climate change." *The Cryosphere* 7(1): 81–102.
- Rigaud, K. K. et al. 2018. *Groundswell: Preparing for Internal Climate Migration*. Washington, DC: World Bank.
- Salazar, J. & Valencia, M. 2020. *Post-Conflict Colombia and Environmental Risks in the Amazon*. Bogotá: Universidad Nacional.
- Sequera, V. & Pinheiro, L. 2021. *Venezuela: Collapsing State and Climate Crisis*. Caracas: UCAB.
- Silva, T. S. F. et al. 2022. "Record fire events and long-term impacts in the Brazilian Pantanal." *Scientific Reports* 12: 1487.

S&C (Centro Soberania e Clima). 2025. *Mobilidade Climática no Brasil: Migração, Território e Justiça Ambiental*. Brasília: S&C. https://soberaniaeclima.org.br/wp-content/uploads/2025/09/Estudo-Mobilidade-Climatica-no-Brasil_Migracao-territorio-e-justica-ambiental.pdf

UNDP Bolivia. 2022. Cambio Climático, Agua y Seguridad Alimentaria en Bolivia. La Paz: UNDP Bolivia.

UNDRR. 2022. Sendai Framework Monitor: Brazil Report 2022. Geneva: UNDRR.

UNHCR. 2023. Regional Overview of Mixed Flows from Venezuela. Geneva: UNHCR.

Van Schaik, L. & Staeger, U. 2021. *The Atlantic Basin and Climate Security: A Policy Agenda*. The Hague: Clingendael.

Vuille, M. et al. 2018. “Rapid decline of snow and ice in the tropical Andes.” *Earth’s Future* 6(3): 456–469.

World Bank. 2021. Groundswell Part 1: Preparing for Internal Climate Migration. Washington, DC: World Bank.

World Bank. 2023b. Groundswell Brazil Report: Climate Mobility Trends. Washington, DC: World Bank.

WWF Paraguay. 2023. Migración climática y desertificación en el Chaco Paraguayo. Asunción: WWF Paraguay.

Naval Technology and the Reconfiguration of Environmental Defense in South America: A Comparative Analysis of Securitization and the Triple Helix in Colombia, Paraguay, and Perú

Julian Orlando Quintero Ibañez²⁶, Juan Carlos Abraham Adrianzen Perry²⁷,

Luis Alberto Delgado Barrios²⁸

Introduction

The accelerating impacts of climate change are no longer confined to ecological discourse; they have become central elements of national and international security agendas. Climate change acts as a "threat multiplier," exacerbating existing vulnerabilities and creating new security challenges, from resource scarcity to the increased frequency of natural disasters.¹ This reality is forcing conventional security actors, including military forces, to adapt their strategies and operational postures. Globally, the relationship between military forces and the environment is complex and often contradictory. Militaries are simultaneously significant polluters and greenhouse gas emitters, yet they are also increasingly indispensable first responders to climate-related catastrophes and are being tasked with new "green" missions.³

In Latin America, a region of unparalleled ecological diversity and profound socio-economic inequality, these dynamics are particularly acute.⁵ The region faces a spectrum of existential environmental threats, from melting Andean glaciers that jeopardize water security to the rampant deforestation of the Amazon rainforest.⁵ In response, states are increasingly framing environmental issues in security terms, a process known as securitization. However, despite the growing importance of this trend, there remains a significant gap in the academic literature, which has largely focused on global powers, leaving a lack of rigorous, comparative analysis of environmental defense reconfiguration in South America.⁷

This article seeks to fill this gap by moving beyond a thematic review to make a robust and original contribution to knowledge. Its central argument is that South American nations are developing highly divergent models of environmental defense, and that these models are shaped by the interplay between the political logic of securitization and the institutional capacity for technological innovation, best understood through the Triple Helix framework. By comparatively analyzing the cases of Colombia, Paraguay, and Perú, this study develops a typology of three distinct models of techno-securitization: "Militarized Enforcement," "Infrastructure Security," and "Emerging Techno-Governance."

The paper proceeds in five parts. The following section outlines the theoretical framework, critically examining the concepts of environmental securitization and the Triple Helix model and proposing a synthesized framework for analysis. Section three details the comparative case study methodology. Section four presents the empirical findings, analyzing the distinct approaches of Colombia,

²⁶ Naval Academy of Strategic Studies, Colombian Navy.

²⁷ Navy's General Staff, Peruvian Navy

²⁸ Command of Naval Educational Institutes, Paraguayan Navy

Paraguay, and Perú. Section five provides a cross-case discussion and analysis, elaborating on the proposed typology and the transformative role of technology. The final section concludes by summarizing the contributions of the study and outlining key directions for future research.

Theoretical Framework

To analyze the evolution of the role of South American armed forces in the face of environmental change, this study employs two complementary theoretical lenses: environmental securitization and the Triple Helix model of innovation.

The Theory of Environmental Securitization

Developed by the Copenhagen School, securitization theory posits that an issue becomes a matter of security not because of an objective threat, but because a powerful actor successfully frames it as an "existential threat" to a referent object (such as the state or its population) through a "speech act".⁹ If this "securitizing move" is accepted by a relevant audience, it justifies the adoption of extraordinary measures outside the bounds of normal politics.

In Latin America, this process is deeply political. On one hand, framing catastrophic environmental threats in security terms can elevate their political priority and mobilize state resources for urgent action.⁹ On the other hand, the region's history of military influence creates a significant risk that securitization leads to the militarization of environmental governance.¹⁰ This can result in the misdiagnosis of complex socio-ecological problems as conventional threats to be addressed through force, often criminalizing marginalized communities while failing to address root causes.¹² The case of Brazil under the Bolsonaro administration serves as a stark warning of "perverse securitization," where a nationalist security discourse was used not to protect the Amazon, but to justify the dismantling of environmental agencies and enable resource extraction, framing international environmental concern as a threat to national sovereignty.¹³ Understanding this dual potential—securitization as a catalyst for either progressive mobilization or regressive militarization—is essential for evaluating the divergent paths being forged in the region.

The Triple Helix Model of Innovation

In contrast to the political logic of securitization, the Triple Helix model focuses on the institutional architecture of innovation through the interaction of three key spheres: university, industry, and government.¹⁶ This framework, adapted here for the security and defense context, provides a powerful lens for examining the capacity of a state to develop and implement technologically advanced solutions to complex challenges.

- **Government:** This sphere includes not only the Ministry of Defense and its operational branches (e.g., the Navy) but also civilian agencies like ministries of environment and national science councils (e.g., Perú's CONCYTEC), which often act as crucial network facilitators.⁵
- **Industry:** This encompasses traditional defense contractors (e.g., Airbus's role in PerúSAT-1), domestic firms, and non-traditional private sector actors whose activities intersect with environmental security, such as artisanal fishing societies driving the adoption of satellite tracking.⁴
- **Academia/Research:** This includes national universities and dedicated public and transnational research institutes, such as the U.S.-Peruvian Naval Medical Research Unit (NAMRU) SOUTH, which links environmental conditions to biosecurity.⁶

A Synthesized Analytical Framework

This article's central theoretical proposition is that these two frameworks are not mutually exclusive but are deeply complementary. The Triple Helix can be understood as the institutional engine that produces and integrates the technological capabilities—such as satellites, drones, and advanced sensors—that become the primary instruments of environmental securitization. The maturity, density, and configuration of a nation's Triple Helix is therefore a key independent variable that shapes the *form* of securitization that emerges. A state with a fragmented or underdeveloped Triple Helix may be limited to traditional, low-technology strategies of military enforcement, whereas a state with a more networked ecosystem is more likely to develop a sophisticated, data-driven model of techno-governance.

Methodology

To explore the interplay between these theoretical frameworks and the practices of environmental defense, this study adopts a qualitative, comparative case study (small-N) methodology. This approach is particularly well-suited for in-depth analysis of complex systems and for exploring similarities and differences between national contexts.

