Report

Proceedings of the 5th Conference on
Science & Geopolitics of Himalaya-Arctic-Antarctic
Technological Innovations and Research Expeditions

February 26-27, 2019
India International Centre, New Delhi

Partnered by

Norwegian Embassy in India

Ministry of Earth Sciences
सत्यमेव जयते

National Centre for Polar & Ocean Research

Defence Research & Development Organisation

INCOIS
Indian National Centre for Ocean Information Services

National Biodiversity Authority

CMLRE
Centre for Marine Living Resources & Ecology

Institute of Information Technology & Management

C N Technologies

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ACKNOWLEDGEMENT

The LIGHTS Research Foundation would like to place on record the guidance received from the esteemed patrons without whose blessings the 5th Conference on Science and Geopolitics of Himalaya-Arctic-Antarctic (SaGHAA-5) would not have been possible. We are indebted to them for their persistent bond, help and valuable suggestions.

Throughout the duration of the conference, from the concept building to its execution, we banked highly on the guidance and advice received from the members of the Advisory Committee. We are grateful to them for their time and patience with us.

The LIGHTS would also like to appreciate the Organising Committee of SaGHAA-5 for the smooth and flawless management of the event that recorded active participation of scientists, legal expert and the policy makers. We extend our warm gratitude to all the session chairs, distinguished speakers, participants and guests for sharing their enlightening research concepts, participating in the discussions and contributing to the recommendations. The SaGHAA-5 owes its success to their contributions and participation.

The conference was supported by the various organisations without whose generous financial support it would not have been possible to manage the conference expenses on accommodation, transport, auditorium, stage and refreshments etc. We would also like to extend our gratitude to Norwegian Polar Institute (NPI) for providing us with their nice collections of photos. We are grateful to all of them. Last but certainly not the least, we thank all our office staff for their uninterrupted enthusiasm and support for contributing to the success of the Conference.

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LETTERS OF APPRECIATION

ROYAL NORWEGIAN EMBASSY

The Ambassador

18 March, 2019

Ms Sulagna Chattopadhyay
President, LIGHTS
707 Bhikaji Cama Bhawan
New Delhi - 110066

The Norwegian Embassy congratulates the Organising Committee of SAGHAA for yet another successful conference on 26th - 27th February, 2019, the 5th in the SAGHAA series.

SAGHAA provides a platform for open discussion on scientific and geopolitical issues related to the Arctic, Antarctic and Himalayas, and new knowledge is generated through exchange of scientific, political and industrial research and development.

As one of the eight Arctic states, Norway has a great responsibility for ensuring sound management of all activities in the vulnerable environment of the Arctic. We have centuries of experience with resource management and sustainable business activity in the north and we are building on this for the future.

We are pleased to have supported this conference. There was good particpation from Norway and the speakers contributed significantly to the technical discussions. I am sure this will further strengthen the Norway-India collaboration in the field of polar research, geopolitics and business.

We look forward to our continued cooperation.

Yours sincerely,

Nils Ragnar Kamsvåg

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राष्ट्रीय ध्रुवीय एवं समुद्री अनुसंधान केन्द्र
पृथ्वी प्रणाली विज्ञान संगठन
पृथ्वी विज्ञान मंत्रालय (भारत सरकार)
हेडलैण्ड सडा, वास्को-डा-गामा, गोवा-४०३ ८०४, भारत

NATIONAL CENTRE FOR POLAR AND OCEAN RESEARCH
Earth System Science Organisation
Ministry of Earth Sciences, (Government of India)
Headland Sada, Vasco-da-Gama, Goa - 403 804, INDIA

डॉ. एम. रविचन्द्रन
निदेशक

Dr. M. Ravichandran
Director

सं:एनसीपीओआर/डीआईआर/जनरल(1)/19
Ref. No:NCPOR/DIR/GEN(1)/19

दिनांक/ Date: 22.03.2019

प्रति/To,
Ms. Sulagna Chattopadhyay
President, LIGHTS
707 Bhikaji Cama Bhawan
New Delhi – 110066

Dear Ms Sulagna,

It has been a pleasure for NCPOR (erstwhile NCAOR) to be associated with SaGHAA, as we both have a common vision for serving the Polar Regions in our own way. I would like to place on record our heartiest Congratulations for the team SaGHAA-5 for holding another successful polar conference during 26-27th February 2019.

The meeting was effective with a number of papers on Antarctic, Arctic, Southern Ocean and Himalayas. It was also great to see an open atmosphere with discussion on certain policy matters of Arctic to UNCLOS and geopolitics too. I am sure the deliberations held will be taken forward for dissemination to the public at large.

The Ministry of Earth Sciences through NCPOR has been mandated with a responsibility for working in the Polar Regions. NCPOR is a platform for launching scientific activity in the Polar Regions with concerns for climate change and environment in those regions. We are keen to look at possible tele-connections between Polar Regions and tropics, especially linkages with Indian Monsoon.

We are glad to be a part of this Conference, since many years. I am sure we can take this forward to masses for preserving the Polar Regions, which are the largest refrigerators on this planet and massive modulators of climate. I am sure this Conference will take these issues ahead with their publications.

Wishing all the best to the SaGHAA Organising team.

Yours sincerely,

(एम. रविचंद्रन /M. Ravichandran)

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EXECUTIVE SUMMARY

The 5th Conference on Science and Geopolitics of Himalaya, Arctic and Antarctic (SaGHAA V, 2019) was organised at the India International Centre (IIC), New Delhi, on February 26th and 27th, 2019 in continuation with the previous SaGHAA conferences held in 2017, 2015, 2012 and 2011. The three Polar Regions-- the Arctic, Antarctic and Himalayas, have drawn the attention of scientists and researchers in the last few decades like never before due to the unprecedented changes in its environment and morphology. The emergence of political interventions and strategic scientific developments in the Arctic Region have transformed the frozen Arctic into a region of opportunities. The growing demand for energy resources has further encouraged exploitation in these parts. Loss of ice shelves in Antarctica too has increased over the past few decades. Calving of great portions of Larsen ice shelf has demonstrated the impact of global warming on cryosphere. Himalaya – the Third pole, analogous to Polar Regions, needs increased attention as nearly 1.3 billion population of the world depend upon its resources, especially on water for sustenance of the life. Three of the world's major rivers—the Indus, the Ganges and the Brahmaputra—originate in the Himalayas. Any major stress on water availability either due to the climate change or due to demand-supply mismatch can only lead to conflict between the countries sharing the resources. New economic opportunities in the polar regions with glacial retreat in the form of ocean trade routes, hydrocarbon explorations, teleconnection with Indian Monsoon have indeed diverted serious attention towards this region. SaGHAA- 5 with focus on Technological Innovation and Research Expeditions has brought into forefront a new dimension related to the cryospheric regions.

The conference was attended by around 150 delegates including several international participants. During the two days, there were 61 presentations spread over the 9 sessions on different themes and 7 presentations in the Rapid Shot session, which gave a platform to the budding researchers.

The current trends in polar sciences- Arctic, Antarctic and Himalayas were covered in three sessions in the two days of delegation. The ocean exploration which included mainly the southern oceans, dealt with contemporary issues of Marine Protected Areas and marine organisms. The theme of the conference was covered in sessions on Ice class lessons, Technological innovations , New Maitri stations and Manning the expeditions. The highlight of the conference was the session on Geopolitics, wherein the current issues of Arctic and Antarctic were discussed in the light of changing environmental conditions. The student participations were covered in Rapid Shots session where seven researchers presented findings of their doctoral research. The conference framework allowed for greater amalgamation amongst specialists from various disciplines, towards which sessions were kept cohesive and unbroken. Opinions of promulgating a common scientific forum for the Hindukush-Himalayan region was also put forward and supported by persons of repute in the field.

The conference achieved its objectives, as was evident from the comments and the responses received from the feedbacks of the various national and international participants. Recommendations from the panel of experts have been penned down for the needful action.

RECOMMENDATIONS OF THE PANEL

The two day deliberations of SaGHAA- 5, brought forth significant recommendations that hold the potential to take cryospheric research and geopolitical involvement of India to the next level.

- The experts recommended a greater engagement with Arctic Council specifically a deeper involvement with its various Working Groups. Noting the excellent cooperation with Norway in the fields of science and technology, it was recommended that India should also explore extending its activities with other Arctic countries such as Canada, Russia, Iceland, Finland etc.
- Experts recommended that the workings of The Arctic Council can be used as a learning opportunity and the lessons can be applied to areas with similar environmental issues such as the Himalayan region. India should build an indigenous forum with all the stakeholders in the region for an inclusive scientific body that addresses policy, science and environmental issues and resources in the Himalayan region. This scientific forum should be above all political considerations as science has no borders and the Hindukush-Himalaya region is a contiguous mountainous region, catering to huge populations in different countries. Although India can take a lead from the Arctic Council, our issues are complex especially where concerns about water sharing arise. India should begin by putting an observational network in place in this region.
- The experts welcomed the idea of replacing the ageing Maitri Station that was on cards and recommended a speedy action on this front. Considering the long term data that has been collected from this site during last 30 years, experts highlighted the importance of its location and need for the continued research from this location. Though, Maitri has different logistic requirements, experiences gained from building of the Bharati, maybe incorporated while building the new Maitri station.
- The experts expressed that since most of nations engaged in polar expeditions have their own dedicated ice breakers, it is important for India too, to have its own Ice Class Polar Research vessel (PRV). Such a PRV can be used in both Arctic and Antarctic and meet India's growing science aspirations in cold seas. Several other countries such as China, Germany, Norway, UK, USA, South Africa, Japan, South Korea and Sweden have own ice-class research vessels. India too should accelerate its prowess and procure a suitable PRV in the near future.
- Experts at the conference pointed out that India needs to engage holistically and systematically in the polar discourse. It should develop policies for regions such as the Arctic and take the views of various stakeholders in framing an outline for further concretisation of India's role in the Arctic-Antarctic and the Himalayan region.
- The experts identified a need to disseminate information and ideas about existing, ongoing and future research among the masses and help mainstream scientific dialogue across various policy, media and industrial stakeholders.
- SaGHAA would shoulder the responsibilities of a think tank and would extend a platform for knowledge dissemination. Proposals were made for Team SaGHAA to meet more frequently i.e. once in six months for disseminating knowledge and research findings on specific thematic issues and large scale conferences once in two years.
- Experts highlighted the need to hold continued discussions related to geopolitics. Leading researchers and diplomats from several countries such as China, Germany, Sweden, Norway and Chile participated in the geopolitics session and pointed out time and again the lack of a robust forum for the three poles. They lauded SaGHAA as a pioneering body providing a much needed forum in India. It is in this perspective that SaGHAA proposes to hold a special and more detailed and exclusive event on geopolitical issues of the three poles and would be happy to contribute in whichever way possible towards formulation of the Himalayan Scientific Forum.

