Fighting in a Storm

Climate Change and India's Military Readiness

IPCS Special Report #226

Siddharth Anil Nair

IPCS
INSTITUTE OF PEACE AND CONFLICT STUDIES

Planetary Security
INITIATIVE

Clingendael
Netherlands Institute of International Relations

IPCS
INSTITUTE OF PEACE AND CONFLICT STUDIES

Clingendael
Netherlands Institute of International Relations

Fighting in a Storm

Climate Change and India's Military Readiness

Siddharth Anil Nair

IPCS Special Report #226
April 2026

April 2026

Cover photo Indian Army and Royal Thai Army personnel take part in a joint military exercise at the Foreign Training Node in Umroi, in India's northeastern state of Meghalaya on September 02, 2025.

About the Institute of Peace and Conflict Studies

The Institute of Peace and Conflict Studies (IPCS) is an independent think-tank in India. It was founded in 1996 with the aim of developing an alternative framework for peace and security in South Asia and the extended neighbourhood. IPCS works to bring policy-relevant research into scholarly and public debate through events, capacity building of the next generation of thought leaders, and media and online outreach. Its research and policy recommendations do not subscribe to any particular political view or interest. This Policy Brief is part of the 2021 IPCS-Clingendael Institute collaboration on climate-security in Southern Asia.

Follow us on social media
@IPCSNewDelhi
IPCSNewDelhi

About the Planetary Security Initiative

The Planetary Security Initiative sets out best practice, strategic entry points and new approaches to reducing climate-related risks to conflict and stability, thus promoting sustainable peace in a changing climate. The PSI is operated by Clingendael - the Netherlands Institute of International Relations.

About the Clingendael Institute

The Netherlands Institute of International Relations 'Clingendael' is a leading think tank and academy on international affairs. Through our analyses, training and public platform activities we aim to inspire and equip governments, businesses, and civil society to contribute to a secure, sustainable and just world.

The Clingendael Institute
P.O. Box 93080
2509 AB The Hague
The Netherlands

Follow us on social media
@clingendaelorg
The Clingendael Institute
The Clingendael Institute
clingendael_institute
Clingendael Institute

Email: info@clingendael.org
Website: www.clingendael.org

About the author

Siddharth Anil Nair is an international security researcher focused on the geopolitics of the Indo-Pacific. His specialisations include armed conflict, climate security, maritime strategy, great-power competition, and strategic partnerships. Currently a Li Ka Shing Foundation Scholar and Master in International Affairs candidate at the Lee Kuan Yew School of Public Policy, Siddharth is also a Research Assistant at the Centre on Asia and Globalisation. He was formerly a Researcher in the South East Asia Research Programme at the Institute of Peace and Conflict Studies, where he led programmatic and project-level activities. Siddharth holds a B.A. (Honours) in Political Science and International Relations from Ashoka University.

Acknowledgements

The author would like to thank Ruhee Neog, Prerana Priyadarshi, Dr. Louise van Schaik, and the IPCS and Clingendael teams for their valuable feedback on various draft iterations. Thanks also go to Fiona Raval for her support with the secondary research employed in this report. Gratitude is due to Adm. Sunil Lanba (Retd.), AM Anil Chopra (Retd.), Lt. Gen. Vinod Bhatia (Retd.), Lt. Gen. B.S. Raju (Retd.), V.Adm. Monty Khanna (Retd.), Air Cmde. S.P. Singh (Retd.), Cmde. Anil Jai Singh (Retd.), Cmde. Sujeet Samaddar (Retd.) and the anonymous senior officers of the Indian Army, Air Force, and Navy who generously gave their time and insights. Any errors are the author's own.

Contents

Executive Summary

Indian national security scholars and practitioners have increasingly acknowledged climate change as a strategic issue. South Asia is a highly vulnerable region that is warming faster than the global average and experiencing record-breaking natural disasters. However, the Indian strategic discourse and matrix remain primarily focused on civilian-centric impacts. Consequently, India's national security strategy presents a critical gap, particularly regarding how climate change directly affects (and in certain cases, impairs) military readiness – not only by altering physical landscapes, intensifying conflicts, and straining resources, but also by impacting four key pillars: personnel, infrastructure, platforms, and equipment. In addition to this paucity of climate security thinking, there is an absence of a coherent articulation of what 'readiness' means for the Indian military.

This report identifies the various factors that shape Indian military readiness and illustrates how climate change affects them. It uses the Cyclone Hudhud event to demonstrate the climate-induced challenges the region faces and their impacts on the Indian military, in significant material and financial terms. It also outlines the state of institutional discourse on climate security and readiness within the Indian military. The central contribution of the report, on how climate change impacts personnel, infrastructure, platforms, and equipment, draws on both qualitative primary and secondary research, particularly interviews with serving and retired senior officers across the three arms of the Indian military. The report highlights how a changing climate and environment threaten recruitment pools and training routines, destabilise supply lines and installations, degrade armour and engines, and limit the use of ordnance and ammunition. This report aims to motivate the Indian military, like certain Asian and western counterparts, to expand beyond the developmental lens and integrate climate security considerations into its strategic acquisition and modernisation plans. Doing so will improve the institution's operational effectiveness and ensure it meets its strategic objectives in a highly volatile climatic and geopolitical environment, as India stares down a 'No War, No Peace' continuum in South Asia.

Introduction

India's regional security faces diverse and growing challenges as the country's demographic, political, economic, and military potential advances. Among these challenges, climate change poses a unique, far-reaching threat. While Indian experts increasingly recognise climate change as a strategic issue, these debates tend to focus on its civilian impacts, which centre on humanitarian assistance and disaster relief (HA/DR). This is undoubtedly important, but the strategic lens must be broadened to encompass the military security implications of climate change.

The 'people-oriented' focus predominates because climate policy discussions in India (and widely across the Global South) remain divided between adaptation and mitigation, given that climate change is considered a 'soft', non-traditional challenge requiring humanitarian interventions.[1] While the effects of climate change on developmental outcomes are well known and studied, focusing mainly on people-centric or civilian impacts reveals a gap in Indian strategic thinking – specifically, insufficient attention to how climate change affects the military. Unlike some prominent global actors, such as the US, Russia, the EU, and China, India has yet to consider these effects fully. This Special Report directly addresses that gap by adopting a militarised lens on climate change, i.e., by assessing its impact on Indian military readiness. Climate change poses a significant threat to the Indian military's operational readiness by altering the physical landscape, intensifying conflict zones, and straining limited resources. What it can also do – and in many cases already does – is expose vulnerabilities in the military's instruments – its personnel, infrastructure, platforms, and equipment.

The report relies on publicly available climate and environmental data, as well as interviews with serving and retired officers from all three services, the Indian Army, the Indian Air Force, and the Indian Navy. A key finding is that India's regional security matrix must expand its thinking beyond civilian-focused security to address the military dimensions of climate change more effectively.

