DOI: 10.53477/1842-9904-23-16

CLIMATE CHANGE AND SECURITY: THE CASE FOR BLACK SEA

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Climate change poses significant challenges to global security by exacerbating existing threats and creating new ones. Competition over scarce resources such as food, water, and land will likely increase as extreme weather events and temperature rise will become more frequent. Climate-related migration is expected to increase political tensions, and in some regions, could contribute to instability and conflict. The changing climate will also impact infrastructure, the economy, and public health, which will have far-reaching security implications. The current issue of climate change highlights the spectre of a new source of instability and conflict that can affect national/international peace and security. Although comparative research and projects on the security implications of climate change are expanding, there are still major knowledge gaps. The paper presents the specialized literature on short-term climate change and its possible influence on the Black Sea regional security. It is increasing the potential insecurities that can arise from extreme environmental phenomena. Based on the assessment, the authors outline priorities for future research in the area of interest and cover the necessary adjustments to facilities, materials, and equipment due to progressive weather changes. It also highlights that natural disasters may increase in number or virulence, necessitating the contribution of armed forces to national security.

Keywords: *climate change; security; sea level, Black Sea; environmental assessment; military operations.*

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Introduction

Climate change has a profound effect on global security, and its impact is already being felt in different parts of the world. The consequences for human security are widespread and often devastating as temperatures continue to rise and extreme weather events become more frequent (IPCC, 2021), and food security is among the most impactful aspects of climate change. It can lead to a decline in agricultural productivity and increase the frequency of drought, floods, and heatwaves. This can cause food shortages, disrupt supply chains, and increase food price, making it more difficult for vulnerable populations to have access to nutrition in order to survive. This, in turn, can lead to increased conflict over resources and contribute to the displacement of populations, further exacerbating security challenges. Another impact is its effect on water resources. As temperatures rise, many regions are experiencing decreasing water supplies, which can lead to conflicts over water allocation and access. This can have wide-ranging consequences for agriculture, energy production, and human health, and can exacerbate existing tensions between communities, regions, and even across international borders.

The sea-level rise, as a consequence of climate change, poses a significant threat to coastal communities and infrastructure, resulting in the displacement of populations, damage to critical infrastructure, and increased vulnerability to storm surges and other weather-related hazards. This can have severe implications for the security and stability of communities, particularly in low-lying and densely populated areas.

Besides genetic factors of climate, in general (solar radiation, atmospheric circulation and active surface), the anthropic factor, through its economic activities, has become an essential element in changing climatic parameters on small or large surfaces.

The multiple and different scientific investigations show that a large part of the changes, especially of the climatic calamities registered globally in the last decades, belong to anthropic activities.

There is also a correlation between the intensity, the rhythm, the areas of global environmental mutations and the degree and necessary time for human adaptation. If the changes in the environment happen too quickly, the resulting stress is too great for living things to adapt to the new conditions. As a result, significant changes can be triggered in the environment (migrations, extensions) and in the inhabitants' lives. In the previous period, extreme phenomena were not a concern per se, but only episodic, occasioned by "events" at a much lower frequency, which led to the absence of categorization, hierarchy, or classification concerns in the global system of environment-society evolution.

The issue is quite different today when their frequency has increased significantly, and the affected areas are getting bigger, causing great disasters in the environment and society, often resulting in the loss of lifes. Therefore, contemporary society is going through a new stage today as the rate of extreme natural phenomena has increased. Their frequency and intensity have increased significantly, and the disasters they cause are getting bigger and more complex because the causes are just as complex.

Moreover, the effects are often felt most acutely by those who are already vulnerable, such as women, children, and seniors, which can exacerbate existing inequalities and increase the risk of social and political instability. The consequences on global security are far-reaching and multi-faceted and require a concerted and coordinated response from the international community. Addressing the causes and impacts of climate change will require investment in mitigation and adaptation measures, as well as increased cooperation and coordination at all levels, to ensure that the global community can respond effectively to these challenges and build a more secure and sustainable future.

There is a wide range of research projects that approach the issue of climate change and its security implications. Some of these projects focus on the direct impacts of climate change on security, such as the relationship between droughts and conflict over water resources, or the impact of sea level rise on coastal communities and military infrastructure. Other research projects examine the indirect impacts of climate change, such as the effect of changing climate patterns on food security, public health, and economic stability.