INTRODUCTION

The concerns on climate change and its impact on biosphere, hydrosphere, atmosphere and lithosphere have been growing. Nowhere these changes are manifested more glaringly than the cryosphere regions of our earth, as the snow and ice exhibit the response to such changes in perceptible form to the naked eyes. The scientist working in the three poles, the largest repositories of snow and ice, have been working relentlessly in these inhospitable and harsh terrains, seeking to enrich the world with their new insights and data. In case of India, there is no formal organisation which offers such prospective platform to allow these scientists, both established ones as well as the aspiring ones to display their works. LIGHTS through its biennial SaGHAA conferences have been endeavouring to provide a suitable platform to such scientists and researchers, experts in the fields of geopolitics, environment, social sciences and policy makers etc. to come together to deliberate and evolve a synergy for better understanding of the issues surrounding the poles. The need for such initiatives arises from the following facts:

First, such burning issues which have the potential to challenge the survival of millions of people, their ecosystem and also their food security, cannot be sidelined and secondly, role of India as an emerging and responsible power of the world. And specially acting as a responsible voice for the third world nations, India has more responsibilities in safeguarding these global commons and securing the future of mankind and their resources, especially the Himalayas. SaGHAA is organised by LIGHTS, a not-for-profit organisation, once in every two years. It is only one of its kind in India at present and its success with each passing conference, since its inception in 2011, has also proven the need for such avenues, by the scientific community as well by the policy makers. SaGHAA-5, like the others in the row, has maintained the legacy of wide scale participation not only from India, but also from across the globe.

SaGHAA strives to provide the platform – where global stakeholders convene to voice ideas, craft idioms and recommend institutions that must shape and propagate the new world order of Himalayas, Arctic and Antarctic. The central theme this year, "Technological Innovations and Research Expeditions" is a reflection of this endeavour. This topic was designed to agitate debate on contemporary global trends and explore opportunities for collective action among institutions, nation-states and non-state actors as we manage a dynamic and unpredictable era of science and geopolitics, environment security and innovation.

SaGHAA 5 is the continuation of the SaGHAA legacy. The previous SaGHAAs have focused on themes like geopolitics, cryospheric concerns of the Arctic-Antarctic, biotechnology, ozone depletion, palaeo-climatic research, Himalayan ecosystem and glaciers etc. This year with the theme of technological innovation and research expeditions, SaGHAA-5 has tried to enlarge the scope and domain of its outreach.

Prelude

A new power dynamics is emerging in the polar regions due to the climate change and associated anthropogenic activities. While technology has brought us closer, it has, in curious ways, made us more aware of our differences and similarities alike. The conference on the theme Science and Geopolitics of Himalaya-Arctic-Antarctic have been held over the years with an objective to develop a synergy amongst scientists and policy makers towards the geopolitics and scientific understanding of Earth-atmosphere and ocean process in the cryospheric regions of the world. This has helped in understanding the processes that influence the variability in polar climate and influence our monsoon at millennial, decadal or even annual scales.

The active participation of the various stakeholders of polar research in SaGHAA-5, starting from the research scholars to scientists and policy makers from across the world reflects the growing concern of the nations towards the impact of climate changes on glaciers and ice caps around the world. LIGHTS has been successful in bringing eminent scientists working in these inter-related fields to a common platform, adding to improve the understanding of these issues and giving relevant advocacy to policy making. SaGHAA-5 with its focus on Technological Innovations and Research Expeditions, for the first time has added another dimension to its discourse.

Focus

New trends and discoveries are emerging with respect to polar areas. Diverse views on topics like climate change, global warming, geopolitics of polar regions, teleconnections with Indian Monsoon, economic opportunities in Arctic regions etc. brought researchers and scientists from across the world to this two day biennial conference in New Delhi, with special focus on the newer technological innovations with respect to polar regions, in addition to the conventional areas of focus. The focus of the SaGHAA 5 was on Technological Innovations and Research Expeditions in the field of cryospheric studies. Given the fact that with climate change and the perceived threats therein, it is now pertinent to look for an amicable understanding amongst intellectuals of various nations to come out with a solution for the vulnerable human population whose livelihoods are greatly dependent on the cryospheric resources of the three poles under consideration.

Objectives

The main objective of the conference was to evolve a synergy between scientists and social, political and legal experts working in the cryosphere of the three Poles i.e. the Himalayas, the Arctic and the Antarctic. The objectives of the SaGHAA conferences may be summarised as follows:

a. To create interface between geopolitics and sciences,
b. To create a multi-stakeholder platform for scientists, policy makers and the industries,
c. To work as a think-tank and contribute in policy formulations,
d. To represent India's commitment and interest in the cryospheric research from the viewpoint of the society,
e. To build capacity of aspiring researchers in polar studies from India.

The Themes

In an effort to capture the complexity of modern times, this year's conference had an expansive scope spanning across nine different themes and with four themes dedicated to technological innovations and research expeditions.

The SaGHAA-5 bounded the issues of science and geopolitics with special focus on climate change. These themes helped enhancing the understanding of the issues dominating the Cryospheric realms of the world. The two days of deliberations covered the following broad themes divided into nine technical and one valedictory session:

1. Current Trends in Polar Sciences
2. Ocean Explorations
3. Ice Class
4. Himalaya-Climate Change
5. Geopolitics
6. Himalayan Glaciers
7. Technological Innovations
8. New Maitri Station
9. Manning Expeditions

A special session -- Rapid Shots was devoted to capacity building and outreach in which young researchers were given an opportunity to present their research results in short.

Support and Participation

An event like SaGHAA-5 which attracted experts and researchers from all over the country and some foreign nations was possible due to generous support from several government departments and organisations. These were: Ministry of Earth Sciences and its autonomous institutions- National Council for Antarctic and Ocean research (NCAOR), Indian National Centre for Ocean Information Services (INCOIS), Center for Marine Living Resources and Ecology (CMLRE), Indian Institute of Technology, Madras, National Center for Earth Science Studies (NCESS), Defence Research Development Organisation (DRDO), National Biodiversity Authority, besides Royal Norwegian Embassy and a private company -- CN Technology.

The success of SaGHAA-5 was essentially due to participation of scientists, academics, policy makers of great repute in the field. The total footfall for the event spanned across two days was about 150 and the most striking feature that needs mention is that most of the participants were present till the end of the valedictory session on day 2.

Outcomes

The footfall in SaGHAA- 5 till the end of day 2 was enough to stand for its success. Important insights about the technological innovations were gained through the deliberations and a meaningful list of recommendations could also be penned from the suggestions of the experts in the panel.

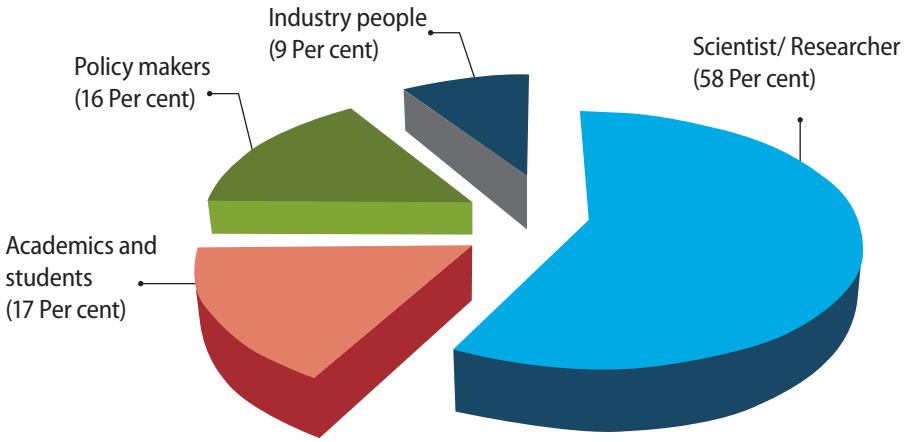
Conclusion

The objectives of SaGHAA has not only been to provide a national platform to such scientists and experts who are working in the cryosphere fields of these regions, but has also endeavoured to bring together all stakeholders like policy makers, glaciologists, social, legal and political experts and students on the same page to discuss the issues. This was done with the main intent of evolving a sustainable strategy based on scientific analyses and ground truth for the benefit of society at large.

The conference concluded on a high and positive note marked by a fruitful consensus based on intense interactive discussions amongst scientists. The participants lauded the SaGHAA-5 global platform which enabled various stakeholders to showcase their work and to make it available for society's common good. People with active interests in the polar arena came together to understand new process and dimensions of cryospheric research and changes owing to climate change.

As the only independent society working in the polar cryospheric science and geopolitics arena, SaGHAA under LIGHTS is now a well recognised forum. Since SaGHAA is accessible to one and all, it makes the outcome inclusive and oriented towards over-arching developments in the cryospheric realms. SaGHAA since its inception has come a long way, from a small initiative to a global event, with polar enthusiasts not only from India but also from across the globe. It is heartening to know that interest in the polar regions are not only growing in India but other countries are also keen to partner with India in its cryospheric initiatives.

Participants in SaGHAA 5.



Note: There were 150 Indian and Overseas participants in SaGHAA 5.

INAUGURAL SESSION

SaGHAA-5 began on the 26th February 2019 with the inaugural session marked by the presence of dignitaries of great repute including policy makers, scientists and students interested in Polar Research from across the globe. The event started with a welcome address by Dr Rasik Ravindra, Chairman, SaGHAA Organising Committee and former Director, ESSO – National Centre for Polar and Ocean Research (NCPOR), Goa. The Guests of Honours - Dr. P S Goel, Raja Ramanna Chair Professor, National Institute of Advanced Studies (NIAS), Dr Nalan Koc, Research Director, Norwegian Polar Institute (NPI), Norway and Dr. B Meenakumari, Former Chairman National Biodiversity Authority and Mr. Helge Tryti, Commercial Counsellor, Royal Norwegian Embassy and Director of Innovation Norway, India addressed the gathering subsequently. The Chief Guest, Dr M N Rajeevan, Secretary, MoES, addressed the august gathering with warm and positive words. Ms Sulagna Chattopadhyay, Convenor of SaGHAA–5 and President, LIGHTS presented the vote of thanks. The inaugural session was also chosen as a platform to release the SaGHAA-5 preconference Book by the eminent dignitaries present on the dais. The book was published as a pre-conference material for the benefit of participants and speakers. It contains literature in the context of the Himalaya-Arctic-Antarctica, the various themes and contemporary issues revolving around the three poles, brief information about the respected patrons, organising committee, advisory committee and speakers, followed by the abstracts of the papers to be presented.