The selection of Colombia, Paraguay, and Perú is justified through a hybrid research design combining elements of Most Similar Systems Design (MSSD) and Most Different Systems Design (MDSD). The cases are "similar" in that all three are South American nations facing significant and escalating environmental and security challenges. They are "different" in their geography (an Andean nation with two coasts, a landlocked riverine nation, and a nation with coastal, mountain, and Amazonian zones), their historical security focus (internal conflict vs. territorial sovereignty vs. multi-vector threats), and their level of technological development. This variation allows the study to move beyond a simple theoretical test and instead construct a robust typology of strategic models. By examining these distinct pathways—from militarized enforcement to collaborative techno-governance—the research generates transferable insights and actionable lessons for the Atlantic community as it confronts its own evolving environmental security challenges.

Data collection was based on a qualitative content analysis of high-quality primary and secondary sources, including national defense and environmental policies, government reports, official military communications, academic peer-reviewed articles, and publications from international organizations and think tanks such as the Stockholm International Peace Research Institute (SIPRI). This study acknowledges the inherent limitations of research in this field, particularly the difficulty of accessing classified military data. However, by relying on a wide range of publicly available official and scholarly sources, the analysis maintains its intellectual rigor and credibility.

Comparative Case Analysis: Three Models of Environmental Defense

The analysis of Colombia, Paraguay, and Perú reveals three distinct models of environmental defense, each defined by a unique interplay of securitization logic and Triple Helix configuration.

Colombia: The "Militarized Enforcement" Model

Colombia's approach is a direct legacy of its long internal armed conflict. The 2016 peace accord with the FARC created power vacuums in environmentally sensitive territories, leading to a surge in illicit

economies such as illegal logging, mining, and coca cultivation, which in turn drove massive deforestation.²² The Colombian state responded by securitizing these activities as direct threats to national security, leading to a strategy of militarized conservation.

The primary instrument of this strategy is *Operación Artemisa*, a large-scale, ongoing military operation launched in 2019 to combat deforestation by deploying tens of thousands of police and military personnel.²² This approach has been heavily criticized for targeting impoverished smallholder farmers while failing to prosecute the powerful actors financing environmental crime, thus exacerbating the suffering of marginalized communities without addressing the structural drivers of degradation.²² The Colombian Navy's role is focused on riverine control, interdicting the illicit flows of drugs, timber, and minerals that are intrinsically linked to environmental crime.²³ From a Triple Helix perspective, Colombia's model is heavily skewed toward the government (military)-industry axis, focused on adapting existing military surveillance and interdiction technologies for environmental enforcement. The roles of academia and civil society in shaping a more holistic strategy appear comparatively marginalized.

This heavy reliance on the military sphere represents a missed opportunity to develop more comprehensive solutions. Such an insular approach overlooks the transnational nature of these environmental crimes, as the illicit goods—drugs, timber, and minerals—are often trafficked through riverine networks to the Caribbean and across the Atlantic, fueling broader regional instability. A multidisciplinary strategy, in contrast, could foster the international cooperation necessary to dismantle these supply chains and address a shared security threat for the entire Atlantic basin.

Paraguay: The "Infrastructure Security" Model

As a landlocked nation, Paraguay's economic vitality is defined by its major rivers, principally the Paraguay-Paraná Waterway.²⁴ This geographic reality has produced a developmentalist form of securitization where the object being secured is not the ecological health of the river, but its economic function as a commercial artery. This is embodied in the Hidrovía project, a massive engineering effort to transform the river into an industrial transport corridor through dredging, channel straightening, and the removal of islands and riparian vegetation.²⁵

While framed as necessary for navigational security, the project poses a devastating threat to the Gran Pantanal, the world's largest tropical wetland, and has been projected to cause the extinction of hundreds of species.²⁷ The role of the Paraguayan Navy is to uphold this dominant economic paradigm by providing security for the very project that is the primary source of environmental insecurity in the river basin.²⁸ The Navy's technological posture is correspondingly focused on presence and patrol, with much of its hardware being decades old.²⁹ Paraguay's Triple Helix for environmental innovation is nascent and underdeveloped, resulting in a technologically lagging, infrastructure-focused model that places economic imperatives in direct opposition to ecological health.

This approach underscores the urgent need to redefine security, framing vital ecosystems like the Gran Pantanal not as obstacles to development, but as strategic assets essential for long-term stability. For the Atlantic community, the relevance of this case is not geographical but institutional. It showcases a stunted Triple Helix where a security force (in this case, a landlocked navy) is marshaled to secure an economic agenda at the direct expense of environmental health. This serves as a critical

case study for Atlantic nations on the perils of a securitization framework that ignores climate change and fails to foster genuine collaboration between government, industry, and academia for sustainable outcomes.

Perú: The "Emerging Techno-Governance" Model

Perú confronts a uniquely complex landscape of environmental security threats, including illegal gold mining in the Amazon, industrial pollution, illegal fishing, and extreme vulnerability to climate change, particularly the El Niño phenomenon.¹² This multi-vector threat environment has catalyzed a multi-layered state response that blends traditional kinetic enforcement (e.g.,

Operation Mercury against illegal mining) with the prominent integration of advanced technology, giving rise to a model of techno-governance.³⁵

The Peruvian armed forces, particularly the Navy and its Coast Guard (DICAPI), play a multifaceted role that includes maritime policing, specialized pollution response, and serving as a cornerstone of the national disaster relief system during climate emergencies.³⁷ The most distinctive feature of Perú's approach, however, is its relatively mature and networked Triple Helix, which leverages technology to create new forms of environmental governance. Key examples include:

- **PerúSAT-1:** A state-led partnership between the Ministry of Defense (CONIDA) and Airbus to develop a high-resolution Earth observation satellite for dual-use security and environmental monitoring.⁴¹
- **SISESAT:** An industry-driven collaboration where artisanal fishing societies have spearheaded the adoption of satellite tracking systems to combat illegal fishing and meet international traceability standards, with government and naval oversight.⁴⁴
- **NAMRU SOUTH:** A transnational, research-focused partnership between the U.S. and Peruvian Navies and Peruvian universities that has developed electronic surveillance systems linking environmental conditions to biosecurity and public health.⁴⁵

These initiatives, summarized in Table 1, illustrate an emerging governance model where the state leverages multi-stakeholder partnerships to deploy technology not just for enforcement, but as a primary tool for monitoring and managing its territory and resources.

Table 1: Triple Helix Initiatives in Peruvian Environmental Defence

Initiative/Technology	Government Actor(s)	Industry/Private Actor(s)	Academic/Research Actor(s)	Primary Environmental Application & Securitization Logic
PerúSAT-1	Ministry of Defense (MINDEF),	Airbus Defence and	San Marcos University, CONCYTEC	Macro-Surveillance: Monitoring

	Peruvian Space Agency (CONIDA)	Space (France)		deforestation, illegal mining, disaster assessment. <i>Logic:</i> <i>Securitizing territory via sovereign technological oversight.</i> ⁴²
SISESAT	Ministry of Production (PRODUCE), DICASTI (Navy)	National Society of Artisanal Fisheries (Sonapesca)	Innovations for Ocean Action Foundation (IOA)	Maritime Domain Awareness: Combating IUU fishing, ensuring traceability. <i>Logic:</i> <i>Securitizing marine resources through co-regulation.</i> ⁴⁴
NAMRU SOUTH / Vigila	Peruvian Navy, Ministry of Health (MINSA)	U.S. Navy	Universidad Peruana Cayetano Heredia, NAMRU SOUTH	Biosecurity & Environmental Health: Surveillance of vector-borne diseases. <i>Logic:</i> <i>Securitizing public health by linking it to environmental vectors.</i> ⁴⁵
CEVAN	Peruvian Air Force (FAP)	Mancomunidades Regionales Amazónicas (Regional Governments)	N/A	Regional Amazon Monitoring: Remote sensing to deter forest degradation. <i>Logic:</i> <i>Securitizing the Amazon through civil-military partnership.</i> ⁴⁹

While Perú's model is the most advanced of the three, its primary value for the Atlantic community lies not as a finished product, but as a strategic blueprint for institutional evolution. Its success in tackling diverse threats stems directly from a commitment to operationalizing the Triple Helix framework, creating the very hybrid governance networks that are essential for managing shared domains. This demonstrates a crucial organizational shift: from a traditional, state-centric view of security to a "Networked Security State" where responsibility is co-produced by public, private, and academic actors. For nations sharing the Atlantic, this offers a tangible pathway for moving beyond siloed national efforts towards building a resilient, technologically-enabled, and truly collaborative governance architecture for the ocean commons.