Many interdisciplinary projects examine the intersection of climate change and security, looking at how climate-related events can contribute to political instability and conflict, or how climate policies can impact global security and international relations, including efforts to build resilience in communities, mitigate the effects of extreme weather events, and reduce greenhouse gas emissions to limit global temperature rise. Relevant project examples are:

1. “Climate Change & (In)Security Project (CCIP)”, a collaboration between the University of Oxford and the British Army’s Centre for Historical and Armed Conflict Research (CHACR), explores the insecurities generated by climate change and the methodology of response;

2. “Climate Change, Global Security and Future Operations” (CLIMSEC) through the Multinational Capability Development Campaign (MCDC), aims to increase understanding of the security risks posed by climate change in the Arctic and other regions, which focuses on the intersection of climate change and security, including the potential for conflict over natural resources, the impact of climate-related migration on political stability, and the potential for climate change to amplify existing security risks (C2COE 2023). MCDC-CLIMSEC program is focused on improving the preparedness of military forces to respond to the security challenges posed by climate change (NUPI 2022).

As the world's leading political and military alliance, NATO established in 2022 *the "NATO Climate Change and Security Centre of Excellence (CCASCOE)"*. CCASCOE aims to address the security implications of climate change as a platform between military actors and civilians that will develop, enhance, and share knowledge on climate change security impacts, and develop best practices contributing to NATO's goal (e.g. reducing the climate impact of allies' military activities). At the European level, with the dedicated research programmes (e.g. European Green Deal), the EU endeavours to "become the first climate-neutral continent that provides a roadmap with actions to boost the efficient use of resources by moving to a clean, circular economy and stop climate change, revert biodiversity loss and cut pollution" (EU Climate Action, 2023). *A climate change and security action plan* refers to a strategy or set of policies aimed at addressing the effects of climate change on national security and global stability. The objective of a climate change and security action plan is to ensure that countries are prepared and able to respond to the security challenges posed by a changing climate and to prevent or mitigate conflict arising from these challenges.

1. What is Climate Change?

Climate change refers to long-term shifts in average weather patterns that have come to define Earth's local and global climates, primarily driven by increased levels in the atmosphere of greenhouse gases, caused by human activities such as deforestation, burning of fossil fuels, and agriculture. As a result, the average surface temperature is rising, leading to more frequent and intense weather events, rising sea levels, and other environmental impacts.

A new report from the World Meteorological Organization (WMO) shows that in Europe the average annual surface temperature has been increasing at a faster rate than the global average temperature with a greater increase in the southern part of the continent, mainly in summer and the Arctic region in winter (EU Climate Action, 2023; WMO 2023). As a result, the rainfalls have increased considerably in northern Europe, while droughts have become more frequent in the south of the continent. Thus, the extreme temperatures recorded recently have been related to the observed increase in the frequency of extreme phenomena, in recent decades, due to the effects of climate change.

Climate change and security refer to the interrelated challenges posed by global warming and its impacts on human societies, political stability, and international security. Climate change affects security in various ways, including the displacement of populations, conflicts over natural resources, food and water insecurity, and changes to ecosystems and ocean currents, among others. The security implications of climate change require a comprehensive and coordinated global response to mitigate its causes and address its effects.

Assessing the effects of climate change on military infrastructures and operations, various impacts on military infrastructure were observed, encompassing:

1. Physical damage to bases, ports, and other facilities due to increased frequency and intensity of extreme weather events such as hurricanes, typhoons, and sea-level rise.

2. Impairment of operational readiness due to power outages, communications failures, and other infrastructure failures caused by extreme weather events.

3. Changes to training and testing environments due to alterations in temperature and precipitation patterns can affect the readiness and ability of military personnel to operate in different regions.

4. Increased costs for maintenance, repair, and reconstruction of military infrastructure due to the impacts of climate change.

5. Altered patterns of migration and instability, lead to increased demand for military support in crisis response and disaster relief operations.

6. These effects underscore the importance of considering climate change as a security challenge and of incorporating resilience and adaptation measures into military planning and infrastructure design.

Moreover, there are various impacts on military operations, including:

1. Increased frequency and intensity of extreme weather events, can disrupt military operations and cause damage to equipment and infrastructure.

2. Changes to ecosystems and ocean currents can affect the availability of resources and access to coastal and Arctic regions.

3. Food and water insecurity, can increase the likelihood of conflict and instability in vulnerable regions and create a need for military support in crisis response and disaster relief operations.