The highlight of the inaugural function was the presence of a galaxy of luminaries and who's- who in the field of Cryosphere research and related technology in India and abroad. Among the distinguished guests apart from those of the dais, who attended the inaugural session were Dr M Ravichandran, Director, National Centre for Polar and Ocean Research (NCPOR), Dr M A Atmanand, Director, NIOT, Chennai, Dr M R Bhutiyani, Former Director, Defence Terrain Research Laboratory (DTRL), DRDO, Dr Ashwagosha Ganju, Former Director, Snow and Avalanche Study Establishment (SASE), DRDO, Prof. Sanjay Chaturvedi, SAU, Prof. A L Ramanathan , Prof. Milap Sharma and Prof. A P Dimri of Jawaharlal Nehru University, New Delhi, Dr R Krishnan, Executive Director, Centre for Climate Change Research, IITM, Dr. Javed Beg, Dr Rahul Mohan, National Centre for Polar and Ocean Research (NCPOR), Dr Rajesh Asthana, Dy. Director General Geological Survey of India, Shri Shree Verma, C N Tech etc. among others. The international dignitaries included H.E. Juan Angulo, Ambassador Designate of Chile in India, Dr Bai Jie and Mr. Xue Quinzhao from Peoples Republic of China, Ms Nelli Mikkola and Mr. Kari Laukia from Finland, Ms Marta Gjortz, Dr Inger Mintkandal and Mr. Vivek from Royal Norwegian Embassy, Mr. Stephan Lanzinger from Germany and Mr. Midtkandal, Former CEO M/S Kings Bay, Ny Alesund. Ms. Sapna Gupta, performed the role of Master of Ceremony, SaGHAA-5, 2019, introducing the each of the dignitaries to the audience.

Welcome address by Dr Rasik Ravindra,

Chairman, Organizing Committee, SaGHAA 5

Dr Ravindra welcomed Dr M N Rajeevan, the chief guest of the event and other Guests of Honour, Dr P S Goel, Mr. Helge Tryti and Dr Meenakumari. He also welcomed representatives from the embassy of China, Chile, Norway, Finland and Germany in addition to other delegates from the academics and business sector who were gracing the conference. He recalled continued support of Royal Norwegian Embassy in India for the SaGHAA events in past too, and thanked H E the Ambassador Nils Ragnar Kamsvag for his contributions in fostering Indo-Norwegian collaboration in the field of science and technology. He mentioned that the conference would not have been possible without the support and assistance of Ministry of Earth Sciences and other Government Departments and other well wishers. Dr Ravindra noted the gracious presence of nearly all the Directors of leading organisations from across the nation which are active in the field of atmospheric sciences, glaciology, oceanography and socio-legal sciences in the Conference and welcomed them all.

Address by the Special Guest: Dr B Meenakumari,

Former Chairperson of National Biodiversity Authority, Chennai

Dr Meenakumari spoke about her association with SaGHAA since its inception and the relevance of addressing themes like technological innovation, in platforms like SaGHAA. She also drew attention to the fact that the concerns for biodiversity have often been neglected while discussing issues of technology, which has taken a forefront. She added that SaGHAA-3 onwards biodiversity was integrated into its domain. Highlighting the focus on sustainability following the Brundtland Report, the Sustainable Development Goals (14 and 15) also focus on the conservation of life below water and life on the land. She stressed on the need to revisit access and benefit sharing that comes under National Biodiversity Act and stated that because of climate change and the resultant thawing of the permafrost, microbes are getting exposed. Unless immediate attention is diverted to this, severe threats may be posed to the human lives.

Address by Chief Patron: Dr P S Goel,

Raja Ramanna Chair Professor, NIAS

Dr Goel appreciated the initiatives of LIGHTS in carrying forward the SaGHAA legacy, highlighting the role of enthusiasts like Ms Sulagna Chattopadhyay and Dr Rasik Ravindra who make events like SaGHAA possible. Highlighting how discussions and deliberations helped making SaGHAA theme specific, he spoke about the role of technological innovation in improving the living conditions. Technological innovations have been adopted to make human life easy on earth, but we are still way behind to adopt such innovations for society at large. Citing the example of windmills in the Antarctic, which has helped in saving a third of energy, he expressed his dismay on why such technological innovations have not been scaled up and used elsewhere for the greater good for a larger number of people in the three poles. Inviting suggestions from the participants, he stressed that such inputs could help gatherings like SaGHAA be more relevant in the days to come.

Address by the Guest of Honour: Mr. Helge Tryti,

Commercial Counselor, Royal Norwegian Embassy and Director of Innovation Norway, India

Mr. Tryti spoke about the need for necessary science to ensure better living conditions in the three Poles. He stressed that innovations are needed to work in harsh conditions, pointing that 10 per cent of Norwegian population lives beyond the Arctic circle and hence innovation is necessary for them and their lives can be improved by high level policy making. He also spoke about the emerging opportunities like markets, maritime activities etc. with ice melt and glacial retreat. He outlined the need for Indian research institutes to know about the requirements and focus their research work accordingly.

Address by Chief Guest, Dr. M N Rajeevan,

Secretary, Ministry of Earth Sciences

Dr M N Rajeevan congratulated the team LIGHTS for organising such events time and again. He said that any change in cryospheric system can affect the climate balance. Pointing out that the retreating Himalayan glaciers could have adverse impact on biodiversity, hydrological cycles, surface runoff, etc., he highlighted the importance of Cryosphere in maintaining climate balance and spoke about the role of MoES in conducting researches on these. He also talked about the need for policy paper on Arctic and concluded his address by stressing the need for more collaboration between India and the Arctic countries. Congratulating a multi-disciplinary forum like SaGHAA, he expressed his interest in having a look at the report of SaGHAA-5 and promised that he'd help in incorporating any relevant suggestions emanating from the two days' deliberations at SaGHAA-5.


Dr M N Rajeevan

DAY 1: 26th FEBRUARY, 2019

SESSION 1

The group photo of the speakers of session 1

CURRENT TRENDS IN POLAR SCIENCES

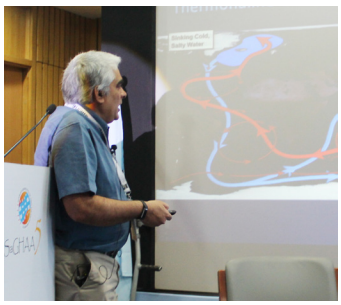
The first session was chaired by Dr. P S Goel, Raja Ramanna Chair Professor, NIAS and Dr Nalan Koc, Research Director, NPI.

The session on the Current trends in Polar Sciences commenced with the key note presentation by Dr. R Krishnan followed by Dr. V K Soni. Other papers presented during this session included the works of Dr. Manish Tiwari from NCPOR, Dr. A K Swain and Dr. S K Roy from GSI, Dr. Rahul Mohan, Dr. Avinash Kumar and Dr. Laluraj from NCPOR,
Dr. Vimlesh Pant from Indian Institute of Technology, Delhi. The rapporteurs of this session were Dr. Lavkush K Patel (NCPOR) and Ms. Namrata Barooa(LIGHTS).

Dr. R Krishnan

Scientist-G and Executive Director, Centre for Climate Change Research (CCCR), Indian Institute of Tropical Meteorology (IITM), Pune.

***Topic:* Possible role of Arctic amplification on weather extremes in the Himalayan region.**



One of the prominent manifestations of climate change is the rapid warming of the Arctic in recent decades as compared to rest of the globe. This accelerated warming of the Arctic, also referred to as Arctic Amplification (AA), is associated with strong reductions in the Arctic snow cover, sea-ice extent and decrease of poleward temperature gradient. Dr Krishnan talked about modelling of CO_2 and its impact on climate change. He talked of how CPIM 6 will contribute to IPCC 6th Assessment report. He highlighted how AA leads to the decline in sea-ice and land ice and also lead to extreme weather events like floods. He focused on the need for greater understanding of the linkages of the changes in the Arctic and the extreme climate events taking place. This will help in developing the understanding of whether events in the Northern Hemisphere can impact climate events in the Himalayas.

Dr. Vijay Kumar Soni

Head, Environmental Monitoring and Research Centre, and Polar Meteorological Research Division, India Meteorological Department, New Delhi.

***Topic:* Perspectives of Polar Weather Monitoring and Research: Efforts of Indian Meteorological Department.**

The Polar meteorology plays a significant role in the global climate system. Indian Meteorological Department (IMD) started meteorological observations since the very first expedition of India to Antarctica. IMD operates meteorological observatory at Maitri and Bharati, looking at the weather and climate observations, ozone hole studies in the Arctic and the Antarctic, solar radiation budget and monitoring of surface ozone variations. The 25 years long term temperature record shows cooling over Maitri station which started around 1998-99. He traced the trajectory of the expeditions in Antarctica which started in 1981 and attained a landmark achievements in 2012 by setting up Bharati in Antarctic, Himadri in the Arctic and Himansh in Himachal Pradesh. Further, he highlighted that the WMO declared Polar Prediction Project in 2013 and the preparatory stage

was operational between 2017 and 2019, intensive observations were being collected to submit to WMO by the IMD. Every year meteorological parameters are being analysed from Maitri. Following WMO's footsteps in establishing regional climate centres (RCCs), IMD is on the verge of establishing the Third Pole Regional Climate Centre (TPRCC) at New Delhi, with the northern TP Node at China, Southern TP Node in India and the western TP Node in Pakistan.

Dr. Manish Tiwari

Scientist-E and Incharge (Paleoceanography)
National Centre for Polar and Ocean Research (NCPOR)
Vasco-da-Gama, Goa

Topic: Pliocene Arctic Climate Teleconnection (PACT) – A Joint Indo-Norwegian Endeavour.