Discussion and Analysis

A Typology of Techno-Securitization

The comparative analysis reveals three divergent trajectories of environmental defense, which can be understood as a typology of techno-securitization models:

1. **Militarized Enforcement (Colombia):** A model born from a legacy of internal conflict, where existing military technologies are repurposed for environmental law enforcement. The Triple Helix is dominated by the state-military, and the securitization logic is one of suppression and control.
2. **Infrastructure Security (Paraguay):** A model driven by a developmentalist logic, where the object of securitization is economic infrastructure, not the environment. It is characterized by a technological lag and an underdeveloped Triple Helix for environmental innovation, creating a direct conflict between security and ecological health.
3. **Emerging Techno-Governance (Perú):** A complex, multi-layered model responding to diverse threats by integrating advanced technology as a central pillar of governance. It is enabled by a more balanced and networked Triple Helix, creating hybrid governance networks that blend enforcement with data-driven management.

The Transformative Role of Technology

Advanced naval, aerospace, and information technologies are not neutral instruments; they are actively reconfiguring the practice of environmental securitization. They redefine threats by making diffuse processes like deforestation into discrete, actionable targets for security forces.⁵⁰ They enable new forms of "virtual" state presence in remote territories through surveillance and monitoring.⁴⁸ Most significantly, as seen in Perú, they create novel governance assemblages—a "Networked Security State"—where security is co-produced by a diverse array of public, private, academic, and international actors, blurring traditional institutional boundaries and reconfiguring state power.⁴⁵

Critical Assessment and Implications

To critically assess these trends, Anselm Vogler's framework of four military roles in relation to the environment is valuable: (1) complicity in environmental harm, (2) engagement in Anthropocene geopolitics, (3) impact alleviation, and (4) policy obstruction.³ All three cases demonstrate the inherent complicity of military forces as polluters.⁴⁸ Perú's investment in a sovereign satellite can be seen as a geopolitical move to assert autonomy.¹⁹ The disaster response roles of the Peruvian and

Colombian navies exemplify impact alleviation.⁵² However, the risk of policy obstruction is profound. Colombia's militarized approach, by targeting low-level actors, may obstruct more holistic solutions¹⁰, while Paraguay's model represents a structural obstruction where securing the economy actively destroys the environment.²⁶ Even Perú's advanced model raises critical questions about whether techno-governance leads to better ecological outcomes or a more efficient form of "green authoritarianism" that prioritizes surveillance over environmental justice and participation.⁵³

To navigate these risks, a strategic paradigm shift is imperative for the broader Atlantic community. The analysis shows that clinging to "Militarized Enforcement" or "Infrastructure Security" models is not only suboptimal but counterproductive, as they fail to address the root causes of environmental degradation and can exacerbate regional instability. The path forward lies in actively cultivating the "Emerging Techno-Governance" model. This requires more than just technological adoption; it demands a fundamental commitment to building the collaborative institutional architectures (the Triple Helices) capable of managing shared security challenges, from the Amazon basin to the High Seas of the Atlantic.

Conclusion and Future Research

This study has argued that South American nations are developing divergent models of environmental defense, shaped by the interplay between the political logic of securitization and the institutional capacity for technological innovation as defined by the Triple Helix. The comparative analysis of Colombia, Paraguay, and Perú has produced a typology of three distinct models: "Militarized Enforcement," "Infrastructure Security," and "Emerging Techno-Governance." The paper's primary contribution is this typology and its demonstration of how advanced technologies are transforming the nature of environmental security and state governance in the region.

Theoretically, this research provides a critical, empirically grounded examination of environmental securitization in the Global South, moving the debate from *whether* to securitize to *how* it is being done and with what institutional and technological means. Empirically, it offers an in-depth analysis of three understudied cases, highlighting the rise of a "Networked Security State" in Perú.

From this analysis, several key policy recommendations emerge for strengthening environmental defense in the Atlantic space and beyond. Institutionally, states must proactively foster Triple Helix ecosystems by creating platforms for public-private-academic collaboration, mirroring the hybrid networks seen in Perú to co-develop security solutions. Operationally, naval and security forces should prioritize investment in dual-use surveillance and monitoring technologies while formally expanding their missions to include environmental monitoring and disaster management, shifting from a reactive enforcement posture to one of proactive stewardship. Finally, at the strategic level, this entire effort must be embedded within a national security doctrine that recognizes natural capital as a cornerstone of state sovereignty and resilience. This ensures that technological governance enhances transparency and democratic accountability, thereby harnessing innovation for environmental security without succumbing to the perils of green authoritarianism.

The findings point to several crucial avenues for future research. First, longitudinal studies are needed to assess the long-term ecological and social justice outcomes of Perú's techno-governance model. Second, further comparative analysis, both within Latin America and with other regions facing similar challenges, could refine the proposed typology. Finally, deeper investigation is required into the

democratic accountability of these emerging networked security states to ensure that the pursuit of environmental security does not come at the expense of human rights and democratic principles.

References

1. Military Must Be Ready for Climate Change, Hagel Says - Defense.gov. <https://www.defense.gov/News/News-Stories/Article/Article/603441/military-must-be-ready-for-climate-change-hagel-says/>
2. Climate Change Threatens National Security Says Pentagon | UNFCCC. <https://unfccc.int/news/climate-change-threatens-national-security-says-pentagon>
3. On In-Secure Grounds: How Military Forces Interact with Global Environmental Change - Oxford Academic <https://academic.oup.com/jogss/article-pdf/9/1/ogad026/56173026/ogad026.pdf>
4. Climate Change and the Military: Discourses and Practices | Oxford Research Encyclopedia of International Studies <https://oxfordre.com/internationalstudies/display/10.1093/acrefore/9780190846626.001.0001/acrefore-9780190846626-e-890?p=emailAiBFmBlpFHD2w&d=/10.1093/acrefore/9780190846626.001.0001/acrefore-9780190846626-e-890>
5. Environmental and Climate Justice, and the Dynamics of Violence in Latin America - SIPRI https://www.sipri.org/sites/default/files/2024-02/delgado_y_otras_en_ingles.pdf
6. Climate Security Nexus in Latin America and the Caribbean: Venezuela and Colombia - CGSpace <https://cgspace.cgiar.org/bitstreams/e07e6a81-f804-42e7-9740-db491b84eeb6/download>
7. Climate And Security In Latin America and the Caribbean. - Instituto Igarapé <https://igarape.org.br/wp-content/uploads/2019/12/2019-12-02-publication-Clima-and-Security-EN-web.pdf>
8. Environmental Security in Latin America - 1st Edition - Gavin O'Toole <https://www.routledge.com/Environmental-Security-in-Latin-America/OToole/p/book/9781138693784>
9. On (In-)Secure Grounds: How Military Forces Interact with Global Environmental Change - Oxford Academic <https://academic.oup.com/jogss/article/9/1/ogad026/7564824>
10. The Amazon as a State Matter: Exploring the Role of Military in Forest Governance <https://gjia.georgetown.edu/2024/11/12/the-amazon-as-a-state-matter-exploring-the-role-of-military-in-forest-governance/>
11. On (In-)Secure Grounds: How Military Forces Interact with Global Environmental Change - Oxford Academic <https://academic.oup.com/jogss/article-abstract/9/1/ogad026/7564824>
12. Climate crisis meets security policy - Friedrich-Ebert-Stiftung <https://www.fes.de/en/shaping-a-just-world/peace-and-security/article-in-peace-and-security/climate-crisis-meets-security-policy>
13. A Military-Green Biopolitics: The Brazilian Amazon Between Security and Development <https://www.scielo.br/j/bpsr/a/nKyHv9SQDHFzPP68m9Bg8wG/>

