CLIMATE CHANGE IN ARCTIC: EMERGING CHALLENGES AND OPPORTUNITIES FOR INDIA

A Dissertation submitted to the Panjab University, Chandigarh for the award of degree of Master of Philosophy in Social Sciences, in partial fulfilment of the requirement for the Advanced Professional Programme in Public Administration (2021-22)

by

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Certificate

I have the pleasure to certify that **Commodore Saurabh Rastogi** has pursued his research work and prepared the present dissertation titled '**Climate change in Arctic: Emerging challenges and opportunities for India**' under my guidance and supervision. The dissertation is the result of his own research and to the best of my knowledge, no part of it has earlier comprised any other monograph, dissertation or book. This is being submitted to the Panjab University, Chandigarh, for the purpose of Master of Philosophy in Social Sciences in partial fulfilment of the requirement for the Advanced Professional Programme in Public Administration of the Indian Institute of Public Administration (IIPA), New Delhi.

I recommend that the dissertation of **Commodore Saurabh Rastogi** is worthy of the award of M.Phil degree of Panjab University, Chandigarh.

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Abbreviations

AMAP - Arctic Monitoring and Assessment Programme

AMOC - Atlantic Meridional Overturning Circulation

AO - Arctic Oscillations

CAO - Central Arctic Ocean

CVMC – Chennai Vladivostok Maritime Corridor

DOD - Department of Ocean Development

EEZ - Exclusive economic zone

ESSO - Earth System Science Organization

ETCW - Early Twentieth Century Warming

EU – European Union

HUC - Himalayan University Consortium

INSTC - International North South Transport Corridor

IOC - Indian Oil Corporation Limited

IOM - International Organization for Migration

IOR – Indian Ocean Region

IPCC - Intergovernmental Panel on Climate Change

ISMR - Indian Summer Monsoon Rainfall

IUCN - International Union for Conservation of Nature and Natural Resources

IWM - Indian Winter Monsoon

KS – Kara Sea

LNG – Liquefied Natural Gas

MEA – Ministry of External Affairs

MoES - Ministry of Earth Sciences

MoU - Memorandum of Understanding

NAM - Northern Annular Mode

NATO - North Atlantic Treaty Organization

NCPOR - National Centre for Polar and Ocean Research

NSR - Northern Sea route

NySMAC - Ny-Ålesund Science Managers Committee

OIL - Oil India Limited

OVL - ONGC Videsh Limited

PRV - Polar Research Vehicle

PRW - Planetary Rossby Waves

RFE - Russian Far East

SIE - Sea Ice Extent

UNCLOS - United Nations Convention on the Law of the Sea

UNESCO-WHC - United Nations Educational, Scientific, and Cultural Organization-World Heritage Committee

UNFCCC - United Nations Framework Convention on Climate Change

UNHCR – United Nations High Commissioner for Refugees

USGS - United States Geological Survey

WDs - Western Disturbances

WMO - World Meteorological Organization

Executive Summary

As a consequence of the climate change, the Arctic region has seen a dramatic transformation over the last few decades. The changes being observed in the Arctic region are primarily driven by the accelerated melting of sea and land ice. The ocean surface area covered by the sea ice has witnessed a decrease of almost 4.7% every decade. Even the thickness of the sea ice layer has reduced by about 10-15% in the same time period.

The changing climate in the Arctic is affecting the flora, fauna and humans alike. The change in the sea ice extent and the sea ice stability impacts the livelihood of the indigenous communities as well as the habitat of the marine life. The traditional routes are becoming dangerous and the ice paths over frozen lakes and rivers are getting more challenging. The region is witnessing warmer temperatures, severe flooding and storms, causing the local population to migrate.

The world's cryospheric region plays a vital role in maintaining the pace of the global climate change and has a significant effect on the global weather system. Melting sea ice at the Arctic is resulting in rising global sea levels, which is a threat to the large population residing in the coastal areas. The rising temperatures are affecting the Polar jet stream flow over the Arctic, which is impacting the weather in the Northern hemisphere. The high temperatures in the Arctic have increased the pace of permafrost thawing over the years, which is adding larger amount of fresh water into the Arctic Ocean. The changing salinity and density of the ocean water is affecting the wind

patterns and ocean currents. Consequently, the world is experiencing variable weather events, mostly, at the extreme end of the spectrum.

The Arctic region is known to possess large reserves of oil and gas and the melting Arctic has led to a gold rush amongst all the states, within and outside the region. All the regional nations are looking to enhance their continental shelf and thereby the EEZs to maximise their claim on undersea natural resources. The depleting sea ice is also opening the shipping routes in the high North; which provides a strategic alternative to the European countries, the Arctic states as well as the countries in the East, such as China, Japan and South Korea. As against the traditional route through the Suez Canal, the Northern shipping route reduces the distance and hence is more economical. However, the extensive offshore and onshore activities are adversely affecting the four million indigenous population of the region.

The economic relevance of the Arctic region has increased conflicts between the Arctic states. The growing geostrategic significance of the region has led to the larger interests being shown by the non-Arctic states, which are increasingly strengthening their linkages with the Arctic states through bilateral and multilateral engagements. The region is witnessing enhanced militarisation by all stakeholders, such as NATO, Russia, China etc. The countries such as China is using its financial prowess to increase its engagements from scientific and polar research to economic, trade and military. The large commercial gains feasible from the Arctic region have shifted the environmental degradation challenges to the back-burner.

India cannot remain isolated from the ongoing climate issues as well as the geostrategic shift to the Arctic region. The research therefore, intends to examine the environmental challenges that India faces from the ongoing warming of the Arctic and the opportunities that India needs to explore to remain strategically relevant in the changing Arctic region. The study reviews India's present engagements with the countries in the Arctic with an aim to suggest measures to increase its presence in the region.

The research primarily uses descriptive methods. The primary research sources include a questionnaire addressed to climate experts, think- tanks, academia, defence experts etc. The secondary research sources include literature survey of journals and reports from the climate agencies and experts.

Various studies have revealed that the climate change in the Arctic region is impacting the pattern of Indian monsoons; which is severely affecting agriculture and hence posing a threat to food security. The extreme weather events such as increased frequency and severity of cyclones, drought and severe summer are also affecting the well-being and livelihood of the Indian population.

The study reveals that India's presence in the Arctic is primarily aimed at Scientific and environmental research. India's interaction with the region is limited to only a few Arctic states such as Norway and Russia. The oil and gas resources in the Arctic are significant to resolve India's energy conundrum and assist in the shift towards the renewable energy. The rare minerals found in the Arctic are also important towards self-reliance in technological advancement.

The study reveals that India needs to increase its presence in the Arctic to fully gain from the environmental changes taking place in the Arctic and become a dominant player in the evolving geopolitics in the region. Towards this, India needs to expand its bilateral and multilateral engagements with all stakeholders and broaden the relationship from mere scientific research to social endeavours.

India needs to increase its connectivity with the region by extending the proposed International North South Transport Corridor and Chennai Vladivostok Maritime Corridor to the Barents and Norwegian Seas and further to Norway and Iceland. There is a need to give a strategic push to the 'Act East' policy to make it a 'Far East' policy. The study brings out the need to review the maritime strategy of the country and utilise the Indian Navy to further its maritime diplomacy with the littoral nations. Self-reliance through construction of a Polar Research vessel is the need of the hour. The study states that education about climate change in the Arctic region and its socio-economic and strategic impact at all levels of the Government including schools and universities will go a long way in generating awareness on the relevance of the Arctic region. It is imperative for India to bring the Arctic draft policy into the force at the earliest so that maximise its efforts towards sustainable engagement with the region

CHAPTER 1

INTRODUCTION

Arctic Region and Arctic Council

The Arctic is geographically demarcated by the Arctic Circle at 66°33′N. The region includes territory of eight countries; Canada, Finland, Iceland, Norway, Russia, Sweden, the United States, and Denmark *via* Greenland (Figure 1.1). The region has a population of almost 10 million and is characterised by ice-floes, midnight sun/polar night, and long periods of below-freezing temperatures (Lavengood 2021).

Figure 1.1. Map of Arctic Littoral States

Source: www.arcticportal.org

The Arctic Council, created in 1996, is the leading international intergovernmental forum for addressing issues relating to the Arctic. The Arctic Council is not a treaty-based international organization but rather an international forum that operates on the basis of consensus, echoing the peaceful and cooperative nature of the Arctic Region.

The Arctic Council has eight Arctic states as members. In addition, permanent status has been granted to six organisations representing the indigenous people of Arctic region. Thirteen non-Arctic states, thirteen intergovernmental and inter-parliamentary organizations and nongovernmental organizations have been approved as observers. The council states that "Decisions at all levels in the Arctic Council are the exclusive right and responsibility of the eight Arctic States with the involvement of the Permanent Participants. The *observer definition clearly, without being subordinate, emphasises on the non-Arctic states to 'accept', 'support', 'recognize', 'respect' and 'demonstrate' various objectives of the Council* (CRS Report, 2021).

Climate Change in Arctic Region

From a few imperialistic expeditions during the 17th to 19th century, the Arctic region in the 20th century witnessed incursions for scientific research being made, primarily following the discovery of rich reserves of natural resources (Gewelt 2016). The developments made the Arctic nations as well as the world realise the regions significance, which has gradually resulted in an increased interest being displayed by both, Arctic and non-Arctic nations.

While the climate change is affecting the ecological balance globally, the negative consequences of the climate change have been more rapid in Arctic Region and have had significant effects on the environment, economic activities and communities (Klimenko 2019). While the temperatures in Arctic region since 1875 have increased three times the global rate, the minimum sea ice area in 2020 was 50% lesser than what it was in 1979. Reports suggest that ice free conditions in summer minimum are expected at least once before 2050. The reduction in sea ice has led to reduction of the surface *albedo effect* (as ice reflects more sunlight and has greater *albedo*), thereby warming the ocean surface and consequent greater warming of the environment (IPCC Sixth Assessment Report 2021). Thawing of permafrost has adversely affected the land features as well as led to release of carbon dioxide and methane in the Arctic. The wind patterns and the ocean circulations have altered due to increased freshwater ingress into Arctic Ocean. The extreme weathers being witnessed in recent years across the continents are understood to be related to the climate changes taking place in the Arctic region.

The Arctic was in a state of evolution as it entered the 21st century. The impact of global climate change has gradually become more apparent and has structurally evolved Arctic region into a theatre of increased geostrategic and economic relevance. The Arctic region has a population of about four million people, which includes indigenous population that is totally dependent on the ecosystem for its living and sustenance. While the melting ice has ushered in economic development of indigenous population and enhanced access to resources; the increased commercial activities are also endangering the traditional lifestyle of the local populace (Long, 2018). The melting Arctic has led to possibilities of new shipping lanes and access to natural

resources such as oil, gas and rare minerals, resulting in a race amongst all stakeholders, within and outside of Arctic region, to remain relevant in the geopolitics of the region (Lavengood 2021).

The changing arctic climate has also raised political and security concerns among the eight arctic countries which have sovereign rights on the land, seas and exclusive economic zones (EEZs). The basic existing legal framework is not adequate to meet the new challenges such as opposing North Atlantic Treaty Organization (NATO) and Russian alliances, bilateral disputes, counter claims on limits of continental shelves and EEZs, growing military deployments, differences on status and use of new sea routes. With the growing significance of Arctic region, non-traditional security issues such as oil spillages and environmental protection issues have also gained importance (Long, 2018) Therefore, the climate changes in the Arctic region are influencing not only the Arctic but the global physical, social, geo-economic and geopolitical realities.

India in Arctic Region

India realised the importance of its vast sea coast and its effect on the country's growth and consequently established the Department of Ocean Development (DOD) in 1981. DOD helped in developing the domain expertise on ocean studies and became the primary organisation in expanding India's ocean programmes. Post gaining experience in the Antarctica, in 2008, India set-up a research station named '*Himadri*' in Ny-Alesund, in the Svalbard archipelago. The research station collects variety of

biological, glaciological and atmospheric data and conducts research on climate sciences (Sinha, 2019).

After persistent diplomatic efforts, in 2013, India was accorded an 'Observer' status in the Arctic council. As an observer of the council, India is committed to the well-being of the Arctic's inhabitants and the region's sustainable development and the protection of its environment. In addition, India maintains cordial and dynamic bilateral relations with all Arctic Council members. In 2019, India was re-elected as an Observer to the Arctic Council.

Statement of the Problem

The Intergovernmental Panel on Climate Change (IPCC) 2021 report has revealed that the temperatures in Arctic are rising at twice the global rate. The report estimates irreversible consequences of global warming especially in Arctic resulting in melting ice sheets, rising seas, species loss and more acidic oceans.

The rising temperatures have caused significant alterations in the biodiversity of marine and terrestrial ecosystems in Arctic. Opening up of erstwhile ice-covered territories have led to debates on sovereignty and international law and has unlocked new economic opportunities, primarily dealing with new shipping routes and extraction of natural resources.

As a region of high-risk climate vulnerability and high-reward economic development, the Arctic has emerged as a critical arena in the 21st century geopolitics,

scientific research and commerce, which has led to increased engagement amongst all the stakeholders in exploring the geopolitical, strategic, and economic potential of the Arctic region.

India is increasingly gaining prominence in Indian Ocean Region and Indo-Pacific. In order to maintain its grip on the emerging geostrategic environment, India needs to proactively enhance its engagement in the Arctic region.

Research Objectives

The following are the research objectives:-

(a) To study the climate changes in Arctic region.

(b) To study the ecological and geostrategic changes arising from the climate changes in the Arctic region.

(c) To examine the challenges to India for the climate changes in the Arctic region.

(d) To examine the opportunities available to India to further its engagement in the Arctic Region.

Research Strategy and Design

Since the research is deductive in nature, therefore the research strategy is quantitative. A descriptive research design will be used as content analysis is being used. The existing literature will be reviewed and adequately value added to achieve the objectives of the research.

Rationale or Justification

The geo-physical changes in the Arctic region is predicted to influence events/activities in India. A large number of studies have projected a connection between climate change in Arctic and monsoons in India. Infact, Indian researches analysing the 'hypothesised tele-connections' between Arctic and Indian monsoons have observed this relation and further investigations and validation of data on seasonal, annual and decadal time scales is being processed (Sinha, 2019). The significance of Agriculture sector in Indian economy is well known and monsoons are critical for a good agricultural produce. Climate changes in the Arctic region are predicted to influence monsoons in India, thereby affecting the country's economy.

The melting of ice in the Arctic region is expected to raise the sea level considerably, affecting those staying in coastal regions and island territories. India has a coastline of 7516 sq km with about 20 per cent of the population living in the coastal areas and a larger percentage of this residing in coastal cities like Mumbai, Chennai and Kolkata. All such coastal cities are at significant risk due to the rising sea levels.

The Himalayan glaciers are the source for the major rivers such as the Mekong and the Brahmaputra. The changing profile of these glaciers along with reduced permafrost and variations in monsoons are cause of concern for a large population dependent on water resource for livelihood and agriculture (Sinha, 2019).

As per a 2008 report released by the United States Geological Survey (USGS) Arctic region is estimated to hold almost 90 billion barrels of oil, 1670 trillion cubic

feet of natural gas and 44 billion of natural gas liquids (USGS, 2008). These large sources of hydrocarbons are vital to meet India's growing demands, especially now, when India endeavours to shift to cleaner fuel. Historically, India and Russia have been allies and have maintained close defence and commercial ties. The melting of ice also offers India an alternative to procure oil from Russia *via* the Northern Sea Route.

Arctic region also holds large concentration of minerals such as iron, gold, nickel etc and rare earth elements such as titanium, cobalt, copper, etc. These minerals and rare elements have applications in advanced technology and are therefore, vital to India's *Make in India* initiative.

The future pattern of climate change and ice-melting in the Arctic is a potential area for competition and contestation where countries' interests are bound to intersect. India's interests in the region till date have been limited to scientific research. However, the changing geostrategic environment necessitates India to comprehensively participate in the events taking place in the Arctic region.

Therefore, the proposed research attempts to study the strategic, economic, climate, science and research implications for India and the opportunities offered by the changing geopolitical scenario.

Research Questions

The research questions are as enumerated below:-

Q1. What climate changes are taking place in Arctic Region?

Q2. What is the geostrategic significance of Arctic Region?

Q3. What are the ecological and geostrategic changes arising in the world from the climate changes in the Arctic region?

Q4. What challenges are being/likely to be faced by India due to the climate changes in the Arctic region?

Q5. What opportunities are offered to India by the climate changes taking place in the Arctic region?

Q6. What is the proposed way ahead for India to maximise its strategic gains from the changes in the Arctic Region?

Limitations

The climate data changes are obtained by observing the environmental variations over a long period of time. Therefore, the ecological data on climate changes taking place in the Arctic region is primarily obtained from the existing studies/reports on the subject. Infact the existing literature too highlights the uncertainties involved in assessment of present and future impact of climate change on the Arctic region and its influence on global climate changes. Similarly, the scientific data correlating changes in Arctic region influencing the climate in India too is limited; therefore, the research primarily pivots on the information available in the secondary sources.

Research Methods and Data Sources

The research primarily deals with descriptive methods. The primary research sources include a questionnaire addressed to climate experts, think- tanks, academia, defence experts etc.

The secondary research sources include literature survey of journals and reports from the climate agencies and experts. In addition, articles, academic papers and documents published on the subject by various research organisations and think tanks have also formed a major sources of research. Articles in various periodicals and websites on the climate changes in the Arctic region have also been explored to supplement the research and formulate the views and recommendations.

Chapterisation Scheme

The broad chapterisation scheme for the study is as given below:

Chapter 1 – Introduction:- The chapter gives an insight on the geography of the Arctic region, Framework of Arctic council and brief overview of India's present engagements in Arctic.

Chapter 2 - Literature Review & Research Methodology:- The chapter elaborates on the survey of literature and details of research methodology.

Chapter 3 – Climate change in the Arctic Region and its effect in the Arctic ecosystem:- The chapter includes the climatic changes taking place in Arctic Region and its effect on the ecological system in the Arctic.

Chapter 4 – Arctic climate and emerging global challenges:- This chapter describes the climate changes occurring globally with reference to the changes taking place in the

Arctic region. The chapter also dwells on the geostrategic challenges arising from the melting ice in the Arctic region.

Chapter 5 - Challenges and opportunities for India:- The chapter outlines the challenges being faced by India from the increasing occurrence of extreme climate changes. In addition, the opportunities that arise and need to be explored by India are also examined in the chapter.

Chapter 6 – Findings and Analysis:- The chapter analyses the findings of the surevy.

Chapter 7 – Way forward for India:- The chapter proposes the way ahead for India to further its engagement with all stakeholders of Arctic region.

CHAPTER 2

LITERATURE REVIEW

Climate change in the Arctic Region has large implications on the global climate because of the influence it has in the middle and lower latitudes, through the flow of air stream and ocean currents. The melting of ice due to global warming has brought in newer opportunities and varying challenges to the Arctic nations. The opening of sea routes and possibilities of extracting oil and minerals in the region has generated interests of the non-arctic nations too. The changing geopolitical situation and the security perspective has been studied by various scholars, researchers and authors. A detailed literature review was carried out to identify, evaluate and interpret the work produced by researchers and scholars on the subject matter of the research problem, identify the research gaps. The details of the literature survey carried out are enumerated in succeeding paragraphs.

Hong, N. (2021). Non-Arctic States' Role in the High North: Participating in Arctic Governance through Cooperation. The author in the research paper has explored the interests of China, Japan and South Korea and their involvement in the Arctic. All the three countries have displayed interests in the Arctic governance and obtained the Observer Status to the Arctic council in 2013. The melting Arctic Ocean provides China, Japan, and South Korea a unique opportunity in trade, access to vast resources in the region and seek to join hands with the Arctic states in the continuing multilateral effort for a new shipping administration in the Arctic Ocean. By 2035, the rapidly developing economies of Asia will be the key drivers of global energy demand

and unexplored resources in the Arctic are critical to meet this demand. Accordingly, China is strengthening its presence in the Arctic by making huge investments in in various Arctic nations. Japan too collaborating with Russian oil and gas projects in the Arctic. China, Japan and South Korea have comprehensive research program to undertake scientific studies in the Arctic region. The three countries are actively involved in various bilateral and multilateral organisations in the region and hence play a significant role in the Arctic affairs. The study reveals that Arctic cannot stay isolated from the tensions across the globe. It perceives high possibility that the shift in the Arctic security architecture will revert the present region of cooperation to the Cold war era region of competition. The opening of Arctic shows that there is no way of Arctic remaining isolated from the growing tensions across the world. While the paper evaluates the interaction of the three major Asian powers and their relationship with Arctic states, it doesn't analyze the role of India, despite being a heavyweight Asian country.

Lavengood, Z. (2021). The Evolving Arctic in the World-System, Journal of World-Systems Research. The author in the study has explored the new geopolitical and economic realities of the Arctic arising from the melting ice and permafrost thawing. The research reveals that the ongoing climate changes have structurally affected the identity of Arctic region from a wasteland to an active theater. The paper brings out the effect of polar warming on resource extraction, industrial fishing, timber harvesting, reindeer husbandry and Arctic shipping. The large economic gains is affecting the indigenous communities through devastation of the heritage land and indifference to the indigenous traditions and culture. The study also reveals the regional hegemonic rivalry between North Atlantic Treaty Organization (NATO) and

a Sino-Russian partnership. The paper concludes that as the Arctic continues to emerge from ice-lock and integrate itself more fully within the wider world-system and world-economy, its unique characteristics and realities will become more clear, evident, and pressing to the world order.

Anthony, I., Su, F., & Klimenko, E. (2021). A Strategic Triangle in the Arctic? Implications of China–Russia–United States Power Dynamics for Regional Security | SIPRI. The research paper examines the security implications of the strategic triangle formed by China-Russia-US and their power dynamics in the region. The paper briefly brings out the evolution of interests and policies of Arctic and non-arctic states. The authors have studied the geopolitical tensions and military security developments in the region including military investments by Russia and US. The study reveals that risk of escalation in military tension in arctic has grown, primarily due to worsening relations amongst major powers over disputes arising elsewhere. The aspirations of other nations in the Arctic council or those with observer status and their influence on this strategic triangle, however hasn't been covered.

Weber, J. (2020). Handbook on Geopolitics and Security in the Arctic - The High North between Cooperation and Confrontation. The handbook is compilation of research papers written by experts on International security, scholars and researchers working in government organisations and international institutions and outlines the critical geopolitical and security issues in the Arctic Region. The respective authors discuss the interests and policies of the Arctic littoral states bringing out the regional security, sovereignty and ecological issues between the regional players. The book examines the emerging interest of non-Arctic nations in the region and explores the

footprint of China, EU and India in scientific, environmental and economic activities of Arctic region. The handbook evaluates the claims made by all stakeholders to expand their territories/ exclusive economic zones as well as the economic situation and the legal structure governing the Arctic. The contributing authors have deliberated on the likely conflicts between Arctic nations arising from competing interests and consequent realignment of alliances leading to power politics in the region.

Sharma, B. (2020). China's emerging Arctic engagements: Should India reconsider its approach towards the polar north? Maritime Affairs: Journal of the National Maritime Foundation of India. The author has elaborated on China's emerging Arctic engagements towards becoming a great Polar power. The research paper gives a detailed insight into China's Arctic infrastructure, (Yellow River Stn 2003, MV Shi Lang, 1993, MV Shi Lang 2 2019) and polar administrative organization including Polar Research Institute of China. The paper also brings out China's scientific research endeavours, investments in the arctic region and initiative to link Maritime Silk Road to the Polar Silk Road, through Northern Sea Route. The study analyses India's endeavours in the Arctic and concludes that presently India's interaction is limited to scientific research. The author proposes the need to diversify and interact with the region with an economic, social, scientific, energy and strategic perspective.

Dodds, K & Nuttal, M. (2019). The Arctic, What Everyone Needs To Know. The authors of the book have offered a crisp insight into the Arctic region, its peoples, environment, resource development, conservation, and politics. They have brought out the connection of Arctic with the rest of the world and how it is affected by the global influences. The authors bring out that the Arctic region is dynamic, complex and

diverse, further complicated by the shifting physical boundaries due to climate change. While indigenous cultures are diverse with many indigenous people, in large parts of arctic, non-indigenous people outnumber indigenous people and Asian, European, and American communities are integral to Arctic economies and societies. They have brought out how the regions importance has grown over time and the role of the indigenous communities in the past and future governance. The impact of warming is uneven; the loss of sea ice and the thawing of permafrost mean risks and vulnerabilities, but also allow opportunities and possibilities. While loss of sea ice and global warming poses threat to the region; industrialisation, urbanisation, resource extraction and commercial shipping also provide opportunities of investment, employment, better education and health, and exposure to improved technology. The authors have outlined climate change, geopolitics, globalization, technology, and northern autonomy as factors that make the Arctic a complex region.