Dr Tiwari focused on how the new climate proxy data shows enhanced Atlantic water inflow during MPWP into the Arctic Ocean and its effect on the sea ice retreat and productivity increase. These results have an enormous impact on analogous observations of ongoing melting of sea ice in the Arctic Ocean and predictions for future heat transport through increased Atlantic water inflow. The pollen abundance data suggest that overall vegetation was poor in the vicinity of the core site or the dispersal and deposition was restricted. Dr Tiwari spoke on paleography, highlighting the need to study Pliocene period. Because of Arctic Amplification, global temperature is rising by 3 ^{0}C and sea and land ice near Antarctic is also declining. The correlation between the past data and the current climate data through isotopes show that there is interrelationship between Indian Monsoon and the Arctic Change. Study of isotopes of the Pliocene period shows climatic variations during the warm mid –Pliocene era. 3 million years ago- Pliocene CO_2 level was as high as it is today. He spoke about the PACT, which aims to establish teleconnection and review past climate experiences to understand the interconnections between the Pliocene arctic climate and the recent weather phenomenon. He emphasised on the correlation between the Arctic climate changes and the variations in the Indian monsoon.

Dr. Ashit Kumar Swain

Superintending Geologist,
Geological Survey of India, SU, Sikkim, India

Topic: Need to worry about polar lakes.

Polar lakes are important not only because of their unique geographical position, but also due to the persistent low temperatures, freeze-thaw cycles, seasonal and inter-annual variations in the lake cover changes. The high latitudes and high altitudes of Himalayas experience more rapid climate change than elsewhere in the world. This is certainly reflected in the polar lakes located in these regions. Dr Swain spoke about the uniqueness of the polar lakes and need to sensitise about impact of climate change, seasonal and inter-annual variations. He also spoke about the biodiversity in the polar region. He mentioned about the types of polar lakes in Antarctica, ice-shelf stability due to lakes, flow of melt water and the situation arising out of accumulation of the excess melt-water. Highlighting the lineaments in glacial ice he concluded his presentation by stressing the need to worry about periglacial, end glacial and subglacial lakes. He also stressed on the cost vis a vis time studies of glacial lakes.

Dr. Sandip K Roy

Director, GSI, Maharashtra State Unit

Topic: Geology of Schirmacher Oasis, cDML in light of the Passage of East African Orogeny through Antarctica- A review.

Dr Roy presented a review work updating it with loads of field geological data. Through his presentation he reviewed Schirmacher Oasis in the light of the passage of the east-African Orogeny. He explained how the pan African Orogeny has a wide spatial and temporal context stretching for more than 3,000 km originating from the Arabian shield in the north and going into the Antarctica in the south. Emphasising on the documentation of the east African orogeny passing through the Schirmacher Oasis, he tried to highlight

the importance of attributes like high grade metamorphic assemblages exposing middle to lower crystal levels, the PTT paths and the poly deformed terrains. The evidence of a continent-continent collision happening in the Schirmacher Oasis region was also brought forth in his presenttaion.

Dr. Rahul Mohan

Group Director, National Centre for Polar & Ocean Research (NCPOR), Goa

***Topic:* Southern Ocean Paleoceanography using diatoms.**

Diatoms are the major contributor (75%) of Southern Ocean primary productivity and hence the major biogenic phase available in the sediments as siliceous frustules. Diatoms are the major tools to infer the past oceanographic and climatic changes in these regions. The glacial periods north of the Polar Front were characterised by high diatom productivity and larger Fragilariopsis kerguelensis and Thalassiosira lentiginosa sizes.

Dr Mohan spoke about temperature mix, carbon dioxide concentration of southern ocean connection through paleo records along with Antarctic Circumpolar contrast, frontal system, water masses in southern ocean , biotic community etc. He also drew attention to the diatoms, siliceous matter and its connectivity with paleooceanography, methodology for studying them, distribution of diatoms and interrelation between ocean glacial and inter glacial link. He also stressed on the future scope of diatom study and how quantification of the past climate changes can help in the understanding of sea-ice variability.

Dr. Avinash Kumar

Scientist-D,

ESSO-National Centre for Polar and Ocean Research (NCPOR), Goa

***Topic:* An Accelerated decline in the Arctic sea ice cover: A record minimum in summer 2018**

Arctic sea ice extent typically attains a seasonal maximum in March and minimum in September.

Arctic sea ice extent declined rapidly to an unprecedented low in the summer of 2018, raising a concern of its disappearance.

The events of twelve lowest extents in the satellite era have occurred in the last twelve years. Dr Kumar demonstrated that the sea ice variability is linked to warming-cooling processes, and in turn supplemented by the cumulative effect of ocean currents, winds and other ocean-atmospheric parameters. Dr. Kumar used satellite data to elaborate the trend in arctic sea ice, winter and summer extent of arctic sea ice which showed significant decline especially after 2017-18. 12 per cent per decade reduction was reported. In the last 12 years maximum decline in sea ice has been made especially in the last September, the lowest sea ice was recorded.

Dr. C.M. Laluraj

Scientist-E and Head, Polar Cryosphere and Ice core Studies

National Centre for Polar & Ocean Research (NCPOR), Goa

***Topic:* Antarctic 'Ice Dust' reveals Climate Change Secrets.**

Dr. Laluraj explained the importance of dust particles and its role in ice cores studies. He also stressed on the past dust records, the impact of dust on climate and glacial system, atmospheric acidity, chemistry, human health, ocean biogeochemistry and productivity. He found that the massive increase of dust flux in the last 30 years, has impacted the earth's Radiation Budget. Based on his research, he concluded that after 1980's atmosphere is getting warmer because of the deposition of dust.

Dr. Vimlesh Pant

Associate Professor, Centre for Atmospheric Sciences,
Indian Institute of Technology, Delhi.

Topic:* *Impact of Arctic sea-ice changes on oceanic physical-biological characteristics in the Arctic Ocean.

Dr. Pant spoke about the unprecedented changes in the Arctic sea-ice in the recent years and its impact on the circulation pattern, physical and biological parameters in the northern high latitudes like variation in upper-oceanic freshwater content, which in turn determines Carbon dioxide concentration. The excess load of anthropogenic carbon dioxide (CO_2) into the ocean affects biogeochemistry of the surface waters and may lead to oceanic acidification. He used CSM model to analyse the past changes, using biogeochemical parameters, SST, chlorophyll and CO_2 flux between atmosphere and ocean. He also reported decadal changes in the CO_2, anomalies in the Nitrate, Phosphate and nutrients etc. CESM model predicts high temperature in the future whereby chlorophyll concentration will decrease in the Arctic and increase in the CO_2 influx due to anthropogenic activities in Arctic than in Antarctic.


SaGHAA
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HIMALAYA-ARCTIC-ANTARCTIC
Impact of Arctic sea-ice
physical-biological
Vimlesh Pant
Centre for Atmospheric
Indian
of Technol
India International

SESSION 2

The group photo of the Speakers of Session 2

OCEAN EXPLORATION

This session was chaired by Dr. M A Atmanand, Director, National Institute of Ocean Technology and Dr. Inger Midtkandal, Science and Technology Counselor, Royal Norwegian Embassy in New Delhi.

The session on Ocean Exploration began with the presentation by the keynote speaker, Dr. Nalan Koc, Research Director Norwegian Polar Institute followed by the presentations of Dr. David Agnew, Executive Secretary, CCAMLR, Dr. N Sarvanane (CMLRE), Captain J S Gill, Dr. S C Tripathy, Dr. Sridhar Jawak, Dr. Anand Jain, Dr. Asha Debi and Dr. R Saraswat.

The Rapporteurs of the second session were Dr. Parmanand Sharma (NCPOR) and Dr. Mahesh Badanal (NCPOR).

Dr. Nalan Koc

Director, Norwegian Polar Institute Tromso, Norway.

***Topic:* Planning for multi-disciplinary observations.**

Dr. Koc diverted the attention of the audience towards the importance of understanding and quantifying the impacts of climate change on the Polar Oceans and ecosystems and their global consequences.

To achieve enhanced understanding of the state and to predict future changes, sustained multi-disciplinary observations are essential. Moored arrays, autonomous platforms, remote sensing and ship-based observations are all required for this purpose. Dr. Koc has focused on the need for more ocean vessels and observation equipment. In this anthropocene era, where both climate and ocean is warming at all heights and depths, she brought forth a growing body of evidence documenting the warming of the Arctic which is influencing the global climate change. Attention was drawn to the lack of data along Astrid Ridge, despite programmes like mutlinational Krill Survey, 2019 in place. Therefore, there is a need for a connected, collaborative and comprehensive polar research to serve the societal needs.

Dr. David Agnew

Executive Secretary, Convention for the Conservation of Antarctica Marine Living Resources (CCAMLR).

***Topic:* Meeting new challenges in the management of Antarctic Marine Living Resources.**

Mr Agnew initiated his talk by expressing his excitement over the depth and quality of research carried out by the participants of SaGHAA- 5. He highlighted how CCAMLR is dedicated to the conservation of marine resources and promotes its rational use. The audience were also informed about the vast variety of problems that the CCAMLR had been facing in the past and also experiencing in recent times. In the 1980s the toughest challenge was to bring in a system of monitoring for the fisheries followed by the regulation of the unregulated fishing through scientific experiments and negotiations with the fishers. The Convention on the Conservation of Antarctic Marine Living Resources is in its 38th year. Over these years it has solved some key problems, including the introduction of precautionary fisheries management, the control of vessels, IUU fishing and the

minimisation of impacts of fishing on the marine ecosystem. However, over the last 10 years the organisation has faced new challenges. Dr. Agnew also mentioned about the various challenges like increasing access to the Antarctic, changing priorities and interest of the members, exploration of tooth fish in new areas, along with changes in priorities of members countries from krill to fin fish. The CCAMLR has proposed to commit for a Marine Protected Area, which will include Weddell Sea, East Antarctic and west Antarctic Peninsula. Therefore, collaborative research and science is the need of the hour so that CCAMLR continues to take correct decision for the Antarctic.

Dr. N Saravanane

Scientist-E, Centre for Marine Living Resources and Ecology, Ministry of Earth Sciences, Kochi

Topic: Recent trends and renewed interest in establishing Marine Protected Areas in Southern Ocean – Indian perspective.

Dr. Sarvanane initiated his talk by introducing the assignment that he was given to improve the relationship between CMLRE and CCAMLR. India, despite being a signatory member to the latter, has not contributed much as the country was more interested in conservation rather than in exploitation of fisheries. Marine Protection Area (MPA) according to him has been one of the major tools of conservation and countries are pushing every year their proposal for MPAs under CCAMLR because there is always economic gain through fishery. He highlighted the fact that the global effort towards promulgation of MPAs started with the World Summit on Sustainable Development in 2012 and since then two important MPAs have been designated. The present work described the pros and cons of using MPA as an ecosystem conservation under Madrid Protocol of ATS or fishery management tool under CCAMLR from the perspective of India. Dr. Sarvanane focused on the need for harmonisation between the treaties and the provision in the articles apart from limiting human intervention in the Marine Protected areas.