14. Securitisation of the Brazilian Amazon: Roots, Development and Implications
<https://dspace.cuni.cz/bitstream/handle/20.500.11956/178389/120428581.pdf?sequence=1&isAllowed=y>
15. Land Without Law: The Effects Of Amazon Deforestation On Brazil's National Security,
<https://thesecuritydistillery.org/all-articles/land-without-law-the-effects-of-amazon-deforestation-on-brazils-national-security>
16. Triple Helix: About Us - Canadian Global Affairs Institute
https://www.cgai.ca/triple_helix_about_us
17. Peru-Strengthening-Perus-National-Science-Technology-and-Innovation-System-Project.pdf - World Bank Documents and Reports
<https://documents1.worldbank.org/curated/en/538891645205800037/pdf/Peru-Strengthening-Perus-National-Science-Technology-and-Innovation-System-Project.pdf>
18. The Implications of Climate Change for the Military and for Conflict Prevention, Including through Peace Missions - Air University
https://www.airuniversity.af.edu/Portals/10/ASPJ_French/journals_E/Volume-07_Issue-3/scottkhan_e.pdf
19. Climate Security and the Military - OAPEN Library
<https://library.oapen.org/bitstream/handle/20.500.12657/90095/9789400604780.pdf?sequence=1&isAllowed=y>
20. How militaries can adapt to confront the threat of accelerating climate change | Kearney
<https://www. Kearney.com/industry/aerospace-defense/article/how-militaries-can-adapt-to-confront-the-threat-of-accelerating-climate-change>
21. Civil-Military Relations and Today's Policy Environment - USAWC Press
<https://press.armywarcollege.edu/cgi/viewcontent.cgi?article=3007&context=parameters>
22. Demilitarizing environmental protection will benefit Colombia's biodiversity - SIPRI
<https://www.sipri.org/commentary/blog/2024/demilitarizing-environmental-protection-will-benefit-colombias-biodiversity>
23. Projecting colombia's future and maritime power - Armada Nacional
https://www.armada.mil.co/sites/default/files/naval_forces_colombia_2015.pdf
24. On (In-)Secure Grounds: How Military Forces Interact with Global Environmental Change
<https://academic.oup.com/jogss/article/9/1/ogad026/7564824>
25. Paraná–Paraguay Waterway - Wikipedia
https://www.iirsa.org/admin_iirsa_web/uploads/documents/lb09_seccion3_eje_hpp_eng.pdf
26. Paraguay River Environmental Monitoring by Rede de Proteção e Conservação da Serra do Amolar, Pantanal, Brazil
https://www.researchgate.net/publication/283327163_Paraguay_River_Environmental_Monitoring_by_Rede_de_Protecao_e_Conservacao_da_Serra_do_Amolar_Pantanal_Brazil
27. The case of the Paraguay-Paraná waterway - Blue Macaws
<https://www.bluemacaws.org/article/the-case-of-the-paraguay-parana-waterway>
28. riverine | Center for International Maritime Security - CIMSEC <https://cimsec.org/tag/riverine/>
29. Paraguay's Military: Internal Security Challenges vs Bloc Obsolescence - MP-IDSA
<https://www.idsa.in/publisher/issuebrief/paraguays-military-internal-security-challenges-vs-bloc-obsolence>

30. Deforestation and Forest Degradation Due to Gold Mining in the Peruvian Amazon: A 34-Year Perspective - MDPI
<https://www.mdpi.com/2072-4292/10/12/1903>
31. The Military and Private Business Actors in the Global South: The Politics of Market Access
<https://carnegieendowment.org/research/2024/08/the-military-and-private-business-actors-in-the-global-south-the-politics-of-market-access?lang=en>
32. Promote improvements to Peruvian public policies for sustainable fishing and aquaculture via the implementation of an ecosystem-based approach, including climate change adaptation with an emphasis on sustainable artisanal fisheries management.
<https://sdgs.un.org/partnerships/promote-improvements-peruvian-public-policies-sustainable-fishing-and-aquaculture>
33. Follow the Water: Emerging Issues of Climate Change and Conflict in Peru
<https://climateandsecurity.org/wp-content/uploads/2024/11/pnaec328.pdf>
34. The Peruvian Space Sector in the New Space Disruption: What are the Opportunities and Challenges for Peruvians in the New Space Age? <https://ceeep.mil.pe/2025/04/24/el-sector-espacial-peruano-en-la-disrupcion-del-new-space-cuales-son-las-oportunidades-y-desafios-para-los-peruanos-en-la-nueva-era-espacial/?lang=en>
35. 'Operation Mercury' Curbed Illegal Gold Mining in Peru | Dartmouth
<https://home.dartmouth.edu/news/2023/09/operation-mercury-curbed-illegal-gold-mining-peru>
36. Operation Mercury: Major success in reducing illegal gold mining in Peru
<https://www.amazonconservation.org/operation-mercury-major-success-in-reducing-illegal-gold-mining-in-peru/>
37. Reflections on the impact and response to the Peruvian 2017 Coastal El Niño event: Looking to the past to prepare for the future
<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0290767>
38. Peruvian Coast Guard - Wikipedia
<https://www.dicapi.mil.pe/organizacion/mision-vision>
39. Peruvian, U.S. Coast Guards conduct pollution control exercise during RS24
<https://www.dvidshub.net/news/473658/peruvian-us-coast-guards-conduct-pollution-control-exercise-during-rs24>
40. U.S. Naval Medical Research Unit SOUTH's Contributions to Strengthening Global Health Security in Peru and Across Latin America | The Journal of Infectious Diseases | Oxford Academic
https://academic.oup.com/jid/article/231/Supplement_1/S1/8006439
41. PeruSat-1 Earth Observation Minisatellite - eoPortal <https://www.eoportal.org/satellite-missions/perusat-1>
42. Peruvian Government: “Satellite investment recovered after first year of operations”
<https://www.airbus.com/en/newsroom/press-releases/2017-12-peruvian-government-satellite-investment-recovered-after-first-year>
43. USGS and the Republic of Peru Sign an Agreement for Remote Sensing Operations and Technological Development | U.S. Geological Survey <https://www.usgs.gov/news/national-news-release/usgs-and-republic-peru-sign-agreement-remote-sensing-operations-and>

44. Peru's artisanal fishing sector commits to satellite tracking - SeafoodSource <https://www.seafoodsource.com/news/environment-sustainability/peru-s-artisanal-fishing-sector-commits-to-satellite-tracking>
45. Our History - Navy Medicine <https://www.med.navy.mil/Naval-Medical-Research-Command/R-D-Commands/Naval-Medical-Research-Unit-SOUTH/Our-History/>
46. US Naval Medical Research Unit SOUTH's Contributions to Strengthening Global Health Security in Peru and Across Latin America - Oxford Academic https://academic.oup.com/jid/article-pdf/231/Supplement_1/S1/61819550/jiae574.pdf
47. NAMRU SOUTH Hosts Students for Military Tropical Medicine Field Exercise in Peru <https://www.southcom.mil/MEDIA/NEWS-ARTICLES/Article/3544700/namru-south-hosts-students-for-military-tropical-medicine-field-exercise-in-peru/>
48. Monitoring Acute Diarrhea via an Electronic SurveillanceSystem in the Peruvian Navy https://www.researchgate.net/publication/285663396_Monitoring_Acute_Diarrhea_via_an_Electronic_SurveillanceSystem_in_the_Peruvian_Navy
49. Exciting Partnership Announced in Peru for Monitoring the Amazon - GCF Task Force <https://www.gcftf.org/exciting-partnership-announced-in-peru-for-monitoring-the-amazon/>
50. About us - SPDA - Sociedad Peruana de Derecho Ambiental <https://spda.org.pe/en/nosotros/>
51. U.S. Naval Medical Research Unit SOUTH's Contributions to Strengthening Global Health Security in Peru and Across Latin America - PubMed <https://pubmed.ncbi.nlm.nih.gov/39928387/>
52. Environmental and Climate Justice, and the Dynamics of Violence in Latin America: Perspectives from a regional working group on climate change, the environment, peace and security in Latin America - Read-Me.Org <https://read-me.org/more-environmental-crime/2024/3/25/environmental-and-climate-justice-and-the-dynamics-of-violence-in-latin-america-perspectives-from-a-regional-working-group-on-climate-change-the-environment-peace-and-security-in-latin-ameri>
53. Integrated Country Strategy (ICS) - Peru - State Department https://www.state.gov/wp-content/uploads/2023/10/ICS_WHA_Peru_Public.pdf

Humanitarian Assistance and Disaster Relief Operations in the Atlantic: Lessons from the French Armed Forces Operation after Hurricane Irma

Eléonore Duffau

Introduction

Climate change is profoundly transforming the strategic and operational environment in the Atlantic region. Rising global temperatures have contributed to an increase in the frequency, intensity, and duration of extreme weather events (IPCC, 2022). In particular, the Atlantic Basin is facing a convergence of climate phenomena including rising sea levels, rising sea surface temperatures, shifting rainfall patterns, intensification of cyclonic seasons, etc. These environmental disruptions generate complex humanitarian crises that increasingly strain the capacities of civilian emergency services. As a result, armed forces are being increasingly mobilised to support civil security responses in the wake of climate-induced disasters.