Post, E., Alley, R. B., Christensen, T. R., Macias-Fauria, M., Forbes, B. C., Gooseff, M. N., Iler, A., Kerby, J. T., Laidre, K. L., Mann, M. E., Olofsson, J., Stroeve, J. C., Ulmer, F., Virginia, R. A., & Wang, M. (2019). The polar regions in a 2°C warmer world. Science Advances. The researches in this research paper have analysed the ecological transformations in the polar region in a 2 deg warmer world. The simulations under two carbon emission models depict increased warming & spatial variability in warming in Arctic. The research addresses impact of ongoing and accelerating sea ice loss as well as increased human activity such as offshore oil drilling and shipping on marine organisms and plant diversity. The study also reflects on the ecological consequences of polar warming on weather in lower latitudes leading to persistent mid-latitude summer extremes, such as floods, heat waves or extreme rainfall

etc. The paper also brings out the impact of melting ice on rise of sea level. The research however doesn't include mitigation measures to be taken to reduce or control the global warming and also any cooperative scientific framework that can be formulated through multilateral mechanisms.

Nanda, D. (2019). India's Arctic potential. ORF. The research paper has examined India's role and stakes in so-called 'Arctic Paradox'. The author deliberates the Arctic conundrum in the light of melting ice which has led to a scramble for territorial claims and seeking larger share of resources among all stakeholders. The paper brings out India's current engagements with Arctic littoral states, especially Russia and increasingly closer ties being formed by other observer nations of Arctic council with the Arctic countries. The author has brought out the need to increase the presence in the Arctic and focus on collaboration with other nations on enhancing research facilities, economic activities and improving relations.

Sinha, U. K. (2019). India in the Arctic: A multidimensional approach. Vestnik of Saint Petersburg University. The research paper examines India's civilizational connect to the Arctic. The paper dwells on India's polar evolution before stating its enduring scientific, diplomatic and political interaction with the Arctic littoral states. The research paper brings out India's engagement with littoral states of Arctic region especially Russia towards building an 'energy bridge' between the countries. The paper concludes that India needs to enhance its interaction with Arctic council towards maintaining sustainable resource development without making the Arctic unstable. While the research paper has been published in 2019, post covid era has seen

major shift in power equilibrium in the world, which will have its influence on the power dynamics in the Arctic region too.

Klimenko, E. (2019). The Geopolitics of a Changing Arctic | SIPRI. The author has studied the Geopolitics of a changing Arctic and the complexity of its security. The paper brings out the growing challenges to water, food, health and economic security arising from climate change – which acts as a catalyst for changing security in the Arctic. The growing strategic significance of the region is also leading to militarisation of the region. The author recommends cross border regional engagements to discuss military security issues to address the security challenges in the region. The focus of the paper, however remains limited to US-Russia-China and doesn't study the influence of other littoral states.

Gewelt, A. E. (2016). India in the Arctic: Science, Geopolitics and Soft Power Perspectives on Contemporary Indian Foreign Policy. The author has analysed the evolution of Indian foreign policy from the point of India's engagement in the Arctic. He has explored Indian Arctic engagements and its geopolitical aspects leading to attaining observer status in Arctic Council in 2013. His thesis establishes the role of soft power as a political strategy in India, especially in its foreign policy. His study reveals that India's role in Arctic is limited to debates and discussions in think tanks, scientific research papers and special forums. The author has brought out the role of 'science diplomacy' being progressed by India in the Arctic. The focus of the thesis primarily remains on India's foreign policy and leaves ample opportunity to progress further research on the engagement of other Asian powers with Arctic region and its implications on India foreign policy.

The existing literature review strengthens the belief that the climate change in Arctic region is influencing the climate across the globe and extreme climate events occurring in various continents may be linked to the changes in the Arctic region. Littorals states in the Arctic region are taking measures to cope with the challenges arising from these climate changes.

The nations in the Arctic region as well as a few Non-Arctic States are also preparing to be ready to utilize the opportunities that may arise due to the melting sea ice in the Arctic region. However, the existing literature has scant knowledge on the challenges that India faces due to the climate change in the Arctic region. India has maintained a Polar station in the Arctic since 2008 and its interest have primarily been focused on the scientific research. The existing literature doesn't dwell on opportunities that India can exploit from the climate change in the Arctic.

CHAPTER 3

CLIMATE CHANGE IN ARCTIC REGION AND ITS EFFECT ON ARCTIC ECOSYSTEM

The Polar Regions are undergoing a dramatic transition as a result of climate change - more quickly and visibly than most other parts of the world. The effects of global warming have been most noticeable in the Arctic, where large areas of sea ice and snow cover are melting, sea water is becoming warmer in many areas, permafrost soil is thawing more frequently and for longer periods, and glaciers in Alaska, Canada, Greenland, Iceland, and Norway are all losing large amounts of ice. Since the late nineteenth century, the Earth has warmed by about 0.8°C, whereas the Arctic has warmed by 2° to 3°C (World Ocean Review, 2019).

Climate models have predicted that if global warming continues at its current pace, the Arctic will be fully ice-free by 2050 (Thackeray & Hall, 2019). The reduction in ice will reduce the earth’s albedo. Albedo indicates the reflection ability of the earth. Ice and snow have a very high albedo, thereby reflecting the sun’s radiations back into the atmosphere; while dark surfaces such as ocean water have lower albedo, which results in greater absorption of solar energy. The release of huge amounts of methane and methane-derived carbon dioxide from gas hydrates beneath Arctic ice would be accelerated by scientific methods of 'Arctic amplification' and a significant drop in 'earth's albedo,' thus exacerbating the general warming process in the Arctic (Ruppel & Kessler, 2017).

This region is home to a rich and frequently unique flora and wildlife, as well as people, especially indigenous communities, who have long lived in and adapted to some of the world's most extreme climate, meteorological, and daylight circumstances (Stephen, 2018). Climate change is having a significant impact on Arctic populations, and the ecosystems of the Arctic are undergoing fast transformations. Extreme events are becoming more common in the Arctic. Recent findings indicate increase in the frequency and/or intensity of rapid sea ice loss episodes, melt events on the Greenland ice sheet and wildfires. Extreme high temperatures have increased, whereas extreme cold events have decreased. Since 2000, cold spells lasting more than 15 days have almost entirely vanished from the Arctic (AMAP, 2021).

Physical Drivers of Change

In the Arctic, climate change is presently, the most critical issue. The Arctic ecosystem is changing at a quicker rate than the global average, with extensive changes in precipitation, snow cover, sea and land ice, permafrost, and extreme events.

The temperature difference between the northern region and the southern parts reduces as the Arctic warms, weakening the westerly winds that form the Polar Jet Stream. Because of the large amount of heat absorbed by the oceans near the Arctic's periphery, sea water does not freeze until October/November. In the meantime, the sea water releases the excess heat and moisture, resulting in significant snowfall and the formation of a high-pressure system over Siberia. Simultaneously, excess heat released by the sea creates a warm temperature pocket to the west. This warm air pocket causes the westerly Polar jet stream to rise higher into the stratosphere. A polar vortex existing

over the Arctic is disrupted by this Polar jet stream. Simultaneously the Polar jet stream is weakened by the disturbed polar vortex, causing impeding high and low-pressure regions to hover over Europe and Asia (as shown in Figure 3.1). As a result of the pressure gradient, cold air is diverted to Asia and Europe, while warm air is diverted to the Greenland Sea. This warm air increases the air temperature over the Arctic Ocean, reducing the number of freezing days and causing the sea ice to melt faster (Turton, 2021). The weakened jet stream deviates and moves the polar vortex further south, thereby resulting in extreme weather events to occur in North America, Europe and Asia.

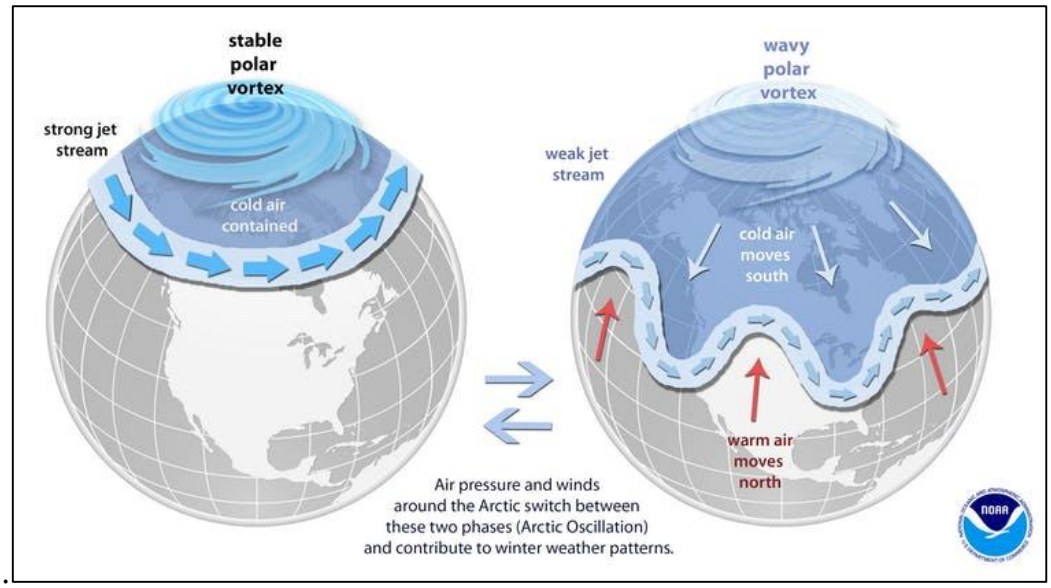

Figure 3.1. How the Polar Vortex Works

Source: https://www.weforum.org/agenda/2021/06/climate-arctic-glacial-melt-rate/

The period from 1971–2019 has witnessed the average Arctic near-surface temperature increasing annually by about 3.1°C (as shown in Figure 3.2), which is more than thrice the global average (Deshayes, 2021). This polar amplification of surface air temperature is taking place as a combined result of surface albedo responses from losses

in sea ice cover, cloud-sea ice exchanges, greater northward transportation of heat and moisture and growing cloudiness and water vapour (Bruhwiler et. al, 2021). The global climate model projections illustrate rise in Arctic annual mean surface air temperatures to 3.3–10°C above the 1985–2014 average by 2100, depending on the future emissions. Most of the predicted models project the sea-ice-free Arctic in September occurring before 2050 (AMAP, 2021).

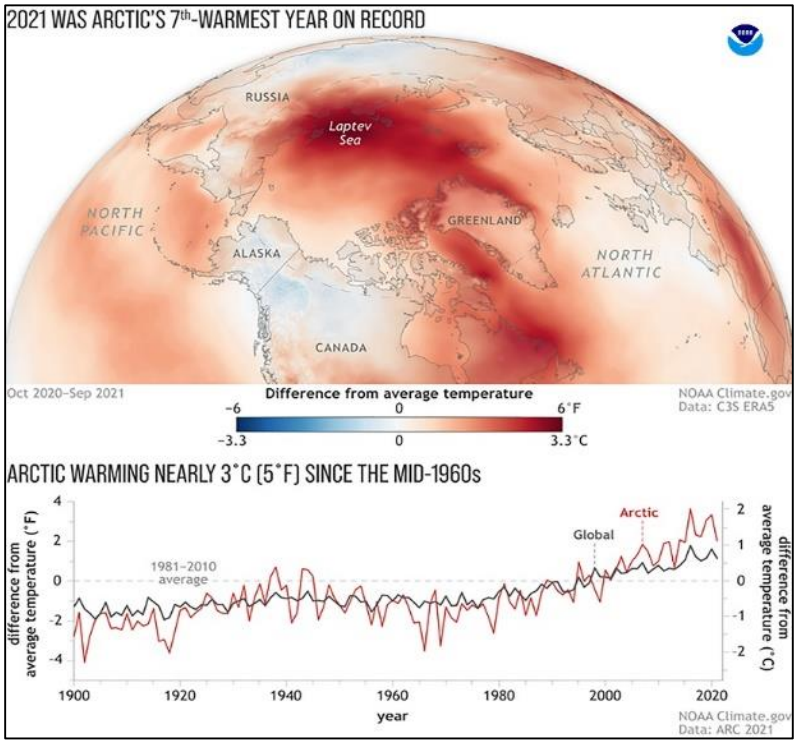

Figure 3.2. Arctic vs Global warming

Source: https://www.climate.gov/news-features/featured-images/2020-arctic-air-temperatures-continue-long-term-warming-streak

The Arctic climate system is influenced by atmospheric humidity, clouds, and precipitation. Local evaporation and moisture transported from lower latitudes contributes to atmospheric moisture in the Arctic. The increasing air temperatures in the Arctic region alongwith the inflow of warmer water from the middle latitudes has caused the Arctic Ocean to warm rapidly, resulting in more moist air being formed in

the region. Fog and cloud development have increased as a result of the increased precipitation (Vihma, 2015). The data obtained since 1993, from the daily weather-balloon launched to an altitude of 30 Kms reveals warmer and moist air in the region. Both, the observed and model data show an increase of more than 9% in total annual precipitation from 1971–2019 (AMAP, 2021). The higher atmospheric humidity and cloud formation in springs, is causing the snow cover on the Arctic sea ice to melt earlier; while in summer, the low clouds and fog enhance warming of the remaining surface sea ice. The scientific models have suggested that in autumn, a reduced sea-ice cover increases cloud formation over the Arctic Ocean, which results in thinner newly formed ice at the beginning of winter (World Ocean Review, 2019).

As a consequence of higher temperatures in the Arctic every successive year, lesser sea ice is noticed by the end of summer. The satellite data between 1979 and 2019 (as shown in figure 3.3) shows decline of more than 43 percent in sea ice coverage every September while sea ice extent is declining over entire Artic region throughout the year (IPCC, 2019).

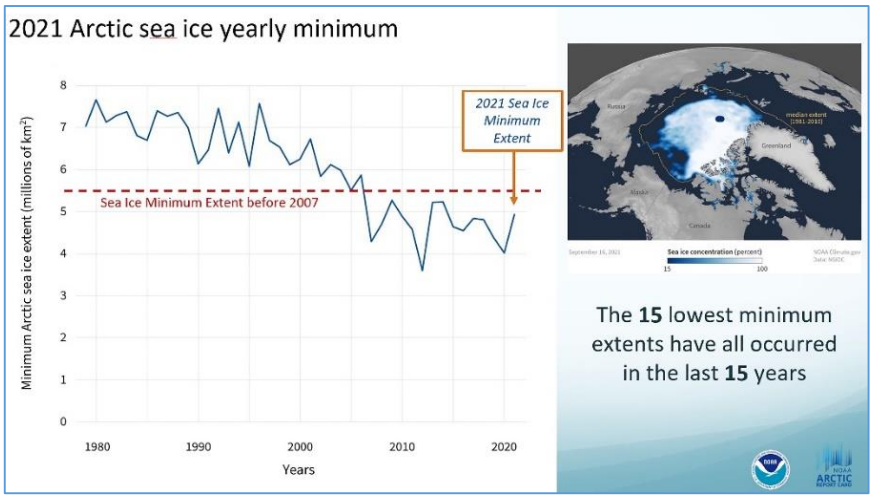

Figure 3.3. Arctic Sea Ice yearly minimum

Source: https://www.noaa.gov/news-release/arctic-report-card-climate-change-transforming-arctic-into-dramatically-different-state

Infact year 2012 saw smallest extent of sea ice ever recorded wherein the ice covered only half of the area in comparison to what was covered three decades ago. In last 30 years, depth of sea ice in the western Arctic has reduced by one-third and since 1985, the thick multi-year ice area (10-13 ft thick) has reduced drastically by about 95%. More than 75% of Arctic sea ice presently is first year sea ice, which is formed only in the past one year and has a thickness of about 3-7 ft (Stephen, 2018). The less ice thickness in summer is resulting in the winter ice becoming thinner and less stable. This thin ice then breaks up easily and quickly in summer, further exacerbating the trend of loss of sea ice. The ice loss from the land masses in the Arctic results in rise in sea levels as well as changes the movement pattern of water in the region, further affecting the water circulation of oceans globally (AMAP, 2021).

The present global warming condition has made the Arctic permafrost less stable than earlier. Since 1970s, the Arctic permafrost has become warmer by about 1.5-2.0°C. Various cold permafrost locations have witnessed greater rates of warming in last two decades. (Dixon, 2020). In fact, over the next few decades, the permafrost melting is predicted to increase significantly. Model projections of Northern Hemisphere near-surface permafrost area shows a reduction from the present area of 15 to 12 million km^2 by 2040; a 20% decrease (Elias, 2021).

Currently, Arctic coastline is eroding by half-a-meter on an average every year. In last 60 years, the north-south length of Muostakh, a Siberian permafrost island has reduced by more than half a kilometre and its area has reduced by 25% in the same period (Bär, 2020*).* Every degree increase in air temperature is expected to result in a loss of 0.8 to 2.3 million square kilometres of permafrost. As per IPCC report, the

permafrost area will reduce by 21 - 37 per cent with a global warming of 1.5 degrees Celsius or less (IPCC, 2021). Another study has estimated that by 2050, more than 36,000 buildings, 13,000 kilometres of roads, and 100 airports would be at risk of damage from near surface permafrost thaw in the Arctic (Hjort *et al.*, 2018). The degradation of Arctic permafrost coasts, besides influencing the biological conditions of the sea, is also compromising land and infrastructure built near the coast. Increased erosion of land is resulting in more mud flowing into the sea, thereby causing large turbidity in shallow water areas. The eroded particulate also contains pollutants such as mercury which on reaching the oceans, affect the marine bio-life.

The frozen grounds in the Arctic are known to store large amount of carbon in the form of fossil animal and plant remnants. These soils are estimated to possess about 1100 to 1500 billion tonnes of carbon. Presently, more than 60 percent of this carbon is permanently frozen and unavailable to global carbon cycle. Hence, the permafrost soils of the Arctic are also known as ‘gigantic ice chests’ (World Ocean Review, 2019). The thawing of permafrost is enabling the release of carbon stored over years. As per IPCC, about 120 gigatons of carbon is predicted to be released by permafrost thawing into the atmosphere by 2100; resulting in additional global warming of about 0.21°C (Resnick, 2019).

Changing Arctic Ecosystems

Climate change is affecting small Arctic communities, particularly indigenous populations, in terms of sustenance, harvest-based livelihoods, and food security. Arctic climate change is also endangering people's safety, health, and well-being, severely

affecting the infrastructure, and negatively impacting various industries. Warmer waters from the adjoining Pacific and Atlantic Oceans are flowing further into the Arctic Ocean; causing an extensive effect on the ocean ecosystems. The distribution and quantity of a range of invertebrate, fish, and marine mammal species, as well as the composition of Arctic plankton populations that constitute the foundation of marine food webs is also seen to be changing.

Between 1982 and 2019, Arctic tundra greenness has increased by about 10% due to the longer and warmer summers (Frost et al, 2020). Arctic vegetation is crucial in energy and carbon exchanges between the land and the atmosphere, and it can generate climate-ecosystem feedbacks that aggravate climate change. For instance, development of shrubs into trees results in reduced albedo of the region. Greater vegetation leads to higher rate of evaporation, leading to increased water vapour content in the atmosphere, which once again gives a positive feedback to global warming (Pearson *et al.*, 2013).

From microscopic plankton to walrus and polar bears, Arctic organisms and mammals have evolved in response to the unique Arctic environment over millions of years and rely on the presence of sea ice to complete their life cycles. As the sea ice recedes, these species will lose habitat, and their future survival will be determined by their ability to adapt to the shrinking sea ice cover (Stephen, 2018). Furthermore, as the Arctic summers warm and the ice-free season becomes longer, species from the southern regions may begin to move northward. Competition for food and other resources between these species has the potential to cause massive ecological restructuring and perhaps extinction. Arctic ecologists are especially concerned about

"tipping points," or areas where a little shift in climate might have significant, irreversible ecological consequences (Arctic Matters, 2015).

Chemical pollution is extremely harmful to tundra vegetation and soils. Toxic chemicals are trapped in the shallow active layer of the soil and take a long time to disperse or degrade. Air pollution from lower latitudes is transported by atmospheric circulation, and the pollutants tend to concentrate in the Arctic. Because of greater emissions resulting from increased human activities as a result of warming, such as shipping, resource extraction and tourism, there is a likelihood of the polycyclic aromatic hydrocarbon concentrations to rise in the Arctic region (Elias, 2021).

In year 2015, two giant viruses were discovered beneath Arctic permafrost researchers by the researchers working in Siberia. According to the scientists, melting of the Arctic ice could result in the release of deadly viruses that have been lying under the Arctic ice for millions of years. It is believed that the present-day ecosystems could get infected by these ‘zombie viruses’ beneath the Arctic ice (Roper, 2019). The evolving interconnectivity between the oceans, *viz.* the Arctic, Atlantic, Indian and Pacific oceans as a result of the melting ice and inflow of water is likely to aid the transfer of the viruses from the Arctic region into the food chain of the other regions. The migration of marine life from the lower warmer latitudes to the Arctic and *vice versa* make the geographically connected populations vulnerable to new challenges (Wormer *et al.*, 2019). Migratory birds from Asia to Arctic and vice versa would enhance the transfer of viruses and deadly infections and add a new dimension to such problems (Sharma, 2021).

Impact on Arctic Communities

Climate change is causing rapid changes in the Arctic, which affect those living in the Arctic and beyond, particularly indigenous population. Ecosystems in the Arctic are undergoing major changes in their structure and functioning, which are influencing global climate change through feedbacks in the climate system. Agriculture, commercial fishing, oil production, and cruise tourism are all expanding in the Arctic, posing threats to coastal population and their livelihoods and the vulnerable ecosystems.

The Arctic has a population of about 4 million people. Approximately, 9 percent of this population are indigenous people who have distinct and unique cultures and represent more than 40 ethnic groups. While 74% of the Arctic population is located in a few large settlements which have populations of 5,000 or more, almost 90% of Arctic settlements are small and have population less than 5,000 people (Wang, 2019). Further, about 66% of Arctic settlements are positioned on permafrost, and nearly half (46%) of those permafrost settlements are in the coastal regions (Ramage, 2019).

The transportation over snow, ice, and permafrost in the Arctic has been affected by the rising temperatures. Degradation of permafrost and increase in the intensity and frequency of local rain events have adversely affected the road infrastructure. The reduction in the sea-ice cover and its thickness has enhanced the risks to transportation over ice and the areas reachable only in winter by ice road are likely to be less accessible in future.

With the oceans becoming warm and fresh, the conditions are more suitable for development of toxic algae blooms. These algae are potential health hazard and risk to food security. Further, heavy rainfall alongwith the melting of snow is expected to facilitate transportation of pathogens which poses risks to safe drinking water. Contaminants, such as mercury released due to permafrost thawing can reach the aquatic ecosystems and thereby polluting it. The availability of traditional foods such as whales, walrus, seabirds and reindeer etc is being affected by the changing temperatures, sea ice, precipitation and tundra productivity. The increasing trend of warmer springs and greater tundra greening alongwith the impacts of climate on wildfire, forage, and predators, is posing many challenges to livelihood of pastors (AMAP, 2021).

The sub-Arctic fish and marine mammal species are observed to be expanding northwards due to the increasing impact of reduced sea-ice cover and warmer waters of Atlantic and Pacific. The movement of the aquatic life towards north increases the opportunities for commercial fishing in some regions of the Arctic e.g., the northern Barents Sea, northern Bering Sea, and Sea of Okhotsk, with increased economic benefits for communities residing in coastal Arctic. The expansion of Salmon farming and other forms of aquaculture northward in parts of North Atlantic Arctic is also creating extra economic opportunities However, spread of parasites amongst local fish population and competition within local fisheries are few associated societal and environmental costs of aquaculture (Stephen, 2018). The warmer climate with its associated challenges has also resulted in decreased health of wildlife and a greater occurrence of worms in fish and sea mammals. All these are affecting the livelihood and health of the indigenous communities.