1 Nair, SA; Priyadarshi, P, and Ruhee, N. IPCS Regional Workshop on Climate Security in the Bay of Bengal, May 2023.

Put another way, human security is national security, and therefore, for a state to safeguard its citizens, its military must also adapt to new and emerging challenges. Climate change has already begun to alter how India's military deploys, equips, mobilises, and fights. The Indian military must thus formally articulate its readiness parameters and integrate climate-security considerations into its doctrine. To that end, this report illustrates, for security policy-makers and practitioners, the linkages between climate change and military readiness.

The Special Report is divided into six sections and is structured as follows: **'Remembering Hudhud'** discusses a climate disaster in India that exemplifies the physical implications of climate change. **'South Asia's Climate Landscape'** summarises the current state of climate change in the region. **'Military-Climate Security'** outlines the current discourse on climate, security, and the military in India and internationally. **'Understanding Readiness'** unpacks the factors that influence military preparedness and operational capabilities. **'Climate Impacts on Readiness'**, the central section of this report, details how climate change affects military personnel, infrastructure, platforms, and equipment. The **Conclusion** summarises the report's main insights for the Indian military.

Remembering Hudhud

To illustrate the tangible effects of climate change-related disasters, consider an example from a decade ago. On 6 October 2014, a low-pressure area formed over the Andaman Sea due to localised surface heating. This tropical depression soon turned into one of the region's worst and first such cyclonic storms in recent memory.[2] Cyclone Hudhud had an eye 15 km wide and a total diameter of nearly 2,000 km. Over the next few days, it cut across the Andaman archipelago and turned towards India's northeastern coast. Soon, it was categorised as a "very severe cyclonic storm" by the Indian Meteorological Department (IMD), similar to a Category IV hurricane.

The overall damage caused by Hudhud amounted to US$ 11 billion.[3] The devastation in Andhra Pradesh, where the storm struck first before moving northward towards Odisha and then Bangladesh, amounted to US$ 3.4 billion.[4] At the time, the Defence Crisis Management Group (DCMG) was led by the Navy in a multi-agency rescue, relief, and recovery mission.[5] The Navy, along with the Army and Air Force, conducted evacuation, road-clearing, airfield repair, and aid delivery missions across the two affected states. Significant resources, i.e., personnel, platforms, and equipment, were allocated to the effort.[6] Operation Lehar, as it was later designated, provided assistance to over 2,20,000 citizens and was considered a success in Indian disaster preparedness and response

2 Cyclone Warning Division. Very Severe Cyclonic Storm, HUDHUD over the Bay of Bengal (07-14 October 2014): A Report. Indian Meteorological Department, Ministry of Earth Sciences, Government of India, October 2014.

3 Indian Red Cross Society. Cyclone Hudhud-After Action Review: Community-based Disaster Risk Reduction Program in Andhra Pradesh. Indian Red Cross Society, April 2015.

4 DNA Web Team. Cyclone Hudhud causes Rs 21,908 crore loss, agriculture sector worst hit: Andhra government. DNA India, December 2014.

5 Press Information Bureau. Naval Chief Reviews Progress of Relief Efforts at Visakhapatnam during Commander's Conference at New Delhi. Ministry of Defence, Government of India, October 2014.

6 Press Information Bureau. Indian Armed Forces Ready to Launch Relief and Rescue Operations After Cyclone 'Hudhud' Strikes Indian Coast. Ministry of Defence, Government of India, October 2014.

by both regional and international experts. The Indian military had, once again, demonstrated its vital role in HA/DR in the region.[7]

The media documented Hudhud's effects on civilian institutions and infrastructure, with policy experts detailing the impact. It also generated a broad public debate on how a significant weather event affected Indian military assets. As the cyclone swept through Andhra Pradesh and Odisha, it passed over the Eastern Naval Command (ENC) in Visakhapatnam. The Navy reported damage to dockyards, hangars, jetties, roadways, runways, warehouses, and workshops. No major naval platforms were lost, but smaller vessels, unable to withstand winds exceeding 185 km/h, sank in the harbour. Larger ships and even submarines broke from hurricane hawsers and drifted along the coast. After the cyclone, many repair workshops were roofless, posing a threat to personnel and platforms. The Navy lost a sailor – a road rescue team member – who was hit by debris.[8] The service also lost 60 per cent of its natural cover (approximately 50,000 trees), hindering its greening efforts.[9] These impacts do not account for those on Army and Air Force assets in the theatre. Publicly reported damage to the Navy was US$ 267 million; although less than the civilian toll, it was proportionately high. Weeks after Hudhud, the Indian Navy's Western Naval Command (WNC) had to prepare for another, but fortunately weaker storm emanating from the Arabian Sea – Nilofar.

7 Bhattacharjee, S and Santosh, P. Hudhud was different and more devastating. The Hindu, October 2018.

8 DHNS. Cyclone cripples eastern naval command. Deccan Herald, October 2014.

9 Indo-Asian News Service. Navy Chief RK Dhowan Reviews Hudhud Impact at Visakhapatnam Base. NDTV, October 2014.

South Asia's Climate Landscape

Cyclones are among the numerous climate threats to India's regional security. Global warming and climate change have severely affected human life worldwide, with worse to come. The last decade was the warmest in 150 years.[10] In late 2023, global mean temperatures briefly surpassed the 2°C mark. Scientists also named 2024 the hottest year on record, with a peak in April.[11] As temperatures rise, unusual weather and climate patterns are becoming more frequent and intense. In 2023, 398 disasters worldwide caused over US$ 380 billion in damages.[12] Asia bears a disproportionate burden – not only due to its demographics and economies, but because it is warming at a faster rate than the global average.[13] In South Asia, the world's most vulnerable region, climate-driven disasters, including floods, heatwaves, cyclones, and droughts, mirror global temperature changes and are at century-high levels. For instance, Cyclone Amphan in 2020 displaced 4.5 million people across India and Bangladesh, resulting in costs of US$ 14 billion and US$ 131 million, respectively.[14] In 2022, floods submerged two-thirds of Pakistan, affecting approximately 33 million people and resulting in US$ 30 billion in damages.[15] Studies on India alone show that the country experienced an extreme weather event almost daily in the first nine months of 2023, resulting in over 2,000 lives lost, 80,000 houses damaged, and 90,000 animals killed, among many unreported effects on ecosystems and livelihoods.[16]

10 Earth Observatory. World of Change: Global Temperatures. National Aeronautics and Space Administration, U.S. Government, January 2022.

11 Paddison, L. Planet endures record-hot April, as scientists warn 2024 could beat heat records for second year in a row. CNN, May 2024.