4. Displacement of civilian populations can create new security challenges, including cross-border migration and increased competition for resources.

5. Altered patterns of disease and illness, can pose new health risks for military personnel and impact their ability to perform their mission.

6. These effects emphasize the importance of considering climate change a security challenge and integrating adaptation and resilience measures into military planning and operations.

2. Vulnerability of the Black Sea Basin to Climate Change Impacts and Potential Threats to Infrastructure and Military Operations

The European climate has warmed by about 1.5 degrees Celsius in the last century, higher than the global average. As a result, the rainfalls have increased considerably in northern Europe, while droughts have become more frequent in the south of the continent (Allen et al., 2018). Thus, the extreme temperatures recorded recently have been related to the observed increase in the frequency of extreme phenomena, in recent decades (Seneviratne et al., 2021), because of the effects of climate change.

The vulnerable areas that are subjects to global warming, in Europe, are:

− Southern Europe and the entire Mediterranean basin, which recorded a water deficit due to the increase in temperature and the reduction in the amount of precipitation;

− Mountain areas, especially the Alps, with a problematic situation in terms of water flow regime, as a consequence of the snow melting and the decrease of glacier volume;

− Coastal regions, including the Black Sea, due to rising sea levels and the risk of extreme weather events;

− Densely populated floodable areas, due to the risk of extreme weather events, heavy rainfall and floods, which cause significant damage to built-up areas and infrastructure;

− Key climate-related hazards that pose risks to inland transport infrastructure and operations have been identified as heatwaves, changes in hot and cold temperature extremes, flash flooding, low river flow levels, and riverine and coastal flooding. Example: a) Precipitation - Changes in the mean values; changes in intensity, type and/or frequency of extremes (floods and droughts): inundation, damage and wash-outs of roads and bridges; increased landslides, mudslides; Port infrastructure inundation and/or damage to port facilities; poor manoeuvrability of locks and vessels due to increased water levels and velocity; b) Sea levels/storm surges: problems in vessel navigation and berthing with ports; navigation channel sedimentation; people/business relocation; Increased risks of permanent flooding; erosion of coastal roads; flooding, damage and wash-outs of roads and bridges.

Northern hemispheric high-latitude climate variations, during the last glacial age, are expected to propagate globally, and the Black Sea region has not avoided exposure to climate change. Therefore, actions are needed in the region to deal with the consequences of global warming in the Black Sea towards better governance, sustainable exploitation of resources and security. However, neither the climatic regime nor specific anthropogenic indicators have been quantitatively linked to climate security on the Western Black Sea (effects on civilian or military infrastructure, energy transition, economic cost or health conditions).

The Dobrogea area and the Romania Black Sea coast have been facing hot summers in recent years, caused by hot and dry air flow, from North Africa and the eastern Mediterranean (Nagavciuc et al., 2022). Often these phenomena are amplified by unusual solar activities, in conditions of poor atmospheric circulation, with long periods of calm (no winds or with low-intensity winds). All of these affect the circulation of coastal waters, by completing installations of hypoxia, “red sea” and mortality of biota.

The Black Sea is semi-enclosed, a permanently stratified (by a pycno-halocline) basin, with relatively low salinity and a thin oxygenated surface layer overlying waters dominated by hydrogen sulfide (below 200 m water depth). The general structure of the Black Sea consists of five water masses arranged in nearly horizontal layers: the quasiomogen upper layer, the cold intermediate layer, the permanent pycnocline, the deep water and the bottom boundary layer (benthic layer). A distinct vertical layering is created between the surface waters 0-100 m and the deep (maximum depth of ~2200 m) limiting the vertical exchange and creating a unique chemical and biological environment (Mihailov et al., 2016).

Due to its nonlinear dynamics, the thermohaline circulation is a key component of the climate system and entailed in abrupt climate changes. Mihailov et al. (2016), based on 40 years of climatological data, detected long-term trends of the inter-decadal changes of the thermohaline parameters of the water masses in the North-Western Black Sea shelf and highlighted the fact that for the central part of the shelf the surface water temperature increases by about 0.1 degree Celsius/year between 1971–2010, while at the bottom the average temperatures are practically constant. By contrast, the salinity values decrease by approximately 0.02 PSU/year.