The impact of climate change on the agricultural activities in the Arctic is quite complex. An increase in temperatures will result in a warmer climate that could assist crop production further north, resulting in better average annual yields. However, it will also cause water shortage and increase in occurrence of diseases, which will consequently have a negative impact on the crop yields. Also, commercial agricultural development is likely to be limited by the lack of infrastructure. Though the permafrost thawing continues to make land transportation routes increasingly unusable, the transportation costs for Arctic agricultural products would get profoundly impacted by the new shipping lanes (Stevenson, 2014). While the increased agricultural production will help in improving the food security in the region; the impact of agricultural activities is going to be minimal since as it is not a traditional cultural livelihood of the local communities.

Permafrost thawing in various regions of the Arctic is causing damage to the buildings, roads, and other infrastructure. The thawing of permafrost changes the shape of the land and the resultant erosion gravely affects the infrastructure, necessitating major repair works, resulting in large costs to the local population. The rate of coastal erosion in the Arctic is one of the highest globally with almost 70 percent of infrastructure being placed in the risk area. Almost 500 cities and villages are situated in areas which are expected to be affected by the permafrost thawing by 2050. The cost of maintenance and repair of infrastructure in the Arctic region affected by the permafrost thawing is likely to be about 30 billion euros by 2060 (University of Helsinki, 2022).

Opportunities and Risks with More Accessible Arctic

The increasing global interconnectivity has accelerated in recent years and the Arctic has become increasingly important for global trade, supply chains and communication network. Access to resources such as oil, gas, and minerals in the Arctic is predicted to rise because of climate change. The Arctic is also influenced by global political power shifts, particularly as the world becomes multi-polar from the extant unipolar. This has also led to an increased attention from the non-Arctic states to the Arctic region. Arctic researchers are increasingly scrutinising and studying the growing complexity of international organisations, legal agreements, and norms that pertain to the Arctic.

There has been an increased exploration in the Arctic region resulting from the enhanced accessibility to the undiscovered oil, gas and minerals deposits. However, an increase in the exploration activities brings along with it several opportunities and associated challenges. The prospects of economic benefits need to be carefully balanced with the adverse impact on the political, economic, physical, ecological, social systems. As the oil activities increase, there is a related risk of oil spill and managing such an oil spill in the remote and harsh environment of the Artic poses unique challenges. The ability to effectively coordinate any disaster management efforts is severely restricted by the limited response/recovery equipment and poor communication infrastructure in many areas of the Arctic. While oil spills are dangerous and harmful to ecosystems anywhere in the world: the affect is much grave for the local population of the Arctic region. Since the local population in the Artic is primarily dependent on fishing and

hunting for its livelihood, any damage, even if temporary, will adversely affect the communities.

With the melting ice and warming Arctic over the years, there has been a gradual increase in the shipping traffic in the region. These ships are primarily entering the Arctic for oil and gas exploration and transportation, undertake research missions and increasingly for tourism. The climate change has allowed the ships to ventures in the waters which were earlier ice-locked. However, the increase in the shipping also increases risks to the environment and people of the region. The Arctic region is hazardous for safe navigation of vessels due to the floating ice remnants and rapidly changing weather conditions. The limited communication network, poor charts and inadequate navigational information are major challenges for the vessels navigating through these waters. All these limitations also restrict the emergency response in event of search and rescue operations. The increased shipping alongwith the associated oil spillages will also adversely impact the marine life.

The warming Arctic is also opening up the Arctic for tourism. With the melting ice, the number of tourists visiting Arctic is also rapidly increasing. The northern Arctic witnessed an increase of cruise ship visitors from 67,752 in 2008 to 98,238 in 2017; a 57% increase (Palma, 2019). An increase in the number of tourists is helping in the economy of the region and creating additional jobs in the forms of restaurants, guides, tours companies etc. However, the rise in tourism is also putting additional pressure on the existing resources, such as water, land, wildlife etc. The growing number of tourists are resulting in increased pollution and environmental degradation.

The warming Arctic is affecting the existing ecosystem and bringing associated socio-economic and political changes to the lives of the indigenous population. There is a growing inflow of new cultures, new ideas, new people and new opportunities from the warmer regions to the high North. The traditional knowledge and values, the cultural identities of the indigenous residents are being impacted by the changing pattern of harvesting, fishing and hunting (Stephen, 2018). Indigenous peoples' distinctive status as Arctic rights holders and keepers of traditional and local knowledge reflects their importance in and for Arctic governance (Alfredsson & Koivurova, 2017).

The Arctic region has been affected by the global warming much more than any other region in the world. The change in climate has caused melting of sea ice, increased fog and water vapour leading to greater precipitation, change in ocean currents and wind patterns. All these changes have influenced the ecosystem of the Arctic region. In addition to the effects on the biodiversity, the region has witnessed large socio-economic, political and governance changes. These changes have resulted from increase in resource extraction, shipping, tourism, and shift in geopolitics of the region. The migration of human and animals including marine life is affecting the way local population lives. The enhanced urbanisation and economic activities is impacting the livelihoods of people and exerting undue pressure on the existing infrastructure and ecosystem.

The changes in the Arctic region are not limited to the region; but also being felt across the globe. The warming of the Arctic is causing sea level rise which is affecting the coastal cities across the world. The increase in the permafrost thawing is causing an increase in the release of Greenhouse gases, which is further exacerbating

the global warming. The warming of oceans is affecting the Polar vortex and Polar jet stream which is causing an increase in the extreme climate events in various parts of the world. The opening of northern shipping routes, increased accessibility to oil and gas reserves in the Arctic and associated risks from excessive resource extraction create numerous opportunities and challenges for both, the Arctic and non-Arctic states.

CHAPTER 4

ARCTIC CLIMATE AND EMERGING GLOBAL CHALLENGES

As the earth gets warmer, Arctic region is witnessing melting of sea ice and there has been a swift change in the perception of the world with respect to the Arctic region. The region has seen a large-scale increase in various studies being taken by Nations, independent organisations and researchers; all of whom are studying the impact of climate change and scientific studies in the field of atmospheric science, geology, glaciology, polar biology and Arctic microbiology. The opening of Arctic as a consequence of increasing temperatures has made Arctic a region with tremendous opportunity for economic gains, especially through resource extraction, shipping, tourism, and infrastructural development. The growing strategic relevance of the region has raised the stakes for all the Arctic and non-Arctic states and there is an increased competition amongst all stakeholders for gaining strategic foothold in the region.

Because of its tele-connections to places further south, the Arctic is an essential part of the global climate. The flow of air streams and ocean currents create these long-distance interactions. Arctic climate change is amplified by positive feedback loops. One such self-reinforcing feedback loop is – reduction in snow and sea ice cover in Arctic due to growing surface air temperatures; which reduces the planetary albedo and causes greater absorption of solar radiations; which then further increases the global mean temperatures (Elias, 2021)

The effects of climate change taking place in the Arctic are being felt far beyond the Arctic. These can be seen as growing frequency and intensity of extreme climate events, especially in North America and Europe and global sea level rise. Raging wildfires in California and Mediterranean countries, devastating floods in India, China and parts of Latin America and extreme heat events across North America, Madagascar and Australia are a few of the effects of climate change taking place world over. A recent study suggests weakening of the Atlantic Meridional Overturning Circulation (AMOC) current system which can destabilize the Gulf Stream; consequently impacting the global climate (Marks, 2021).

The increasing melting of ice in the Arctic is reported to have a direct linkage with the Monsoons in India. Similarly, climate change in the Arctic are impacting the climate systems in China and as far as Australia. While various studies have shown connections between climate change in the Arctic and weather patterns in lower latitudes, the linkages have been complex and inconsistent. Notwithstanding, local geographical consequences of major changes in the Arctic are creating a slew of problems for indigenous populations.

Global Consequences of Climate Change in the Arctic

The weather and climate across the earth is influenced by the wind patterns and ocean currents. However, the climate change in the Arctic is interfering with the present system and affecting the weather several minds away in the lower latitudes. The changes in the layers of land snow and sea ice is altering the flow of energy and moisture between the earth's surface and the atmosphere. The resultant changes in the

energy causes an upward motion of the air flow, which interferes and weakens the Polar vortex flowing in the stratosphere over the Arctic region.

The disrupted polar vortex causes the upward moving waves to reflect towards earth in a manner so that as to cause meandering of the Polar jet stream. The southward movement of the jet stream brings colder at lower altitudes above North America, resulting in colder winters. An experiment carried out using Machine learning technique revealed a typical sequence of activities wherein the surface temperature changes in the Arctic initially which affects the stratospheric polar vortex and then cold waves in North America and Asia are witnessed over a few months (Figure 4.1). A computer based model evaluated the cause and effect of atmospheric changes with the Arctic changes and supported the analysis of the Machine learning experiment (Cohen, J., & Barlow, M., 2021)

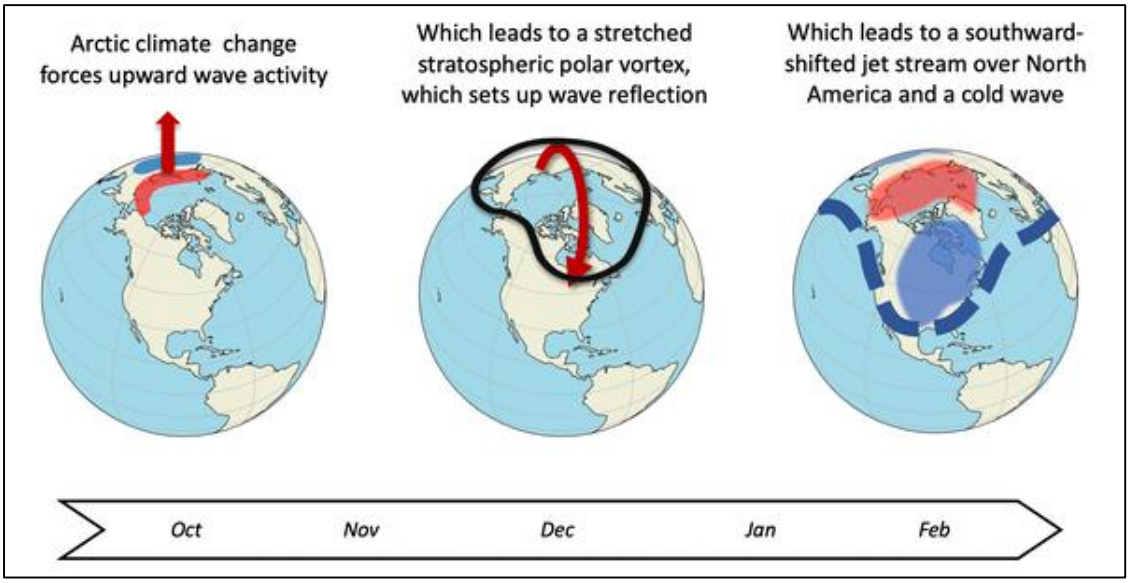

Figure 4.1. Time-based pathway from Arctic climate change to cold temperatures in North America.

Source: https://www.weforum.org/agenda/2021/09/arctic-warming-trigger-extreme-cold-waves-texas-freeze-study/

The ocean currents circulation is affected by the salinity as well as water temperature. Therefore, the changes in the Arctic which are causing excessive melting of ice, are leading to large amount of fresh water being added to the Arctic Ocean; which will then influence the oceans current. Any change to the ocean current flow, which is a major driver for global weather pattern, therefore impacts the weather worldwide. While there are not any predictions to the extent of the effect of climate change in the Arctic on the ocean circulation as yet; the research is ongoing, studying the possibility of slowing down of Atlantic Meridional Overturning Circulation (AMOC), a major current in the Atlantic Ocean due to the changes in Arctic Ocean. It is believed that the AMOC is slowing down, and any significant change in the AMOC flow would change winds, temperatures, and precipitation patterns globally with large regional effects along the east coast of the United States and the west coast of northern European countries. (Arctic Matters, 2015)

The measurements recorded from various sources reveal 20.3 cm average global sea level rise since 1901. The data from the high precision altimeter satellites reveals that period between 1993 and 2002 witnessed a global mean sea level rise of 2.1 mm per year, which increased to 4.4 mm per year between 2013 and 2021(World Meteorological Organization, 2021). Global mean sea level evolution from January 1993 to September 2021 is shown in Figure 4.2. The Greenland Ice Sheet is the world's second largest source of freshwater. The melting of the Greenland ice sheet therefore has global consequences. From 2003 to 2008, the melting Arctic glaciers and the Greenland Ice Sheet have resulted in an increase of about 1.3 mm, which is more than 40 percent of the annual sea level rise observed globally. Incase, there is no change in

the global emissions, then by the end of the 21st century, Greenland alone could contribute to sea level rise of 14-33 cm (Arctic Matters, 2015).

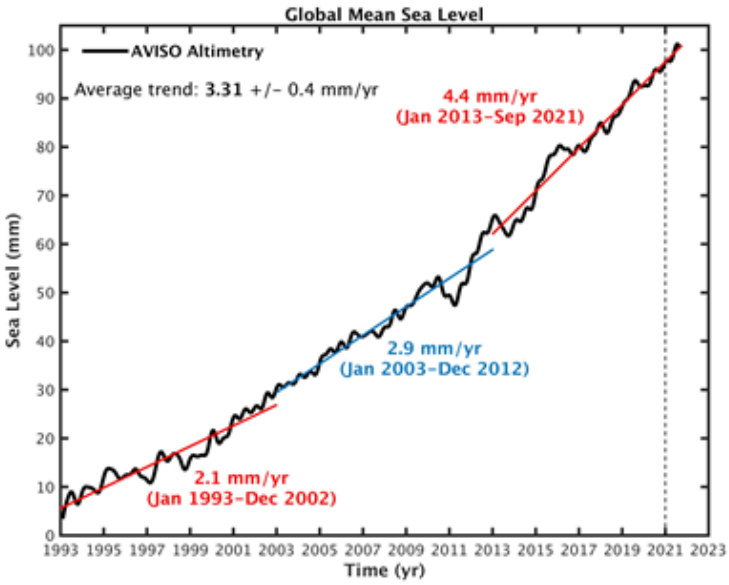

Figure 4.2. Global mean sea level evolution from January 1993 to September 2021.

Source: AVISO altimetry (https://www.aviso.altimetry.fr)

Presently, almost 40% of the world's population lives within 60 miles of the coasts. By 2030, about 880 million people are expected to be residing in coastal regions and by 2050, more than two-thirds of the population is likely to be at risk of coastal flooding. Therefore, the sea level rise along with the associated storm surges pose considerable threat to both, the people and infrastructure in the densely populated coastal regions (Hodgkins, 2019; Gill, 2021). The storm surges are already a present danger. The storm surge that accompanied Super storm Sandy caused damage worth billions of dollars to businesses and infrastructure (Gibbens, 2019).

Arctic and subarctic waters account for 10% of global fish catches. Changes in the Arctic maritime environment might have a big impact on this global food source, affecting local populations, regional labour markets, and worldwide trade. The melting

of ice has resulted in opening of new areas for fishing; thereby improving the outlook for fishermen. Increased accessibility and warmer waters has resulted in southern species such as Pacific salmon being found in Northern regions. However, new species are also a threat to existing marine life in the region. The influx of freshwater and increasing temperatures also have significant effects on the marine food chain. Additionally, the climate change may cause extinction of certain species which may result in loss of opportunity to benefit in the field of medicine, microbiology, engineering and other applications (US Climate Resilience Toolkit, 2016).

Extreme Events Worldwide

The climate change in the Arctic has resulted in an increased frequency of extreme weather events. Figure 4.3 depicts the selected significant climate anomalies and events in 2020. During the storm season of 2020, globally 102 named tropical storms were witnessed, which was well above the average of 85 storms from 1981-2010. Three of the tropical cyclones attained an intensity of Category 5 on the Saffir–Simpson scale. A record 30 named storms against an earlier record of 28 in 2005, were recorded in the North Atlantic hurricane basin. A record 12 landfalls took place in the USA. Hurricane Laura, which made landfall in western Louisiana, caused widespread damage leading to an economic loss of almost US$ 19 billion. Eastern coast of Nicaragua in Central America was hit by Hurricanes Eta and Iota, within a time span of just two weeks. Calgary in Canada was hit by a hailstorm, which caused insured losses of more than US$ 1 billion. Super Typhoon Goni was the strongest cyclone in recorded history to make landfall in the Philippines in western North Pacific, which necessitated evacuation of more than one million people. India suffered losses

exceeding US$14 billion when Cyclone Amphan made landfall near the India-Bangladesh border. Northern islands of Vanuatu affected almost 65% of population and caused extensive damage in Fiji, Tonga and the Solomon Islands. France and Italy witnessed rains exceeding 500mm within 24 hours during Storm Alex (World Meteorological Organisation, 2021).

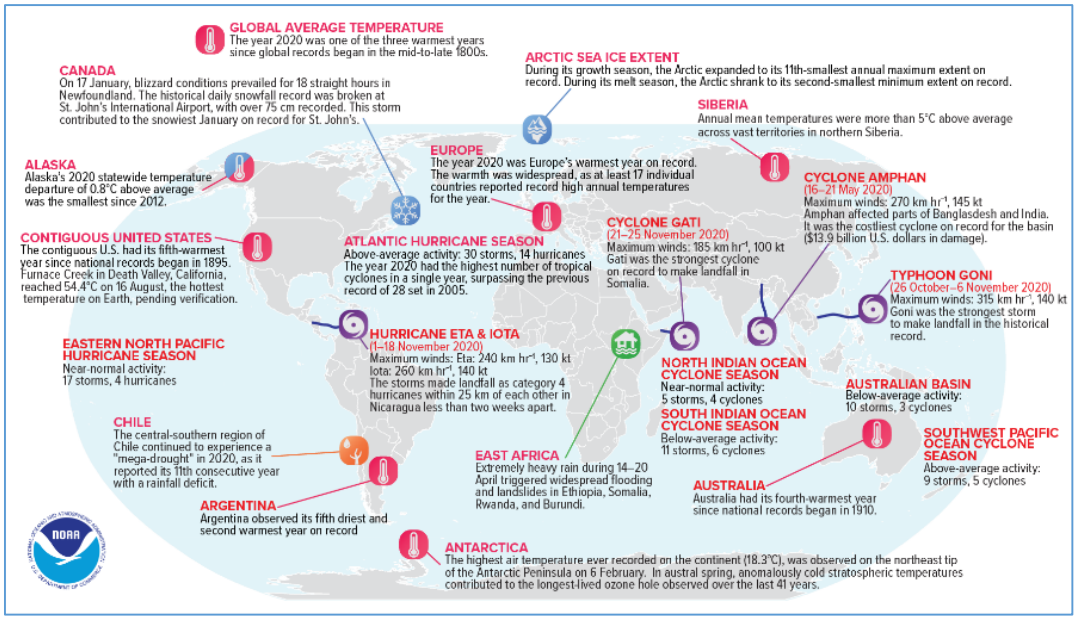

Figure 4.3. Selected significant climate anomalies and events in 2020

Source: NOAA NCEI

North America. Mexico recorded its warmest year in 2020, breaking a 49-year-old record. It was also drier than average in Mexico in 2020 due to delayed onset of the North American Monsoon and absence of tropical cyclones from the Pacific Ocean. Alaska region has seen an average decadal increase of annual temperature by 0.50 degree in last fifty years. While west America witnessed warm and dry weather, the East saw wet conditions due to an active storm track. The Avalon Peninsula in Newfoundland, Canada was hit by a strong blizzard with hurricane force winds (National Centres for Environmental Information, 2021). In year 2021, western North

America suffered with exceptional heat waves which resulted in large number of deaths. The agricultural activities in Canada have been adversely affected in 2021, wherein the wheat and canola crop production for 2021 is forecasted to be lower than 2020 levels by more than 30 percent (World Meteorological Organization, 2021).

Central America and the Caribbean. The Caribbean basin in 2020 recorded the second highest annual average temperature since 1891, wherein Cuba set a record of 39.7°C (National Centres for Environmental Information, 2021). Central America recorded the hottest summer in 2021 with Death Valley, California recording 54.4 °C, which is the highest temperature recorded in the world since the 1930s. Northern California also saw numerous major wildfires. The period from Jan 2020 to Aug 2021 was the driest, more than 10 percent below the previous record. On the other hand, many parts of Central America and Northern Mexico also witnessed abnormal cold weather (World Meteorological Organization, 2021).

South America. In year 2020, majority of South America reported above-average temperatures. Central South America recorded its second-warmest year in 61 years. Bolivia, Paraguay and Southern Brazil suffered one of the worst droughts on record and Paraguay River shrivelled to its lowest levels in five decades. The drought caused considerable agricultural losses amounting to almost US$ 3 billion in Brazil's coffee-growing regions. Low water level in the rivers reduced the hydroelectric production and disturbed river transport (World Meteorological Organisation, 2020). The decadal mega drought of South-Central Chile continued in its 11th year. Argentina recorded driest year since 1995 (National Centres for Environmental Information, 2021). On the other hand, Northern Amazon basis witnessed unrelenting above-average

rainfall in the first six months of 2021 which caused significant flooding in the region (World Meteorological Organisation, 2021).

Africa. Seychelles observed its highest annual temperature in 2020 since 1972. Madagascar saw a malnutrition crisis alongwith drought in 2021. Ethiopia, Somalia, Rwanda and Burundi witnessed exceptionally heavy rains in April 2020 which caused extensive flooding and landslides and triggered a desert locust outbreak. The Lake Victoria region recorded the wettest year in 40 years recorded history wherein the lake level rose by almost a meter (National Centres for Environmental Information, 2021).

Europe. Frequency of heat waves, droughts and wildfires has increased in the Southern and central Europe in recent times. Even the Mediterranean area is getting drier, prone to higher intensity and frequency of heat waves and droughts (European Commission, 2021). Europe experienced the warmest recorded year in 2020 and record temperatures were recorded in European Russia, Belgium, Finland, Poland, France, Spain, Netherlands, Norway, Sweden, and Switzerland. In 2021, Sicily recorded 48.8 °C, while Kairouan in Tunisia reached a record 50.3 °C and Montoro, Spain recorded 47.4 °C. Major wildfires occurred across many parts of the region with southern Turkey and Greece being most affected. Most of the Middle East too experienced drought during autumn 2020 (National Centres for Environmental Information, 2021). At the same time, Northern Europe is experiencing considerably high wet weather where floods in winters have become common. Western Germany and eastern Belgium recorded 100 to 150 mm rains over two days in Jul 2021 which resulted in large scale flooding and landslides causing almost 200 deaths. Most parts of

Europe were affected by an unusual spring cold outbreak (World Meteorological Organisation, 2021).

Asia. Japan and Russia registered their highest annual temperatures on record in 2020. Annual temperatures in northern Siberia were about 5°C above average while average temperatures in winter across Russia were also higher by a similar margin. Hong Kong in East Asia recorded 50 hot nights with daily minimum temperatures remaining above 28°C. The Indian subcontinent, China, Japan, the Republic of Korea and certain parts of South-East Asia received unusually high rainfall during the year. In 2020, the duration of two months Meiyu season, which is a rainy season in July - August over the Yangtze and Huaihe River Valleys of China was doubled. A record total average rainfall since 1961 from May – October was reported in the area, which affected more than 45.5 million people (National Centres for Environmental Information, 2021). In Jul 2021, Zhengzhou, China recorded 201.9 mm of rainfall in one hour, 382 mm in 6 hours, and 720 mm for the entire extreme rainfall event; which was greater than the regions annual average. The associated flash floods caused approximately 302 deaths and reported economic loss of about US$17.7 billion (World Meteorological Organisation, 2021).

Oceania. First six months of year 2020 saw drier than average weather across majority of the locations in Micronesia; while the second half was wetter than average. Despite an increase in rainfall, 2020 was Australia's the fourth warmest year since 1910. New Zealand observed a record dry spell where at least 15 successive days recorded less than one millimetre rain every day from later December 2019 to February 2020 (National Centres for Environmental Information, 2021).

A study by Carbonbrief reveals that 70% of the 405 extreme weather events and trends recorded over last 20 years are found to be made more likely or more severe by human-caused climate change. Of the 122 attribution studies at extreme heat events around the world, 92% found that the event or trend more likely or more severe by the changing climate. The 81 studies of rainfall or flooding revealed that almost 58% events were made more likely or more severe by increased human activity. 65% of the 69 drought events were also made more severe by the climate change. The study found that with global warming, extreme cyclone precipitation events and consequential flooding will become more frequent and intense (Pidock R & McSweeney R, 2021).

Socio-economic Impact of Extreme Events

The frequency and intensity of the extreme weather events have witnessed an increase in the last decade or so. In year, the global undernourished population peaked at 768 million and these numbers were already recorded by October in year 2021; depicting the growing effect of the extreme weathers on the world population. The extreme rainfall events in 2021 have disrupted livelihoods and affected agriculture across the world. Successive droughts in various parts of Asia, Africa and South America have overlapped with equal severity of storms and hurricanes which has significantly affected the region's ability to recover from the recurring weather shocks. The extreme weather conditions, which are being worsened by the changing climate have adversely impacted the population, leading to greater displacement which makes them even more vulnerable to the hostile weather (World Meteorological Organisation, 2021).