12 Pandey, K. Weather disasters behind 95% natural calamities in 2023 that cost over $1 billion, finds report. Down To Earth, February 2024.

13 UN News. WMO report: Asia hit hardest by climate change and extreme weather. United Nations, April 2024.

14 Aaboe, S; Et.al. State of the Global Climate 2020: Provisional Report. World Meteorological Organization [Accessed via Reliefweb.int], December 2020.

15 Liu, C and Faseeh, M. A $30 Billion Disaster Is Just the Tip of a Deadly Climate Cycle. Bloomberg, July 2023.

16 Pandey, K and Rajit, S. Climate India 2023: An Assessment of Extreme Weather Events (January-September). Down To Earth, Centre for Science and Environment, November 2023.

Hazards are severe, and climate patterns continue to worsen. Droughts and floods, for example, have become more frequent. Extreme shifts in the climate system mean areas face drought followed by heavy flooding, and vice versa.[17] In 2017, Kerala experienced a 34 per cent rainfall deficit, but the following year faced torrential rains that were over 150 per cent above the 94-year average.[18] Meanwhile, from 2016 to 2018, South India (and Sri Lanka) had their worst droughts in 150 years.[19] This pattern spans India, as states with rainfall deficits suddenly face excess rain, such as Ladakh, Chandigarh, Kerala, and Sikkim in 2023.[20] Other hazards, such as heatwaves, glacial melt, and rising seas, which are considered slow-moving, are also accelerating. Some are existential.

In 2023, temperatures in Maharashtra, Andhra Pradesh, and West Bengal broke 50-year records in April-May.[21] In 2024, the hottest year so far, temperatures in New Delhi, Pholodi, and Sirsa exceeded 50°C. A current analysis of Himalayan glaciers suggests that around 80 per cent of them could disappear within 80 years, potentially devastating Nepal and other neighbouring countries.[22] Other studies indicate that 90 per cent of the Maldives, which averages just 1 meter above sea level, will be submerged soon.[23] Government-backed research shows that 28.7 per cent of India's coastline erodes at a rate of 6.5 mm per year, above the global average.[24] Events from the past decade, especially the last two years, demonstrate the need for urgent attention and action. Climate change is here.

17 Prabu, S and Vishwas, C. Decoding India's Changing Monsoon Patterns: A Tehsil-level Assessment. Council on Energy, Environment and Water, January 2024.

18 Walia, A and Nusrat, N. Kerala Floods, 2018. National Institute of Disaster Management, Ministry of Home Affairs, Government of India, September 2020.

19 Jain, N. Southern India's 2016-2018 drought was the worst in 150 years. Mongabay, May 2021.

20 Pandey, K. North India Deluge 2023: Rainfall during July 1-10 broke multiple records. Down To Earth, July 2023.

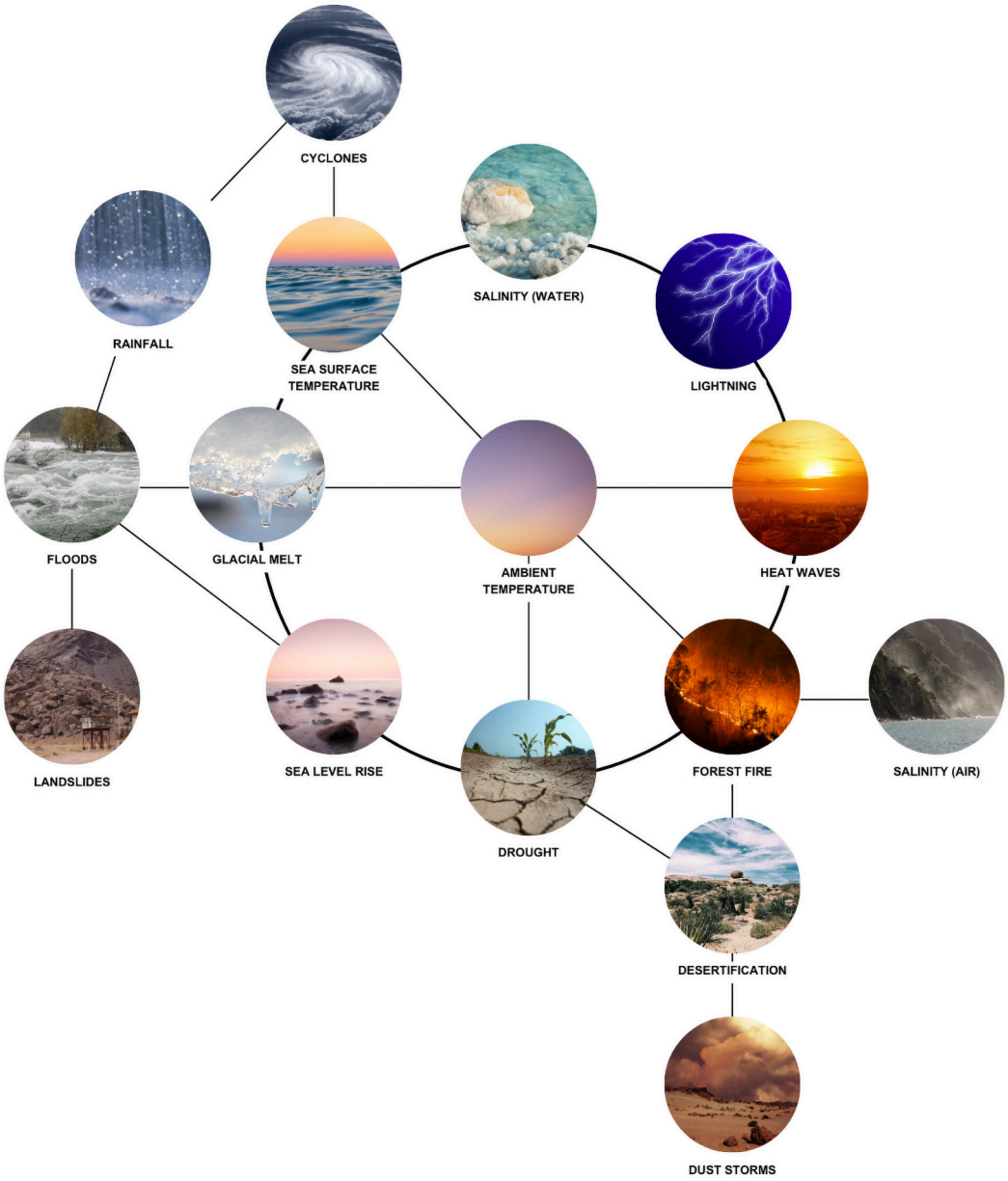
21 Deutsche Welle. India's sweltering heatwaves cause unbearable suffering. Frontline *(The Hindu)*, May 2023.

22 Wester, P. Et.al [Eds.]. Water, ice, society, and ecosystems in the Hindu Kush Himalaya: An outlook. International Centre for Integrated Mountain Development, July 2023.