In France, the militarisation of emergency response to natural disasters has followed this trend. Between 2010 and 2023, requests from French civil security authorities for military assistance in the context of extreme weather events increased by over 200% (De Guglielmo Weber, 2024). This rising reliance reflects both the growing severity of climatic shocks and the unique capabilities of military forces—such as logistics, rapid deployment, and command-and-control structures—to operate effectively in degraded environments. The French experience exemplifies how national defence assets are becoming essential actors in non-traditional security domains, especially those linked to climate resilience and disaster relief.

A critical example that illustrates this evolution is the military operation launched in response to Hurricane Irma in September 2017. Irma remains one of the most powerful and long-lasting tropical storms ever recorded in the Atlantic Ocean. Meteorological services recorded sustained winds exceeding 300 km/h and wind gusts of over 360 km/h²⁹, ranking Irma as a Category 5 hurricane on the Saffir-Simpson Hurricane Wind Scale (Valo, 2017, September 6th). Its trajectory included catastrophic impacts on several island territories, including Barbuda, Anguilla, Saint-Barthélemy, Saint-Martin, the Virgin Islands, and parts of northern Cuba, before threatening the southeastern United States. The total economic damage caused by Irma was estimated at nearly 100 billion U.S. dollars, making it one of the costliest natural disasters in modern history (AccuWeather, 2017, September 13th).

The French overseas territories of Saint-Barthélemy and especially Saint-Martin were directly in the path of the hurricane. The islands were devastated: infrastructure was destroyed, communication systems collapsed, and critical logistics hubs—such as ports and airports—became inoperative, significantly complicating the arrival of humanitarian aid (Houdayer, September 7th). Civil security services were mobilised immediately: gendarmes, firefighters, Red Cross volunteers, health staff, etc. To strengthen state support to the population, the French armed forces were quickly mobilised to restore order, deliver aid, evacuate victims, and support reconstruction efforts. Their engagement

²⁹ A gust is an average of the strongest winds measured over a period of less than one second. It is an instantaneous wind, as opposed to what is known as the average wind, measured over ten minutes and at a height of ten metres.

lasted several weeks and highlighted multiple operational and structural challenges in military-civil coordination under extreme conditions.

This paper investigates the French military's HADR operations in the wake of Hurricane Irma. It analyses the deployment strategy, coordination mechanisms, and lessons learned from the intervention. It further examines how these insights contributed to the evolution of HADR doctrine within the French military and offers recommendations for Atlantic nations seeking to enhance their military readiness in a period of increasing climate-induced extreme weather events.

The French military humanitarian assistance and disaster relief operations after hurricane Irma in 2017

The French army's HADR Operation

The French military response to Hurricane Irma in September 2017 demonstrated both the necessity and complexity of large-scale HADR operations in overseas territories. The intervention unfolded across three successive phases—anticipation, emergency response, and reinforcement—each reflecting the adaptation of military capabilities to a degraded, high-risk operational environment.

Upon the alert issued by meteorological services regarding the trajectory and potential impact of Hurricane Irma, the French Armed Forces in the Caribbean (FFAA) implemented early pre-positioning measures. Food supplies and personnel — including 280 gendarmes, firefighters, military personnel from the 33e Marine Infantry Regiment (RIMa) and personnel from the Civil Security Military Units (UIISC)³⁰ — had been pre-positioned on Saint-Martin and Saint-Barthélemy (Assemblée Nationale, 2017). This initial presence enabled the establishment of forward observation and limited security capabilities prior to landfall but was insufficient to address the full scale of the disaster.

The cyclone struck the islands during the night of September 5th to 6th, causing unprecedented destruction. In Saint-Martin, over 95% of homes were damaged, and approximately 60 % were uninhabitable (Houdayer, 2017, September 7th). On both islands, electricity was cut off, drinking water and petrol were unavailable. Therefore, communication networks were severed, essential infrastructure such as the prefecture, schools, administrations, hospital collapsed, and emergency services on the ground were themselves incapacitated. An interministerial crisis cell was activated under the authority of the Prime Minister Edouard Philippe, and a logistical coordination base was established in Guadeloupe to manage the deployment of aid (Observatoire Défense et Climat, 2025). However, the loss of communication between pre-positioned units and central command delayed the initial operational response and necessitated immediate efforts to secure deployed personnel and stabilise the situation (Observatoire Défense et Climat, 2025).

Beginning September 7th, the French government initiated a large-scale interservice deployment both from Guadeloupe and Martinique, and from metropolitan France. Reinforcements included several hundred gendarmes and police officers for public order and emergency support, as well as personnel

³⁰ The Civil Security Military Units (UIISC) are permanent specialized military units under the French Ministry of the Interior, trained to support civil protection operations. They are currently four Units comprising around 1,500 personnel. deployed in emergency situations such as natural disasters – especially forest fires, technological accidents, and humanitarian crises, both in France and abroad.

from the UIISC, militaries, firefighters, medical teams, and canine search units (Lagneau, 2017, September 10th). The French Navy played a decisive role in the initial response with reconnaissance missions with a Falcon 50M aircraft. The frigate *Ventôse*, already operating in the area, was able to conduct an immediate aerial reconnaissance using its Panther helicopter. This allowed for rapid damage assessment and the identification of critical priorities such as reopening port infrastructure. Upon arrival, naval divers conducted underwater inspections to clear debris and assess dock integrity, enabling the unloading of humanitarian aid (Observatoire Défense et Climat, 2025). The *Germinal*, another frigate, was redirected from Martinique with additional supplies and a second helicopter. Together, these vessels established a maritime logistics bridge with Guadeloupe, ensuring continuous delivery of emergency cargo via three daily rotations. The air force focused on reopening the airstrip in Saint-Martin and Saint-Barthélemy to enable continuous aerial logistics. After one day of clearing, an airlift was established with rotations involving CASA tactical transport aircraft, several Puma and civilian helicopters, and a few assets from the Ministry of the Interior. Several rotations per day to Guadeloupe enabled critical supply delivery and medical evacuations. On September 9th, after the passage of hurricane José, an A400M strategic airlifter from metropolitan France delivered heavy equipment, a dozen army personnel, mechanics and a Puma helicopter to bolster operations (C.H.A avec AFP, 2017, September 10th). Ground forces carried out a range of missions: security patrols to prevent looting, debris clearance, infrastructure repairs, and general support to local authorities and populations (Observatoire Défense et Climat, 2025). As Hurricane Maria approached on September 19th, the armed forces reinforced their deployment with a full unit of Civil Security Military personnel to Guadeloupe, Saint-Martin and Saint-Barthélemy (Ministère de l'Intérieur, 2017 September 19th).

Very quickly after the passage of Irma, the authorities recognized the scale of destruction and the inadequacy of local capacity. Therefore, the amphibious helicopter carrier *BPC Tonnerre* was dispatched from Toulon (mainland France) on September 12. It carried 400 gendarmes and around 500 military personnel from all armies (*Ouest France*, 2017, September 25th). The ship also brought 1,200 tons of supplies, more than a hundred vehicles, several aircrafts and heavy engineering assets for reconstruction efforts, civil security and gendarmerie vehicles and supplies (*Ouest France*, 2017, September 25th). Arriving on September 23 - after the passage of hurricanes Irma, José, and Maria - it initiated the second operational phase focused on reconstruction. With its landing craft and helicopters, the *Tonnerre* facilitated shore-to-shore delivery of equipment, water, and aid to otherwise inaccessible zones. Naval divers ensured safe landings of each landing craft on beaches. The ship also transported firefighters, police, customs officers, and replacement vehicles to reestablish disrupted public services. Meanwhile, the frigate *Ventôse* continued rescue missions in remote areas.

While the rapid deployment of French military assets enabled an immediate response to the disaster, in coordination with civil security forces, the unfolding of the operation also revealed a series of structural and situational challenges. These difficulties significantly shaped the operational environment and highlighted key limitations in crisis management capacities.