According to the Internal Displacement Monitoring Centre, almost 23.1 million displacements of people on average each year from 2010 – 2019 are estimated to have been caused due to weather related events. According to International Organization for Migration (IOM) and UN High Commissioner for Refugees (UNHCR), most of these displacements caused by hydro-meteorological events are either extended or delayed wherein the people are unable to return to their original homes. Such a population may also have to deal with recurrent displacement with no time to recover from the resultant shock. (World Meteorological Organisation, 2020)

The changing climate is affecting the entire ecosystem, be it terrestrial, freshwater, coastal and marine and the degradation of these ecosystems is also picking up pace. The human well-being is getting limited by the degraded ecosystems which is also limiting their adaptive capacity to build resilience (World Meteorological Organisation, 2021).

The frequency and severity of the extreme weather events is likely to increase with the increasing temperatures worldwide, leading to greater loss of property and infrastructure. In fact, one of the biggest threats to the global economy arises from the changing climate. Since the global warming makes the natural disasters more intense, there increased frequency will cause considerable loss in productivity and income of people. For instance, the rising sea levels will cause loss of land that could have been used agriculture or developing infrastructure. For example, rising sea levels result in loss of land that could have otherwise been used productively and heat stress can lead to crop failures (Swiss Re Institute, 2021).

It is estimated that the climate change activities can result in a reduced global economic output of about 11 – 14 % by 2050; this amounts to about $23 trillion reduction in the annual economic output globally as a consequence of climate change. The expected economic output of the European countries and the USA is likely to shrink by about 6-10 percent. However, the poor and developing countries may face an economic growth downturn by almost 20% even if the global temperature rise is restricted to two degrees Celsius by 2050 (Flavelle, 2021). A research in a journal named 'Nature Communications' states that an increase in earth's temperature by 3°C by 2100 as a consequence of melting permafrost caused by increasing Arctic temperatures may have an overall economic impact of about $70 trillion. An immediate action to limit this growing temperature to just 1.5°C by 2100 will still add $24.8 trillion to overall climate costs (Johnson, 2019)

Geostrategic Challenges and Opportunities

Communities and governments in the Arctic region, as well as those well beyond the Arctic Circle, face new difficulties and opportunities as the Arctic changes. The Arctic holds strategic significance primarily to the five littoral Arctic Ocean states, *viz* the United States (Alaska), Canada, Russia, Norway, and Denmark (Greenland). The Arctic region is also important for Iceland, Sweden, and Finland - the other three Arctic states.

Various activities such as shipping, resource extraction, scientific research commercial fishing, tourism, etc influence the security and economic development not only of the States in the Arctic region, but also those beyond the region. For example,

a shipping route through the Arctic will provide an alternate route to countries to exploit the large oil and mineral resources of the Artic. Therefore, any changes taking place in the Arctic will have geostrategic implications (Council on Foreign Relations, 2021).

Resource Extraction

Starting with the Canadian fur trade in 1608, commercial whaling from 1611 to 1914, precious metals from 1870 onwards, and oil and gas since World War II, the Arctic has always been a location where significant resources could be extracted. Given its remoteness, Russia has used parts of its Arctic territory (particularly Novaya Zemlya) for nuclear weapons testing since 1955. For decades, this area and the nearby Kara Sea have served as dumping places for Russian nuclear waste.

The Circum-Arctic Resource Appraisal, undertaken by the U.S. Geological Survey (USGS) in 2008 reported that the Arctic region is considered to possess approximately 25 percent of the earth's undiscovered recoverable petroleum resources, which includes, 13 percent oil, 30 percent natural gas and 20 percent liquefied natural gas. More than 80 percent of these resources are thought to be offshore. It is expected that geographically largest unexplored potential area for petroleum residual on earth is available on the widespread Arctic continental shelves (US geological Survey, 2008).

The Arctic region also has important mineral reserves, including several rare minerals that are essential in the production of electronics. As these reserves are explored and tapped, rising demand for these raw materials, combined with the Arctic's

increased accessibility, increases the opportunity for the region to become more developed.

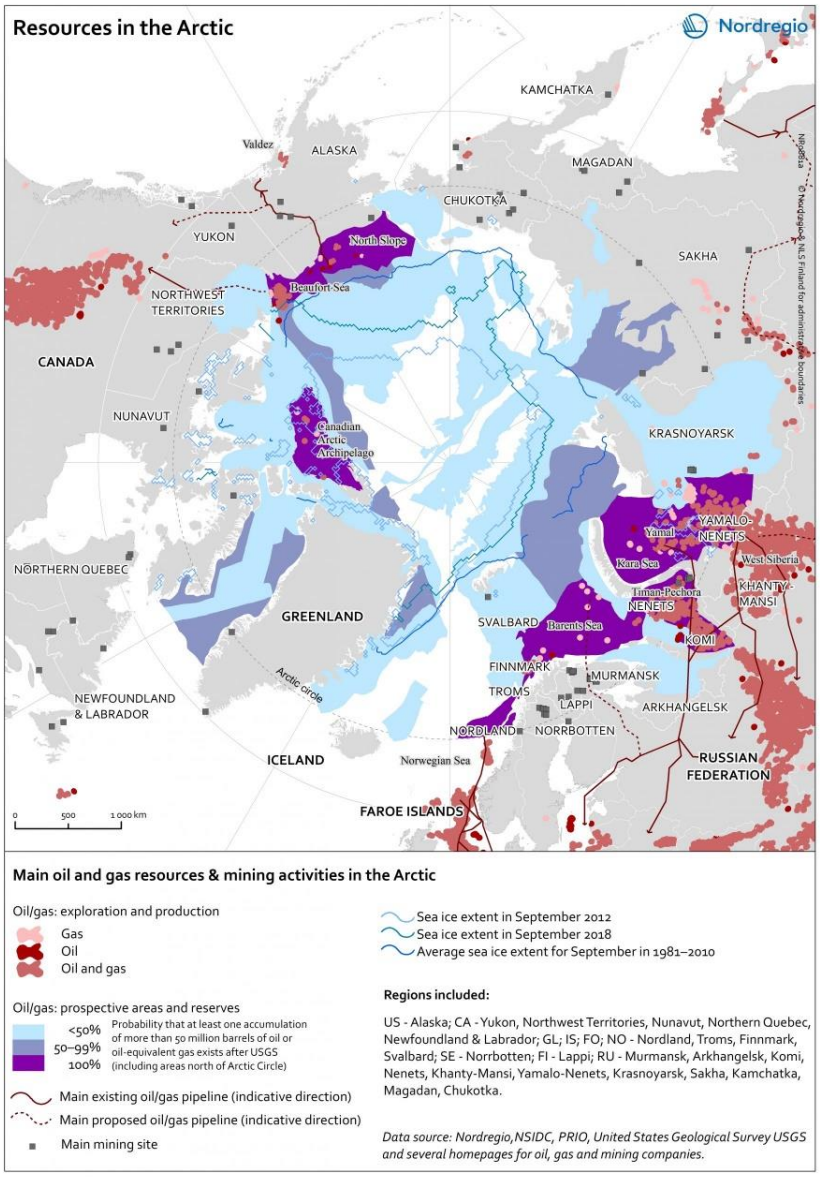

Figure 4.4. Oil & gas resources and Mining Activities in the Arctic

Source: https://nordregio.org/maps/resources-in-the-arctic-2019/

Although receding ice has made Arctic resources more accessible, their exploitation and development are still reliant on technological advancements, global supply and market dynamics, and political considerations. The Arctic region presents a diverse picture in terms of resource locations, security problems associated with

extraction, and economic possibilities (Figure 4.4). For example, Oil and gas are already being exploited in the Norwegian and Russian sectors of the Barents Sea, however, ice cover and infrastructure issues persist in other places (Zandee *et al*., 2020).

New Shipping Routes

As a consequence of global climate change, the Arctic region offers three polar shipping routes, *viz* the Northwest Passage (through the Canadian archipelagos), the Transpolar Route (from the Atlantic to Pacific via North Pole) and the Northern Sea route (NSR) from Europe to Asia along the Russian coast (Figure 4.5).

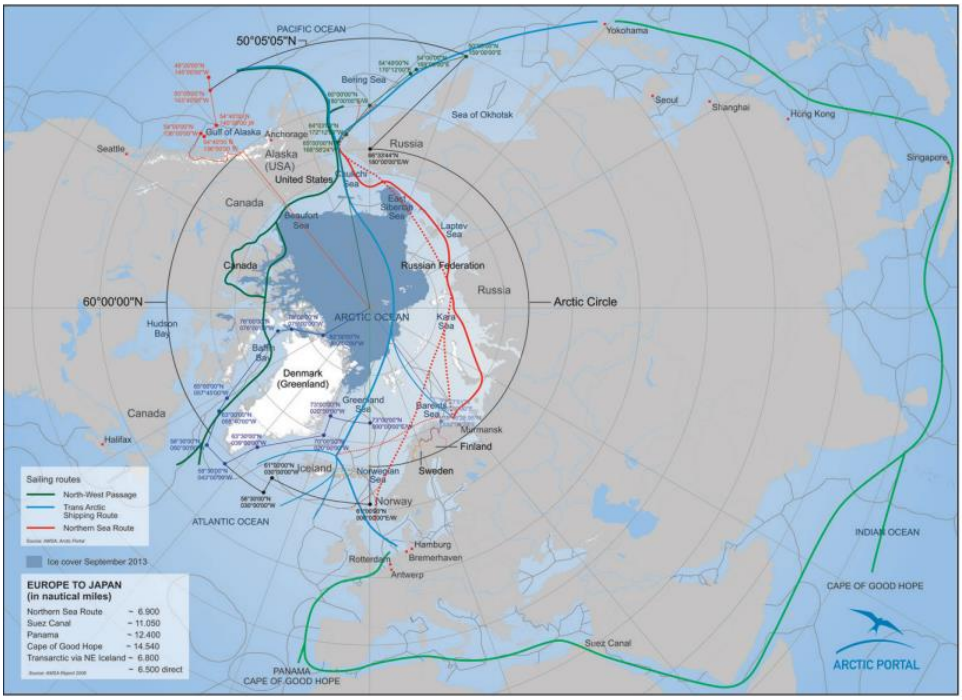

Figure 4.5. Arctic Shipping routes

Source: https://arcticportal.org/images/news/2019/documents/Northern_Sea-Route_Portal.pdf

Greater sea ice extent, floating and loose icebergs and other limitations make the passage through the Northwest route and the transpolar route navigationally unsafe.

However, the shipping traffic through the NSR is gradually increasing and gaining significance (Nguyen *et al.*, 2021).

The NSR's significance is undeniable in terms of its ability to transport commodities at economically beneficial pricing between European and Asian markets. The distance between Europe and East Asian ports is estimated to be 6,000 nautical miles less than the ship transits through the Cape of Good Hopes. Similarly, the NSR route is 2,700 nautical miles and 5,380 nautical miles shorter than the Suez Canal and Panama Canal routes, respectively (Aksenov *et al.*, 2017). The reduced distance ensures lesser transit time and hence considerable reduction in fuel emissions and related global warming. Further, the maritime routes through the region don't pose any restrictions based on the size and tonnage of the vessels as is the case in Suez Canal. The opening of polar routes also allows flexibility to the merchant shipping against risks such as grounding of vessel in the Suez, which disrupted the global supply chains in 2021 (Dreyer, 2021).

The NSR is already operational, with its peak season being between July and October, and has seen significant traffic growth over the last decade. 25 million tons of goods were transported through NSR in 2019, which was a 140% increase since 2017 when 11 million tons of goods were shipped. The number of vessels passing the region rose from five in 2009 to 71 in 2013, with 31 vessels failing to complete the journey. In the same way, NSR saw 62 transits in 2020, compared to 37 in 2019 (Agarwala, 2021). Although the routes have primarily been utilised for local transportation, primarily by oil and gas tankers, they are now being seen as having global trade potential. In general, vessel traffic in the NSR is expected to increase. Summer tourism

has grown significantly over the last two decades and is anticipated to continue. Thirteen new ice-capable cruise ships were launched by various operators across the world in 2019, with at least another 28 expected to be commissioned by 2022 (Humpert, 2019)

Presently, the number of operators on these routes are low because of the restrictions imposed by the seasonal variations. The current tonnage of commodities being shipped through the NSR is equivalent to the weekly tonnage flowing through the Suez Canal. Weather conditions are extremely erratic, and expenses (due to a lack of suitable infrastructure, expensive insurance premiums, limited Search and Rescue (SAR) capabilities, the need for icebreakers, and oil spill prevention) as well as environmental dangers are likely to remain high in the near future (Turunen, 2021).

Commercial Fishing

Commercial fishing prospects in the Central Arctic Ocean (CAO) are projected to expand in the coming years, as climate change causes substantial fish stocks (such as cod and halibut) to migrate further north as their habitats in lower latitudes get warmer. However, since the most economically important sub-Arctic species live within the EEZs, economic competition or major Arctic fisheries are unlikely to arise. In addition, the EU and nine other nations signed the International Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean (CAO) in October 2018, which forbids commercial fishing in the CAO for the next 16 years (Zandee *et al.*, 2020).

Geostrategic Implications of Melting Arctic

The United States (Alaska), Canada, Russia, Norway, Denmark (by virtue of Greenland, a member country of the Kingdom of Denmark), Finland, Sweden, and Iceland are the eight countries with territory north of the Arctic Circle. These eight countries are members of the Arctic Council and are often referred to as the Arctic countries or Arctic States.

The Arctic Council, established in 1996 by the Ottawa Declaration, is made up of the eight Arctic nations. It is the primary international intergovernmental platform for discussing Arctic concerns. The Arctic Council is not a treaty-based intergovernmental body, but rather a consensus-based international forum that represents the Arctic Region's peaceful and cooperative ethos. The Ottawa Declaration states explicitly that "*The Arctic Council should not deal with matters related to military security*."

The eight Arctic governments must agree on all decisions made by the Arctic Council and its subsidiary bodies. Six groups representing indigenous peoples in the Arctic have been designated as Permanent Participants. "In conjunction with the Council's negotiations and conclusions," the Permanent Participants "enjoy full consultative rights." Thirteen non-Arctic countries have been recognised as council observers: Germany, the Netherlands, Poland, and the United Kingdom (approved in 1998); France (2000); Spain (2006); China, India, Italy, Japan, Singapore, and South Korea (2013); and Switzerland (2017). A total of 38 observer governments and organisations have been approved, including 13 intergovernmental and inter-

parliamentary groups and 12 non-profit organisations. The *observer definition clearly, without being subordinate, emphasises on the non-Arctic states to 'accept', 'support', 'recognize', 'respect' and 'demonstrate' various objectives of the Council* (CRS Report, 2021)

The physical, social, geo-economic, and geopolitical conditions of the Arctic region are undergoing unparalleled changes. The security of the Arctic is being impacted significantly by these rapid developments. Following the conclusion of the Cold War, three decades of peace and stability in the Arctic allowed it to move away from state-centric and military-oriented concepts of security and instead focus on security that puts people and communities first (Klimenko, 2019).

Five out of the eight countries surrounding the Arctic are playing a major role in the region's evolving geopolitics. A race to 'Securitize the Arctic' has begun among the major Arctic states in pursuit of their perceived geopolitical, geo-economic, and strategic goals. This securitization process appears to be controlled and driven not only by classic military strategic concerns, but also by non-traditional security threat dilemmas involving energy, the environment, sustainability, human security, connectivity, and so on. These Arctic governments are using such securitizing discourses to build their own supremacy over the region and its vast resource and strategic potential (Sharma, 2021).

With ice retreating and thinning, and improved access to natural resources, coastal governments are referring to Article 76 of the UNCLOS more frequently. They strive to show the Commission on the Limits of the Continental Shelf that their

continental shelf is increased, allowing them to exercise sovereign rights beyond the EEZ (UNCLOS, 1994, p. 54, Article 76). While this pattern may not lead to future conflict at current time, the possibility cannot be fully eliminated.

The constantly changing Arctic has prompted a rethinking of the region's security paradigm. Multiple geopolitical challenges have arisen as a result of the Arctic's opening up to both Arctic and non-Arctic states. The 'changing Arctic' also has an impact on a number of European and Asian countries, either directly or indirectly. Climate change has also altered the balance of interests between state and non-state entities, resulting in new forms of cooperation. The Arctic's accelerated rate of global warming is posing a slew of problems with regional and global ramifications (GBPC perspective, 2021).

In the changing global world order, it is likely that the global rivalry between US, Russia and China will aggravate the tensions and influence the existing relations in the Arctic. As the old and new Arctic challenges are moved from the realm of "normal politics" to the contested domain of "security politics," Asian states that are directly or indirectly impacted by the changing Arctic recognise that securitization of the Arctic is leaving little room for addressing common global concerns (Sharma, 2021).

Competition in the Arctic Ocean

Responses to climate change in the Arctic not only lead to international governance collaboration, but also to competition for natural resources, particularly

hydrocarbons, and control over shipping routes that are becoming increasingly important commercially.

Due to perceived risks to the sovereignty in the new emergent territories and routes, the Arctic states are attempting to dominate them for their own economic and geopolitical reasons. Presently, there are many practical challenges for ships and shipping companies sailing through the NSR today, such as limited and incomplete navigation charts, large insurance costs, inadequate polar specialised crew, limited search and rescue options and a very restricted window for shipping in a year. However, as the economic and geopolitical prospects of shipping through this route become clearer, it is expected that these challenges will fade away in the coming decades. The Arctic States, such as Russia, USA and Canada are making enormous strides in the region, analysing the developing possibilities of new polar routes. Such states are using political, economic, and military measures to exert pressure on the region's shipping through these new routes. The creation of these new shipping lanes also allows access to previously inaccessible areas of the region (Spohr *et al.*, 2020).

Russia has declared its dominance over the government of the NSR by referring to it ‘national single transport communication of the Russian Federation’ (Russian Federation, 2008) in its Arctic strategy and adopted stringent enforcement steps to regulate the region's shipping. Russia seeks to reach annual shipment worth US$ 80 million by 2024 (Zandee *et al.*, 2020). It claims the right to regulate commercial vessels travelling through these seas since it considers part of the route to be its internal waters. Russia's imposition of high tariffs on foreign vessels travelling through the NSR, as well as additional high fees for services such as ice breaker escorts, use of port facilities,

and so on, are examples of how they are influencing the region's geopolitics in their favour (Moe, 2014). The US, on the other hand, considers the passage to be in international waters, and hence considers Russia's regulatory restrictions to be illegal. Similarly, Canada's designation of the Northwest Passage as "internal waters," as well as the ensuing enforcement steps taken to limit shipping in the region, demonstrates the country's aggressiveness in the region (Sharma, 2021)

Amongst the Arctic states, Russia has the largest coastline and also owns the greatest piece of the resource-laden land in the region. The extraction of energy and available resources in the region is prime objective of Russia and it has ensured a focussed approach towards extraction of oil and gas in the region. As the energy demands grow, the world economies are exploring different avenues to limit the increasing energy prices. Asian economies are being drawn to the Arctic's tremendous energy resources because of their potential to meet the escalating future energy needs. Opening up the Arctic's immense energy reserves to a country like China offers huge economic and strategic benefits for its oil and gas exports passing via the NSR (Nanda, 2019). Therefore, the changing Arctic plays an important role in the geo-economics of the Asian countries. China has expressed interest in Arctic countries' scientific research and resource extraction. Since Russia lacks the technological know-how to exploit shale and Arctic fields on its own, China has positioned itself as a "near-Arctic" cooperation partner, prompting Gazprom to seek joint ventures with Chinese companies such as China National Petroleum Corporation. China and Russia are developing their strategic collaboration, with the Chinese supplying finances and the Russians providing China a geostrategic location for resource development as well as access to the NSR (Sharma, 2021).

Militarisation of Arctic Region

A substantial military build-up in the region is being undertaken by the countries by propagating fear wherein the evolving challenges are being termed as ‘threats’ to the region (Shea, 2019). This has led to bigger issues of climate change getting obscured by the sovereign threats. Some nations are using narratives of fear and threat from a foreign opponent or a close neighbour to legitimise their own actions of increasing military build-ups and dominance in these regions. By acting as a security guarantor to these developing Arctic issues, such states are establishing their own supremacy (Pezard, 2018).

The Arctic played a major role during the cold war as the two world superpowers faced each other in various military and political standoffs. The importance of the Arctic as a site for deploying strategic weapons and early warning systems, as well as its geographical proximity, to both the USA and erstwhile USSR, made it one of the most highly militarised regions of the world during the Cold War. As the cold war ended, Arctic region lost its relevance in the geostrategic sphere. However, the period of peace emerged in the Arctic with number of regional organisations being formed to deliberate and tackle challenges of climate change, environmental degradation, regional cooperation and development (Raspotnik & Østhagen, 2021).

With the beginning of the 21st century, the increased anthropogenic activities arising from greater interaction between human beings and the environment is again taking the Arctic towards new level of securitisation. The region is being re-securitized

as a result of the rising vicious spirals of hard military build-ups by all stakeholders in the region (Sharma, 2021).

There is a considerable militarisation of the region taking place with development of military infrastructure, expansion of military bases, increase in the number and complexity of military exercises, deployment of improved and sophisticated weapons and sensors (Nilsen, 2019). The assertiveness of the states in their briefs, policy's, research work and media reports is quite noticeable wherein greater emphasis is being placed on greater role of the hard military measures in protection of the nation's political and economic interests (Barnes, 2017). The level of security in the Arctic is so high that states are even training and utilising polar marine creatures like whales, dolphins, and sea lions for military tasks in the region. (Boulègue, 2019). Infact in 2007, to bolster its territorial claim, Russia placed a titanium Russian flag on the seabed at the North Pole in 2007. In light of the region's strategic, economic, and developing military postures, such sovereignty claims could lead to direct armed clashes (Sharma, 2021).

China has emerged as a new Arctic actor in recent years, adding to the evolving geo-economic and geo-strategic mix. As China continues its efforts to influence the world to extend its control, the Arctic has emerged as the latest region where China is expanding power in both soft and hard terms (Raspotnik & Østhagen, 2021). China's Arctic White Paper was released in 2018, referring to China as a "near-Arctic state" and describing trans-Arctic shipping routes as the "Polar Silk Road" concept (Havnes, 2020).

Russia and the United States have become more competitive in the region. Both countries have also sought collaboration in the North Pacific on satellite navigation and military exercises. Since 2010, Russia has steadily increased its military presence in the Arctic by forming new Arctic units, upgrading old airfields and infrastructure, and establishing new military stations along the Arctic coastline. Furthermore, Russia is expanding its military operations beyond the coast into the Central Arctic. Furthermore, Russia presently possesses the world's largest icebreaker fleet, with 36 ships across the Arctic Ocean. It now intends to grow its fleet. USA on the other hand has also enhanced the deployment of its warships and submarines in the Arctic region. In May 2018, US Navy declared that it would re-establish the 2nd Fleet. US Navy also plans to replace its existing one each heavy and medium icebreaker by three each heavy and medium ice breakers by 2024.

It is not just the warming Arctic that is leading to increased militarisation of the region, but also the greater global competition between the USA, Russia and China that is influencing the security of the region. As the tensions between these powers increase, aggravated effects will be witnessed in the Arctic region in form of greater push for obtaining rights over land and resources through partnerships and alliances (Zandee *et al*., 2020).

The shift in the Arctic is mostly influenced by events in other parts of the world. However, these changes have long-reaching consequences for the atmosphere, sea level rise, and our global carbon budget that go far beyond the region (Hodgkins, 2019). The struggle to survive is today viewed as a global existential catastrophe; we must act together immediately merely to ensure the survival of human civilisation. Weather

patterns around the world are being drastically altered, wreaking havoc on economies through property and infrastructure destruction, lost productivity, mass migration, and security risks. According to a recent analysis, adding just 10% to the USD 6.3 trillion in yearly global infrastructure investments would keep the average temperature rise below 2°C and, as a result, prevent global GDP losses Swiss Re Institute, 2021).