Capt. J S Gill

Former Nautical Advisor, Govt. of India,
Sr. DDG/Addl. D.G. Shipping.

Topic: Marine Scientific Research Vs UNCLOS'82.

Captain Gill mentioned about UNCLOS 82 convention on the law of the sea and how it has retained the basic principle of consent by coastal States for research on the continental shelf and extended it to the Exclusive Economic Zone (EEZ). In the process of drafting EEZ legislation, some states have adopted their older fishing laws and regulations, by redefining the jurisdictional zone to which they apply. Because there is no definition of what constitutes marine scientific research in the Convention, the result of adapting older fishing laws to the EEZ is the creation of two consent regimes: one regime to be generally applied to marine scientific research and another to be specifically applied to scientific research relating to fishing. He emphasised on the fact that there are researches on ship manning and recently regulations have been put in place for polar ship manning. Capt Gill emphasised on the need of a research vessel to enhance the quality of scientific research, as they offer great platform for marine as well as polar research.

Dr. Sarat Chandra Tripathy

Scientist–E, Group Director, I/C (Ocean Sciences)
ESSO-National Centre for Polar and Ocean Research (NCPOR)

Topic: Salient findings from the Indian Southern Ocean Expeditions.

The Southern Ocean (SO), being the world's largest high-nutrient low-chlorophyll (HNLC) region, plays a significant role as a sink for atmospheric CO_2 via its solubility and prevailing biological pumps. It is observed that the productivity in SO regions is closely related to the hydrodynamics across the fronts and convergence zones. Scientific insight gained from physicochemical and biological studies performed during Indian Southern Ocean Expeditions

(ISOE) in the last decade highlights some interesting findings and emphasises India's research activities in the SO Region for better understanding of the oceanographic processes, biogeochemical cycles, marine productivity and global climate change scenario. Dr. Tripathy focused on variation in nitrogen uptake and productivity variability in different frontal zones of southern ocean. He also claimed that different regions in southern ocean act as both sink and source of DIC (CO_2).

Dr. Sridhar D Jawak

Remote Sensing Officer (Sr. Advisor), Svalbard Integrated Arctic Earth Observing System (SIOS), Longyearbyen, Norway.

***Topic:* Technological innovations in Earth observation and remote sensing to provide geo-information in Svalbard.**

His presentation primarily focused on recent Earth Observation and remote sensing activities of the Svalbard Integrated Arctic Earth Observing System (SIOS) and member institutions. He covered a few selected technologically innovative applications in Svalbard like understanding permafrost movement using microwave and unmanned aerial vehicle data, estimation of glacier velocity over Svalbard using interferometric synthetic aperture radar. Dr. Jawak spoke about SIOS , a Norwegian initiated collaboration to create a regional system for Arctic earth science system, integrating new technologies for field studies along with synthesising data from various sources, investigate immediate benefits of merging etc. SIOS is planning to make these remote sensing products available for the wider research community by collaborating with members from different nations SIOS which will provide seasonal and annual variations of glaciers.

Dr. Anand Jain

Project Scientist-C, Arctic Expedition and Logistics Division
National Centre for Polar and Ocean Research, Goa

***Topic:* Bacterial communities involved in complex organic carbon cycling in a high Arctic fjord: A small beginning towards a larger goal.**

With the continued rise in temperature and concurrent increase in complex organic matter inputs, it is anticipated that microbial cycling of complex organic matter will play a decisive role in regulating the carbon export, storage and food web dynamics in the Arctic region. Despite enormous biogeochemical significance of heterotrophic bacteria not much is known about the bacterial communities involved in complex organic carbon cycling in the high Arctic fjord environment. Through his presentation he stressed the importance of tiny living creatures (bacteria) under Arctic warming scenario and discussed the results obtained from field as well as experimental studies conducted in Kongsfjorden.

Dr. C R Asha Devi

Scientist D, Centre for Marine Living Resources and Ecology, Kochi

***Topic:* Ecology of microzooplankton in the Arctic Fjord Kongsfjorden and comparison with major ecosystems.**

The significance of microzooplankton mediated food web in the Kongsfjorden was elucidated for the summer season, with significant top – down controls on ciliates by the Copepods, which is envisaged as a factor to be considered while defining the planktonic food web. The high degree of seasonality in environmental conditions are key elements that determine the diversity of organisms in the Arctic and planktons being the drifters in the ocean and due to their rapid response to environmental changes can be considered as proxy to

understand such changes. The latitudinal gradient in ciliate diversity was also assessed, in defining the functional role of ciliates, and was found to be discrete for different ecosystems. Dr. Asha emphasised on the importance of planktons in the Arctic food web, with focus on the Speaking on plankton, which are distributed in the ocean and have an important role in the trophic transfers and microbial food web interactions.

Dr. Rajeev Saraswat

Senior Scientist, Micropaleontology Laboratory, Geological Oceanography Division, CSIR-National Institute of Oceanography, Goa

Topic:* *Did Polar Regions modulate glacial-interglacial transitions in the northern Indian Ocean?

The changes in insolation due to a variation in eccentricity, precession and obliquity are the major factors responsible for glacial-interglacial transitions. The changes in the extent of huge Polar ice-sheets, as a result of insolation, are suggested as the pace-makers of the glacial-interglacial transitions at ~100 kyr periodicity. A couple of past seawater temperature records from the northern Indian Ocean, has a clear lead of warming over the rise in atmospheric CO_2 during the last glacial-interglacial transition. A large increase in upwelling and a resultant rise in CO_2 outgassing from the northern Indian Ocean, accompanies this first phase of deglacial warming. Dr. Saraswat has focused on the need for quantification of the natural variability in order to understand the human induced variability. According to him, Indian monsoon shows a 60 yrs periodicity and this can be mainly because of human interventions. But, the situation was not the same in the earlier years. Monsoon has been the tipping point for the global climate change during the past. The deglaciation was triggered by local insolation leading to increased monsoon driven productivity resulting in release of carbon dioxide, contributing to global CO_2.


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HIMALAYA

SESSION 3

The group photo of the speakers of Session 3

ICE CLASS

This session was chaired by Mr. Roar Marthiniussan, Subsea Division at Kongsberg Maritime, Norway.

It started with the talk by the key note speaker Dr. M A Atmanand, followed by the presentations of Dr. Ekaterina Kim, Dr. Rajasekhar , Mr. Kari Laukia and Mr. Niklas Hallgren.

The Rapporteurs of this session were Dr. Anand Jain (NCPOR) and Mr. Prashant Pandit (TERI).

Dr. M A Atmanand

Director, NIOT and Chair of Intergovernmental Oceanographic Commission, Regional Committee for the central Indian Ocean (IOCINDIO), UNESCO.

Topic: Emerging Trends in designing Polar Vessels for Indian Polar Research Program and its Cost-Benefit Analysis.

It is crucial to get insight into how a floating laboratory (i.e., Polar Research Vessel) is designed and built to meet the mission requirements for the Indian Polar Research Programmes. The logistics of polar research also require extraordinary efforts and cooperation at all levels.

Various aspects with respect to challenges and emerging trends in designing a Polar Research Vessel (PRV) to minimise the impact and foot print of vital scientific research in the sensitive polar environment and the cost–benefit studies for chartering vs. owning a PRV were discussed explicitly. Dr. Atmanand focused on the need for developing PRV along with the need for escort vehicle, to provide with year around research and data. According to him, PRV should be the ones with open water efficiency, strength of vessels, efficiency in ice breaking etc.

Dr. Ekaterina Kim

Associate Professor, Norwegian University of Science and Technology

Topic: Automated Vehicles in Arctic Marine Research and More.

Scientific explorations in the harsh environment of Arctic will push technology to its limits. There is a need for innovative approaches, in part because one cannot operate in conventional ways in Arctic areas. Norwegian University of Science and Technology has more than 20 years of extensive experimental investigations in polar areas. Their AUR- and UAV-Lab is running a common pool of advanced aerial and underwater equipment, but they too face challenges. She spoke about the ABCD project, which allows for dark condition studies, and can be used for ship wreck search in the Arctic region. The automated vehicles can act as simulator for Arctic marine structures,study of drifting ice, collision impact assessment etc.

Dr. D Rajasekhar

Scientist G and Project Director, Vessel Management Cell
National Institute of Ocean Technology, Chennai

Topic: Research Ship Management Strategy and Innovative Engineering Solutions.

Factors such as ship operations, ship conditions and fuel management are considered for energy saving. Implementation of Energy management

system onboard Sagar Nidhi complies with Ship Energy Efficiency Management Plan (SEEMP) - a regulation set by International Maritime Organisation (IMO). The Ballast water management system provides stability, improves propulsion, manoeuvrability and prevents the transfer of aquatic micro-organisms. Integrated automation takes input from sensors, radar and satellites. He spoke about different types of ships i.e. cargo, research and merchant. Out of the total 5 research vessels, NIOT maintains three Research vessels and two coastal research vessels. He highlighted few of the problems of research vessels such as lack of infrastructure and other facilities in comparison to other countries, slow clearance procedure etc. He gave few suggestions on reduction of cost and increasing the operational days of PRV.

Mr. Kari Laukia

Director, Head of ship design and engineering of Aker Arctic Technologies Inc. Finland

Topic: Challenges in Designing PRVs.

Mr. Laukia spoke about his company, which manufactures ice-breakers, ice tanks. he mentioned about his company's experience of designing 60 per cent of the world's ice breakers using different technologies. He also talked about the procedures which go in making of the ships like Feasibility studies, concept design, basic design, ship production, hull testing on ice etc. Their job is to support the ship building process and once it is delivered they visit the field for testing. Energy efficiency according to him is the driving force of modern day ship building and he mentioned about 'winterisation' which is also an integral part in making ice breakers. He also mentioned about Polaris Design, which is a Baltic Escort Ice breakers, one of the most modernised ships designed by Aker Arctic.

Mr. Niklas Hallgren

CEO,Lights Structures.

Topic: Monitoring the effects of ice forces with the Ice Class Research Vessel for Polar Code.

Light Structures presented fibre optic Ice Load Monitoring (ILM) system that is implemented on several Ice Class Research Vessels around the globe. He spoke about ship monitoring, hull stress monitoring to improve safety and reduce operational cost. His company is also involved in ice load monitoring. He informed that Light Structures has installed over 200 monitoring systems on vessels and has developed Hull Stress Monitoring System. He also talked about why ship monitoring is important. He informed delegates about Ice Cold Monitoring which is developed with the help of Norwegian project.