Sea level. Another climate-related impact is the sea-level rise, which may lead to erosion, flooding, coastal inundation and saltwater intrusion. However, for the Mediterranean and Black Sea regions, the sea-level rise has been around 12 cm in the last century, which reaches the average record for the global sea-level rise estimated between 10 and 20 cm. The sea level is rising slowly but constantly (Mihailov et al., 2018), with an estimated rate in the Western Black Sea of approx. 1.37 mm/yr (at Constanta - Romania) and in the Eastern Black Sea side with 6.68mm/yr (Poti – Georgia). Maintaining the current value would lead to an increased average level of about 0.8m in 50 years or 1.7m in the next 100 years. As a conclusion, the western Black Sea coast does not appear especially vulnerable to sea-level rise (Mihailov et al., 2018).

Coastal erosion. The deltaic coastlines of the Black Sea, of the main deltas, represent the most sensitive sectors to erosion and are superposed on the areas with relatively high storm waves and incidence angles (Danube, Kizilirmak, Yesilirmak, Sakarya, Rioni, Enguri, Kodori, Chorokhi), the low-lying areas along the lagoons, firths, coastal barriers and spits and the rocky areas.

Romania has a 245 km coastline along the north-western shore of the Black Sea, in the counterclockwise direction. Similar to any coast in the world, the Romanian coast has been dealing with beach erosion. Since 1975 to the present, the erosion process of the beach has been particularly intense, with the shore being over 600 m in certain sectors. In the southern part of the Romanian Black Sea coast (Portita to Mangalia), the shore becomes typically accumulative, with broad beaches and dunes, the shoreline advancing between 1962 and 2017 by about 4-5 m/year (Spinu et al., 2017). Sea level rise and the intensification of meteorological and hydrological extreme phenomena because of the climate change and in direct association with the decrease of sedimentary material transported by the Danube, coupled with modifications of sea currents, have resulted in pronounced erosion of the shores, the deltaic and lagoon sectors being the most affected (Spinu et al., 2017).

Teleconnections (evidence linked Atlantic teleconnections to Black Sea hydroclimate). In terms of climatic effects analyzed through the atmospheric index (ATI, formed by averaging the mean surface air temperature in winter, sea surface atmospheric pressure, and evaporation minus precipitation) may be so severe that the resulting anomalous hydrographic events can occur, as the most essential relating local climatic response to large-scale atmospheric motions. The North Atlantic Oscillation (NAO) index is a general indicator of the strength of the westerlies and winter climate over the eastern North Atlantic and Eurasia. A positive winter NAO index is associated with the strong pressure gradient between Azore's high-pressure and Iceland's low-pressure systems, bringing cold and dry air masses with strong westerly winds to southern Europe and the Black Sea region (Hurrell et al., 2003). In a recent study, Ionita et al. (2015) emphasized the combined effect of different teleconnection patterns (e.g. NAO, Arctic Oscillation - AO, East Atlantic - EA) on the seasonal dryness/wetness variability at the European scale.

Divergence phenomena. On the western coast of the Black Sea, the onset of the divergence phenomenon is due to western, southwestern and southeastern winds, which generate an Ekman transport with an offshore component. The upwelling brings toward the surface the waters from below, with low temperature and high salinity. This phenomenon occurs in early summer when the thermocline is shallow and the requested energy can be provided by wind. The upwelled waters due to their rich nutrient content, subsequent phytoplankton blooms can occur. Although coastal upwelling is not a permanent feature of the region, several such events are observed almost every year. Of all the situations analyzed, we observed that the significant decreases in the sea surface temperature occurred nearshore (Mihailov et al., 2012, 2013).

Based on the long-term data analysis (from 2000 to 2018), of the main physical parameters of seawater, Mihailov et al. (2012) demonstrated that 31 divergence processes were detected on the North-Western Black Sea shelf based on daily in-situ data, with significant predominance in late spring (May) and early summer (June). Also, the Romanian Black Sea coast is an intense touristic area, the upwelling consequences are unpleasant for tourists due to strong differences between air and sea temperatures, the „red tide" in the bathing waters and the presence of dead marine organisms because of the severe hypoxia following intense phytoplankton blooms. In meteorology, the convergent and divergent phenomena are important due to their effects, such as difficulties in sea surface temperature prognosis, sea fog appearance near shore, as well as breeze intensification due to the strong horizontal thermal gradient (Mihailov et al., 2012.