23 Manzo, D. Et.al. Facing dire sea level rise threat, Maldives turns to climate change solutions to survive. ABC News, November 2021.

24 Rijiju, K. Rajya Sabha Starred Question No. *228: Rising Sea Level Impact on Coastal Areas. Ministry of Earth Sciences, Government of India, August 2023.

Figure 1 Climate change effects and hazards caused by rising temperatures. Designed by the author and intended as an approximate visualisation of complexity and linkages



Climate-Military Security

There is broad acknowledgement within the Indian strategic community that climate change has indirect impacts on security through its effects on food, water, and energy, as well as development and governance.[25] Some high-level officials across the Indian military establishment have publicly recognised these linkages. In January 2024, Minister of Defence Rajnath Singh stated, "Climate change is not just a weather-related phenomenon but a serious issue related to national security."[26] The concept of 'climate security', or the security implications of climate change, is thus not new in India.

The Indian military has long monitored the environment and its impact on the battlefield. In recent years, this has intensified as it contends with multiple non-traditional security threats like irregular human migration, unreported and illegal fishing, piracy and terrorism at sea, etc. The Indian military's Joint Warfare Doctrine not only indicates a link between such threats and climate change, but classifies the latter as one such threat.[27] The military's stake in addressing climate change is also well established. Speaking in December 2023, former Chief of Air Staff Air Marshal Vivek Ram Chaudhuri noted that the international landscape is constantly shifting and "the threat of global conflict looms large... fuelled by ideological division, resource scarcity, and climate change."[28] That same month, the former Chief of Army Staff, Lieutenant General Manoj Pande, said that South Asia is marked by unresolved traditional challenges and increasing non-traditional ones, all of which "coupled with regional vulnerabilities to climate change-induced disasters have kept the region in a flux."[29] And, in March 2024, former Chief of Naval Staff Admiral Radhakrishnan Hari Kumar

25 IPCS Taskforce. Six Questions on Climate Security for India: 2021-22 IPCS Taskforce Report, Institute of Peace and Conflict Studies, November 2022.

26 Press Information Bureau. Raksha Mantri inaugurates 29 bridgesits mandate, as reflected later & six roads constructed by BRO across seven States/Union Territories at a cost of Rs 670 crore. Ministry of Defence, Government of India, January 2024.

27 Directorate of Doctrine. Joint Doctrine Indian Armed Forces. Headquarters Integrated Defence Staff, Ministry of Defence, Government of India. [Accessed via BharatShaki.in], April 2017.

28 Asian News International. Threat of global conflict looms large, fuelled by ideological divisions and resource scarcity, says IAF Chief VR Chaudhari. The Economic Times, December 2023.

29 Press Trust of India. We're Constantly Seized With Contemporary Threats: Army Chief. Kashmir Observer, December 2023.

highlighted the "need for accurate and immediate focus on the pressing challenge of climate change."[30]

There is, however, a limit to the military's cognisance of the implications of climate change for its mandate. This presents a gap in Indian regional security planning. First, there is very little in the way of an official, coherent articulation of the climate change challenge within national strategy. Many countries – primarily in the West – are institutionalising climate change as a national security threat. Washington, for example, states that "...of all the shared problems... climate change is the greatest and potentially existential for all nations."[31] London, too, claims "drivers such as climate change and resource scarcity...increase[s] the likelihood of conflict, instability, and state failure."[32] Second, as a next step, there is insufficient serious consideration of the 'climate-military security' nexus. In 2021, NATO established a Climate Change and Security Centre of Excellence to coordinate climate awareness, adaptation, and mitigation initiatives within the alliance.[33] Similarly, the European Union, through its Joint Research Centre on Science and the European Defence Agency, has published reports on the climate's impacts on defence installations, operations, and readiness; the most important being the EU Climate Change and Defence roadmap in 2021.[34] Several other national initiatives are being considered and are underway in capitals such as Tokyo, Beijing, and Jakarta, addressing issues including low-carbon warfare and military-environment relations.

Such a discourse is absent in India as climate change is viewed mainly through a developmental lens, with the implications for people-centric security

30 Press Information Bureau. METOC Seminar 'Meghayan 2024' - An Insight into the Frontline of Climate Change. Ministry of Defence, Government of India, March 2024.

31 White House. Biden-Harris Administration's National Security Strategy. U.S. Government, October 2022. *This position, of course, has not been reiterated by the Trump Administration, given the politicisation of climate change and popular narratives of climate denial in the US.*

32 Cabinet Office. A Strong Britain in an Age of Uncertainty: The National Security Strategy. Her Majesty's Government of the United Kingdom of Great Britain and Northern Ireland, October 2010. *These threats have been elucidated in greater detail in the latest national security assessment of ecosystems by the UK Department of Environment, Food and Rural Affairs.*

33 Secretary General. NATO releases 2024 Climate Change and Security Impact Assessment Report. North Atlantic Treaty Organization, July 2024.

34 R. Tavares da Costa, E. Krausmann and C. Hadjisavvas. Navigating Climate Change in Defence–Climate Risk Management Guide for Chiefs of Defence Staff, Publications Office of the European Union, March 2024.

considered – justifiably – first.[35] 'Climate action' and 'climate justice' dominate the Indian strategic vocabulary, as policymakers and practitioners are generally reluctant to 'securitise' climate change for two reasons: concerns about military overreach, humanitarian crisis contexts and geopolitical biases in the global climate agenda.[36] However, it may be time for India to reconsider its approach to the intersection of climate change and military security. There are already conversations within the establishment on 'riskification', 'environmentalisation', 'climatisation', and 'greening' security.[37] The Indian military has, coincidentally, begun to incorporate environmental considerations into its higher-level planning through sustainability, resilient infrastructure, and ecological initiatives.[38] The next step, and the motivation for this report, would be to formally acknowledge that climate change has an intrinsic impact on the Indian military's readiness, capabilities, and operations.

35 Asian News International. India will always be a 'champion' for climate action, says Ruchira Kamboj. Business Standard, February 2024.

36 Jayaram, D. Shifting discourses of climate security in India: domestic and international dimension. Third World Quarterly, 45(14), pp.2108-2126, February 2024.

37 Jayaram, D. 'Climatizing' military strategy? A case study of the Indian armed forces. International Politics, 2021(58), pp. 619-639, 30 May 2020.