EXIT

SESSION 4

The group photo of the speakers of Session 4

HIMALAYA-CLIMATE CHANGE

This session was chaired by Dr. Ajit Tyagi, former DGM, IMD and Dr. Gopal Iyengar, Advisor to Ministry of Earth Sciences.

The session started with the presentation by the Key note Speaker Dr. M Ravichandran followed by the presentations of Dr. Gufran Beig, Prof. Milap Sharma, Dr. Aswagosha Ganju, Dr. A L Ramanathan, Dr. T P Sabin, Dr. A K Singh, Dr. S K Nandi, Dr. Manish Pandey and Dr. Luvkush Patel. The session also saw discussion and question-answer round. This session was the last session of the first day of the two day conference.

The Rapporteurs of this session were: Dr. Abul Amir Khan (DU) and Ms. Namrata Barooa (LIGHTS).

Dr. M Ravichandran

Director, National Centre for Polar and Ocean Research, Goa

Topic: Himalayan Cryosphere in a changing Climate.

Dr. Ravichandran directed his talk tot he Himalayan Cryosphere, the state of glacial melting, the future scenario and NCPOR's role in such a situation. he highlighted the importance of the third pole as 20 per cent of the world population depend on its water resources and this calls for a need to study the melting glaciers. The unique geographic region -the Himalaya and the Tibetan Plateau is known as the Third Pole, because it's ice fields contain the largest reserve of fresh water outside the Polar Regions. This region is the source of the 10 major river basins that form the lifeline of approximately 1.9 billion people including 240 million in the mountain and hills of the Hindu Kush Himalaya. Dr Ravichandran spoke about difference in the climatic zones of Himalaya i.e. western, central and eastern Himalaya and described the varying mass balance of the glaciers in these three regions, giving examples from Chota Shigri glacier and cautioning about the impact of climate change threats prevailing over the Himalayan glaciers. In this context he mentioned about the differential retreat rates of the Himalayan glaciers. Finally he explained how NCPOR is trying to assess the rate of change and the dynamics of select glaciers in the Third Pole to understand its impact on the hydrology. It is also involved in long term monitoring programme for mass balance, energy budget and also hydrological balance. Recent efforts have also been directed towards generating models and instrumentations for black carbon monitoring. Moreover, NCPOR is planning for an enhanced monitoring network, strengthening modelling efforts to understand the present situation and forecast the future and predict the possible impact of the cryosperic change. To this end, he suggested that there was a need for regional collaboration.

Dr. Gufran Beig

Scientist G and Program Director

System of Air Quality and Weather Forecasting And Research (SAFAR), Indian Institute of Tropical Meteorology (IITM).

Topic: Extreme Pollution Event and Stubble Burning Impacts.

Dr Beig in his talk tried to draw attention towards air pollution which is a crucial concern in Delhi and tried to link it with the black carbon composition of the Himalayan glaciers. He drew the attention of the audience on the fact that the first air quality forecasting system was made for Delhi in 2010 and the same has been scaled up in recent times. This system is known for its precision and accuracy and can predict air quality 72 hours in advance.

Stubble burning inventory has also been devised in recent years with 400*400 m resolution. He spoke about the emission inventories that were done in Delhi in 2018 which showed that transport sector contributed a sizeable portion to the total emission and the contribution grew by 40 per cent since 2010 and similarly, the contribution of the industrial sector also grew by 48 per cent. However, the contribution of the residential sector declined by 64 per cent in recent years. All these measures can help in planning mitigation strategies. He also drew attention to the simulation which allows to show how dust from the Gulf region travels to Rajasthan and contributes to pollution in Delhi. However, to him air pollution is aggravated by the upper wind speed and direction and several other meteorological factors.

Prof. Milap Chand Sharma

Professor, Centre for Study of Regional Development (CSRD), Jawaharlal Nehru University, Delhi.

Topic: Understanding Cryosphere-Climate Interaction and Societal Response in the NW Himalaya, INDIA.

Prof. Sharma talked about the findings from the DST funded Climate Change Programme as a part of which the glaciers were studies which drained into the villages of his study area. It is a reality that global ice/snow cover, the most sensitive indicator to climate change, has shown large scale shrinkage and recession. Almost half a billion population of India and South Asia depends on the snow/glacier melt waters for the basic livelihood. Miyar Basin, a major watershed of Chandrabhaga River which contains 76 ice bodies, with 16 valley glaciers of varied dimensions, was studied. Prof. Sharma spoke about the establishment of two DGPS base stations for geodetic assessment. The glaciers in Uttarakhand and Himachal Pradesh were studied and not much changes were noticed. Even the radio-carbon dating supported the fact and only receeding glaciers depicted some changes which according to Prof. Sharma should not be a matter of concern.

Dr. Aswagosha Ganju

Former Director, Snow and Avalanche Study Establishment Defence Research and Development Organisation (DRDO).

Topic: Inner Himalaya: An opportunity to turn the terrain to economic fortune.

India is facing regional imbalances that have left a large portion of its population economically backward. One of the reasons for this is poor infrastructure.

The Himalayan states have suffered because of the remoteness of the areas and difficulty in execution of infrastructure development plans in a limited time. Dr Ganju spoke about how the mountains have a whole lot of cultural diversity and tourism is not progressing the way it should have. He used the example of Uttarakhand to focus on how it receives a good amount of tourists but it's contribution on tourism and tourism development is pretty low. He also focused on the presence of many unexplored location in the inner Himalaya like Doda, which should be developed to increase living standards of local population by developing local resources. Thrust should be on the innovation for sustainable tourism. There is a need to develop new technology and expeditions should be promoted to explore the unexplored.

Dr. A. L. Ramanathan

Professor, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi

Topic: Monitoring of the Himalayan and Arctic Cryosphere: a multidisciplinary approach through in-situ observations.

Various studies on the Himalayan glaciers have been continuing as they are of particular interest in terms of future water supply, regional climate change and as well as the catastrophic mountain hazard such as Glacial Lake Outburst Floods. There have been the monitoring of glaciers like Chota Shigri and others i.e. monitoring of long-term mass budget for Patsio glacier (Himachal Pradesh) since 2010, Stok glacier (Ladakh, Jammu and Kashmir) since 2015, Lato glacier (Ladakh) since 2018 and

one glacier in Eastern Sikkim for this process. He also mentioned about the declining trend in the Geodatic and Glaciological Mass balance and how the summer temperatures are increasing and winter precipitation is declining.

Dr. Sabin T P

Scientist D, Centre for Climate Change Research, Indian Institute of Tropical Meteorology , Pune.

Topic: High-resolution global climate modeling for the Himalayan region.

Warming trend in surface temperature causes changes in precipitation pattern and increases extreme events. Accordingly, the Hindu Kush-Himalaya Mountain Ranges also show impacts of climate change.

IITM is exploring the information from CMIP5, dynamically down-scaled CORDEX-SA (50km), statistically downscaled NEX-GDDP (25 km), variable resolution simulation from LMDZ (35 km over SA) and High-Resolution IITM-GFS (27 km) in this study, to understand the sizeable spatial heterogeneity in precipitation and temperature-related indices over this complex mountainous belt. Dr. Sabin, mentioned how the CMIP 5 model gives a better view of Himalayan climate, which suggests the rise of annual average temperature and precipitation.

Dr. A K Singh

Former Director, ICAR- Directorate of Coldwater Fisheries Research (DCFR)

Topic: Strategic Approaches to Promote Rainbow Trout Farming in India.

There is a vast scope and potential for enhancing fish production in hills. The important aquaculture species in hills is trout, which is cultivated in ice-melt cold-water of Himalayan states. Rainbow trout farming is fast becoming the most remunerative coldwater fish that provides livelihood and food security to the hill population, but the potential of trout resources have not been fully utilised because of lack of infrastructure. However, Dr. Singh said that brighter opportunities have come up recently and pointed out that there has been increase in trout production from 147 tones (2001) to 1000 Tonnes (2019) because of research works and state initiatives. ICAR-Directorate of Coldwater Fisheries Research is also undertaking concerted research and development efforts to expand and intensify rainbow trout production.

Dr. S K Nandi

Former Scientist 'G' and Group Head-EA&CC, G.B. Pant National Institute of Himalayan Environment & Sustainable Development, Uttarakhand.

Topic: Forest ecosystems and plant biodiversity: Climate change and implications in the Indian Himalaya region.

Indian Himalayan Region (IHR) is amongst the 35 global biodiversity hotspots for its unique and rich biodiversity. About 8,000 angiosperms, 44 gymnosperms and 600 petridophyte species have been reported in the IHR. Out of these, 1,748 species are known to have some medicinal uses.

Dr. Nandi focussed on how this region is very sensitive to changing climatic conditions, partly due to human induced perturbations. As a consequence, the forest ecosystems and plant biodiversity in the region is predicted to respond to this rapid warming.

Dr. Manish Pandey

Assistant Professor in UCRD, Chandigarh University, Mohali.

Topic: Surface facies analysis vis-à-vis melting of a Western Himalaya Glacier.

Analysis of the WorldView-2 PAN as well as multi-spectral satellite imagery of the Chhota Shigri Glacier situated in Chandra Valley of Western Himalaya was done to quantify different surface facies using three different image classification algorithms. Melting rate of glacier surface computed using glaciological method was compared with different surface types and the results show that dirty snow has higher melting rate as compared to clean snow and in the same way, DMS melts faster

than SMD. Results of this study have important implications in reducing uncertainty in mass balance and energy balance models. Dr. Pandey tried to put focus on the glacier melting trends over the years, which shows a lot of variation. Chota Sigri glacier has different types of surfaces and glacial facies. He also identified 6 types of glacial surfaces.

Dr. Luvkush Patel

Project Scientist-B, Himalayan Cryosphere Programme-Polar Sciences, ESSO-National Centre for Polar and Ocean Research, Goa.

Topic: Thermal behaviour of debris covered glaciers, Western Himalaya.

Debris are one of the unavoidable components of the Himalayan glaciers and have a critical role in glacier dynamics. Dr Patel spoke on complex nature of debris materials. The surface temperature becomes crucial factor to estimate thermal resistance of debris to calculate ablation under debris covered glacial area. Attempt were made to quantify the thermal resistivity of supraglacial debris of Chandra basin by using heat flux method. Dr Patel used satellite data for estimating thermal resistance debris.