Difficulties on the Ground for the French Armed Forces: Need for Metropolitan Reinforcement, Social Tensions, Weather Constraints, etc.

The French military intervention in the aftermath of Hurricane Irma was marked by a series of operational, logistical, environmental, and social challenges that tested the limits of the armed forces'

crisis response capabilities (Arnell, 2018). Despite anticipatory measures and a relatively rapid mobilisation, the sheer magnitude of the disaster - combined with the geographical isolation and infrastructural vulnerabilities of the affected territories - necessitated extensive reinforcements, particularly from mainland France.

One of the most critical constraints was the limited local capacity to sustain high-intensity operations over time. Although essential infrastructure such as airports, hospitals, communication routes and the desalination plant in Saint-Martin were progressively brought back online, full restoration remained slow and uneven, severely hampering the coordination and delivery of humanitarian assistance (Descoux, 2018, July 10th). Priority was given to the evacuation of the most vulnerable individuals, but degraded facilities and disrupted communication channels further complicated situational awareness and resource allocation.

Social tensions on the ground were also significant and rapidly escalated in the days following the hurricane. The initial breakdown in communications, delays in the delivery of aid, and widespread reports - often amplified by media coverage - of looting and insecurity fuelled a climate of anxiety and mistrust among the population. The psychological toll of facing a second imminent cyclone, Hurricane José, further deepened this collective distress, especially among metropolitan residents unfamiliar with such crises (Descoux, 2018, July 10th). As rumours spread and panic took hold, large crowds gathered around the airport in increasingly precarious sanitary conditions, creating a chaotic atmosphere. This ultimately led to the emergency evacuation of over 7,000 individuals (Descoux, 2018, July 10th). Gendarmerie units, already stretched to capacity, supported by the militaries, were tasked with a dual mission: maintaining public order and supporting emergency response efforts, all under intense public pressure and in a stressful environment.

The operational dependence on aerial mobility proved particularly acute (Arnell, 2018). The archipelagic geography of the French Caribbean and the damages inflicted to road and port infrastructure made airlift capacity indispensable. However, the existing air assets (two helicopter detachments from the national navy, a *Panther* and an *Alouette III*) in the region were insufficient to meet the scale of demand (Arnell, 2018). As a result, an air bridge had to be established with reinforcements from the French Caribbean territories and the mainland. This included the deployment of reconnaissance aircraft (FA50), tactical transport planes such as the CASA - which were the only ones able to land at Saint-Martin airport, and rotary-wing assets from both the military and the Ministry of the Interior (Arnell, 2018). Moreover, the A400M strategic airlifter, deployed from metropolitan France, played a pivotal role in delivering large quantities of equipment, including heavy logistics and an additional helicopter. The coordination of these operations was facilitated by the deployment of an interservice transit detachment (DÉTIA), ensuring interoperability and continuity across platforms (Arnell, 2018).

The already complex logistical environment was further strained by the approach of Hurricane José on September 9th, which forced the temporary suspension of all air and maritime traffic and required the sheltering of deployed personnel for over 24 hours, compounding operational delays and heightening concerns over potential damage and civil unrest (Descoux, 2018, July 10th). In anticipation of new shocks, the French Navy reinforced the island with an additional 100 personnel. Just over a week later, Hurricane Maria posed a renewed threat on September 20th and caused damages to command structures in Guadeloupe but spared the islands. Overall, relief efforts had to be strategically delayed to avoid exposing more responders to dangerous conditions, further extending

the operational standstill. This sequential exposure to extreme weather events - paired with the visible standstill of relief operations - fuelled public frustration. Many residents perceived the response as too slow, especially in a context where expectations for rapid intervention were heightened by both the severity of the crisis and the growing desperation on the ground (Annick Girardin, 2017, September 11th).

From a strategic perspective, the Irma operation underscored the structural imbalance in force projection capabilities in the French Antilles. The military presence in the region remains predominantly maritime, while the response to Irma highlighted a vital need for rapid and sustained air mobility. The lack of an integrated sea-air continuum limited operational flexibility and exposed vulnerabilities in France's ability to adapt to sudden-onset climate events (Arnell, 2018).

In total, nearly 800 military personnel were mobilised in response to the crisis, and the operation extended for almost two months (Arnell, 2018). Conducted under extreme environmental, security, and social conditions, the intervention revealed both the strengths and the limitations of the French armed forces in responding to large-scale natural disasters in overseas territories. What lessons have the armed forces learned from this unprecedented event and deployment?

Lessons Learned for the French armed forces from Operation Irma

Operation Irma offered a critical opportunity to extract operational lessons and inform future disaster response strategies in France's overseas territories. The scale and complexity of the intervention highlighted structural and procedural gaps in crisis preparedness, particularly regarding capabilities, communication routes, interagency coordination, and interoperability with regional partners.

One of the key takeaways was the imperative for enhanced regional cooperation in areas prone to climate-induced emergencies. In the aftermath of Irma, the coordination between French, Dutch, British, and American assets operating in the northern Lesser Antilles demonstrated the operational benefits - and challenges - of multinational responses. While the initial French focus was directed toward the protection and evacuation of its own citizens in Saint-Martin and Saint-Barthélemy, the scope of humanitarian need rapidly expanded. For instance, following the subsequent impact of Hurricane Maria on the island of Dominica, the French frigate *Ventôse* was tasked with a secondary humanitarian mission. With no operational communication infrastructure on the island, French sailors had to dock and conduct in-person assessments with local authorities to determine urgent needs - ranging from water and food supplies to medical evacuations and engineering assistance. This mission was later reinforced by the arrival of the amphibious helicopter carrier *BPC Tonnerre*, further emphasising the necessity of flexible, multilateral coordination protocols (Observatoire Défense et Climat, 2025).

In response to these operational challenges, France has expanded its participation in joint training exercises with regional and international partners to improve interoperability and readiness (Observatoire Défense et Climat, 2025). Exercises are now specifically tailored to the realities of overseas territories and simulate high-intensity HADR scenarios. For example, every two years, the French armed forces in the Antilles (FAA) conduct an international exercise at the start of the hurricane season entitled 'CARAÏBES' with partner forces in the area: the United States, the Netherlands, England, the Dominican Republic and *Croix du Sud* in the Pacific (De Guglielmo Weber *et al.*, 2024). These exercises seek to ensure a permanent and coordinated naval presence through

rotational deployments and shared planning frameworks with allied nations, anticipating the increasingly frequent disruptions linked to climate volatility.

Doctrinal adjustments have also emerged as a direct consequence of Operation Irma (Observatoire Défense et Climat, 2025). Post-mission feedback (RETEX in French) has taken a more central role in refining response protocols, culminating in the creation of an internal dedicated HADR manual. This document outlines standard operating procedures, mission preparation processes, and equipment recommendations for emergency deployments. It provides a unified reference for armed forces personnel operating under degraded conditions, with special emphasis on communication, logistics, and population support.

One particularly illustrative lesson concerned emergency communications. In the absence of conventional networks, survivors on Saint-Martin were able to contact rescuers by transmitting distress signals over maritime radio channel VHF16, using a pleasure boat's onboard equipment. These calls were picked up and relayed by French naval units, enabling timely rescue. As a result, the French Navy has integrated VHF16 monitoring into its standard procedures and now recommends that all deployed units carry FM transmitters to facilitate emergency broadcasting in disconnected environments (Observatoire Défense et Climat, 2025).

Finally, the operation underscored a structural dependency on reinforcements and aerial logistics from metropolitan France (Arnell, 2018). A report by the French Senate's Overseas Delegation noted a critical lack of strategic planning for force propositioning in overseas territories. Irma revealed the limits of existing airlift capacity, as well as the need to strengthen both the resilience of local infrastructure and the responsiveness of on-site military units. This finding was echoed during the 2022 "Caraïbes" joint and multinational exercise, which reaffirmed the necessity of maintaining elevated levels of military air mobility in the region as part of future HADR readiness (De Guglielmo Weber *et al.*, 2024). Current policy reflections are thus oriented toward reinforcing the size and capabilities of propositioned forces, investing in hardened infrastructure, and ensuring that air transport capacities are scaled to match the evolving risk profile of overseas territories.