38 Author's interaction with serving senior officers of the Indian military, February, 2024. *These include programmes like the 'Sons of the Soil' and 'Eco-warriors' initiatives in the Indian Army and the 'Ecological Task Force' battalions of the Territorial Army; and the Green Roadmap developed for the joint services.*

Understanding Readiness

The Indian military, comprising three branches, operates across diverse contexts, from counterinsurgency in the northeastern mountains and valleys, to border security in the northwestern deserts, to maritime protection in the southern seas. Operations are guided by three primary national objectives: preserving sovereignty and integrity, safeguarding strategic economic and political interests, and maintaining internal stability.[39] These objectives inform the specific roles of each arm: the Air Force supports regional deterrence, the Navy advances economic interests, and the Army contributes to both internal and external security. Military effectiveness depends on their level of readiness, or defence preparedness, which is maintained even during peacetime to address health, natural, non-state, and border emergencies. The current regional environment, described by the military as an "intermediate continuum of no war, no peace," encompasses a wide range of missions, from civil assistance to high-intensity combat, all of which are susceptible to the impacts of climate change.[40]

Despite its importance, however, readiness is insufficiently discussed and defined in Indian strategic literature. Readiness, or preparedness, generally refers to the availability and allocation of materiel, as well as military planning and procedures. A distinction exists, though context-dependent. Readiness is defined as the "ability to produce, deploy, and sustain military forces,"[41] while preparedness refers to the "capacity to anticipate, prevent, withstand, and respond to major threats."[42] Readiness speaks to the present, whereas preparedness speaks to the future.

39 Singh, S.J. Et.al. Ensuring Secure Seas – Indian Maritime Security Strategy, Directorate of Strategy, Concepts, and Transformation, Integrated Headquarters, Ministry of Defence (Navy), [Accessed via Bharatshakti.in], 2015.

40 Choudhury, D. Et.al. Doctrine of the Indian Air Force 2000-22. Air Headquarters, Indian Air Force, Ministry of Defence, Government of India, June 2022.

41 Herrera, G.J. The Fundamentals of Military Readiness [R46559]. Congressional Research Service, Library of Congress, U.S. Government, October 2020.

42 Niinistö, S. Report: Safer Together – Strengthening Europe's Civilian and Military Preparedness and Readiness. European Commission, October 2024. *This seminal report has helped connect the issue of war preparations and natural disaster response.*

A well-known definition of readiness is the 3M model, derived from the business and management field. The framework revolves around money, manpower, and materiel, asking how, for what, and by when they should be made ready.[43] All three are intrinsic to military modernisation, expansion, sustenance, and jointness initiatives, and are key in determining "a state's capacity to create and leverage its hard power."[44] While the Indian military's doctrinal and strategic documents repeatedly mention readiness (or preparedness), there has been no official enunciation. Nonetheless, one can see aspects of the readiness factors discussed above in the operations carried out by the three arms, whether in Operation Lehar or in Snow Leopard (the Indian response to Chinese intrusions in the north). With the 3M framework in mind, senior officers of the military define readiness as the: (1) ability to deter and defeat new or existing threats,[45] (2) capacity to undertake a broad spectrum of taskings in a finite amount of time,[46] (3) ready availability of materiel and logistical arrangements to mobilise them,[47] (4) flexibility to transition from day-to-day sustenance to war-fighting,[48] and (5) speed at which assets and units can be deployed to respond to a major crisis from a situation of absolute peace.[49]

Inquiries into the differences between operational and combat readiness have yielded little absolute clarity, with the only answer being that context – i.e., whether it is a time of peace or war – is the defining aspect. To that end, a list of readiness factors can be generated, including recruitment, training, procurement, research and development, construction, exercises, budgets, redeployments, repairs, and related areas. There is also growing awareness that these factors in newer, unconventional domains, such as cyber and space, would need to be improved to build greater synergy in joint-service operations and joint theatre commands.[50]

43 Betts, R.K. Military Readiness: Concepts, Choices, Consequences. Brookings Institution, February 1995.

44 Singh, H. Establishing India's Military Readiness Concerns and Strategy. IDSA Monograph Series, 5, Manohar Parrikar Institute for Defence Studies & Analyses, November 2011.

45 Author's interview with a former flag officer of the Indian Army, May 2024.

46 Author's interview with a former flag officer of the Indian Navy, November 2024.

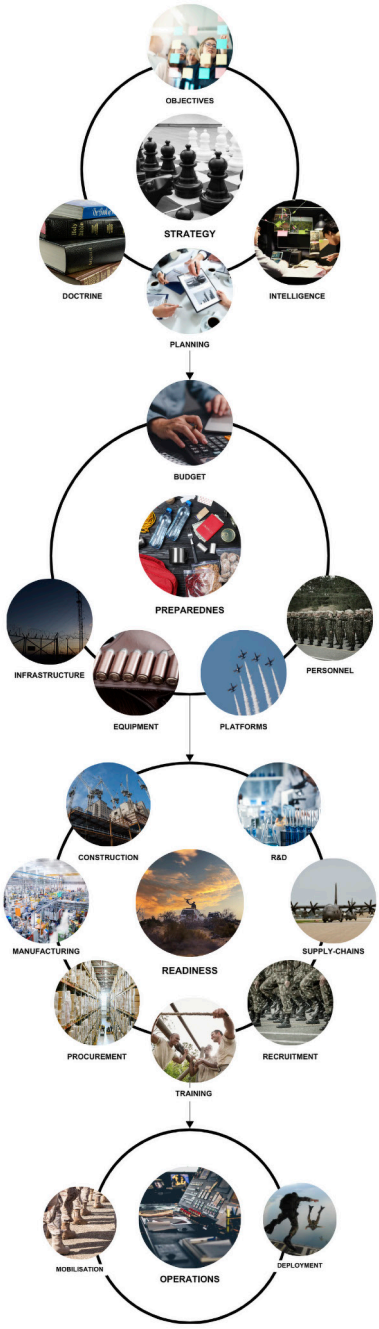
47 Author's interview with a former flag officer of the Indian Air Force, April 2024.

48 Author's interview with a former flag officer of the Indian Army, June 2024.

49 Author's interview with a former flag officer of the Indian Navy, April 2024.

50 Pandit, R. Top meet kicks off to review military readiness, challenges & strategy. Times of India, March 2023.

Figure 2 Military readiness and its factors. Designed by the author and intended to show the process, not comprehensive



Climate Impacts on Readiness

Climate change has numerous direct and indirect effects on the aforementioned factors that drive readiness. These effects are evident in personnel, infrastructure, platforms, and equipment. Some readiness factors are particularly urgent or vulnerable, including increasing impacts on personnel health from extreme weather events and inadequate infrastructure resilience to natural disasters. Platforms and equipment are also experiencing accelerated wear and maintenance issues due to environmental changes. These vulnerabilities differ from theatre to theatre depending on the geography and climate of the area of operations. The following visualisation illustrates these impacts by individual readiness factors:

Personnel

There are several studies on the effects of climate change on human physiology. Existing analyses indicate both short and long-term ramifications.[51] For personnel, recruitment is particularly vulnerable, especially given the human-power-intensive nature of the Indian military. Anomalous temperatures on land and at sea create several insecurities, including food security, water security, and the preservation of natural habitats.[52] Beyond the physical effects on unstable landforms, these issues snowball into broader societal problems, including poor nutrition, compromised immunity, inadequate education, and reduced productivity, which in turn lead to greater mental distress and loss of function.[53] The number of diseases and potential pathways is increasing, and as a result, the pool of healthy and educated recruits will decline.[54] Once in the recruitment pipeline, cadets and officers remain vulnerable to these challenges depending on where they are training or deployed, whether in volatile terrain, disease-prone

51 Franchini, M. and Pier Mannucio, M. Impact on human health of climate changes, European Journal of Internal Medicine, 26(1), 1-5, January 2015.