Dr. V D Mishra

Snow and Avalanche Study Establishment, DRDO

Topic: Estimation of Net Radiation Flux of Antarctic Ice Sheet in East Dronning Moud lands, Antarctic , during clear sky days, using Remote Sensing data and meteorological data.

Dr Mishra spoke about the importance of the study of cryosphere-atmosphere interventions to understand various physical occurring on the ice sheets. He mentioned about the estimation of Net Radiation flux and satellite variation with ground data. He talked about MODIS data 2007-10 and LIMA image which is crucial. He also talked about MODIS air and dew point. Through this we can estimate relative humidity. He also outlined the estimation of net long wave radiation flux. Albedo of the ice sheet has been estimated. He talked about the Landsat and 8 images of Antarctic ice sheet in east droning.

Dr. Rakesh Bhambri

Scientist, Wadia Institute of Himalayan Geology

Topic: Monitoring of Himalaya- Karakoram Glaciers and associated hazards from ground and space.

Dr Bhambri initiated his talk on the importance of the glaciers for generation of hydro-power and irrigation purposes and why the monitoring of the same is essential for the associated hazards. He also spoke about the Karakoram glacier and the hazards that they pose because of the GLOFs. The fluctuations of individual glaciers of Karakoram lacks consistency, though the total ice mass remains stable. The Karakoram glacier presents an anomalous behaviour, as these are surge type glaciers, with surge intervals identified for 27 glaciers. In these glaciers, about 150 floods from ice-dammed lakes are identified in historical records and from remote sensing. He also pointed out that these differ from the Himalayan GLOFs, which are attributed to climate change. Though field work is highly recommended in studying the glacial fluctuations, yet they involve cost and may also come with some threat to human lives.

The End of Day 1 of the Conference

The first day of the conference included Inaugural Session and 4 sessions followed by Discussions after every session. It comprised of 34 speakers in total, with 10, 9, 5 and 10 speakers for Session 1, 2 ,3 and 4, respectively.


SaGHAA5

DAY 2: 27th FEBRUARY, 2019

SESSION 5

The photo of the participants of the Panel Discussion that followed Session 5

GEOPOLITICS

This session was chaired by Dr. P S Goel.

The session took off with the presentation by the keynote speaker and Special Guest, H E Nils Ragnar Kamsvag, Ambassador of Norway to India followed by the presentation of Prof. U K Sinha, Mr. Stephan Lanzinger, Ms. Sulagna Chattopadhyay and Prof. Sanjay Chaturvedi. This was followed by a Panel Discussion by Dr. P S Goel, HE Nils Kamsvag, Mr. Xue Qinzhao (First Secretary, Sci-Tech Affairs, Chinese Embassy in India) and Ms Nellie Mikkola (Second Secretary, Embassy of Finland).

The Rapporteurs of this session were: Dr Sridhar Jawak (NCPOR) and Dr Sweta Bhusan (LIGHTS).

HE Nils Ragnar Kamsvag
Ambassador of Norway to India.

Topic: The Arctic Strategy of Norway.

The Arctic offers major opportunities for development. We find opportunity in traditional sectors such as the seafood sector and oil and gas sector and in new industries such as marine bioprospecting and seabed mining. The tourism industry is growing. Norway has set up a number of institutions that work towards sustainable development of the Arctic. H E spoke about SaGHAA, as an important platform for geo-politics. He stressed the importance of the Arctic Region for the economy of Norway, whether it is food or tourism. He added that there was a need of Integrated ecosystem based management and strong basis for employment and value creation. Arctic Policy looks at sustainability as a major cause. He stressed on the need for knowledge development, opportunities for research in Arctic ocean, climate etc and the need to keep this region in peace, stability and inter-state cooperation. He also spoke about India-Norway cooperation and the need for development of Blue-economy.

Prof. Uttam Kumar Sinha
Fellow at National Nehru Memorial Museum

Topic: India and Arctic: Building an Arctic Culture.

The tales of risk, adventure and enterprise from the Arctic/North Pole has always captured the imagination of the public. Arctic is an interesting ground for popular imaginaries and textual interpretations and the scientific emphasis on Arctic has shaped many narratives in the 18th and 19th century as it also does in recent times. In India, the Vedas (oldest scriptures of Hinduism written in Sanskrit) were the fountain head of knowledge of the Arctic. Prof Sinha focused on the need for the integration of scientific knowledge, practise of peace in India like Arctic does. India might be a distant land from Arctic, but we are similar in some other ways viz. the ecosystem and biosphere along with connection of science. India –Arctic shares a very long and old relationship as claimed by Bal Gangadhar Tilak. Science should be the lens through which Arctic should be looked at and India has taken a lot from the knowledge which led to the formulation of the Arctic policies. The recent focus on the political, commercial and cultural connect to the Arctic along with a multi- disciplinary approach can help in a better, dynamic and robust understanding. He also emphasised on the tripartite connection between Norway, Russia and India may bring in a new direction to India's future Arctic policy.

Dr. Sanjay Chaturvedi

Professor and Dean, Faculty of Social Science, Dept. of International Relations, South Asian University, New Delhi

Topic: Revisiting Antarctic Geopolitics: Continuity and Change.

The seven territorial claims and counter claims, legally frozen, under Article IV of the Antarctic Treaty, not only remain geopolitically alive for all practical policy purposes but in some cases have become far more assertive recently. With climate change making the Antarctica more accessible, geopolitically driven perceptions of resource-hungry Asian economies, intricately combined with the ethical imperatives of providing human security especially to billions in the 'Majority World' or the Global South are also on the rise and demand scrutiny. Dr Chaturvedi focussed on the probable future scenario, when a ban on mining would likely come up for discussions. There is a need to revisit the ATS, in order to balance the political economy and moral economy.

Mr. Stephan Lanzinger

Head of Science Section, Embassy of Federal Republic of Germany in India.

Topic: German Polar Research.

Numerous German research institutions, universities and companies conduct polar research, including the Alfred Wegener Institute (AWI), Helmholtz Centre for Polar and Marine Research to namr a few. The forthcoming MOSAiC project (Multidisciplinary Drifting Observatory for the Study of Arctic Climate) - the biggest Arctic expedition of all times – will involve scientists from 17 nations. Mr. Lanzinger stressed on the need for better climate, mitigation of climate change and biodiversity changes. He also spoke about German contribution in the research on Arctic, especially the work done by Max Plank Society for Polar Research and Alfred Wegener Institute. He informed that MOSAiC program will lead to better understanding of climate procedure of Arctic.

Ms. Sulagna Chattopadhyay

President, LIGHTS and Founder-Editor, Geography and You

Topic: Need for Regional cross-border cooperation in Himalaya: drawing inspiration from Arctic Council.

Ms Sulagna Chattopadhyay spoke about how the Himalaya plays a significant role in the socio economic development of the Asian stakeholders apart from supporting nearly 2 billion people in one of the most densely populated region of the world. The magnitude of the problems faced by indigenous population and geographical spread is such that no single stakeholder can do justice to the subject. She spoke about the impact of climate change on the various tribes across the Himalayan-Hindukush region and how they have been side-lined. She called for urgent need to address their concerns especially with respect to their traditional livelihood which are at loss due to climate changes. She focused on the need for establishing a permanent forum that can think beyond the geographical boundaries like Arctic Council. She proposed for the formation of a Himalayan-Hindukush Science Forum and need for generating data base for further studies about this region. She stressed on the need for collective will and believed that science being a common language can solve crisis facing the mankind in these regions.

Panel discussion

This panel discussion was moderated by Dr P S Goel.

A panel discussion on science and geopolitics was moderated by Dr P S Goel, closely following the 5th Session. The panellists included HE Nils Rangar Kamvag, Ambassador of Norway to India, Royal Norwegian Embassy in New Delhi, Dr. Xue Qinzhao, the First Secretary to Sci-tech Affairs, Chinese Embassy in India, Dr. Stephan Lanzinger, Head of Science Section, German Embassy, New Delhi, Ms Nelli Mikkola, Second Secretary, Embassy of Finland and Dr Uttam Sinha, Fellow at National Nehru Memorial Museum. As a moderator, Dr Goel asked the panel members to put forward the main takeaways for the future as to what ideas they had in terms of the need for closer collaborations and geopolitical ties that rose from these regions.

Ms Nelli Mikkola was invited to speak first. She began by saying that geopolitics to her is a key to understand the region as a whole and every government should pay close attention to such forums where discussions were ongoing. She was inspired by the idea of the Himalayan Science Forum and in this regard she mentioned that the member states to the Arctic Council would be happy to share their best practices if such a scientific forum was constituted for the region as a whole, with all the regions' stakeholders. Moreover, she added that the potential Indian-Arctic strategy seemed to be an important opportunity for collaboration.

Dr Uttam K Sinha drew attention to the three ' i's of the Arctic. The first way to look at the Arctic, he said, would call for an 'interdisciplinary approach' to deal with its challenges. This is mainly because of the fact that challenges in the region is very complex though there are growing opportunities in the region as well. Therefore, he said that a holistic, comprehensive and interconnected understanding was required. For him the second 'i' would stand for 'Institution building' and there is a need for a careful study on the Arctic Council, a post cold-war product which is still robust and alive and gain from its experiences. The whole idea of having a Himalayan Forum reflected how geography is being looked at from an ecosystem, bio-regional perspective and therefore, experiences of the Arctic Council can help in this regard. Himalayan Scientific Forum, according to him would be a lighter way to involve the countries in South-Asia and moreover, if the climatological, glaciological and the scientific parameters are looked at, China should also be a part of this

Forum. This Forum could bring in extraordinary thinking and probably redefine geopolitics. The Third 'i' that he mentioned was that of 'Information Sharing'. Transparency of information, robust data burden and benefit sharing aspects also need to be focussed on.

Dr Stephan Lanzinger emphasised on the fact that the Himalayas required intense international collaboration and therefore, there should be international cooperation to this end. He welcomed larger international participation on geopolitical issues in platforms like SaGHAA in the days to come.

Dr Xue Qinzhao expressed his thanks to the organisers and went on to add that he identified broad areas of common interest during the two days of the deliberations. To him SaGHAA is an important platform which should encourage higher levels of collaboration, cooperation and cross border scientific Programmes in future will ensure better understanding of natural processes of the ecosystem of the three poles. He mentioned that the rising temperature and the changes in the pattern of monsoon in India could cost a decline of 2.5 per cent of GDP by 2050 and would also degrade the living standards of the people. Therefore, the is a need to address this urgently by working and acting together to mitigate the challenges brought in by the climate change. He urged the need for a greater collaboration to fight the problem in a better way for a better future.