Recommendations for Strengthening Atlantic Armed Forces' HADR Capabilities

Considering the increasing frequency and severity of climate-induced disasters, Atlantic nations must adopt a strategic, coordinated, and anticipatory approach to enhance their armed forces' HADR capabilities. Based on the French experience during Operation Irma and lessons learned across multiple crises, the following recommendations are proposed:

Anticipate Growing HADR Demands on Armed Forces by Civil Security Services

Develop Integrated Disaster Response Reporting Tools: Establish a standardized system for tracking and reporting military support to civilian emergency operations across all territorial levels (local, regional, national), ensuring centralized situational awareness and strategic oversight.

Reassess the Evolving Role of Armed Forces in Natural Disaster Response: Defense ministries should engage in a strategic reassessment of the armed forces' mission portfolio considering climate-related disasters, clarifying the scope, limits, and long-term implications of their involvement in civil protection. This includes adapting doctrine, planning, and resource allocation to reflect the growing expectation that military forces will be systematically mobilized for crisis response operations in support of civilian authorities.

Build Redundant and Autonomous Response Capacity in Vulnerable Regions

Invest in Specialized Units: Develop or reinforce rapid-response military units, tailored to local climate risks, with capabilities in search and rescue, decontamination, engineering, and medical support.

Enhance Strategic Lift and Mobility Assets: Increase the availability and modernization of air and sea transport platforms, particularly in overseas, coastal or remote territories.

Preposition Emergency Supplies in Resilient Locations: Establish national reserves of essential goods (water, food, shelter, fuel, medical supplies) in climatically secure hubs to shorten response time during crises.

Upgrade Amphibious Logistics Capabilities: Ensure naval projection forces include adequate amphibious support, such as light transport ships, to reach isolated communities quickly after infrastructure collapse.

Promote regional and multinational cooperation

Establish Atlantic Disaster Coordination Protocols: Develop formal frameworks between EU states, the U.S.A, Canada, and regional bodies like the Caribbean Disaster Emergency Management Agency (CDEMA), for rapid mobilization and interoperability of HADR forces. This Atlantic framework should include African regional institutions with relevant mandates, such as the Economic Community of West African States (ECOWAS) and its Humanitarian Affairs Division, as well as the African Union's Continental Early Warning System (CEWS).

Support Knowledge-Sharing Platforms: Contribute to a transatlantic mechanism to share best practices, training tools, and operational feedback (RETEX) from disaster interventions.

Conduct Joint Exercises Adapted to Local Threats: Institutionalize multinational HADR exercises with Atlantic countries (e.g., "Caraïbes" or "Croix du Sud") focused on interoperability, logistics coordination, and joint command under degraded conditions.

Enhance Resilience of Military Infrastructure and Logistics

Map Climate Vulnerabilities of Military Sites: Systematically assess the exposure of military installations and critical infrastructures (ports, hospitals, coastal roads, desalinisation plants, energy infrastructures, state administrations) to sea-level rise, storms, and extreme heat.

Develop Relocation and Hardening Strategies: Prepare long-term plans for relocating or climate-proofing military assets in high-risk zones.

Cultivate a Risk-Aware Civil-Military Culture

Train Personnel in Climate Risk Management: Implement mandatory training modules on local climate risks for all military personnel stationed in vulnerable territories.

Contribute to Civilian Risk Preparedness: Armed forces should support civilian authorities in promoting a culture of risk awareness through joint drills, public outreach, and first-aid training initiatives tailored to climate-related emergencies.

Bibliography

Reports

Arnell, G. (2018). Rapport d'information sur les risques naturels majeurs dans les outre-mer. Tome 1 : Rapport. *Sénat*. <https://www.senat.fr/rap/r17-688-1/r17-688-11.pdf>

De Guglielmo Weber, M., Duffau, E. Van den Bossche, C. (2024). Interventions de secours d'urgence en réponse aux catastrophes climatiques : quel rôle et quels enjeux pour les forces armées françaises ? *Observatoire Défense et Climat*. <https://defenseclimat.fr/interventions-de-secours-durgence-en-reponse-aux-catastrophes-climatiques-quel-role-et-quels-enjeux-pour-les-forces-armees-francaises/>

IHEDN. (2021). Contributions et coopérations des forces militaires aux interventions lors de catastrophes climatiques : perspectives transatlantiques. Comité 4, sous-groupe 2, 72^e session nationale « Politique de Défense ». <https://ihedn.fr/wp-content/uploads/2021/06/IHEDN-72e-SN-POLDEF-C4.2-Note-operationnelle.pdf>

Gros, P., Taithe, A., Thomas, A., Tourret, V. (2021). La contribution des armées aux interventions de secours d'urgence en catastrophes naturelles de grande ampleur. *Observatoire des conflits futurs (FRS / IFRI)*. Note n° 68/Consortium CONFLITS-2035. <https://www.frstrategie.org/sites/default/files/documents/programmes/observatoire-des-conflits-futurs/publications/2021/02.pdf>

Press articles

C.H.A avec AFP. (2017, September 10th). Ouragan Irma: un A400M de l'armée de l'air attendu aux Antilles. *BFMTV*. https://www.bfmtv.com/societe/ouragan-irma-un-a400m-de-l-armee-de-l-air-attendu-aux-antilles_AN-201709090034.html

Houdayer, G. (2017, September 7th). Bilan humain, dégâts matériels : ce que l'on sait après le passage de l'ouragan Irma à Saint-Martin et Saint-Barthélemy. *FranceBleu*. <https://www.francebleu.fr/infos/climat-environnement/ouragan-irma-le-gouvernement-francais-revoit-le-bilan-provisoire-a-la-baisse-quatre-morts-retrouvees-a-saint-martin-1504798833>

Valo, M. (2017, September 6th). Irma, l'ouragan le plus puissant jamais enregistré dans l'Atlantique. *Le Monde*. https://www.lemonde.fr/planete/article/2017/09/06/irma-l-ouragan-le-plus-puissant-jamais-enregistre-dans-l-atlantique_5181793_3244.html#:~:text=L%E2%80%99ouragan%20Irma%20est%20arriv%C3%A9%20au-dessus%20des%20Antilles%20accompagn%C3%A9,%C3%AEles,%20et%20juste%20avant%20sur%20Anguilla%20et%20Barbuda.

Websites

AccuWeather. (2017, September 13th). *Harvey, Irma damages predicted to cost \$290 billion; Atlantic hurricane season only at midpoint*. [https://www.accuweather.com/en/weather-news/harvey-irma-damages-predicted-to-cost-290-billion-atlantic-hurricane-season-only-at-midpoint/357213#:~:text=AccuWeather%20predicts%20an%20economic%20impact%20of%20\\$242.9%20billion,billion%20among%20the%20costliest%20hurricanes%20of%20all%20time.](https://www.accuweather.com/en/weather-news/harvey-irma-damages-predicted-to-cost-290-billion-atlantic-hurricane-season-only-at-midpoint/357213#:~:text=AccuWeather%20predicts%20an%20economic%20impact%20of%20$242.9%20billion,billion%20among%20the%20costliest%20hurricanes%20of%20all%20time.)

Assemblée nationale. (2017, September 19th). *Question écrite n°1100 de M. Gilbert Collard au Premier ministre*. <https://www.assemblee-nationale.fr/dyn/15/questions/QANR5L15QE1100>

Descoux, J.-M. (2018, July 10th). [RETEX] IRMA : répondre à la catastrophe. *Ministère de l'Intérieur*. <https://www.gendarmerie.interieur.gouv.fr/gendinfo/terrain/rete/rete-irma-repondre-a-la-catastrophe>

Girardin, A. (2017, September 11th). Interview de Mme Annick Girardin, ministre des Outre-mer, à France Inter le 11 septembre 2017, sur les mesures prises à Saint-Martin et à Saint-Barthélemy après le passage de l'ouragan Irma. *Vie Publique*. <https://www.vie-publique.fr/discours/203644-interview-de-mme-annick-girardin-ministre-des-outre-mer-france-inter>

Lagneau, L. (2017, September 10th). Ouragan Irma : Le Premier ministre annonce l'envoi de nouveaux renforts militaires. *Opex360*. <https://www.opex360.com/2017/09/10/ouragan-irma-le-premier-ministre-annonce-lenvoi-de-nouveaux-renforts-militaires/>