Eutrophication and hypoxia are responsible for the degradation of coastal ecosystems, but they can also negatively impact open-sea populations. The strong vertical gradients of the oxygen concentration in the coastal waters are a combined result of physical processes and biological activity, influenced by water temperature and salinity, nutrient concentration, circulation and mixing. The strong thermohaline stratification of the shelf waters during the summer limits the vertical mixing, leading to the occurrence and intensification of hypoxic, and even anoxic phenomena (Mihailov et al., 2013).The hypoxia recorded in the 2010 summer in the central and southern part of the Romanian coast is a negative consequence of the upwelling phenomenon but also the high air temperature values, the limited deep water mixing led to the high values of seawater temperature (26-28 degrees Celsius) favouring the strong algal bloom (high Chl-a concentration of 16.93µg/L in June). In general, the process of raising deep waters to the surface has a positive effect on the marine ecosystem through the supply of nutrients necessary for the development of living marine organisms (Mihailov et al., 2013). The hypoxia phenomenon manifested a sharp decrease in the oxygen concentration in deep waters. As an effect of low oxygen concentration in the littoral Black Sea waters significant mortality of species, such as mullets, dragons, scorpions, large flatfish, shrimps and molluscs, was recorded (Mihailov et al., 2013).

Sea ice. Black Sea freezing in winter is observed regularly in its northern parts and near the Kerch Strait, due to the relatively shallow north-western shelf part and the river inflow of the three major European rivers Danube, Dnieper, and Dniester, as well as Don through the Azov Sea, carrying a large amount of fresh water to this part of the Black Sea (Matov et al. 2022, 974). The depression of the freezing point varies linearly with salinity and according to the International Practical Temperature Scale of 1968 (IPTS-68) standards calculations (Barber 1969, 929–931), the freezing point of the seawater is -0.819°C for the 15 PSU mean value of the salinity at Constanta. Since 1929, moderate freezing has been observed in the Black Sea, but February 2012 was extremely cold and the Black Sea ice reached Constanta, Romania (Mihailov M.E., 2017).

3. Climatic Hazards, Impact and Risks

As a result of the temperature increases that can perturb the hydrological cycle, the analysed region is very likely to experience a wide range of impacts in response to climate change. Climatic hazard phenomenon can be observed on the western Black Sea shelf by an increase in droughts or flood severity with a negative impact on forest areas changing the areal of various tree species, and moving the limits of vegetation zones (Lupu et al. 2010).

Drought and water scarcity in Romania - causes:
− an increase of the yearly average temperature by 0.3°C;
− increase in the number of tropical days (>30°C)
− decrease in the number of cold days (<0°C);
− a rapid increase in the phenomena after the year 2000;
− a decrease in precipitation (mainly in the southern part of the country);
− a decrease in runoff.
Impact on the water regime:
− reduced inflows to water reservoirs;
− reduced streamflows in major catchments;
− reduced recharge of groundwater;
− high frequency and duration of drying up of rivers having a catchment area of less than 500 km^2.
Effects of water scarcity and droughts:
− threatened water supplies for human settlements and industries;
− reduced water availability for agriculture;
− reduced hydropower production (more use of coal and gas power);
− disturbance of inland navigation;
− increased risk of algal blooms;
− changes in salt loads in streams (both increases and decreases possible);
− impact on river flora and fauna.

Sea-level rise or extreme events intensification affects the coastal infrastructure for the long-term (as harbours - civilian and military, lighthouses - necessary for navigation security, etc.). On the Romanian Black Sea coast, the extreme events are sea ice (rare events), strong winds - storms (mainly in the cold season due to Arctic influence), Saharan dust, etc.

According to ICPDR (ICPDR, 2023) scenarios concerning water scarcity and drought in Romania will determine an increase in average temperature (0.5-1.5°C in the medium-term and 2.0-5.0°C), prolonged droughts in the south and south-eastern part of the country, and reduction of the water inflow by 20%).

In the literature, there are many classifications of climatic hazards and risks according to different criteria as follows: by the way of manifestation, by the degree of vulnerability, by triggering velocities and occupied area, by duration, by the number of climatic elements that generate the risk state, by the way of manifestation, according to the climatic zones, according to the season, according to the damages and the victims produced, etc.