In addition to being a major stakeholder in global climate change, the melting Arctic is expanding in geostrategic relevance and undergoing unparalleled physical and geopolitical changes. As the earlier impassable and non-navigable territory becomes accessible to shipping and extraction of resources, it is also becoming an arena for competition. Though, conventionally the nations in the region have focussed on cooperative governance to sort out all their issues, the accessibility to resources and renewed economic interests may lead to disputes between countries of the Arctic region as well as non-Arctic states over territory, continental shelf, and transit rights. As the scientific, economic, political opportunities offered by the region improve, the militarisation of the region will increase. While the chances of a conflict taking place in near future is low; the growing stakes in the Arctic resources and land, could strain the relationships between the stakeholders.

CHAPTER 5

CHALLENGES AND OPPORTUNITIES FOR INDIA

The Arctic region is becoming significantly more accessible due to changing climate, increased availability to resources, and the geopolitical and geo-economic architecture. The Arctic region has emerged as a crucial participant in global dynamics as a location that is gradually gaining geostrategic relevance in global politics, research, and economics.

The changing geopolitical situation arising from the melting of ice and warming of Arctic has offered new opportunities for cooperation on one hand, and enhanced the competitiveness and tensions in the region, on the other. As a result, the Arctic countries are steadily drifting towards conflict with one another. The effects of climate change in the Arctic region are influencing locations in the middle and lower latitudes as well, leading to a growing role for non-Arctic governments in the previously strictly controlled Arctic affairs.

The 'Observer' nations are questioning the Arctic Council's role and scope in view of the opening up of maritime routes and resource exploitation. Few Arctic states share this perspective, which is mitigated by concerns about security, environmental degradation, and military competitiveness in the region. Countries outside the Arctic region increasingly consider the region as a promising opportunity for economic expansion. India, too is affected by the changing climate in the Arctic. Be it the weather changes, changes in the monsoon pattern or the rising sea levels, India is directly

influenced by the climate change. However, India continues to interact with the region primarily through scientific research and studies of the physical environment, climatology, glaciology, and oceanography, rather than taking a comprehensive approach to the region

India’s March into Polar Regions

India has a civilizational link with the Arctic in the past. Bal Gangadhar Tilak stated in his study 'The Arctic Home in the Vedas' (1903) that the forefathers of India's old Vedic civilisation resided in the Arctic region. The Vedas, one of India's oldest books, became a source of knowledge about the region (Sinha, 2019).

India had signed the Spitsbergen Treaty in 1920, recognising Norwegian sovereignty over the Svalbard Islands. Polar research in India grew out of the country's post-independence ocean perspectives and thinking. Since the Indian summer monsoon rainfall is governed by a system of changing sea surface temperatures, the sea and its shoreline have long been important to India. As a result, in 1981, India established the Department of Ocean Development (DOD) with an aim to understand the oceans, develop technology to harness resources and understand various physical, chemical and biological processes. As a result, the DOD became the central agency to support comprehensive ocean development programmes in India. One of the programmes of the DOD was the Antarctic expedition and Polar science (Saigal, 1994). The DOD was in charge of monitoring and studying the Antarctic, and by 1983, India established a permanent research station, Dakshin Gangotri, in the region (Pusarla, 2016). India's

polar research has been conducted in the Antarctic, which has progressively given it the capability and capacity to engage in the Arctic.

In 2006, the DOD was renamed and created as Ministry of Earth Sciences (MoES). The MoES is mandated to provide a framework for all key elements of weather and climate including hydrology, seismology and natural hazards. Its charter also includes exploration of the three poles of the Earth, *viz* Arctic, Antarctic and Himalayas (MoES, Government of India, 2021).

The experience gained from the scientific research activities in the polar region, commenced with the Antarctic has been expanded to the Arctic region. In 2007, India launched its first scientific expedition to the Arctic Ocean, and in July 2008, it established the "Himadri" research base at the International Arctic Research Base in Ny-Alesund, Svalbard, Norway, to conduct research in disciplines such as glaciology, atmospheric sciences, and biological sciences (MEA, Government of India, 2013).

This led to India becoming a full member of the Ny-Ålesund Science Managers Committee (NySMAC). This also inspired the Earth System Science Organization (ESSO) under the MoES to take another significant step towards research in the Arctic by deploying India’s first multi-sensor moored observatory, IndARC, in the Kongsfjorden fjord of the Arctic in 2014. This was followed by establishment of Gruvebadet atmospheric laboratory at Ny-Alesund in 2016 (Sarma, 2018). Himadri Research Station gives field and laboratory support, while the IndARC conducts research and gather real-time data at varying levels in the fjord on the Arctic climate and its effects on the monsoon and the Gruvebadet laboratory measures cloud,

precipitation, long-range pollutants, and other background atmospheric factors (Seethi, 2021). Over 300 Indian researchers have worked at the station since its inception. Since 2007, India has sent 13 expeditions to the Arctic and has 23 current projects (The Hindu, 2021).

In 2012, India applied for the Observer status in the Arctic council. In 2013, India was granted Observer status along with China, Japan, South Korea and Singapore. As an Observer nation, India has kept its focus on environmental studies and scientific research (Nanda, 2019). Being an Observer nation, allowed India to participate in various working groups of the Arctic council and interact with the Arctic nations to enhance its engagements in the region. In 2019, India was re-elected as an Observer to the Arctic Council (Giri, 2021).

India's North and south polar research is currently a thorough, comprehensive, and ongoing programme that is assessed and reviewed on a regular basis in accordance with national priorities and global perspectives. India's research from one pole to the other has been broadened with the Arctic research programme. Having research stations at both poles gives India a significant advantage in gathering data and comparing it. One of the primary aim of Arctic glacier research is to observe and compare the rate of change in Himalayan glaciers, and then understand its impact on hydrology, ecology, and climate of India. Growing evidence of altered glacier profiles, diminished permafrost, and monsoon variability is a cause of livelihood worry for the great majority of people who rely on water for agricultural purposes. Indian scientists are using ice as a data repository to monitor the biogeochemical characteristics of Himalayan ice by collecting data from the Arctic (Sinha, 2019).

Climate change has accelerated the environmental change of the Arctic region, which will have a significant impact on economic resource exploitation, shipping routes, and trade, and will bring a diverse range of opportunities and problems. India has focused on scientific engagement since its membership to the Arctic Council, without clearly expressing its strategic interests. There are concerns that great power rivalries, frequently fuelled by issues beyond the Arctic, would manifest themselves in Arctic affairs, skewing the environment significantly. India must be prepared to face the challenges and take advantage of the opportunities presented by the changing dynamics in the Arctic region (Pareek, 2020).

Impact of Changing Arctic on Indian Monsoons

The geo-physical changes taking place in the Arctic region are a cause of concern for India. A large number of studies have suggested connection between the climate changes taking place in the Arctic and the monsoons in India. It is imperative that the tele-connection between the Indian Ocean and the Arctic is understood to better comprehend the monsoon dynamics that is so significance for India's agricultural sector. While the Indian researchers have identified certain relationship between the two, but there is a need for greater investigation on intra-seasonal, inter-annual and decadal time scales (Pathak *et al.*, 2017). Also, NASA and European satellite data spanning 25 years reveals that melting of the glaciers in Antarctica and the Greenland ice may result in rise of global sea levels by 65 cm in 2100; adversely affecting the coastal cities (Weeman & Lynch, 2018). With more than 7500 sq km of coast line and 170 million population residing in coastal areas, India too is severely affected by the sea level rise (Seetharaman, 2019).

Monsoon rains are critical for India's agricultural sector, which accounts for roughly a sixth of the country's economy and employs over 50% of the country's 1.4 billion people. Around 70% of India's annual rainfall occurs during the Indian Summer Monsoon Rainfall (ISMR) season. It accounts for up to 90% of the rainfall in various areas of western and central India. It is the primary source of water for over a billion people. Its variability has a direct effect on agriculture and hence has a significant impact on the national economy. Extreme ISMR occurrences are becoming more frequent, resulting in severe flooding and enormous socioeconomic issues, necessitating effective adaptation and mitigation efforts. Understanding both the local drivers and remote tele-connections of extreme ISMR occurrences is critical for a more accurate assessment and future projections of extreme ISMR events over a range of time frames (Chatterjee *et al.*, 2021).

According to a study conducted by the National Centre for Polar and Ocean Research (NCPOR) under the Ministry of Earth Sciences, the frequency of extreme rainfall events (daily rainfall >150 mm) in September in central India has been increasing in recent years, mirroring the decline in summer sea ice extent during the Early Twentieth Century Warming (ETCW, 1920–1940) period and recent warming since the 1980s (Chaubey, 2021).

As global warming continues to melt glaciers and sea ice, the Arctic Ocean's freshwater content is expected to increase. The inflow of freshwater into the oceans impacts the salinity of the sea water, which in turn affects the ocean currents that carry warm water from the equator to the poles and vice versa. In tropical regions, this disturbance of ocean currents results in a greater temperature gradient between land and

sea, which is linked with the monsoon circulation (Ghosh, 2018). While the warming of higher northern latitudes may at first increase summer monsoon rainfall as a result of air-ocean interaction, its effect once the heating propagates down to lower latitudes needs greater investigation and analysis.

A study suggests that Canadian part of the Arctic is influenced by the large quantity of heat released during extreme rainfall events over India, resulting in considerable loss of sea ice (Krishnamurty et al, 2015). Additionally, it is commonly asserted that the simultaneous increase in mid-latitude severe weather events is related to changes in sea ice conditions caused by 'Arctic Amplification' (Cohen et al., 2018).

A possible relation between the sea ice extent (SIE) in the Barents-Kara Sea (KS) has been studied by various scientists. The reduction in the SIE in the KS region of the Arctic Ocean during the summer, leads to greater convection and upward movement of the air. This air then descends further south and intensifies into a deep anti-cyclonic atmospheric circulation over northwest Europe. The inter-linked disturbance to the Polar jet stream also exaggerates the phenomenon. This anomalous upper atmospheric disturbance is then propagated further south into subtropical Asia, eventually encompassing the entire Indian region (Figure 5.1). The altered upper-level atmospheric circulation, combined with an above-normal Arabian Sea surface temperature, aids in increased convection and moisture supply, resulting in August-September extreme rainfall events (Chatterjee *et al.*, 2021).

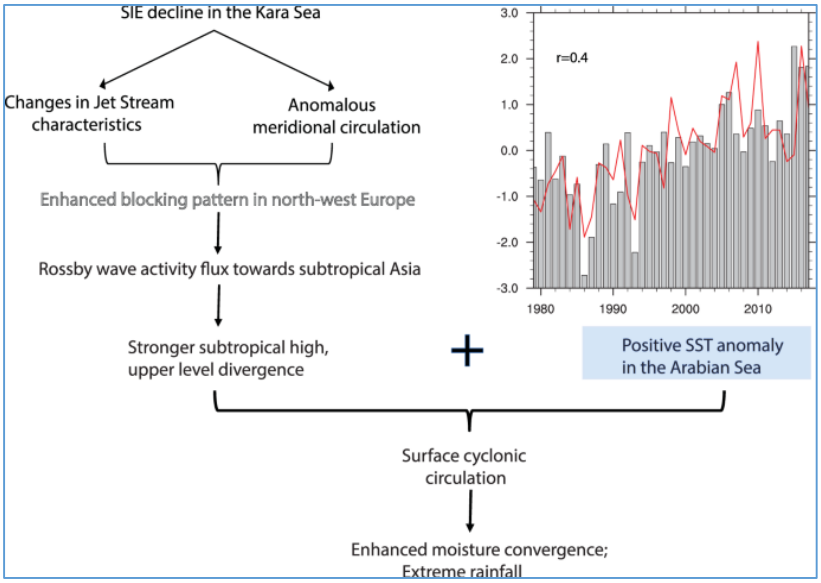

Figure 5.1. Schematic Diagram depicting relation between Sea Ice Extent (SIE) in Barents-Kara Sea (KS) and Indian Summer Monsoon Rainfall (ISMR)

Source: https://www.nature.com/articles/s41612-021-00191-w?proof=tr

Compelling evidence has been discovered by researchers at the Potsdam Institute for Climate Impact Research (PIK) that monsoon rainfall will increase by five percent with every degree Celsius of warming. This increases the likelihood that critical crops, such as rice, will be deluged during critical growing stages. Additionally, as global warming continues, the monsoon is likely to become more erratic. Since the monsoon has a profound effect on Indian society as a whole, increased variability causes difficulties not only for agriculture, but all other domains of public life. Yearly variability would also complicate methods of coping with the rainy season's increased intensity (Agence France-Presse, India Today, 2021).

In addition to the summer monsoon, India receives rains during North East Monsoons too. The North East Monsoon also known as Indian winter monsoon (IWM) results in precipitation during November to February. Snow and rainfall during IWM plays a significant role in maintaining rivers and glaciers, which are also the source of

fresh water for large number of rivers in North India. Precipitation during IWM is largely associated with Western Disturbances (WDs) which originate in the Mediterranean and move eastwards towards the Indian sub-continent. The WDs are vertically structured, wherein there is an upper level trough and lower level cyclonic circulation. The interaction of these WDs with the Western part of Himalaya's causes excessive rainfall and snowfall over North and West India. The WDs account for more than 30 percent of rainfall in the Western Himalaya region during the IWM (Dimri *et al*., 2015).

Recent studies have revealed that majority of climate variance in Northern latitudes is influenced by the Arctic oscillations (AO), also known as the Northern Annular Mode (NAM). Arctic Oscillations are pressure anomalies in the Arctic with the opposite anomaly in the mid-latitudes of about 37°-45°N. The AO's positive phase is characterized by air pressure less than average over the Arctic corresponding to higher-than-average pressure over the Pacific and Atlantic Oceans. The Polar jet stream in these conditions is farther north than average, causing the storms to shift northwards. Hence, during positive AO phase, there are fewer cold air occurrences than normal in the regions of the mid-latitudes such as North America, Europe, East Asia etc.

On the contrary, during the AO's negative phase Arctic region has more-than-average air pressure, while the Pacific and Atlantic oceans have less-than-average pressure. Under these conditions, Polar Jet stream shifts southwards towards the equator. As a result, regions in mid-latitude experience greater events of frigid polar air during winters (Figure 5.2).

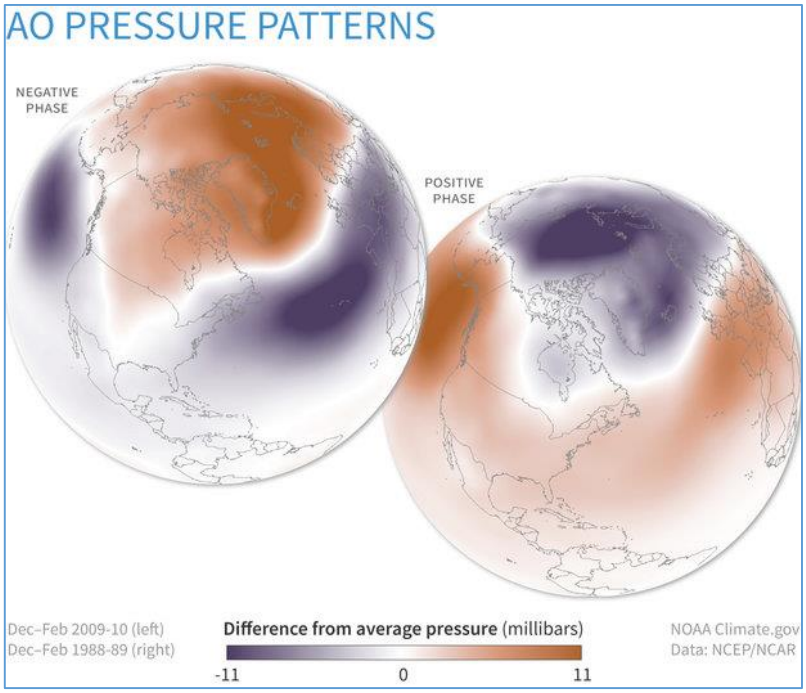

Figure 5.2. Average Air Pressure during Positive and Negative AO

Source: https://www.climate.gov/media/13079

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An analysis of positive and negative AO year composites by National Centre of Environmental Prediction/National Centre for Atmospheric Research, reveals that during positive AO years, warmer Indian Ocean and colder Tibetan region results in a stronger north–south temperature gradient, which intensifies the northern movement of the moisture influx from the Arabian Sea, causing excessive precipitation in the Himalayan Region. Further, considerable warm conditions prevail over Arabian Sea while concurrent cooling over Mediterranean Sea and part of Indian Ocean and Bay of Bengal is seen during positive AO years. The conditions are therefore favourable to support the inflow of subtropical westerlies. These stronger westerlies assist in increasing the strength of the WDs and the IWM (Midhuna & Dimri, 2018).

Additionally, weakened Hadley circulation is seen in consonance with the positive AO years. The Hadley circulation is a global atmospheric circulation pattern which causes equatorial air to rise and flow towards pole, drop down in the subtropics, and then return to the equator along the Earth's surface. This circulation is known to control precipitation in the subtropics and creates the inter-tropical convergence zone (DeRoberts, 2019). The weakening of Hadley Cells in positive AO years leads to southwards movement of the polar and extra-tropical mass to move southwards, which results in mid-latitude interactions, thereby causing increased precipitation over Indian regions (Midhuna & Dimri, 2018).

Scorching Heat Wave

In recent years, the summer months in India are increasingly witnessing unprecedented deaths across the country due to Heat waves, which are primarily excessive hot weather alongwith high humidity. In a study *"Large-scale connection to Deadly Indian Heatwaves"*, published in British journal, *Quarterly Journal of Royal Meteorology,* the researchers have reported that more warming of Arctic region is noticed during the spring months of Apr-May which coincide with the heat waves in India in same months (Minocha, 2021).

The warmer Arctic reduces the temperature gradient between Equator and Pole, which causes reduction of zonal winds that move from west to east in mid-latitudes and results in its vertical shear. The reduced zonal wind increases the amplitude of the Rossby wave. The Planetary Rossby Waves (PRWs) are large scale atmospheric circulation disturbances, caused by rotation of air masses relative to the Earth's surface.

Quasi-resonant amplification takes place when the planetary Rossby waves clash with equally large scale atmospheric movements that arise horizontally from the earth's rotation and results in meandering of the Polar Jet stream. This phenomenon positions the amplified Rossby waves in such a manner that leads to formation of high pressure area over various locations including India, causing sinking motion and drastic increase in the surface temperature (Figure 5.3). The increased surface temperature results in heat waves in India (Minocha, 2021).

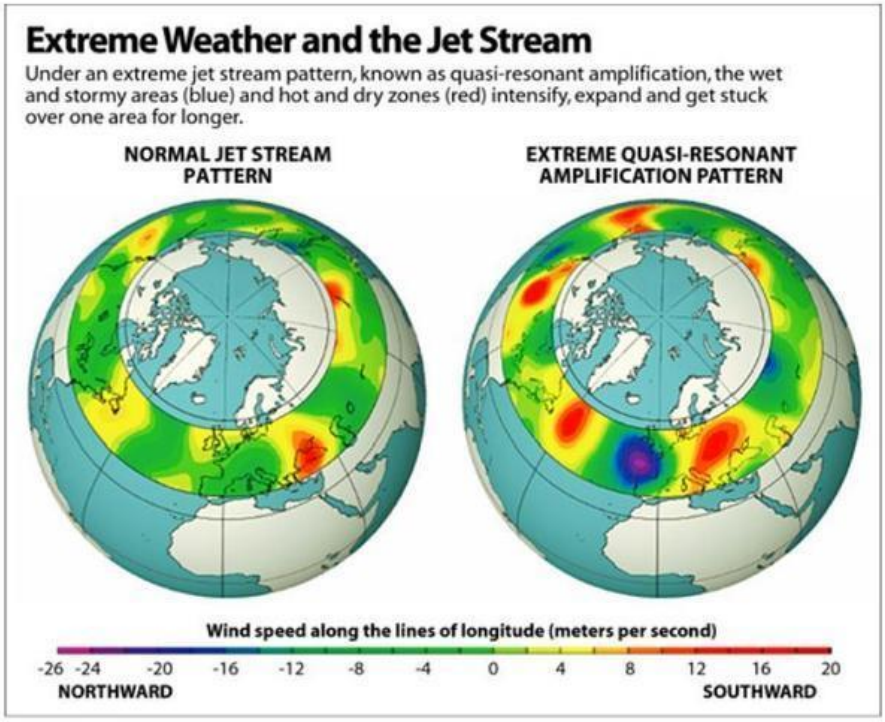


Figure 5.3. Extreme Quasi-Resonant Amplification Pattern

Source: https://www.digitaljournal.com/tech-science/the-impact-of-burning-fossil-fuels-on-today-s-extreme-weather/article/535974

Rising Sea Levels

India's coastline is approximately 7,500 kilometres long and passes through nine states, including state capitals. India's coastline is home to a fifth of the country's population (Anima, 2020). Communities along India's coast are at risk of sea level rise,

erosion, and natural disasters such as storms and cyclones becoming more intense and frequent. They are expected to be accompanied by storm surges, torrential rain, and flooding (Byravan, 2021).

Sea levels along India's coastline have risen by 8.5 centimetres over the last 50 years, and scientists predict that by 2100, 36 million Indians will live in areas prone to severe flooding. Nevertheless, some coastal regions are more vulnerable than others, as evidenced by repeated displacements in the same locations. Tropical storms from the Bay of Bengal threaten communities along the country's east coast. Between 1990 and 2016, India lost 235 square kilometres of land to coastal erosion. According to a 2017 study on change in Indian shoreline between 1989 and 2001, the highest percentage of erosion occurred in West Bengal, with change occurring along 70% of its coast, followed by Kerala (65%), Gujarat (60%) and Odisha (50%) (Panda, 2020).

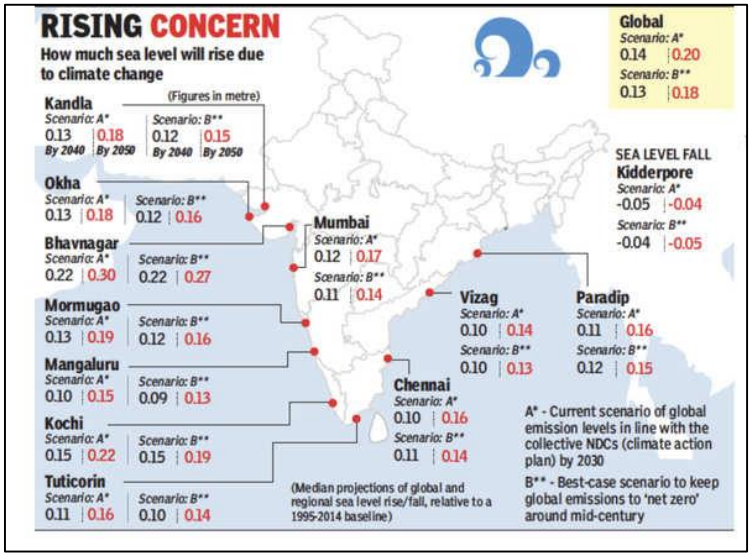


Figure 5.4. Rising Sea Levels in Indian Coastal Cities

Source: https://timesofindia.indiatimes.com/india/mumbai-chennai-10-other-cities-to-see-sea-levels-rise-in-30-yrs-nasa/articleshow/85413908.cms

Apart from displacement and relocation along the eastern seaboard, rise in sea-level and flooding may result in increased migration from coastal cities. Similarly, metropolatian cities such as Mumbai, Chennai, and Kolkata face a significant risk of flooding and sea-level rise in future (Figure 5.4), which may necessitate relocation of large number of people residing in the urban coastal regions. Incase there is no deliberate proactive relocation of population from high risk areas planned, then there may be a need to undertake forced relocation and migration of people in urgent circumstances (IPCC, 2019).

India's Strategic Challenges and Opportunities in Arctic Region

As a rising great power with potent military and economic strength and widespread goodwill, India needs to accelerate the expansion of its role in the twenty-first century world, including underexplored areas such as the Arctic. India, too, must explore Arctic opportunities in light of its ever-increasing energy needs. To take advantage of these opportunities, India seeks a stable Arctic, free of disruptions to peaceful marine shipping and exploration, despite competing interests of major powers and coastal states. However, the Arctic has been remilitarized in recent years as geopolitical competition has intensified. Conflicts over disputed exclusive economic zones (EEZs) are envisaged, ranging from provocative actions below the conflict threshold to full-fledged war, as disputes over EEZ claims may intensify into threats to national sovereignty. The broad range of possible disputes poses a threat to both Arctic and non-Arctic states such as India that have growing interests in the region (Rao, 2020).