52 Crimmins, A. Et.al. The Impact of Climate Change on Human Health in the United States: A Scientific Assessment, US Global Change Research Program, April 2016.

53 Author's interview with a former senior officer of the Indian Air Force, May 2024.

54 Mora, C. Et.al. Over half of known human pathogenic diseases can be aggravated by climate change. Nature Climate Change, 12, pp. 869-875, August 2022.

areas, or extreme heat. For example, in 2016, nearly ten soldiers of the Army lost their lives in Siachen due to an unsafe hanging ice glacier that melted and collapsed.[55] Troops in high-altitude regions also face harsher winters, disrupting acclimatisation and rotation cycles.

Frequent illnesses due to heat stress and disease disrupt training, as soldiers are deployed in areas for too long, are unable to use their allocated leaves effectively, and become under-motivated due to seasonal changes in their surroundings.[56] In 2022, an Army soldier, the only one reported, came down with a case of melioidosis in New Delhi.[57] In 2024, Border Security Force soldiers were dangerously exposed to heatwaves, with some fatally succumbing to stroke and dehydration.[58] Cardiovascular and pulmonary health is also highly vulnerable to changes in temperature and elevated pollution levels. Training regimens and syllabi will need to be adjusted, as unpredictable environmental changes may result in exercise delays or cancellations, further straining deployment cycles. The Air Force's Vayu Shakti exercise in 2022 was likely delayed by bad weather in Bikaner. This is true for disease and health protocols, allowances, and insurance, all of which will result in higher budgetary costs.[59] The increased demand for personnel in humanitarian aid and relief, as well as peace missions, will result in a higher operational tempo, thereby reducing overall stamina. Humanitarian deployments in urban areas may expose troops to violence, petty crime, and trafficking, which – in a high-stress scenario – might require militarised intervention. Climate change's multidimensional effects will thus affect recruitment drives, training programmes, and soldiers' performance of their duties.

55 Press Trust of India. Global warming making Siachen riskier for soldiers. The Economic Times, July 2018.

56 Author's interaction with serving senior officers of the Indian military, February 2024.

57 Raina, S; Et.al. Unearthing the burden of melioidosis in North India – an emerging threat in a non-endemic region. Current Research in Microbial Sciences, 8, January 2025.

58 Press Trust of India. Gujarat: BSF officer, jawan die due to extreme heat exposure during Pak border patrol. The Economic Times, July 2024.

59 Author's interaction with serving senior officers of the Indian military, February 2024.

Infrastructure

Climate effects on infrastructure are well-documented. Infrastructure here includes office buildings, warehouses, factories, repair facilities, roadways, railways, airfields, hangars, generators, pipelines, and related facilities.[60] The direct effects of climate-induced hazards, such as cyclones, floods, and forest fires, lead to the destruction and degradation of essential systems. Examples include sea-level rise and erosion, which increase risks to critical coastal infrastructure, such as ports and terminals like Diamond Harbour and Haldia Port.[61] Other effects include the thermal expansion of tarred roads and steel infrastructure, as well as the cessation of channel operations due to silt deposition. Railway lines exposed to high temperatures can buckle and crack, disrupting national and transregional supply chains. Higher temperatures also put a strain on installations in hot zones, increasing energy demand for cooling. Floods from cloudbursts and glacial outbursts can impact inland installations, such as power plants and factories, as well as the Teesta III hydroelectric dam and pharmaceutical plants in riverine areas.[62] Similar effects occur on asphalt roadways and airfields.

In recent years, airports have had to halt operations due to flooding and damage, as seen with Chennai International Airport in 2023.[63] While these impacts affect critical civilian infrastructure, they also affect the military. Interactions with senior officers have revealed that such events involving administrative, ammunition, and surveillance facilities have occurred over the past forty years; however, these are confidential and cannot be confirmed publicly. In 2004, for instance, a riverine flood along the Sutlej River washed away key Army posts along the Line of Actual Control (LAC) with China.[64] Supply lines and bases in the Himalayas are destabilised by retreating glaciers and shifting rivers. This was repeated along the LAC in 2023 during the floods in Sikkim.

60 Filho, W.L; Et.al. An assessment of priorities in handling climate change impacts on infrastructures, Scientific Reports, 14, 1447, Nature, June 2024.

61 Sarkar, S. Rising sea imperils India's ports. India Climate Dialogue, [Assessed via PreventionWeb], July 2019.

62 Dutta, S. As India's smallest state votes, a broken hydro plant takes centerstage. Al Jazeera, April 2024.

63 Paramasivam, P; Dash, J. Chennai airport flooded as Cyclone Michaung nears India, Reuters, December 2023.

64 Gautam, P.K. The Parechu Lake Incident: A Preliminary Analysis, Institute of Peace and Conflict Studies, November 2004.

Frequent landslides cause significant destruction in mountainous areas, destroying pillboxes, tunnels, and rally points. Anomalous snowfall has the same effect, causing a readjustment in the quantity and timing of logistics supplies across the northern and northeastern theatres, not to mention the wholesale reestablishment of military installations.[65] Water infrastructure is also highly vulnerable, particularly due to oscillations in floods and droughts. This affects training areas, especially those near population centres. Areas with decreased rainfall bear the costs of lower water reserves and higher repair costs for poor-quality aquifers.[66] Such resource stresses in front-line theatres have the potential to alter and generate new areas of responsibility. With one-in-a-hundred-year events becoming more frequent,[67] the most pressing challenge for India is enhancing the resilience of its critical infrastructure.