Impact on Economy and Security. By its location in the geographic area of the Black Sea, Romania has some important comparative advantages derived from geostrategic and geo-economic dimensions: a) significant energy resources, b) a major transport corridor for Eurasian energy resources to the European consumers (the Caspian Sea - Black Sea - Mediterranean Sea), and c) the major factor for EU and Romanian energy security.

Climate-disrupting critical waterways and transportation routes (infrastructural security) - as harbours - civilian and military, lighthouses - necessary for navigation security, etc. due to sea level rise, coastal erosion, extreme storm or high-wave events. Romania is still the largest natural gas producer in Central and Eastern Europe, according to Eurostat (2019) and has substantial renewable potential in hydropower, solar, and wind energy.

Climate change can also lead to a reduction in hydroelectric power production by reducing water resources. In addition, decreased water resources also affect the operation of nuclear power plant cooling systems. Problems could arise in the energy sector, especially in the production of energy in hydropower plants, taking into account that southern and south-eastern Europe and, implicitly, Romania are much more exposed to the risk of drought. The increase in winter temperatures will lead to a decrease of 6% - 8% of the energy demand for heating in 2021-2050. In contrast, by the year 2030, summer energy consumption could increase by up to 28% because of high temperatures.

National And Military Security. Within migration studies focusing on the Black Sea basin, predominant attention is given to key factors related to migration, primarily centring on educational and employment opportunities, as well as freedom of expression. However, there is a notable lack of emphasis on climate change-related factors such as environmental degradation and the associated poverty.

Romania is the most important and advanced outpost of Euro-Atlantic structures (NATO and EU) to the East (Turkey - wider and more populous – being just a NATO member and Bulgaria, which is part of both structures being two times lower as surface and three times smaller as population). In the short and medium term, the NW Black Sea shelf does not seem to become afflicted with climate-induced conflicts. For the continental and coastal Romanian region, humanitarian interventions and stabilization missions consist of military interventions for civilian support in extreme events (flooding, ice-breaking or snow removal actions, and protecting sensitive areas). However, despite several crises, the riparians have not engaged in militarized conflict on water scarcity.

Perhaps the most direct and obvious significance of climate change for the military is its impact on infrastructure. The climate-related risks to military infrastructure and force training and extreme weather events can also increase the potential for conflict and migration within and beyond NATO's immediate vicinity (Aldea et al. 2022, 31-36). Low-lying military installations such as naval bases are particularly susceptible to rising sea levels and intense weather events. Not only coastal facilities may be affected. Extreme heat may impact training, and changes to ocean buoyancy (changes in the seawater density) by External forcing as heat fluxes (heating and cooling) and freshwater fluxes (evaporation and precipitation plus runoff from land).

The Romanian Black Sea coast is vulnerable to:

− coastal erosion or new sand deposits (northern area, e.g. Sakhalin Island and Musura Bay -Romanian-Ukrainian border). The status of legal maritime boundaries based on baseline territorial features is entirely uncertain if such features are submerged due to sea-level rise or are declared uninhabitable under current legal definitions - as mentioned in the UN Convention on the Law of the Sea (UNCLOS). Rising seas could have an enormous impact on national waters and the exclusive economic zones (EEZ) over which a coastal or island state has special rights (e.g., regarding the exploration and use of marine resources, including energy and mineral deposits);

− sea-level rise or extreme events intensification affects the coastal infrastructure for the long-term (as harbours – civilian and military, lighthouses - necessary for navigation security, etc.). On the Romanian Black Sea coast, the extreme events are sea ice (rare events), strong winds - storms (mainly in the cold season due to Arctic influence), Saharan dust, etc.

For the continental and coastal Romanian region, humanitarian interventions and stabilization missions consist of military interventions for civilian support in extreme events (flooding, ice-breaking or snow removal actions, and protecting sensitive areas).

4. Climate Implications and Adaptations on Military Operations, Security and Defence

In the forthcoming years, the Armed Forces must consider appropriate adaptation strategies to confront operations within challenging climatic settings. Imperative measures involve adapting facilities and military equipment, minimizing emissions, integrating climate considerations into military planning to counter threats to human security and natural disasters, and actively participating in conflict prevention efforts. The extreme cold or hot environments we have previously dealt with will impact the equipment's performance, disrupting its functionality and leading to atypical and premature degradation and deterioration. We are well aware of the impact that both low and high temperatures can have on gunpowders and ammunition, leading to challenges in their preservation and handling. These temperature variations also influence their range and performance, factors that must be considered when employing them in automatic systems and when planning both fires and logistics.