Growing Chinese Footprint in the Arctic Region

Recent years have seen a belligerent China pursuing economic and military expansion via the Belt and Road Initiative. China has also included the Arctic in its Polar Silk Route initiative. China's polar activities have always been centred on capacity development and the development of polar infrastructure. China's ambitions to become a great Polar power, as articulated in 2014 by then-CCP General Secretary Xi Xinping, demonstrated the critical role of Polar affairs in the country's ambitions (Banerjee, 2021).

In 2003, China established its first Arctic Scientific Research base, Yellow River Station, on Norway's Svalbard Island and began construction of its second Arctic station at Karholl, in 2012 as a joint venture with Iceland. Additionally, during the polar voyages of its Polar and Research vessel, the MV Xue Long, China established temporary ice research stations on Arctic floes. MV Xue Long deployed an unmanned ice station during its ninth Arctic voyage. The scientific research data collected by these polar research stations has scientific and strategic implications. In order to collect remote sensing data on changing climate, minerals, and the environment, in 2016, China established its first ground receiving station in Kiruna, Sweden. This station would be critical for China's 'Gaofen' project, which is a network of observation satellites designed to bolster China's global surveillance abilities. China commissioned the MV Xue Long 2, a domestically built polar research vessel and icebreaker, in 2019 (Sharma, 2020).

China lacks direct coastal connections to the Arctic, but it refers to itself as a 'near Arctic state,' as one of the continental states located near the Arctic Circle. Apart from conducting numerous polar research expeditions, China is collaborating on scientific research with Nordic countries through bilateral and multilateral cooperation. China published a white paper titled 'China's Arctic Policy' in 2018 that established a clear mandate for China's short and long term Arctic goals (Banerjee, 2021).

The Arctic is a mineral-rich region. China seeks to dominate strategically valuable resources in the region to meet its growing requirement of industrial raw materials. State-owned enterprises are investing significant sum of money in a variety of resource extraction projects in the Nordic countries that control such Arctic resources. China is also extensively invested in a number of Russian oil and gas projects throughout the region. Russia is looking at China for technological capabilities and substantial investments in oil and gas extraction. The shipment of LNG to China through the Yamal LNG project is a major development, as the NSR significantly reduces the travel time and distance as compared to the route via Malacca Strait. NSR also allows China an alternate route to ship various commodities and oil, thereby providing strategic flexibility. The usage of LNG also contributes to China's goal of reducing carbon emissions. Gazprom and China National Petroleum Corporation have agreed to build a gas pipeline, called Power of Siberia that will supply 38 billion cubic metres of natural gas per year for 30 years by 2025 from Irkutsk and Yakutia. Once the pipeline becomes operational, China will be Russia’s second largest gas importer. Presently, Russia is the largest exporter of oil to China (Doshi, 2021).

China is also looking to establish a 'data silk road' through the Arctic, where Chinese companies are negotiating with their Finnish counterparts to lay underwater fibre optic cable connecting Europe and Asia via the Arctic Northeast Passage. Constructing such a data silk road through the Arctic will bolster China's current high-speed connectivity with Europe and serve as a strategic alternative to the Indian and Pacific Oceans (Sharma, 2020).

The opening of the shipping routes through the Arctic Ocean would diminish the strategic relevance of Indian Ocean Region, thereby denying India the strategic advantage that it has over China (Rao, 2020).

Key to India's Energy and Resources Conundrum

India is the third largest energy consumer in the world. With an energy consumption of 809.2 million tonnes of oil equivalent in 2018, it is the fastest growing energy consumer in the world. India is dependent on imports for about 82.1% of its crude oil and approximately 44.4% of natural gas requirement. India's domestic production has seen a decline, with a 4.15% decline in crude oil and a mere 0.69% rise in natural gas respectively in year 2018-2019 over 2017-2018. In the same period, crude oil import increased by 2.75% in quantity terms and 38.26% in value terms; while LNG imports marked an increase of 4.74% in quantity terms and 37.88% in value terms. According to the International Energy Agency, India's oil and gas demand is expected to double by the year 2040 (Ministry of Petroleum & Natural Gas, 2020).

India is highly dependent on a variety of energy providers. However, due to political uncertainties and other security issues, the supply lines from the various energy producers are vulnerable to risks. India gets almost 60 percent of its oil from the Middle East and North Africa. However, these regions have recently seen a high level of geopolitical insecurity. As a result, India needs to develop a more viable plan for addressing its future energy needs. Presently, LNG is merely 6.2 percent of India's primary energy mix. As LNG is a critical factor to boost India's economic growth, India seeks to increase LNG share to attain 15 percent of its primary energy mix (Bhagwat, 2020).

The Arctic region's 25 geologically defined zones are estimated to contain 90 million barrels of oil, 1670 trillion cubic feet of natural gas, and 44 billion barrels of technically recoverable natural gas liquids. All of these resources collectively account for around 22% of the world's unexplored but technically recoverable resources (USGS, 2008). Looking at India’s growing demand of Oil and Gas, with its large resources, Arctic provides India a suitable alternative to meet its energy needs. Since the Arctic resources have the possibility to solve India’s energy conundrum, India needs to enhance its exploration activities in the Arctic region (Bhagwat, 2020).

The Arctic region is rich in minerals such as iron, gold, nickel, lead, and platinum, as well as a variety of other rare earth elements such as titanium, cobalt, copper, and manganese, which are integral components of modern technology (USGS, 2021). These rare earth elements are used in the production of smartphones, electric/hybrid automobiles, solar panels, wind turbines, timepieces,

high-tech electrical devices, and advanced weaponry (Sharma, 2020). Rare metals and rare earth elements are crucial for the continued viability of a range of industries, including nuclear, defence, information technology (IT), and alternative energy sources such as wind, solar, electric vehicles and others (Krishnamuthy, 2020). The Russian region of the Arctic accounts for 90% of Russia's nickel and cobalt production, 60% of copper production, and over 96% of platinum metals production. Indian rare earth reserves are poor in heavier fractions and abundant in lower fractions. Thus, the Russian Arctic has the potential to compensate for India's acute shortages of rare earth and vital minerals (Bisen, 2021).

Strategic Cooperation between Russia and India

India engages with Russia in various fields, including space, atomic energy, and defence. In addition, India has invested US$ 16 billion in Russia's oil and gas sector, including sourcing and supply, upstream investments, and collaborations (Chaudhury, 2021)

The Russian sector holds around 41% of the world's Arctic oil deposits and 70% of the world's Arctic gas reserves. Arctic oil and gas reserves will be a significant component of the country's energy mix. Since economic activity in this sector accounts for 11% of national GDP, 20% of exports, 17% of oil output, and 80% of natural gas production (Dmitrieva, 2021), Russia has ensured continued efforts towards continued exploration of oil and gas and other projects in the Arctic. Consequent to sanctions from the West, which led to pull out of various Western companies, Russia has aggressively started engaging with energy firms in Asia to participate and invest in the Arctic LNG

2 project (Shapovalova, 2020). ONGC Videsh Limited (OVL) has invested in Russian energy projects such as the Sakhalin 1-project in 2002 and signed an agreement with Russia's state-owned oil company Rosneft in 2015 to invest in the Vankor field in Siberia. In 2016, the Indian energy consortium comprising Indian Oil Corporation Limited (IOC), Oil India Limited (OIL), and Bharat Petro Resources Limited (BPRL) purchased 23.9 percent and 29.9 percent shares, respectively, in JSC Vankorneft and LLC Taas-Yuryakh fields (MEA, Government of India, 2020).

As stated in the Saint Petersburg declaration, “India and Russia will strive to build an “Energy Bridge” and expand bilateral relations in all areas of energy cooperation, including nuclear, hydrocarbon, hydel, and renewable energy sources, and in improving energy efficiency. We are interested in launching joint projects on exploration and exploitation of hydrocarbons in the Arctic shelf of the Russian Federation” (MEA, Government of India, 2017). Consequently, India and Russia are deliberating increasing their investments on the use of Arctic energy. Rosneft acquired a 49 percent stake in India's Essar Oil Ltd in August 2017. On June 04, 2018, GAIL received the first shipment of Russian LNG under a renegotiated 20-year contract with Gazprom for the supply of 2.5 million tonnes of LNG per year. A USD 13 billion investment by Rosneft in the Vadinar refinery is the largest foreign direct investment in India's oil and gas sector (Bhagwat, 2020).

The "Basic Principles of the Russian Federation's Arctic State Policy for the Period to 2035," announced by President Putin on 06 March 2020, seeks participation from investors for Arctic shelf exploration activities, establishing mineral resource centres and logistic hubs that from part of global supply chains using the NSR.

(Klimenko, 2020). India has been undertaking oil and gas exploration for substantial duration now and has gained considerable experience in this filed. India may therefore consider sharing its expertise with the Russian side on offshore hydrocarbon exploration.

Russia intends to develop the NSR as a globally competitive transportation corridor. Though the development of the NSR presents India with limited opportunities in terms of time and space, it may nonetheless provide a strategic option to India's energy supplies should the Russian High North's oil and gas fields expand (Sharma & Sinha, 2021).

India has a distinct opportunity to leverage its strategic partnership with Russia and collaborate with it in a variety of sectors, including energy, hydrography in NSR, exploration of minerals, renewable energy, timber industry, provision of technically skilled manpower, climate change research, engagements between Russian and Indian academician and institutes (Bhagwat, 2020).

However, with Russia's developing ties with China and India's own growing partnership with the USA necessitate India to strategize its associations and linkages so as to maintain a fine balance with all stakeholders.

Connectivity with Arctic Region

As the shipping routes open up in the Arctic, India needs to explore its connectivity with the region via the International North South Transport Corridor

(INSTC). The INSTC is a multi-modal transportation network spanning over 7200 km, which connects the Indian Ocean to the Caspian Sea via the Persian Gulf and further with Russia and Northern Europe using the sea, road, and rail transportation modes. The INSTC is the shortest trade route between Russia and India and seeks to lower the transportation costs between India and Russia by about one-third and cut transit time from existing 40 days by about 50 percent. The INSTC connectivity effort has the potential to catalyse revolutionary development in the region by promoting trade, transit, and overall economic development. Additionally, it will enhance growth prospects and create better employment opportunities, thereby improving the economy of the regional stakeholders. India needs to consider integrating INSTC with the Scandinavian-Mediterranean (ScanMed) Corridor and the projected Arctic Northern Sea Passage (Cyril *et al.*, 2021).

India and Russia proposed the development of a maritime route between Vladivostok and Chennai during the Eastern Economic Forum in 2019. The initiative intends to connect both the major ports in the two countries and overcome India's and Russia's current lack of connectivity (Iyer & Kapoor, 2020). The Russian Far East (RFE) is endowed with natural resources, accounting for 98% of Russian diamonds, 50% of gold, 90% of borax, 14% of tungsten, and 40% of fish. This region also holds about 30 % of the country's coal reserves and hydro-engineering resources. The forest cover in RFE is about 30% of Russia's total forest area. Russia's increased impetus on the growth and development of RFE is evident from the fact that since 2015 the cumulative FDI in RFE has nearly risen to US$ 80 billion. The region's industrial growth has outpaced the national average, and industrial production has increased at a rate twice that of the national average (Bisen, 2021). Therefore, the

RFE offers a tremendous opportunity for both the countries to give a strong thrust to their deepening engagement.

The Chennai–Vladivostok Maritime Corridor (CVMC), which will connect the Indian ports of Chennai, Visakhapatnam, and Kolkata to Vladivostok, Vostochny, and Olga on Russia's east coast and hence serve as an extension to the NSR. Once fully operating, the CVMC will reduce the required time to transport cargo between India and Russia to 24 days, from the existing 40 days via the European route. As a result, the CVMC will enhance India's strategic position in the South China Sea and expand its role in the Indo-Pacific region by bolstering its naval presence to safeguard oil and trade flows from Russia's Far East. The CVMC, in conjunction with the International North-South Corridor (Figure 5.5), has the potential to link India and the Arctic closer than ever before in terms of connectivity, while also providing job opportunities for India's rising population (Sharma & Sinha, 2021).

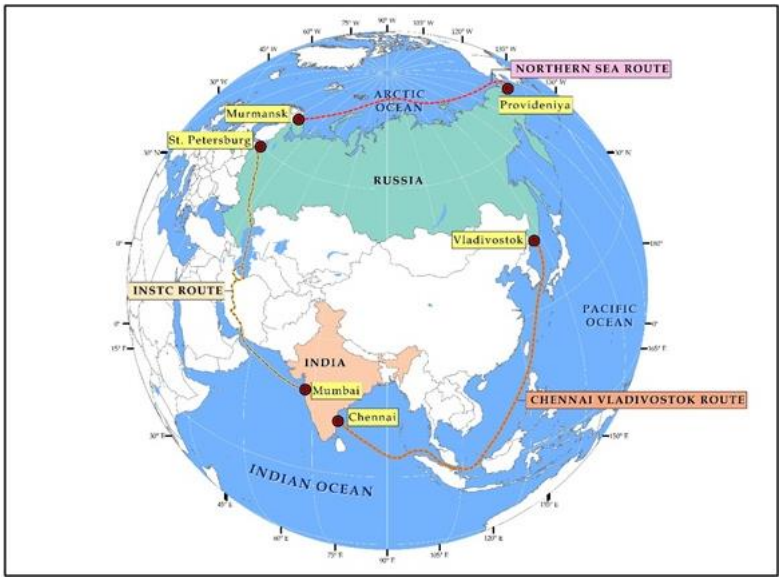


Figure 5.5. India's Connection with the Arctic Region by linking of INSTC and CVMC

Source: Manohar Parrikar IDSA, New Delhi

Indian Options to Engage Arctic States

India's increasing prominence in the economic and scientific areas during the changing geostrategic significance of the Arctic allows it an opportunity for India to enhance its ties with the Arctic states. In2010, India launched the Norwegian programme for research cooperation with India (INDNOR), which focuses on international political concerns, the climate change, use of clean energy, and social development. India and Sweden signed a Memorandum of Understanding (MoU) in 2019 to collaborate on polar science. In February 2020, the NCPOR signed a MoU with Polar Knowledge Canada (POLAR) to expand the spectrum of Arctic research with Canada (Agarwala, 2021). India and Finland inked a cooperation agreement in November 2020 on environmental preservation and biodiversity conservation (Tayal, 2020).

With the region's developing great power rivalry between the United States, Russia, and China, these states may be willing to diversify their economic and military allies in order to alleviate regional tensions. India must make the most of these possibilities to strengthen its regional ties (Rao, 2020). India doesn’t have financial power like China to establish advantageous alliances and partnerships with the Arctic states. Therefore, India needs to leverage its technological competence, scientific capabilities and goodwill to deepen bilateral and multilateral engagements with the region's countries.

Polar research in the Arctic continues to be a specialist field of study. While numerous nations conduct their own study on environmental changes, polar research

provides an opportunity for substantial scientific partnerships between marine biologists, glaciologists, and atmospheric scientists (Sharma & Sinha, 2021). Sea-ice retreat and permafrost thawing are resulting in an increase of infectious viruses in the ecosystem. The discovery of one such 'metallo-lactamase-1 gene' (codenamed blaNDM-1) in the Arctic in 2013, following its detection in a hospital patient in India in 2007, demonstrates the genes' long-distance migration trend (McCann *et al.*, 2019). Being a leader in medical research, India can engage with the Arctic states in the field of medical science. Polar medicine research enables the study of a variety of organisms that may aid in the development of future treatments and drugs. Bioprospecting for the purpose of developing drugs can be a critical area of collaboration (Sharma & Sinha, 2021).

The Indian Navy has served as a diplomatic instrument for India's foreign policy, helping to influence the maritime environment in the country's interests. The Indian Navy's deployments are in support of this policy, and in 2016, three navy ships visited Vladivostok in Russia's Far East. This was followed by a visit to ports in a number of Arctic states by an Indian Naval warship in 2019, including St Petersburg (Russia), Bergen (Norway), Karlskrona (Sweden), and Helsinki (Finland). India is also looking at formulation of Reciprocal Exchange of Logistics Agreement with Russia, which will allow India access to the Russian Ports in the region. Such an agreement will be instrumental towards increasing India’s operational reach in the Arctic region (Agarwala, 2021). Additionally, India holds considerable experience in undertaking hydrographic surveys; India could offer its expertise in preparation of navigation charts to the Arctic nations (Bhagwat, 2020).

Arctic has also gained significance in the field of digital connectivity. As industrial and commercial activity gather momentum, the Arctic region is becoming increasingly connected to the rest of the world via undersea fibre optic cables and satellites. As a result, internet connectivity has increased dramatically (Raspotnik, 2017). The extreme weather in the Arctic necessitates establishment of connectivity via satellites. India has a robust satellite programme and considerable expertise in launch of satellite; which could be utilised to help the Arctic states in enhancing connectivity at cost-effective prices. In addition, India also has a well-developed IT sector that could provide technical solutions for developing the region's software technology infrastructure. The Arctic is an ideal site for large data hubs, and both the space and information technology sectors offer India promising avenues for engagement with the region (Sharma & Sinha, 2021).

With an average age of 29 years, India is presently the world's fifth youngest country. India has become the largest emerging consumer market and the greatest workforce provider, both in terms of skilled and unskilled labour, as a result of the young demographic dividend. India can explore the Arctic region as a destination for its large workforce, especially since Arctic region provides ample economic opportunity while suffering with scarcity of population (Sharma & Sinha, 2021).

To carry out diverse energy and mineral resource extraction projects in the Arctic region, a pool of competent mariners with arctic operations experience and a trained staff are necessary. Presently, India employs 9.35% of all seafarers worldwide in the marine industry. By providing training to both its current and future generations

of seafarers, India can capitalise on the emerging shipping activity in Polar Regions (Bisen, 2021).

The Arctic region, with its stunning and vulnerable landscapes and enchanting northern lights, offers a one-of-a-kind experience and is another area of potential cooperation. While India currently has very few interactions and people-to-people ties with the Arctic states, with the exception of Russia, the melting of sea ice has increased India's opportunities to engage and collaborate with these countries. India may highlight its ancient civilizational ties to the region dating all the way back to Vedic times in order to connect with the region's indigenous inhabitants. India needs to explore the potential of sustainable tourism in the Arctic region (Sharma & Sinha, 2021).

To sum up, it is seen that the climate change taking place at distances exceeding 7000 km north is directly impacting India. The rising temperatures in the Arctic region are triggering major climate events globally including India. The melting of ice and the reducing sea ice extent in the Arctic is directly influencing the duration and severity of Indian monsoon as well as resulting in a rise in global sea levels. The temperatures in the Arctic are rising and causing major climate events world over including India. India is directly affected by the melting of ice which is influencing the severity and duration of the monsoons and causing a rise in sea level; which has direct influence on the livelihood of the citizens.

India’s engagement with the region till date has been largely restricted to scientific research. As the world and India face newer climate related challenges, the ensuing economic and trade linked opportunities dictates a change in India’s approach

to the region. India needs to further its energy interests in the region to greater bilateral and multilateral engagements with all stakeholders. There is a need for India to prioritise its economic, scientific, energy, social and strategic outlook while setting a clear and robust roadmap of its Arctic strategy.

CHAPTER 6

FINDINGS AND ANALYSIS

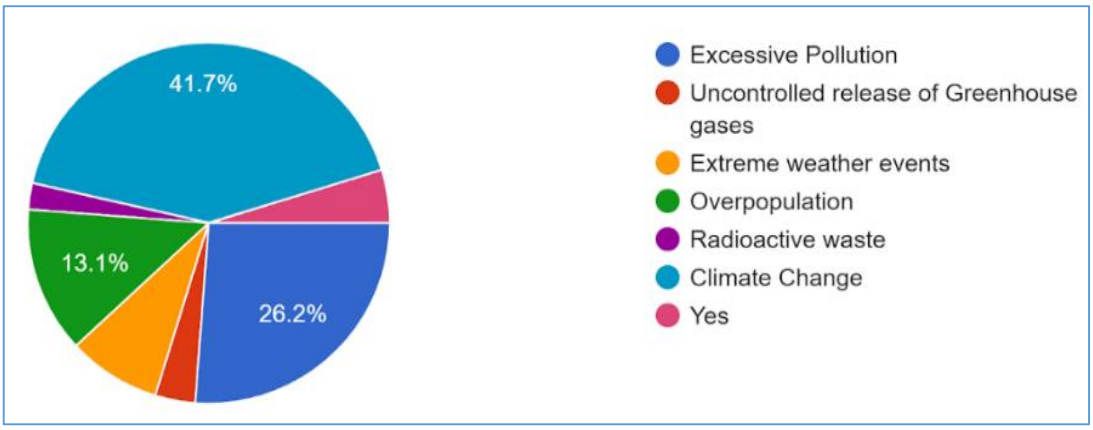
Findings of the Survey

A Google questionnaire was administered to analyse the views of the respondents on the effect of climate change in the Arctic. The questionnaire was sent to the respondent *via* Google form and their inputs were sought on various issues pertaining to the challenges being faced globally and by India due the changing climate as well as the opportunities that a melting Arctic offers to the world. Specific inputs with respect to the way ahead for India were also sought from the respondents. The questionnaire is placed at Annexure 1.

The respondents included people from various strata of the society, such as officers from the Armed Forces, Academicians, researcher scholars and college students. The survey was therefore able to capture the views of respondents from age group varying from about 18 years to more than 60. The educational qualification of the respondents too varied from undergraduates to PhD holders. The questionnaire was responded by 84 people.

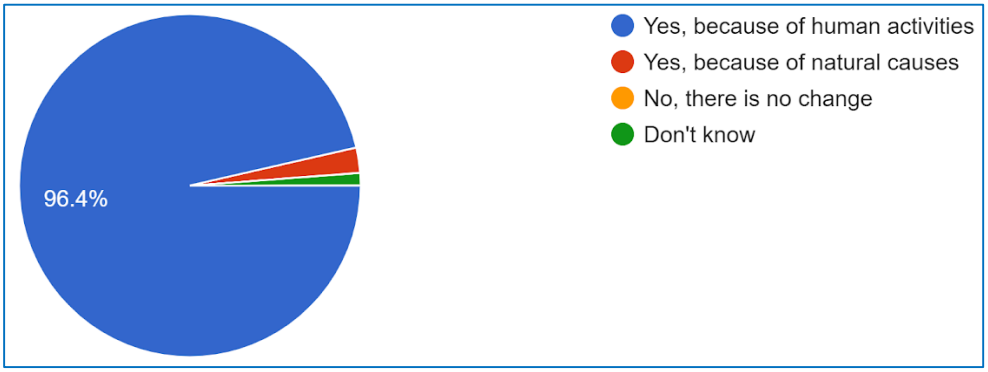
26.2% of the respondents felt excessive pollution to be the most serious environmental issue affecting the world; 41.7 percent of the respondents believe it to be the climate change. A lesser number felt overpopulation, extreme weather events,

and uncontrolled release of greenhouse gases to be significantly affecting the world environment.



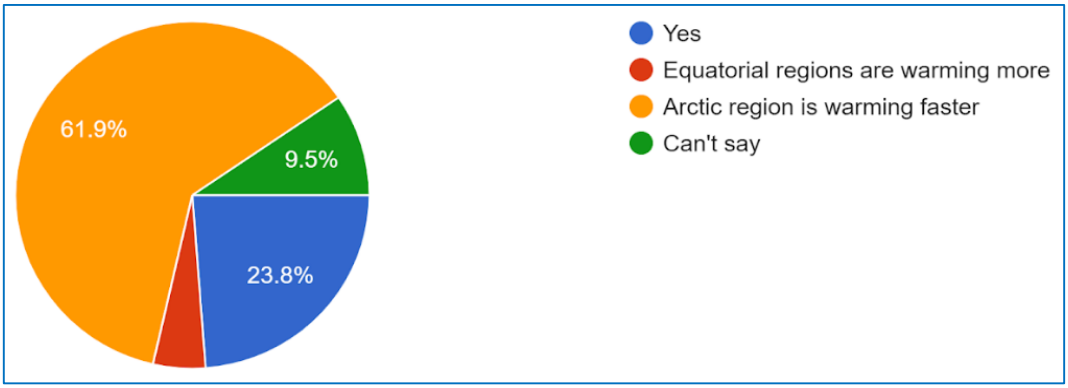
Environmental issue most seriously affecting the world today

An overwhelming 96.4 percent respondents agree that the earth's temperature is rising over the last few decades and human activities are responsible for it.