Platforms

As with personnel, climate change has a similar effect on platform (and equipment) performance. Machines and their instruments face severe challenges due to environmental factors.[68] This will result in increased budgetary, maintenance, and human-power costs in the long-term and degrade the Indian military's combat capabilities in the short-term. There are limited reports on such impacts due to the secretive nature of military operations. Nonetheless, a changing climate will require alternative materials for armour, engines, hulls, and hard points. For instance, high temperatures affect the engines of ground-based and aerial vehicles.[69] In tanks and armoured personnel/infantry fighting vehicles, heat stress increases the likelihood of mechanical failures and breakdowns throughout the vehicle's life cycle. High temperatures also affect the performance of fighter and helicopter engines, as well as their lift, payload, and safety specifications. These mean frequent repairs, fewer primed sortie assets, and slower operational response times. Glacial or riverine changes could mean a

65 Author's interview with former flag officer of the Indian Army, May 2024.

66 Luisa, L. How climate change impacts infrastructure: experts explain, University of Sydney, November 2019.

67 Author's interview with former flag officer of the Indian Navy, April 2024.

68 Schaik, L.V; Et.al. Ready for take-off? Military responses to climate change, Planetary Security Initiative, March 2020.

69 Wu, T; McAulay, K.J. Predicting Diesel Engine Performance at Various Ambient Conditions, SAE Transactions, 82(1), SAE International, pp.582-601, 1973.

reduced ability to conduct air-mobility and high-altitude missions. Other ambient and oceanic conditions can lead to shorter flight/sailing periods.

Environmental factors, such as dust, mud, and salt, exacerbate the issue.[70] Climate change effects, in the form of frequent storms and intense humidity, combine in ways that allow dust and salt to enter and damage internal circuitry and mechanical integrity. For example, platforms in the southwestern theatre must be rotated out every two years to extend equipment life and control material damage. This period may become shorter in the future as climate change intensifies. A related problem is caused by frequent cyclonic storms in the southeastern theatre, which require assets to be brought inland for protection. This, of course, does not negate the need to allocate additional assets to disaster relief missions, independent of warfighting readiness.

Space-based platforms, too, face such challenges. While reconnaissance and communications satellites have always experienced drag in the thermosphere, climate change has altered conditions across all layers, with a key change being a contraction in the mesosphere.[71] As a result, higher temperatures in low orbit have reduced the fuel efficiency and material integrity of these satellites, requiring frequent launches to maintain an open information envelope for navigation, communication, and intelligence at all times.[72] This raises high-tech operational costs. As in space, operations at sea have also become vulnerable. High sea-surface temperatures and salinity levels cause erosion and fouling, which negatively impact propulsion systems and hull integrity.[73] Other hydrological changes require subsurface combatants, such as hunter-killer submarines and drones, to constantly adjust their trajectories, trim, and attitude to operate effectively in the littoral environment.[74] Submarines may find themselves unable to communicate with the outside world, or worse, unable to dive and protect themselves from acoustic propagation, which would

70 Author's interaction with serving senior officers of the Indian military, February 2024.

71 Tran, L. NASA Satellites See Upper Atmosphere Cooling and Contracting Due to Climate Change, Goddard Space Flight Center, NASA, June 2021.

72 Author's interview with a former flag officer of the Indian Air Force, May 2024.

73 Deng, Q, Et.al. Effect of seawater salinity on the fretting corrosion behaviour of nickel-aluminum bronze (NAB) alloy, Tribology International, 193, May 2024.

74 Author's interview with a former flag officer of the Indian Navy, November 2024.

compromise their stealth capabilities.[75] Across the three domains, platforms will require newer materials, technologies, and capabilities to withstand the coming climate and environmental changes.

Equipment

The equipment housed on such weapons platforms, as well as those allocated to personnel – including navigation, targeting, communication systems, medication, protective gear, and handheld devices – are also exposed to these effects. Ambient temperatures can increase the wear and tear on heat-sensitive systems. Dust storms, salt exposure, and magnetic interference from frequent thunderstorms can affect equipment performance.[76] For example, radar systems in regions with higher temperatures or frequent dust storms struggle to effectively identify targets within their range. These conditions degrade internal electronics and surface materials.[77] Electromagnetic interference in navigation and communications equipment may become more common as the upper atmosphere thins and exposure to solar activity increases. Lightning strikes, which threaten the entire spectrum of military readiness, are now more frequent due to increased ambient convection.[78] Missiles and guided rockets face similar problems, whether in storage or when deployed. Changes in land temperatures and vegetation cover can influence ground-hugging missile trajectories. If not properly stored, dust and salt can damage ordnance electronics, cause navigation issues, and wear the outer surface, degrading heat shields and compromising aerodynamics.[79] This is true for humidity- and cold-induced degradation. Such effects reduce the shelf life of equipment and ammunition, including small arms.

Firearms and artillery, which require precise calibration for accuracy and repeated use, are susceptible to heat and humidity, which can affect their range,

75 Gilli, A; Et.al. Climate Change and Military Power: Hunting for Submarines in the Warming Ocean, Texas National Security Review, 7(2), Spring, pp. 16-41, 2024.

76 Author's Interaction with serving senior officers of the Indian military, February, 2024.

77 Skolnik, M.I. Factors affecting radar performance, Encyclopedia Britannica, 9 January 2025.

78 Press Trust of India. Climate change causing more frequent and deadly lightning strikes: Scientists, The Economic Times, July 2024.

79 Kouroupis, J.B. Flight Capabilities of High-Speed-Missile Radome Materials, Johns Hopkins Applied Physics Laboratory Technical Digest, 13(3), 1992.

accuracy, and reliability. Heat waves and cloudbursts pose direct risks to supply caches for both military and civilian use. These non-military events require greater use of equipment, leading to increased attrition in rough and resource-scarce areas. During Operation Parakram in 2001 and in other operations over the past decade, high temperatures caused ammunition dumps to combust.[80] Landmines used in wars in the western theatre have drifted from their original positions due to heat waves, threatening area-wide contamination.[81] In 2023, flash floods in the northeast caused mortar shells to wash downriver, killing two and injuring four civilians.[82] Such vulnerabilities require greater investments in temperature-controlled, waterproof, and vacuum-sealed caches as well as frequent testing and maintenance.[83] At the individual level, personnel will need to be equipped with IP65/67-level protective equipment, including boots, gloves, body armour, and mapping instruments with higher levels of ruggedisation, as well as next-generation pharmaceuticals and nutraceuticals.

80 Panag, H.S. The ammunition dump blows up!, Newslaundry, September 2017.

81 Author's interview with former flag officer of the Indian Army, September 2024.

82 India Today News Desk. 2 dead in Bengal as mortar shell flowing through Teesta floodwaters explodes, India Today, October 2023.