Focusing on their effects on systems, it is important to note that extreme temperatures directly influence the operational capabilities of vehicles, particularly those exposed to the elements for extended periods. Ensuring meticulous preventive maintenance becomes crucial to mitigate temperature-induced effects on all vehicle components. Snow-covered terrain and low temperatures necessitate special considerations for the proper operation and maintenance of various types of vehicles. In such conditions, optimal vehicle functionality, especially for tracked ones, demands accurate preemptive maintenance. This underscores the importance of highly trained crews who can perform these tasks effectively, even though they may require increased time and effort due to the challenging conditions.

To ensure self-sufficient logistical operations for the successful execution of their duties, operational bases located in challenging environments must possess a comprehensive range of capabilities. These bases need to establish robust command and control structures, healthcare facilities capable of stabilizing casualties, and efficient transportation systems to cater to initial requirements in terms of ammunition, fuel, sustenance, and water. These bases must possess self-reliant water production systems, including potable water treatment plants, as well as a stable energy supply. Moreover, they must seamlessly integrate all the tactical capacities essential for fulfilling their mission objectives. In addition to these requisites, operational bases positioned in challenging areas must be primed to adapt their infrastructural facilities to withstand the impacts of climate change, particularly in the face of extreme weather conditions. When contending with elevated temperatures, the incorporation of effective cooling systems becomes indispensable. These systems serve not only the critical purpose of safeguarding personnel from heightened physiological strain due to heat exposure but also ensure the continued functionality of communication, information systems, and other electronic equipment that are central to the base's operational effectiveness.

Climate change introduces noteworthy hurdles to military logistics, necessitating the acquisition of capabilities that can effectively withstand the impacts of dynamic and extreme climatic conditions. In such an environment, the intricacies linked to preserving materials subjected to higher-than-normal levels of wear, coupled with an upsurge in the demand for vital resources, present substantial challenges for logistical procedures. Unfavourable weather conditions, whether characterized by harsh heat or extreme cold, can significantly curtail the available time window for conducting logistics operations. This alteration to the logistical timeline profoundly influences the planning process. In the domain of maintenance, the concept of predictive maintenance emerges as a critical resource. It stands as an indispensable strategy, offering a means to counter the exigencies brought forth by the logistical demands of military forces in the face of climate change effects.

Climatic conditions will not only disrupt the operational aspects but will also exert a substantial influence on the intricate supply chains necessary to sustain military operations, thereby imposing constraints on equipment storage and leading to an escalation in associated expenses. The climatic variations are likely to mandate an augmentation in the allocation of specific resources critical for ensuring the seamless operation of military units. The provisioning of both water and fuel will emerge as paramount considerations in the blueprinting of logistical support, yet they are not immune to challenges posed by fluctuating temperatures. In environments marked by sub-zero temperatures, particular emphasis must be placed on water storage and distribution systems to avert freezing-related issues. Frequently, the adverse effects of inclement weather will deteriorate access routes, possibly necessitating the deployment of assets such as helicopters or even boats in flood-prone areas to facilitate the transportation of supplies. These measures underscore the adaptive nature of logistical strategies, compelling the integration of diverse transportation methods to ensure sustained support in challenging environments.

Adaptability affects Army and Navy differently. The impact of global warming is progressively reshaping how the Navy carries out its missions. This influence is particularly significant within the maritime domain, where the inherent risks are already posing a substantial and noteworthy challenge. However, the weather anomalies and their consequences will not only have an impact on the tasks of the Navy but also its assets, both units and naval bases, will be affected by it.

The elements that influence climate change, the resulting impacts, the assumptions made, and the constraints imposed on military operations all prominently feature in both proactive and crisis-responsive planning. Irrespective of circumstances, the foundational premise underlying operational planning remains constant – that military operations are indispensable for countering threats and vulnerabilities, whether originating from opposing forces or external factors like weather disturbances. Within the operational planning framework, particularly at the operational level, the process initiates with a comprehensive evaluation of the prevailing situation. This evaluation is founded on a strategic analysis that serves to establish a lucid understanding of the "what" that needs to be achieved, the prevailing "conditions" influencing the context, and the applicable "limitations". Grounded in this comprehension, the focus shifts toward formulating the "how" of operations, which entails devising an integrated operational design. This operational design serves as the bedrock for the subsequent refinement of the operational concept, as well as the meticulous development of a comprehensive and detailed operational plan.