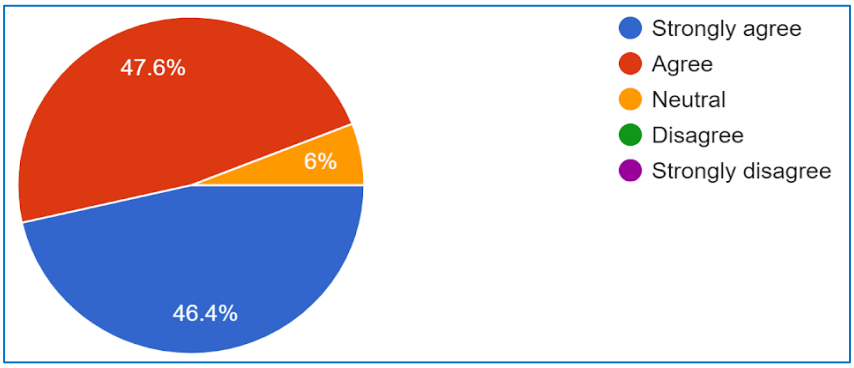
Is the Earth's temperature rising over past few decades?

Replying to the question if all parts of the earth are warming at a uniform rate, 61.9 percent respondents felt that the Arctic is warming faster than the other parts of the world.



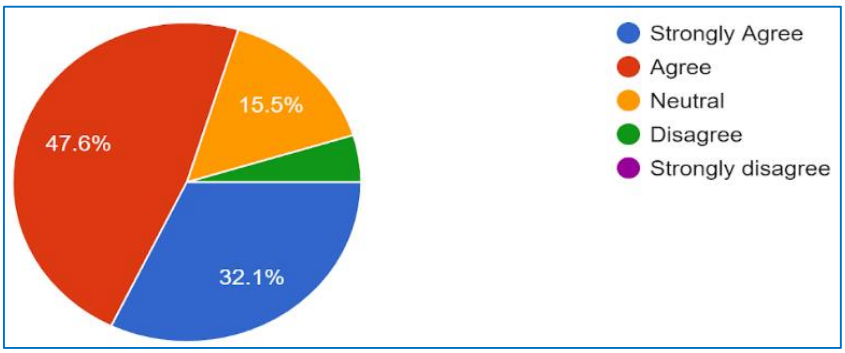
Is the Earth warming at a uniform rate?

94% of the respondents agreed that the climatic changes taking place in the Arctic region are influencing the climate in other parts of the world.



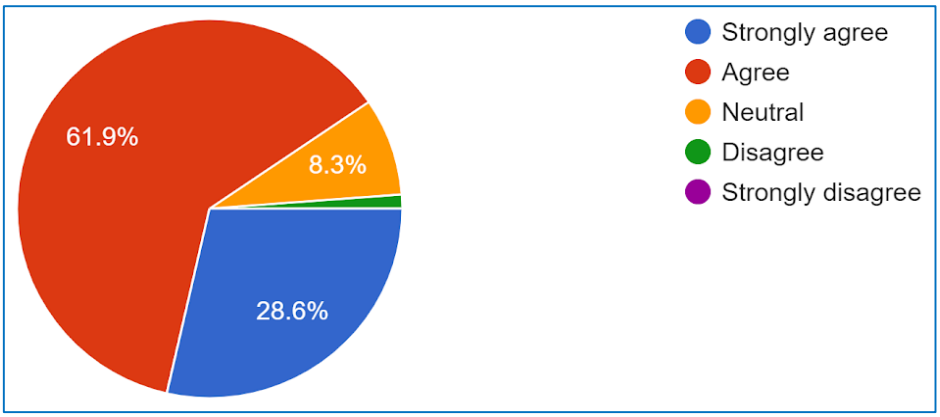
Is the climate change in Arctic influencing global climate?

79.7 % of the respondents believed that the extreme weather events occurring around the world are due to the climate change in the Arctic; while 4.8% did not feel so.



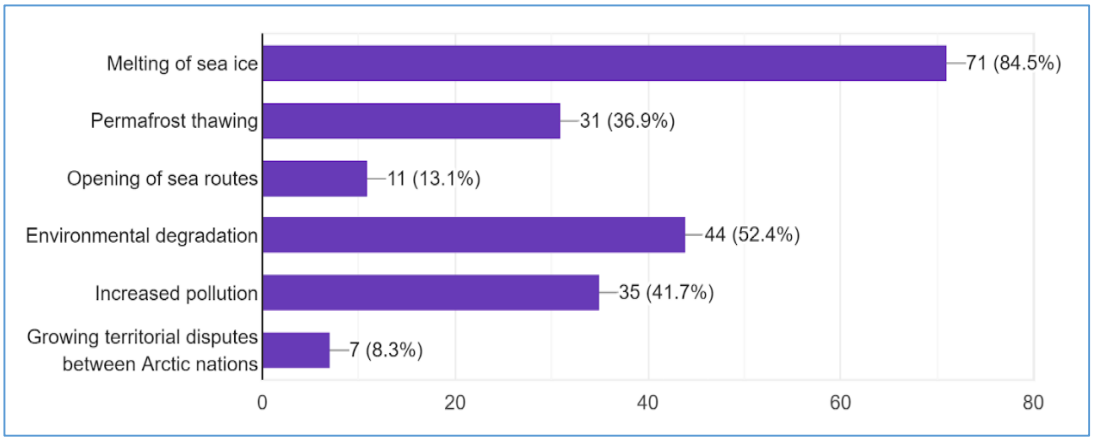
Relation of global extreme weather climate events to Arctic climate change

90.5 percent of the respondents believed that the melting of sea ice in the Arctic region affects the wind pattern and ocean currents.



Melting of Sea Ice in Arctic Region changes wind pattern and ocean currents

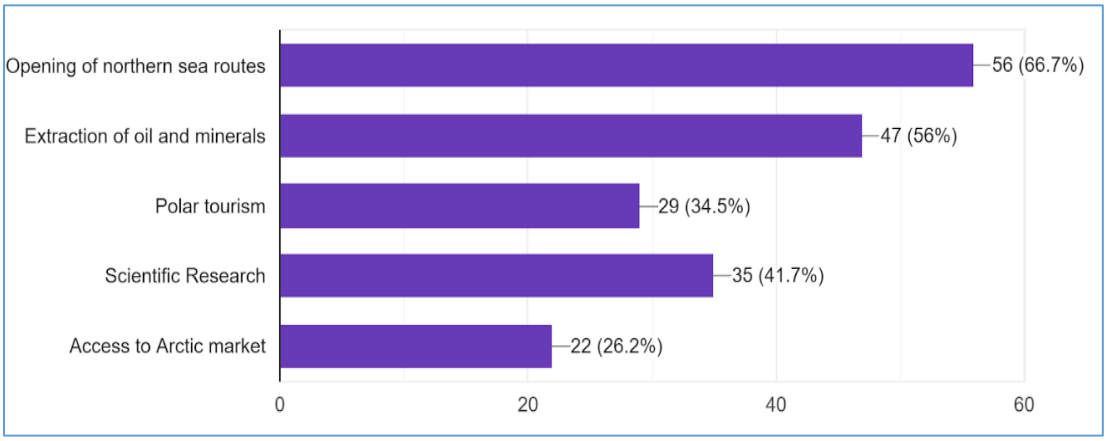
While responding to the question on the biggest challenge faced by the indigenous people of the Arctic region, 84.5 percent respondents felt that melting ice was the cause of major social and economic issues being faced by the local population. 52.4 percent responses suggested environmental degradation as the cause of their problem. (Respondents were allowed to select more than one choice).



Biggest challenge for people of Arctic Region

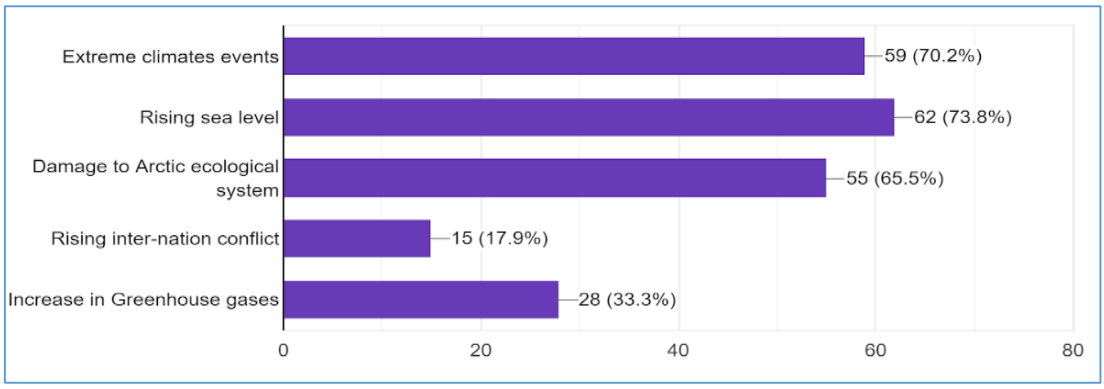
The respondents believed that opening of the northern sea routes is the greatest opportunity that the melting ice has offered to the nations across the world; 66.7 percent

supported this choice. 56 percent respondents felt it to be the resources extraction while 41.7 % believed enhanced scientific research to be a useful opportunity offered by the changing Arctic. The other options of increased Polar tourism and access to the Arctic markets to the world were selected by 34.5% and 26.2 % respondents.



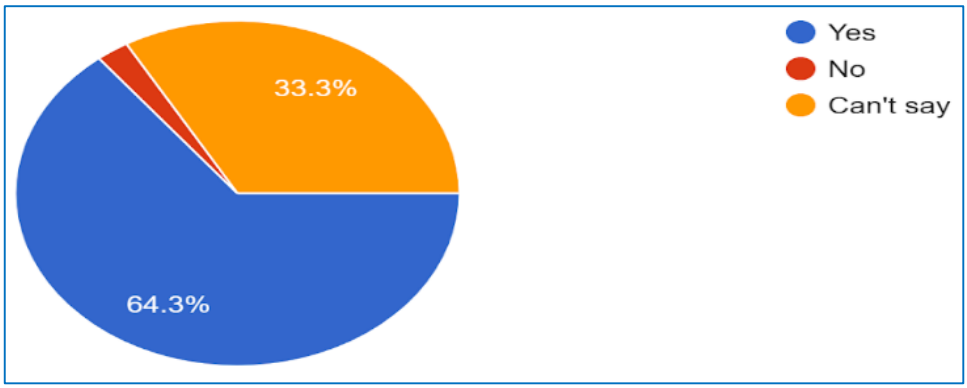
Opportunity offered by melting ice to the nation's world over

In response to the biggest challenge arising globally from the climate change in the Arctic region, respondents felt that extreme climate change (70.2%), rising sea levels (73.8%) and damage to Arctic ecological system (65.5%) are major challenges being faced by the global population.



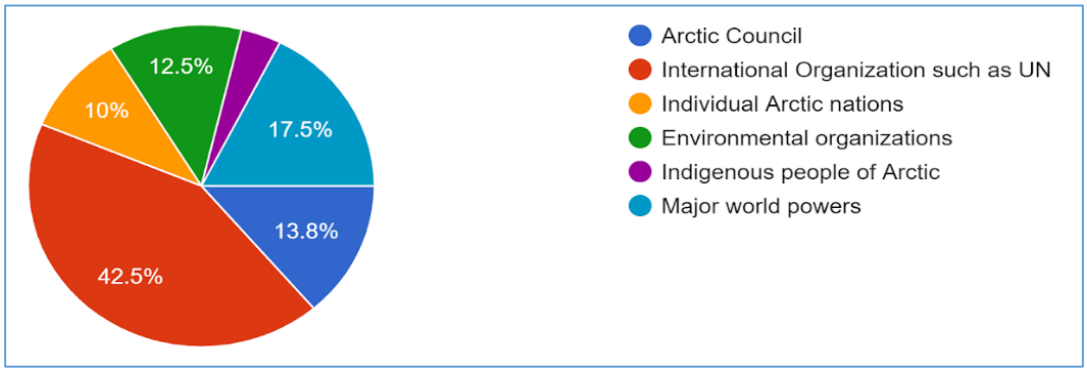
Biggest challenge arising globally from climate change in Arctic Region

64.3% respondents felt that increased accessibility to the Arctic region has enhanced the military and commercial interest of nations located beyond the region.



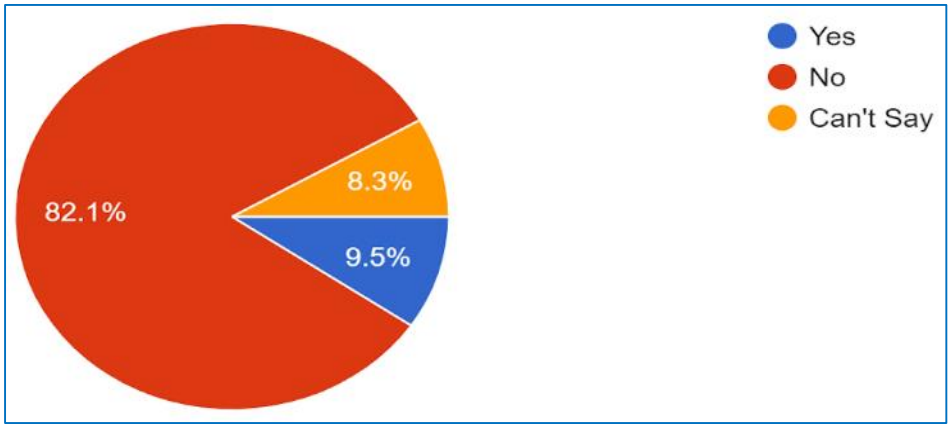
Has increased Arctic accessibility enhanced military and commercial interest of non-Arctic states?

Responding to the question on the organisation that should take the responsibility for tackling the climate change in the Arctic region, the respondents had varied views. 42.5 % respondents believed that International organisations such as United Nations must take the lead, while other felt major world powers (17.5%), Arctic council (13.8%), environmental organisations (12.5%) and individual Arctic nations (10%) must be leading the efforts to control the climate change.



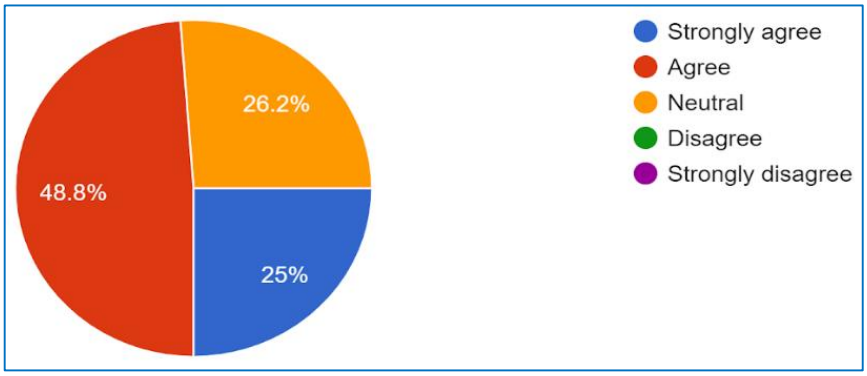
Who should take main responsibility to tackle climate change in the Arctic

82.1 percent respondents felt that India cannot remain isolated for the changes taking place in the Arctic region.



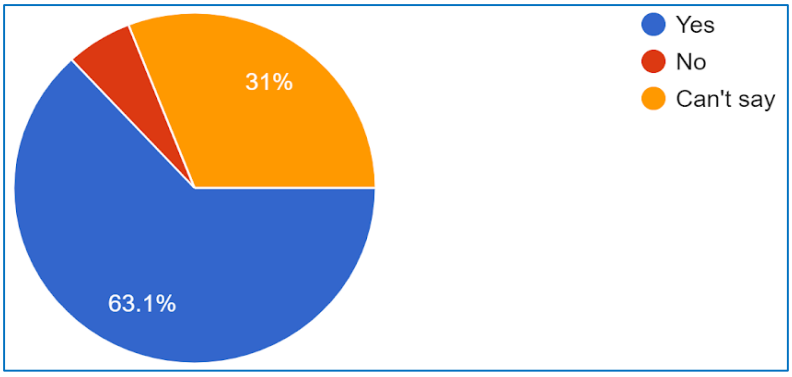
Can India remain isolated by the changes taking place in the Arctic?

73.8 % respondents agreed that the climate changes in the Arctic region are influencing the Indian monsoons.



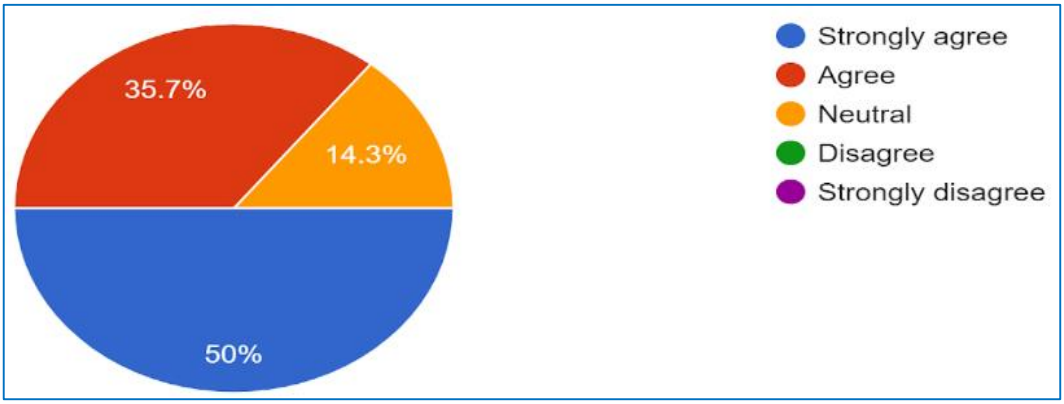
Indian monsoons are getting influenced by the climate change in the Arctic

63.1% respondents opined that Himalayan glaciers are being affected by the climate change in the Arctic region.



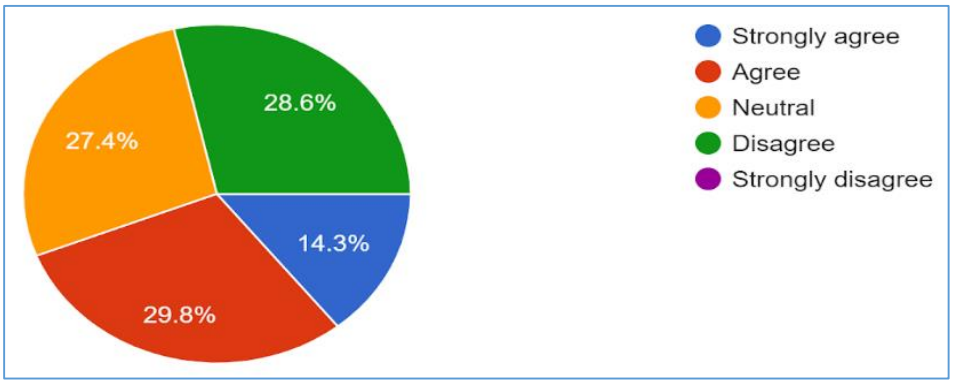
Are Himalayan glaciers affected by the climate change in the Arctic region?

An overwhelming 85.7% respondents believed that India needs to increase its research activities in the Arctic region to evaluate and examine the effect of changing Arctic on the Indian climate.



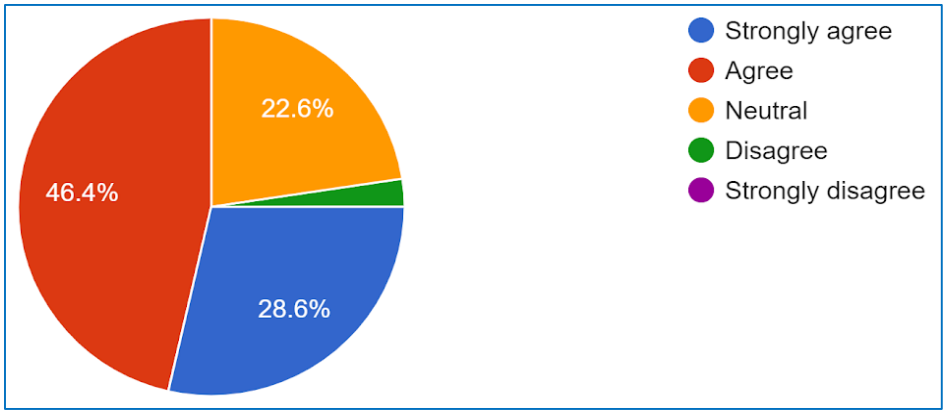
Does India need to increase its research activities in Arctic to evaluate its effect on Indian Climate?

44.1% respondents agreed that opening of northern sea routes across the Arctic Ocean will reduce India's geographical significance in Indian Ocean Region (IOR); 28.6 % of the respondents however disagreed and felt that the northern sea routes will have no consequence on India's position in the IOR.



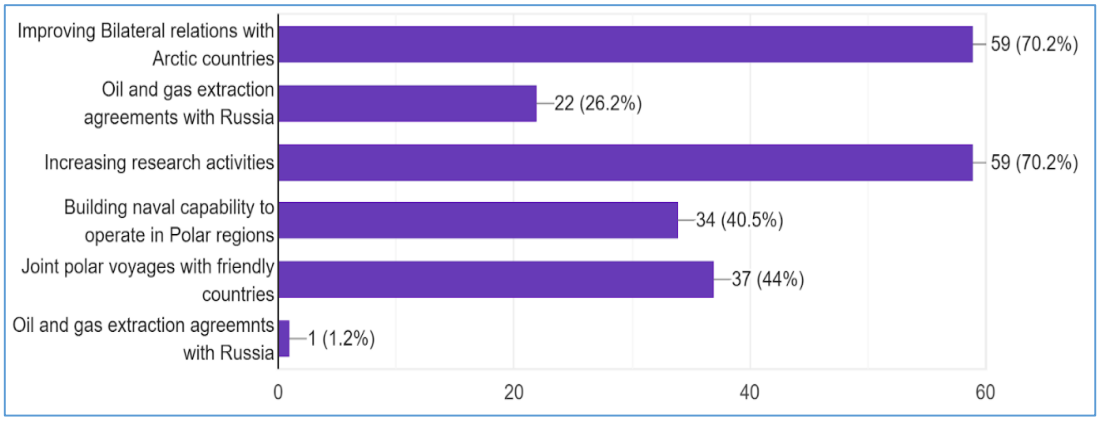
Will opening of Northern Sea Routes reduce India's geostrategic significance in Indian Ocean Region?

75 percent respondents agreed that India needs to increase its presence to become a dominant actor in the evolving geopolitics in the Arctic region.



India needs to increase its presence to become a dominant actor in evolving geopolitics in Arctic region

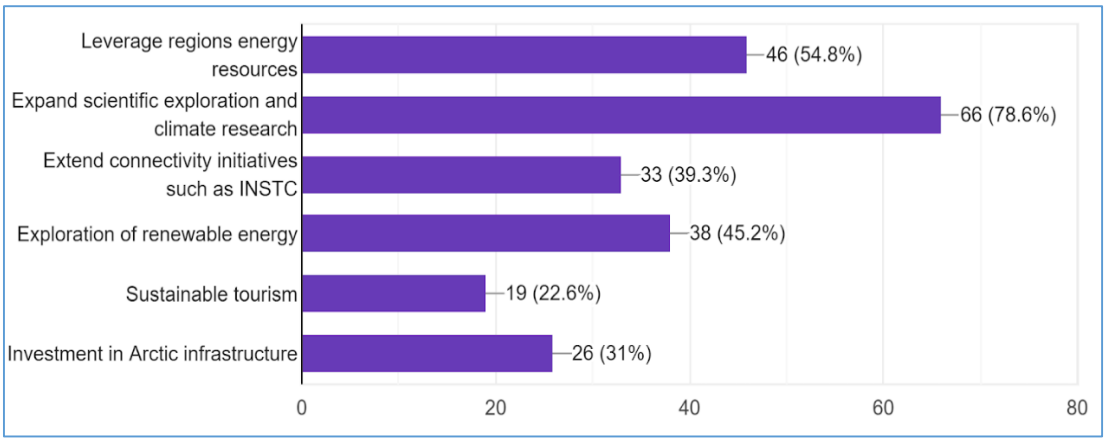
70.2% responses opined that improving bilateral relations with the Arctic countries and increasing research activities in the Arctic would increase India's presence in the Arctic region. Building naval capabilities to operate in Polar Regions (40.5%) and undertaking joint polar voyages with friendly countries (44%) were other measured believed to help India increase its presence in the region.



How can India increase its presence in the Arctic region?

78.6% respondents opined that opening of the Arctic region provides India an opportunity to expand its exploration and climate research; while 54.8% percent believed that melting Arctic region allows India to leverage the regions energy

resources to meet its growing energy requirements and 45.2 % felt the changing climate in the Arctic has provided India an opportunity to explore renewable energy.