Ministère de l'Intérieur. (2017, September 19th). *Ouragan Maria : point de situation - 19 sept. 12h*. <https://www.interieur.gouv.fr/fr/Archives/Archives-ministres-de-l-Interieur/Archives-Gerard-Collomb-mai-2017-octobre-2018/Actualites-du-ministre/Ouragan-Maria-point-de-situation-19-sept.-12h>

OuestFrance. (2017, September 25th). *Ouragan Irma : Le BPC « Tonnerre » est arrivé à Saint-Martin*. <https://lemarin.ouest-france.fr/defense/ouragan-irma-le-bpc-tonnerre-est-arrive-a-saint-martin-b68cbade-78bb-414f-8f22-0ad5ecc726a2>

Podcast

Observatoire Défense et Climat (2025). *Le rôle de la Marine dans les interventions de secours d'urgence climatique. Avec le Capitaine de vaisseau Schaar*. [Podcast]. <https://soundcloud.com/sur-le-front-climatique>

Conclusion - Climate Change and Security Challenges in the Atlantic: a pole-to-pole prospective vision

Sandra Maria Rodrigues Balão

The purpose of this 2025 Atlantic Centre research project was to analyze Climate Change and Security Challenges in the Atlantic today, seeking to understand and characterize the phenomenon in a holistic way and propose concrete measures to make a consistent contribution. Not only to its mitigation – considering, among other things, the role of technology, State capacity building (especially focused on increasing surveillance to improve the maritime situational awareness) and international cooperation between different stakeholder – but to go further, advancing recommendations to address its causes and presenting concrete proposals and possible measures that can enhance future solutions.

The Atlantic Basin is a critical locus where climate change acts as a paramount multiplier of security challenges, affecting an interconnected socio-ecological and geopolitical system spanning from the Arctic to the Antarctic, across maritime, terrestrial, cyberspace, and outer space domains (Balão, 2021; Bueger & Edmunds, 2024). Responding to this complex reality, the report rigorously examines the legal, social, economic, technological, and operational dimensions to provide a comprehensive picture of Atlantic climate-security risks and strategies.

Culminating in a multidimensional understanding of the Atlantic Basin's climate-security nexus, grounded in rigorous empirical research, cross-regional case studies, and comprehensive legal and strategic analyses, each of its chapters has engaged with distinct yet interconnected questions—from legal frameworks and migration dynamics to economic vulnerability, maritime governance, technological innovation, and disaster response—offering substantive insights and policy recommendations.

Elizabeth Nwarueze critically examines international legal regimes to highlight gaps and collaboration needs for marine environmental protection. Her research is focused on answering the key question: How can existing international maritime legal regimes support effective climate adaptation? She identifies important capacity gaps and advocates for strengthened regional cooperation under UNCLOS and the BBNJ Agreement to uphold marine environmental protection (Boyle et al., 2021; Rajamani & Peel, 2021). She demonstrates that international law provides a critical but incomplete scaffold for climate adaptation and collaboration, emphasizing the urgent need for coherent, inclusive legal frameworks that address transboundary marine threats and lay the foundation for shared maritime governance.

William Lyons applies narrative intelligence to explore how environmental stress triggers migration, insecurity and insurgency in the Sahel, highlighting the indispensable integration of narrative intelligence and human security frameworks into climate-security policy responses (European Parliament, 2022).

Fahd Azaroual and Jamal Machrouh analyse the economic vulnerabilities of Atlantic African insular states within climate change contexts, arguing for sustainable, climate-resilient development strategies (FAO, 2024).

David Willima on the other hand focuses on Climate Change as a threat multiplier in the Gulf of Guinea, elucidating how climate stress compounds maritime insecurity in the Gulf of Guinea.

Through a comparative study of Ghana and Nigeria, Juliet Obeng, together with Alberta Ama Sagoe, Kofi Duodu and Lawrence Dogli examine issues linked to climate-driven resource depletion and governance challenges, underscoring the necessity of integrated maritime governance.

Also, within the Gulf of Guinea, and based on his study of the Cameroon case, Edouard Yogo reveals the compound security crises of resource exploitation and governance in Central Africa, advocating for governance strengthening to improve the mitigation of complex risks, as well as the need for both political and technical solutions.

Travelling to the South, Bruno Magalhães and Mariana Plum present Brazil's climate-driven human mobility and displacement as a central regional security concern, stressing the need for integrated humanitarian and security policy responses and reiterating the necessity for integrated, adaptive governance models that span humanitarian and security sectors.

Julián Quintero, Juan Perry and Luis Barrios demonstrate how the role of technological innovation and civil-military collaboration in South America, as outlined in the Triple Helix model, enhances environmental defense, arguing that science and technology are central to resilience and strategic adaptability.

And finally, still within South America but under a French perspective, Eléonore Duffau offers critical lessons from French Humanitarian Assistance and Disaster Relief (HADR) operations following Hurricane Irma, emphasizing strategic civil-military readiness for climate disasters preparedness in military-led humanitarian responses in the Atlantic.

These findings by the authors collectively indicate that:

- Climate-security risks in the Atlantic are deeply interconnected across environmental, social, technological, and geopolitical domains.
- Challenges must be addressed holistically, aligned with a System of Systems, Whole of the Atlantic Approach.
- Equitable and inclusive partnerships that bridge global North-South divides and pole-to-pole geographies are essential for achieving sustainable solutions.

Building on these findings, the report innovatively proposes a Pole-to-Pole Whole of Atlantic Academia—a decentralized, inclusive, research and education network that bridges polar and tropical Atlantic actors for equitable knowledge co-production and shared scientific diplomacy, facilitating shared data, joint curricula, equitable knowledge production, and science diplomacy—empowering all Atlantic states to co-create solutions on a global scale.

Simultaneously, the Pole-to-Pole Whole of Atlantic Strategy envisions an integrated strategic governance and resilience architecture that aligns legal international frameworks with regional security policies, civil-military cooperation, and climate adaptation practices across all domains – including active engagement with cyberspace and outer space governance, recognizing their expanding roles in climate monitoring, maritime security, human security and geopolitical stability. In addition, mechanisms for inclusive, multilateral cooperation must be established to ensure that

both northern and southern Atlantic actors, including small island states and developing countries, are full partners.

These proposals respond logically and coherently to the report's collective evidence: demonstrating that effective climate-security governance demands an interdisciplinary, cross-regional, and "transdomain" approach encompassing sea, land, cyberspace, and outer space.

Together, these proposals crystallize the necessary corollary of the empirical and normative insights generated by the report's contributors. They create a visionary, actionable blueprint for transforming the Atlantic into a continuous, resilient, knowledge-based security community, capable of addressing the unprecedented and interdependent threats of the Anthropocene.

Through this ambitious yet actionable policy framework, the Atlantic region can evolve into a resilient, knowledge-driven, and cooperative security community capable of anticipating, managing, and mitigating unprecedented climate-related risks. This integrated governance model would position the Atlantic not only as a crucial arena of international collaboration but also as a leading example of planetary stewardship for future generations.

This pole-to-pole, whole-of-Atlantic approach is both an innovative leap and a pragmatic necessity. It consolidates legal mandates, scientific advancements, and strategic imperatives into a coherent framework of shared stewardship—linking environment, society, economy, and security through multilevel cooperation.

In shaping future policymaking, the report urges multilateral institutions, governments, academia, and civil society to unite behind this pole-to-pole vision, mobilizing resources, political will, and innovation to realize a secure, sustainable Atlantic Basin - and by extension, the global commons - for the 21st century and beyond.

Ultimately, this report positions the Atlantic Centre and its partners as catalysts for a pioneering framework – one that embeds scientific rigor with strategic innovation, ensuring that the Atlantic serves as a beacon of collaborative resilience – to secure a sustainable and peaceful Atlantic future from pole to pole.

Coordinator
Sandra Balão

Co-authors

Alberta Ama Sagoe
Bruno Magalhães
David Willima
Edouard Epiphane Yogo
Eléonore Duffau
Elizabeth Nwarueze
Fahd Azaroual
Jamal Machrouh
Juan Adrianzén Perry
Julian Quintero Ibañez
Juliet Affrah Obeng
Kofi Duodo
Lawrence Dogli
Luís Delgado Barrios
Mariana Plum
William Lyons

Assistant

Francisco de Arantes e
Oliveira

ISBN-978-989-54481-9-7



ATLANTIC
— CENTRE —