Conclusions

Climate change can affect security in several ways. It can lead to water and food scarcity, which can cause conflicts over resources. Changes in temperature and precipitation patterns can also increase the frequency and intensity of natural disasters, causing mass displacement of populations and putting a strain on societies and economies. Climate change can also impact global health, leading to the spread of diseases and pandemics, as well as exacerbating existing humanitarian crises. Furthermore, it can alter ecosystems, leading to the loss of biodiversity and the degradation of key ecosystems that support human well-being. These impacts can increase the risk of conflict, instability, and violence, both within and between countries, thereby affecting national and international security.

According to the European Commission, the Black Sea region is a distinct area, bringing together ten states: 6 riparian states - Bulgaria, Romania, Ukraine, Russian Federation, Georgia and Turkey -, and 4 states - Armenia, Azerbaijan, the Republic of Moldova and Greece, whose history and proximity to the Black Sea basin recommend them as relevant actors in the area. The Black Sea basin is the second largest source of oil and natural gas after the Persian Gulf, with substantial renewable energy potential (hydro, solar and wind energy).

The Black Sea region is particularly vulnerable to the impacts of climate change, and the effects are already being felt in various ways. Interconnected key issues were identified (generally for all regions): water, food, health, economic, infrastructural, national and military security. Here are a few ways in which climate change affects the security of the Black Sea region:

1. Water Scarcity: The Black Sea region is facing a growing water scarcity problem, with increasing demand for water from agriculture, industry, and population growth. This is exacerbating existing tensions over water resources and increasing the risk of conflict between states and communities in the region.

2. Agricultural Impacts: The Black Sea region is one of Europe's major agricultural areas, and climate change is having a significant impact on crop yields and productivity. This reduces food security and increases the risk of food shortages, which can contribute to political instability and conflict.

3. Coastal Erosion and Flooding: The Black Sea region is also experiencing rising sea levels and increased frequency of storm surges and flooding, which are affecting coastal communities and infrastructure. This is leading to the displacement of populations, damage to critical infrastructure, and increased vulnerability to natural hazards.

4. Energy Supply and Demand: Climate change is affecting the energy supply and demand balance in the Black Sea region, with increasing demand for energy to meet the needs of a growing population and a changing climate. This is exacerbating existing energy security challenges and increasing the risk of energy-related conflicts.

5. Human Security: Climate change is having a profound effect on human security in the Black Sea region, with increased frequency of natural disasters, displacement of populations, and reduced access to resources. This is exacerbating existing social and political tensions and increasing the risk of conflict.

To progress toward a Navy that remains prepared to confront novel challenges without compromising its efficacy in addressing existing ones, it becomes imperative to address the following fundamental inquiries: How can the Navy actively contribute to diminishing its ecological impact without compromising its operational capabilities? What requisites must the Navy fulfil to effectively operate in regions marked by climatic conditions previously unencountered in its operational contexts?

The crux of the matter lies in identifying the key factors that enable the alignment of the Navy's equipment, systems, and personnel to effectively function in adverse weather scenarios, all while preventing the exacerbation of the repercussions of global warming. It is not incidental that the Navy plays a role in the generation of carbon dioxide (CO2) and other greenhouse gases. The Navy must persist in the advancement of technologies that, without impeding its functionality, systematically reduce its polluting impact, ultimately striving for its complete elimination. To accomplish this, meticulous consideration is essential, evaluating how our naval forces can achieve equilibrium among energy sources, materials, and equipment that are less reliant on carbon. All the while, this transformation must maintain a high level of interoperability, preserve operational effectiveness, and uphold the capacity for rapid response.

In conclusion, the impacts of climate change on the Black Sea region are complex and far-reaching and require a comprehensive and coordinated response from the international community. Addressing the causes and impacts of climate change will require investment in mitigation and adaptation measures, as well as increased cooperation and coordination between states, communities, and other stakeholders in the region, to ensure that the region is better prepared for the challenges of a changing climate.

Disclaimer:

This study was financed from the Sectorial Research-Development Plan of the Romanian Ministry of National Defence, PSCD 2021 – 2024 Project (097 / 2021, 092 / 2022, 093/2023): "Development of an integrated monitoring system to increase the quality of hydro-oceanographic data in the area of responsibility of the Romanian Naval Forces".

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