What are the opportunities offered to India by opening of the Arctic region?

Analysis of the Survey Findings

The breakdown of the respondents reveals a near equal participation by people from various walks of life, *viz* defence officers, bureaucrats, academicians, research scholars and students. The change in climate is considered as the major issue affecting the environment today. As expected, a significant number of respondents felt that increased human activities have accelerated the climate change. It is therefore imperative that the world populace takes steps to slow down the process of global warming through various environment conservation measures.

A large number of respondents replied that the Arctic is warming much faster than the other parts of the world. This is consonance with the IPCC studies which suggests that Arctic is warming at least three times faster. The respondents agreed that the world is getting affected by the climate changes in the Arctic and the severity and the intensity of the extreme weather events being observed in various parts of the world

was increasing due to the changing climate in the Arctic. A considerable number of respondents believed that the wind patterns and ocean currents were being affected by meting of ice in the Arctic region. The responses indicate the awareness amongst the respondents on the widespread effect of climate change in the Arctic region.

The opening of shipping routes has put Arctic on the world's trade map and opened up vast economic opportunity for the region. Additionally, the melting ice has enhanced the possibilities of resource extraction, provided opportunities for scientific research and increased polar tourism. As a consequent of the shipping routes, the trade opportunities and access to the Arctic markets will increase. However, the melting ice has exacerbated the social and economic issues being faced by the indigenous population of the Arctic region. The environmental degradation of the region is another issue being faced by the local populace. It is therefore imperative that a balance be maintained between economic gains from opening of shipping routes and resource exploration and its effects on the Arctic ecosystem.

The responses of the participant's reveals that the major challenges faced by the world from warming of the Arctic are increased extreme weather events and rising sea levels. The damage to the Arctic ecological system is also affecting the global ecosystem. Further, the responses confirms that greater accessibility has increased the military and economic interest of non-Arctic states in the political, economic and social activities of the region.

The study reveals that international organisations such as United Nations need to take greater responsibility in ensuring reduction of global warming and release of

greenhouse gases, so as to slow down the positive feedback loop of climate change taking place in the Arctic. It is also felt that major world powers, the Arctic Council and various environmental organisations too need to be proactive in taking action to control the climate change.

As far as India is concerned, majority response confirmed that India cannot remain isolated from the ongoing climate change in the Arctic region. The study brings out that there is correlation between the climate changes in the Arctic and the Himalayas and the Indian monsoons. To understand the tele-connections between the Arctic and the Indian climate, it is imperative for India to reinforce its research endeavours in the Arctic region.

While there is no consensus amongst the respondents regarding strategic loss to India in the Indian Ocean region with the opening of the shipping routes in the North, but it is agreed that India needs to take initiative to increase its presence in the region so as to become a dominant actor in the evolving geopolitics of the Arctic region. A large number of the respondents opined that opening up of Arctic offers India an opportunity to play an important role in resource exploration in the region. India should also leverage the regions energy resources including the renewable energy to resolve its energy conundrum. The response from the respondents suggests better bilateral relations, greater research activities, joint polar voyages and building own naval capabilities to operate in Polar waters as a few options to enhance its role in the region.

CHAPTER 7

WAY FORWARD FOR INDIA

As the climate changes are being observed globally, a consensus has evolved that, if the growing temperatures are not controlled, the planet's ecosystem will face adverse conditions and non-reversal changes. The constantly rising levels of Green House Gases are already wreaking havoc on the vulnerable ecosystems and people worldwide. Its manifestations include melting ice and glaciers, collapsing polar ice caps, permafrost thawing, altered monsoon patterns, increasing sea levels, and deadly heat waves (Yadav & Kumar, 2019).

According to the IPCC reports, the sea level may rise by about 0.5 – 1.0 m by the end of the century. The population residing at the Coasts along with the coastal infrastructure and assets are most vulnerable due to the rising sea levels. India has been identified as one of the most vulnerable countries in the world to get affected by the global sea level rise (Kulp & Strauss, 2019).

Glacier retreat is one of the most prominent indicators of the Earth's changing climate. Glaciers are melting on all six continents, as well as in the Arctic Circle, as a result of global warming. The Himalayan mountain ranges alongwith the Hindu Kush and Karakoram store more than 60,000 km^2 of ice. These ranges are the perennial water source for major rivers, such as Ganga, Brahamputra and Yamuna. Approximately 750 million people are dependent on these glaciers and rivers for the water supply. Any changes in the volume and time of the water flow can cause significant social and

economic implications. Further, as the glaciers melt, they will severely impact the lives and livelihood of population residing downstream (World Bank Group, 2021). With each passing year, the climate change is resulting in large physical, ecological, economic and social changes.

India would also suffer significantly from climate change, as the Indian economy is highly dependent on sectors such as agriculture, water, and forests, all of which are highly sensitive to climate change. India is facing a real risk, necessitating the development of strong responsive ability to resist climate change. Changes in temperature, rainfall and humidity are resulting in severe and frequent cyclones, floods, heat waves; all which is impacting the nation's development as it affects critical sectors such as agriculture, fisheries, health, infrastructure etc (DST, Government of India, 2010).

Sustainable Actions by India towards Climate Restoration

While countries proclaim to adhere to the lofty Paris climate goals, globally the carbon emission and the energy demand has been growing at a faster rate, implying that very little is being done to reduce emission and control pollution. Consequently, the race to improve one's own economy is causing greater emissions worldwide, which in leading to erratic weather patterns; which in turn results in substantial energy demand for either cooling or heating. This then increases the emissions, hence causing a vicious cycle of emission and energy demand. While 70 percent of countries in the world have committed to net zero emissions over varying time periods, it seems to be too little, too late. The IPCC seeks greater progress in controlling the missions; however

irrespective of whatever action is taken by the world, the current greenhouse emission rate will lead to global warming of 1.5°C by 2030 and over 2°C by the end of the century (United Nations News, 2020).

To restrict the rate of global warming, active efforts are required to be taken to not only reduce but also remove the existing greenhouse gases. The creation of carbon sinks and restoration of habitat through mangroves is a possible way ahead. Efforts may be taken to re-cool the Arctic, interrupt the spiral of ice loss, rise in sea levels; steps that may cause a feedback loop which reverses the effect of global warming. Another method which may cool ocean surface and stimulate cooling of Arctic summer is Marine cloud brightening. This process would include spraying of salt by floating solar-powered pumps upwards to brighten clouds so as to form a reflective fence between the Sun and the ocean (King & Lichtenstein, 2021).

Since the commencement of the United Nations Environment Programme in 1972, India has been actively engaged on Climate Change and Sustainable Development, through participation in the Rio Declaration-Earth Summit 1992, the Kyoto Protocol-1997, the Johannesburg Declaration on Sustainable Development-2002, Copenhagen accord and the Paris Agreement of 2009 and 2016, respectively, within the United Nations Framework Convention on Climate Change (UNFCCC). India is also a signatory to five major international conventions, including the International Union for Conservation of Nature and Natural Resources (IUCN) and the United Nations Educational, Scientific, and Cultural Organization-World Heritage Committee (UNESCO-WHC) (Yadav & Kumar, 2019).

India has been extraordinarily successful in meeting its commitments to global climate action goals over the last seven years. India led 121 countries in forming the International Solar Alliance in 2015. India assumed the leadership role in creating an international multi-sectoral alliance for Disaster-Resilient Infrastructure in 2019 in order to minimise the effects of disasters on socio-economic and ecological infrastructure. Despite being one of the lowest per capita carbon emitting countries in the world, India has been proactive in reducing its emissions. India's forest cover has increased significantly over the last decade, and the country's largest major polluting industries have committed to achieving sustainable development goals during this decade. By end 2020, India had made significant progress toward meeting its climate action commitments under the 2015 Paris Agreement, becoming one of only a few countries and the world's largest economy to do so. India's "spirit of trusteeship toward planet Earth," as professed by the Indian Prime Minister at the November 2020 G20 Summit, encapsulates its efforts as an assiduous and reliable economic power (Giri, 2021).

During international climate summit COP 26, India brought out that since 2009, the developed nations continue to fail to provide USD 100 billion annual support to developing nations. Notwithstanding, India made a commitment to achieve net zero emissions by 2070, attain non-fossil energy capacity of 500 giga watt and meet half of its energy requirements from renewable energy sources by 2030. To harness solar energy and optimise the electricity generated, India launched 'One Sun, One World, One Grid' during the conference (The Economic Times, 2021).

India's noticeable commitments to the world, and specifically to Arctic nations on climate change, make India eligible to be an equitable partner as the members of Arctic Council members. Being a part of the Arctic Council, India can advocate for the reduction in emission of greenhouse gases and the amelioration of their devastating effect on Arctic ecosystems. This request also aligns with the Arctic Contaminants Action Program proposed by the Arctic council. Together with observer nations Japan and South Korea, India and Russia can develop a roadmap for strategic Asian Hydrogen Energy Technology. The imperatives of the roadmap could emphasis on the exchange of hydrogen fuel and energy technologies, which can be helpful in sectors such as transportation, power generation, oil refining and chemicals. Additionally, International Solar Alliance led by India can assist countries to use solar energy for production of the cleanest "green" hydrogen. Such steps would allow India to restore its energy and trade interests in the Arctic region while adhering to internationally acceptable environmental safeguards (Giri, 2021). In the Arctic, India currently operates one research station, one laboratory, and two observatories. India should pursue establishment of earth stations to receive satellite data from remote sensing satellites. This would allow India to observe the environment and explore natural resources in the northern hemisphere (Agarwala, 2021).

India’s Arctic Dilemma

On one hand the increased accessibility of Arctic is unlocking a much greater strategic and economic potential of the region; while on the other, it is leading to severe problems for the world. It is well understood that progress and development of Arctic region will have far-reaching consequences for the rest of the world. The erratic weather calamities, rising sea levels and altered weather patterns are severely impacting the

world. The existing global powers and aspirant powers are engaged in a competition to establish their dominance and monopoly on the Arctic Region. While the opening of sea routes has reduced the travel time and distances between the regions, but it has led to a greater race to control the region and the route (Pareek, 2020). The Arctic thus poses an ‘antithetical situation’, with economic gains on one side and resource governance and reduction of climate risks on the other (Bhagwat, 2020). To preserve the Arctic’s ecosystem, it is imperative to maintain a careful balance between both of them. The Arctic must continue to be governed with greater international cooperation, as mandated by International Law and the 2013 Arctic Vision (Pareek, 2020).

Though the Arctic is geographically faraway from India, however, the change in climate in Arctic is influencing the Indian climate and impacting India’s economy. Considering the growing geostrategic relevance of Arctic region, it is imperative for India to participate in the regions activities, not only from the point of view of scientific research but also active strategic presence and participation (Chandran, 2019).

India, along with 13 other countries, has been a permanent observer country in the Arctic Council since 2013. In 2019, during the Arctic Council's ministerial meeting in Finland, this status was reconfigured to India (Sinha, 2020). India needs to increase its active participation in Arctic governance by attending all Arctic council working group meetings. India should reiterate its commitment to the Arctic nations' sovereignty and work to foster mutual trust through observance of international law and adherence to mechanisms to resolve disagreements and conflicts. As an observer nation, India must contribute to the Council's work by financing selected projects and providing India's expertise to various regional concerns. India's active participation in Arctic

Council core working group meetings can act as a geopolitical check on the Arctic Council's other dominant players (Sharma, 2020).

The emerging changes in the Arctic are posing ever-increasing environmental and geostrategic challenges for the region, which are also influencing the relationships between the Arctic and non-Arctic states. China’s aggressive efforts to gain access into the region to strengthen its strategic and economic foothold is being viewed with restraint and concern by all the stakeholders in the Arctic region. To meet its ambitions to be a major player in the region, China is investing heavily in Arctic countries' energy, mining, and other development projects. China's Arctic infrastructure development and its scientific cooperation evidently demonstrates Arctic's significance in China’s growth plans (Sharma, 2020).

Given India's demand for Arctic oil, gas, and minerals, there is a strong likelihood that China will extend its competition with India to the Arctic region. Considering the geographical distances, India should be pragmatic in its approach and seek to cooperate and collaborate with the Arctic states in exploiting the oil and energy resources located within their undisputed EEZs (Pareek, 2020). Further, India’s geography severely restricts it to dominantly influence the geopolitical competition in the Arctic region. However, India has been a preferred partner due to its confidence building measures as well as cooperative policies with the Arctic nations. It can therefore play a major role in the security architecture of the region by integrating with the competing Arctic nations through bilateral and multilateral engagements; and be a peace broker, if and when required (Rao, 2020).

Way Forward for India

Increase Collaboration with Arctic States. India maintains very close cooperation with Norway since India's only Arctic research station has been established in Svalbard archipelago of Norway. Towards undertaking advanced research in the Arctic, India is collaborating with the Norwegian Polar Institute. However, India needs to expand its relationship with all the Scandivinian countries in the field of Arctic scientific and social endeavours (Sharma, 2020). In addition, India needs to enlarge its scope of engagement with countries such as Japan and South Korea too and gain strategic foothold in the region.

Extend Connectivity with Arctic Region. As a strategic concept, an 'Indo-Arctic' initiative could serve as a springboard for India. Such an initiative could allow India to form a framework to engage with countries in the Arctic Ocean via Indian and Pacific Ocean. India should approach the Arctic through the prism of increasing scientific research, understanding climate change, expanding the 'Act East' policy, and enlarging framework with Russia. Since the region from Indian Ocean to the South China Sea and the Pacific Ocean is highly vulnerable to the climate events in the Arctic, one of the primary objectives of the Indo-Arctic construct should be the climate change concerns (Chandran, 2019). To further broaden its interaction, India needs to boost it trade and cultural interfaces with the Arctic nations. India needs to increase its cooperation in enhancing sustainable economy and use of resources (Agarwala, 2021). The Chennai-Vladivostok maritime route could extend connectivity to the Barents and Norwegian Seas and further to Norway and Iceland. India and Russia need to partner

with nations across South East Asia and East Asia to operationalize this connectivity link and make it economically sustainable (Chandran, 2019).

Self-Reliance for Polar Research. India's engagements with the Arctic region is primarily focussed on scientific research, however, currently India undertakes its Arctic expeditions by charting out polar vessels from other countries. To ensure freedom and flexibility in its scientific research pursuit, India needs to either procure or construct its own Polar Research Vehicle (PRV**)** (Ramanathan, 2019). Such a step will not only assist the country become self-reliant in its polar endeavours, but also boost the operational reach of Indian Navy (Sharma, 2020).

Review Maritime Strategy. As China seeks to use northern shipping routes and India too looks at Arctic region to meet its demand of renewable energy, it is imperative to undertake a review of Indian maritime strategy and expand the secondary regions of interest to include the Arctic and adjoining areas and maritime routes (Pareek, 2020). India should also consider developing its security alliances and extending its mutual reciprocal logistics agreements with more nations to enhance its reach and presence in the region (Rao, 2020).

Establish Single Point-of-Contact at Government Level. Presently, India's primary focus in the Arctic is largely limited scientific research and environmental studies, which can be overseen by the MoES. However, as India increases its engagement with the region to include trade, commercial and strategic interests, it may be prudent to create a dedicated desk/office under the MEA, which could have a holistic view of India's priorities in the region (Agarwala, 2021). The setting-up of such a single

point of contact would improve the perception in the world community on India's growing interest in the Arctic affairs, consequently gaining confidence of the Arctic nations (Pareek, 2020).

Expand Researchers Pool. Considering the region's evolving geopolitical shift, Indian researchers must be encouraged to pursue polar studies research from both scientific and geopolitical perspectives. At the national level, the Government may create a pool of researchers who are pursuing advanced social science research in the polar region (Sharma, 2020). There is a need to impart fundamental knowledge at the school and undergraduate level on the ecology and ecosystem of the Arctic and its effect on the global climate. India may consider formulating MoUs with the Nordic and Baltic universities to encourage research by students to further its understanding of the Arctic, the economic and strategic significance of melting ice and its geostrategic relevance to India. The larger impact of such an endeavour would be increased awareness amongst India's large skilled population, which could optimally utilise the Arctic region's employment opportunities. Simultaneous education of bureaucrats, policymakers, and researchers is also essential to understand the right perspectives of Arctic region so as to implement the appropriate strategy for India's engagement in the region (Agarwala, 2021).

Information Sharing between Himalayan and Arctic Indigenous Communities. The Himalayas, located in India, are widely accepted as the third pole of the earth. The global warming is leading to various environmental issues in Himalayas as much as in the Arctic. Hence, majority of the issues confronting indigenous communities at the poles will be common with the communities residing in

the Himalayas. Therefore, information sharing and experience learning will deepen understanding and develop greater trust between the two communities. Additionally, it would contribute to the development of strategies for mitigating the effects of climate change through collaborative research conducted at institutions such as the Himalayan university consortium (HUC) (Gjerdi, 2018).

India's Draft Arctic Policy

India, China, South Korea and Japan have Observer status in the Arctic Council. While South Korea released its Arctic Master Plan in 2013, Japan did so in 2015 and China released its white paper on the Arctic in 2018. India has released its draft Arctic policy in 2021.

India's Arctic Policy focuses on the synergy between polar and Himalayan studies. The Arctic research is expected to aid India's scientific community in its study of the rate of melting of the Himalayan glaciers, the third pole, which are known to contain the world's largest freshwater reserves outside the Polar Regions. India is of a firm view that all activities in the environmentally delicate Arctic region should be sustainable, transparent and responsible with due adherence to the international law. India, as a responsible partner, seeks to strengthen its engagement with the Arctic region and its governing bodies (Rej, 2021).

India's draft Policy roadmap for sustainable engagement is based on the five pillars, *viz* science and research, economic and human development cooperation,

transportation and connectivity, governance and international cooperation and national capacity building (Ghosh & Aggarwal, 2021).

The draft policy recommends India to explore possibilities for investment in Arctic infrastructure, including offshore exploration, construction of ports, railways, and airports. It seeks active involvement of public and private sector firms in India having proficiency and expertise in these sectors. The policy establishes a link between the specific cultures of the Arctic's indigenous population and the Himalayan inhabitants; both of whom are inextricably affected by climate change and socio-ecological transformation of the region. The inhabitants of both the region have commonalities of the challenges faced by interference to the distinct ecosystems. India needs to have focussed approach to assist the indigenous communities of the Arctic overcome these challenges. The draft policy aims to enhance India’s approach to the Arctic region by expanding its awareness, capability and capacity in research activities, strengthening the NCPOR and enhance its human resource capabilities for improving its engagement in the region (Seethi, 2021).

Conclusion

While national governments, international organisations, and non-state players pursue distinct approaches to Arctic governance, a unified approach is required to effectively address the region's environmental, economic, sociocultural, and geopolitical challenges (Long, 2018).

Looking at the environmental changes occurring in the Arctic region, the present circumstances offer a Hobson's choice to the world; economic development of the region and world through resource extraction or preservation of the ecosystem in the Arctic. Therefore, the world community needs to find a fine balance between economic growth and benefits vis-à-vis environmental degradation taking place due to uncontrolled resource extraction, and shipping.

India has maintained a delicate balance in ensuring its own development without adversely affecting its environment and looking for sustainable growth. In the global affairs too India has maintained its bilateral and multilateral relations with nations across the globe and is known for following international rules based order. India, therefore needs to play an ever-increasing role in scientific research, economics, trade and politics of the region and enhance its influence in the region. India needs to harness its traditional relationships with Arctic nations, cooperative image and democratic structure to attain a pole position in the growing geostrategic Arctic region.

Annexure 1

Questionnaire

Research Survey: Climate change in Arctic Region opportunities and challenges for India

This is online survey as part of Research being undertaken as part of Advanced Professional Programme in Public Administration (APPPA) being conducted by Indian Institute of Public Administration (IIPA). All the information provided by the participants in the survey would be kept confidential and will be used only for the research.

* Required

1. Your Age group (in years) * *Mark only one oval.*

- ◯ upto 18
- ◯ 19-30
- ◯ 31-45
- ◯ 46-60
- ◯ More than 60

2. Profession * *Mark only one oval.*

- ◯ Academician
- ◯ Research Scholar
- ◯ Entrepreneur
- ◯ Defence
- ◯ Other:

3. Educational Qualification * *Mark only one oval.*

- ◯ Below Graduate
- ◯ Graduate
- ◯ Post Graduate
- ◯ Doctorate

4. From the list below, please choose the environmental issue that is most seriously affecting the world today * *Mark only one oval.*

- ◯ Excessive Pollution
- ◯ Uncontrolled release of Greenhouse gases
- ◯ Extreme weather events
- ◯ Overpopulation
- ◯ Radioactive waste
- ◯ Climate Change

5. In your opinion, do you think the temperature on earth has been rising over the past few decades? * *Mark only one oval.*

- ◯ Yes, because of human activities
- ◯ Yes, because of natural causes
- ◯ No, there is no change
- ◯ Don't know

6. Over the years, the earth is warming at a uniform rate * *Mark only one oval.*

- ◯ Yes
- ◯ Equatorial regions are warming more
- ◯ Arctic region is warming faster
- ◯ Can't say

7. Climate Changes in the Arctic region are influencing the climate in other parts of the world * *Mark only one oval.*

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

8. The increase in extreme weather events occurring around the world is related to climate changes in Arctic region * *Mark only one oval.*

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly disagree

9. Melting of sea ice in the Arctic region has resulted in change in wind pattern and ocean currents * *Mark only one oval.*

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

10. The biggest challenge for the people of Arctic region arises from (more than one option may be selected) * *Check all that apply.*

- [ ] Melting of sea ice
- [ ] Permafrost thawing
- [ ] Opening of sea routes
- [ ] Environmental degradation
- [ ] Increased pollution
- [ ] Growing territorial disputes between Arctic nations

11. The biggest opportunity that melting of ice in the Arctic region offers to the countries across the world is through (more than one option may be selected) * *Check all that apply.*

- [ ] Opening of northern sea routes
- [ ] Extraction of oil and minerals
- [ ] Polar tourism
- [ ] Scientific Research
- [ ] Access to Arctic market

12. Opening of northern sea routes due to melting of sea ice is a boon for development of the Arctic region * *Mark only one oval.*

- ◯ Strongly agree
- ◯ Agree
- ◯ Neutral
- ◯ Disagree
- ◯ Strongly disagree

13. The biggest challenge arising globally from climate change in the Arctic region is (more than one option may be selected) * *Check all that apply.*

- [ ] Extreme climates events
- [ ] Rising sea level
- [ ] Damage to Arctic ecological system
- [ ] Rising inter-nation conflict
- [ ] Increase in Greenhouse gases

14. Increased accessibility to the Arctic region has enhanced the military and commercial interest of nations located beyond the region * *Mark only one oval.*

- ◯ Yes
- ◯ No
- ◯ Can't say

15. Who do you think should have the main responsibility for tackling climate change in Arctic region? * *Mark only one oval.*

- ◯ Arctic Council
- ◯ International Organization such as UN
- ◯ Individual Arctic nations
- ◯ Environmental organizations
- ◯ Indigenous people of Arctic
- ◯ Major world powers

16. Can India remain isolated from the changes taking place in the Arctic region * *Mark only one oval.*

- ◯ Yes
- ◯ No
- ◯ Can't Say

17. Climate Changes in the Arctic region are influencing the monsoons in India * *Mark only one oval.*

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

18. In your opinion, Himalayan glaciers are being affected by the climate change in the Arctic region * *Mark only one oval.*

- Yes
- No
- Can't say

19. India needs to increase its research activities in Arctic region to evaluate its effect on Indian climate * *Mark only one oval.*

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

20. India occupies a geostrategic location in Indian Ocean Region (IOR). Opening of northern sea routes (across Arctic Ocean) will reduce India's geographical significance * *Mark only one oval.*

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

21. India needs to increase its presence to become a dominant actor in evolving geopolitics in Arctic region * *Mark only one oval.*

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

22. India can increase its presence in Arctic region by (more than one option may be selected) * *Check all that apply.*

- [ ] Improving bilateral relations with Arctic countries
- [ ] Oil and gas extraction agreements with Russia
- [ ] Increasing research activities
- [ ] Building naval capability to operate in Polar Regions
- [ ] Joint polar voyages with friendly countries

23. Opening of Arctic region provides India an opportunity to (more than one option may be selected) * *Check all that apply.*

- [ ] Leverage regions energy resources
- [ ] Expand scientific exploration and climate research
- [ ] Extend connectivity initiatives such as INSTC
- [ ] Exploration of renewable energy
- [ ] Sustainable tourism
- [ ] Investment in Arctic infrastructure

24. Any suggestions/recommendations *

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