83 Author's interview with former flag officer of the Indian Air Force, April 2024.

Table 1 Summary effects of climate and environmental hazards on the four factors of military readiness

Climate/ Environmental Factor	Personnel	Infrastructure	Platforms	Equipment
Extreme heat/ heatwaves	Recruitment stress, undermotivation, and frequent illnesses disrupt training and deployment. Harsher working conditions; greater risk of heat stress and reduced stamina; higher demand for HADR during heat-induced crises.	Asphalt/tarmac deterioration; airport and road shutdowns. Strain on bases in hot zones; higher cooling and energy demands; rail and road buckling and cracking	Tanks and IFVs are prone to breakdown; reduced lift/ payload in aircraft/naval training is disrupted; reduced sortie availability in extreme heat.	Ammunition instability; reduced firearm accuracy; reduced shelf life; mines drift; greater ruggedisation required. Shortened lifecycle; increased wear-and-tear on heat-sensitive systems; need for temperature-controlled caches.
Floods/glacial outbursts/ cloudbursts	Casualties from glacial collapse; deployment stress. Increased deployments for HADR; higher operational tempo.	Military posts, dams, factories, and supply infrastructure are destroyed; landslides disrupt installations. Coastal bases, depots, and ports are vulnerable to inundation and storm damage.	Unpredictable seas disrupt naval operations and coastal training.	Ordnance displacement; munitions washed downstream. Water damage to stored matériel; higher need for resilient storage and waterproofing.
Cyclones/storms	Increased disease pathways and stress.	Coastal installations, ports, and terminals are threatened.		Radar degradation; missile guidance errors.
Sea-level rise/ salinity	Food and water insecurity lead to malnutrition and poor immunity.	Coastal erosion is undermining ports and coastal bases.	Propulsion system corrosion and fouling; reduced hull integrity. Submarines forced to adjust trajectory and trim; comms and stealth compromised.	Salt-induced degradation of ordnance and electronics; reduced shelf life.
Anomalous snowfall	Cold injuries; deployment stress in high-altitude regions. Soldiers face harsher winter campaigns; disrupted acclimatisation and rotation cycles.	Logistic-line disruptions in northern and northeastern theatres. Supply lines and bases in the Himalayas are destabilised by retreating glaciers and shifting rivers.	Reduced ability to conduct air mobility and high-altitude training.	Cold-induced degradation of electronics, vehicles, and weapons.

Climate/ Environmental Factor	Personnel	Infrastructure	Platforms	Equipment
Dust/ desertification	Disease and heat stress on soldiers.		Aircraft rotation is required to preserve systems.	Radar blind spots; electronics degradation in ordnance.
Atmospheric change (upper layers)	Longer training cycles; higher health and insurance costs.	Instability in power and water infrastructure due to drought–flood oscillations.	Reduced satellite efficiency from atmospheric drag and mesosphere contraction.	Navigation and communication interference; more frequent lightning strikes.
Forest fires	Increased deployment strain.	Destruction of depots, warehouses, and repair facilities.		Risk to ammunition and gear storage.
Water scarcity/ drought	Malnutrition; weakened immunity in recruits and personnel.	Contaminated storage; aquifer depletion raises maintenance costs.		
Thunderstorms/ lightning	Psychological strain and health risks.		Aircraft safety compromised.	Lightning-induced damage to electronics and ordnance degradation.
Disaster displacement/ migration	Greater HADR/ security deployments; exposure to urban violence, petty crime, and trafficking.	Strain on cantonments/bases near population centres; pressure on logistics.	Platforms diverted from warfighting to HADR.	Equipment diverted to non-military use; higher attrition.
Resource stress/ competition	More frequent troop deployments to contested or resource-stressed regions.	Borders and posts redundancies by shifting watersheds; new areas of responsibility.		Increased attrition of equipment in rough terrain and resource-contested areas.

The final, and most important, dimension of climate change's impact on Indian military readiness lies in planning and strategy. That climate change exacerbates existing threats while generating new ones is well-established.[84] This extends beyond the immediate effects illustrated above and shapes strategic decision-making. Terrain, topography, and prevailing environmental conditions have historically determined the success of military campaigns. India's own military history demonstrates this principle – the most oft-cited example being the 1971 War with Pakistan.[85] Indian military planners chose to launch the offensive in December, aiming to deter a Chinese incursion from the Himalayas and secure firm ground for launching large armoured pincer formations.

Today, climate-induced shifts in the South Asian weather system compel the military to redress campaign seasons as days grow hotter, wetter, and colder.[86] This means adjusting operational calendars, training cycles, and deployment schedules to accommodate adverse conditions.[87] Anomalous weather at sea and on land, particularly in arid and high-altitude regions, increasingly disrupts joint-service exercises and operations, affecting readiness, force posture, and personnel, platform, and equipment allocation. Retreating glaciers, shifting rivers, and extreme weather events complicate border management, territorial defence, and internal security, while heightening the Indian military's responsibilities in humanitarian missions. A dangerous possibility along the LAC is shifting natural markers due to glacial melt and anomalous snowfall (as seen in the Alps), which could incite future confrontations with China in the contested region.[88]

84 Choudhury, A, Et.al. Climate Security in the Bay of Bengal. Institute of Peace and Conflict Studies-Clingendael Institute, January 2022.

85 Cheema, J.S. India's Politico-Military Strategy for the 1971 India-Pakistan War. Journal of Defence Studies, Manohar Parrikar Institute for Defence Studies and Analyses, 15(4), pp. 7-34, October-December 2021.

86 Author's interview with a former flag officer of the Indian Air Force, April, 2024.

87 Chopra, A. Why Indian armed forces must institutionalise climate change in their planning and operations. Firstpost, November 2023.

88 Haubursin, C. The Italy-Switzerland border is melting, Vox, February 2022.

Resource competitions, border disputes, and domestic socio-economic vulnerabilities are increasingly susceptible to environmental stress, with heightened migration, crime, and localised conflict already observable across the South Asian region.[89] These effects impose additional burdens on logistics, infrastructure, and equipment, necessitating adaptive, resilient, and contingent strategies.

89 Hsiang, S.M. and Marshall, B. Climate, conflict, and social stability: what does the evidence say?, Climatic Change, 123, pp. 39-55, October 2013. *The link between climate and conflict is a highly debated subject. Since the early 2000s, several studies using multivariate methods have been conducted. However, consensus in the scientific domain on the causal link between the two phenomenon remains inconclusive. For a nuanced understanding of the field, please read the 2013 commentary to this paper.*

Conclusion

The research findings presented in this Special Report illustrate the impacts of climate change on Indian military readiness. To that end, it seeks to motivate the Indian military to explicate its readiness parameters and, more importantly, integrate climate-informed threat assessments into its planning and operations. This may involve recalibrating areas of responsibility and strategic priorities across its various theatres. By incorporating climate considerations, the Indian military can enhance operational effectiveness *and* achieve strategic objectives. Effective adaptation will require greater institutional attention, scientific measurements, resource allocation, joint-service coordination, research and development of new materials, and implementation of best practices from other contexts. This will entail new doctrines, operational concepts, and capabilities that account for climate-induced impacts on personnel, infrastructure, platforms, and equipment. Such an approach will ensure readiness is maintained as India navigates the 'No War, No Peace' continuum in an increasingly volatile climatic and geopolitical South Asia.