HE Nils Ragnar Kamsvag elaborated on what Uttam Sinha opined. To him, the geopolitical situation of the member nations of the Arctic Council was just as complex as those in the Hindukush Himalayan Region. He mentioned that despite tensions between Norway and Russia, because of larger scientific collaborations and cooperation, trust has been built among them. The scientific forum on the third pole, according to him could learn deeply from the geopolitical experiences of the members of the Arctic Council.

SESSION 6

The group photo of the speakers of Session 6

HIMALAYAN GLACIERS

This session was chaired by Dr M Ravichandran, Director, NCPOR and Dr Rajesh Asthana, Deputy Director General, Geological Survey of India.

The first presentation of this session was by the key note speaker, Prof. A P Dimri of JNU followed by the presentations of Dr. M R Bhutiyani, Dr. Dhruv Sen Singh, Dr. Parmanand Sharma, Dr. A K Mitra, Mr Antti Hyvarinen and Dr. Pankaj Kumar. This was followed by another round of discussion.

The Rapporteurs of this session were: Dr. Cheryl (NCPOR) and Dr. Neelu Singh (NCPOR).

Prof. A P Dimri

School of Environment Science, Jawaharlal Nehru University, Delhi.

***Topic:* Himalayan Climate: Past and Future.**

Prof. Dimri through the recent IPCC report suggested that, Himalayas are one of the most vulnerable systems to climatic changes. This change in climate may result into the irreversible alterations in the hydrology, climate, demography and the underlying ecosystems. With the recent generation of high-resolution climate models, it has been shown that such changes may have wide range of variability in space as well as in time. This may be accounted to the unique setup of the Himalaya. Prof. Dimri also suggested that by the year 2100 North –Eastern India is going to get dry, the rainfall regime will be shifting more towards west, thus reducing the precipitation over NE India.

Dr. M R Bhutiyani

Visiting Professor, Department of Geology, Fergussan College, Pune.

***Topic:* Karakorum Anomaly - A myth or Reality.**

Studies have confirmed that the glaciers in the north-western Himalaya (NWH) were in a state of retreat in the last century. The larger glaciers appear to have receded at a comparatively lower rate than the glaciers with smaller length.

This conforms to the global trend of the world's mountain glaciers which have undergone negative mass balance and terminal recessions. However, in the late 1990s widespread evidence of glacier expansion was found in the central Karakorum in contrast to a worldwide decline of mountain glaciers. This anomalous behaviour, termed as 'The Karakoram anomaly', was first described in 2005 and has been attributed to prevalence of the "Karakoram Vortex" (KV). Dr. Bhutiyani spoke about the anomalies which are occurring due to climate change induced melting of glaciers. Most of the glaciers which are surging are transverse glaciers, which is due to doubling of Surface velocity. He also spoke about the negative mass balance of glaciers at the Siachen.

Dr. Dhruv Sen Singh

Department of Geology, Centre for Advanced Study in Geology, University of Lucknow.

***Topic:* Geomorphology, Sedimentology and its implication for Climate change, Gangotri Glacier, Garhwal Himalaya, India.**

Gangotri glacier is one of the longest and well studied glaciers and is known internationally for its rapid rate of retreat. It has been observed that the glacial landforms and landscapes are modified by the paraglacial processes which evolve as soon as the glacier vacates its valley. The results of the studies indicate that the Gangotri Glacier region exhibits complex and varied geomorphic features evolved by glacial and paraglacial

sedimentary environments. It has been concluded that apart from glacial, the lacustrine mass movement, fluvial and flash flood processes are very active and important sedimentary environments in a glaciated region. Dr. Singh spoke about how different glacier responded to climate change differently. Retreat of Gangotri Glacier was high in the past and as per the IPCC report, it is likely to vanish by 2075.

Glacial landscapes are modified by both primary and secondary factors. Kedarnath tragedy seconds the opinion that glacial landforms change quickly and are modified by secondary processes. Therefore, analysis of sedimentological history is important. Rate of retreat of Gangotri glacier is decreasing but it is important to note the area from which we are collecting the data. Gangotri glacier has glacial , periglacial and sedimentary features, therefore sediments should be collected from glacial zones and not the fluvio-glacial zones.

Dr. Parmanand Sharma

Scientist E and Scientist In-Charge (SIC), Himalayan Cryosphere Programme, Polar Science Division, National Centre for Polar and Oceanic Research (NCPOR), Goa.

Topic: Glacier Mass and climate change in the Himalaya and their effects on the humans and the Environments.

Himalayas known as the "Water Tower of the world", has one of the highest glaciated areas outside the Polar Region. It is also the source of many perennial rivers that are crucial for livelihood of the densely populated region of the Asia. There are nearly 9000 glaciers in the Himalayas and most of them are retreating. Quantification is important and NCPOR has initiated a study on these glaciers. They concluded that most of them are losing their masses. Dr. Sharma has also talked about the impact of glacial changes on the environment and human lives.

The climate change has influenced glaciers thinning and retreat in the Himalaya impacting hydrology of the region. Due to the high mass loss from glaciers, numerous new lakes have formed including significant increase in already existing proglacial lakes,which has increased the threat of GLOFs in Himalayan regions. He asked for a greater consensus on the issue.

Dr. Ashis Kumar Mitra

Scientist - G, ESSO-National Centre for Medium Range Weather Forecasting(NCMRWF), Noida, Ministry of Earth Sciences, India

Topic: Real-Time Polar Sea-Ice Prediction with NCMRWF Coupled Model.

NCMRWF has implemented a coupled climate model with sea-ice model as an interactive component. With advent of satellite data and high performance super computers, now it has become possible to include the large-scale processes of atmosphere, ocean, land-surface and cryosphere including the polar sea-ice of Arctic and Antarctic regions into high resolution numerical global simulation models. The model simulates the mean sea-ice concentration, extent and thickness in both the poles in a realistic way. The simulation of inter-annual variability of sea-ice is also seen to be realistic. Dr. Mitra spoke about the CICE model of USA and Unified Model-Seamless Modelling system of NCMRWF. He also spoke about global ocean data assimilation system and need for extended range forecast in order to get higher resolution.

Mr. Antti Hyvärinen,

Scientist, Head of Group, Atmospheric Aerosols Finnish Meteorological Institute, Finland

Topic: Role of light absorbing impurities on the Arctic and Himalayan Cryosphere.

Mr Hyvarinen spoke about the need for research to support decision making, apart from drawing light on the study of light absorbing impurities. He also mentioned about remote observations. There are many collaborators to measure an Arctic haze and some spatial differences were also measured. He also gave examples of deposition of black carbon in the arctic and soot on snow experiment to show the relation between snow albedo and EC concentration. He also stated that the depth of snow pit was declining every year and there was a peak in concentration and deposition of impurities every year. Finnish Meteorological Institute has measurement from Finish Lapland, Arctic and Himalayan glaciers and also of those in Antarctica, Central Asia , Faroe Island, Scotland etc.


EXIT

RAPID SHOTS SESSION

Group photo of the speakers of Rapid Shot

This session was chaired by Dr Rahul Mohan, Group Director, National Centre for Polar and Ocean Research (NCPOR) Goa

RAPID SHOTS round was organised for the upcoming scientists, which was meant to provide them with a platform for presenting their work and research on the cryospheric issues.

Dr. Mahesh Badanal

Research Scientist B, Antarctic Science Division
National Centre for Polar and Ocean Research, Goa.

***Topic:* Paleolimnological records from the ice-free regions of Schirmacher Oasis and Larsemann Hills, East Antarctica.**

Dr Badanal spoke about how the Antarctic continental margin is marked with ice-free areas which are host to numerous freshwater lakes. These lacustrine systems are rich in sedimentary deposits which archive in them the regional and general climatic variations. These lakes respond to the seasonal variations in climate over glacial-interglacial time scales and can be inferred from biogenic and authigenic sedimentary proxies.

Through his study, he reported paleolimnological variations from two sediment cores retrieved from freshwater lakes viz., L-49 (Schirmacher Oasis) and Stepped Lake (SL-3: Larsemann Hills) of East Antarctica. The cores were collected from different geomorphologic settings. These observations confirm that the basin was marine and later became isolated as a result of postglacial isostatic uplift after 4.7 kyr BP.

Dr. Cheryl A Noronha -DMello

Project Scientist B, Antarctic Science Division
ESSO-NCPOR, Goa.

***Topic:* Subglacial Lakes: Scope for Indian Exploration in Antarctic.**

Dr. Cheryl presented a paper on Subglacial lake exploration that has recently attracted the interest of the scientific community owing to their unique and extreme nature. These are the lakes beneath the ice sheet or glacier with low temperatures, elevated pressures, limited nutrient supply, absence of sunlight and no direct exchange with the atmosphere. She focused on the Subglacial lakes in Antarctica, which mainly exist where temperatures at the glacier bed are maintained at the pressure-melting point from a combination of geothermal or frictional heating and the thermal insulation provided by the thick ice cover. These lakes are proving to be attractive models to explore fundamental themes in limnology as well as have direct global implications such as landscape–lake interactions, the viability and adaptation organisms to environmental extremes, and subglacial aquatic environments as a planetary storehouse of ancient microbes and past climate records.

Dr. Abul Amir Khan

Research Associate, Department of Geology, University of Delhi

***Topic:* Estimation and comparison of glacial melt in the central and western Himalaya using two and three component isotope mixing model.**

Dr Khan spoke about his research where two domains were studied. The first study site represents the upper Ganga river basin, central Himalaya while the second site lies in the Chandra sub-basin in the Lahaul-Spiti district of Himachal Pradesh in western Himalaya. The results of the hydrograph separation suggest

that the surface runoff is the major contributor to the total river flow in both the domains. He also suggested that there is a significant temporal and spatial variability in the end member components. For instance, river water isotopic composition becomes depleted post-monsoon and electrical conductivity remains low in the post-monsoon season.

Dr. A D Udhayaraj

Wildlife Institute of India, Dehradun

Topic: Mapping vegetation extent in the Antarctic oasis using Multispectral Remote Sensing data

Dr. Udhayaraj spoke about how a robust monitoring of the changes in the distribution and density of cryospheric plant species requires accurate and high-resolution baseline maps of vegetation. His study uses high-resolution satellite imagery to map vegetation as an imperative indicator for environmental change. His present research indicates that the overall accuracy of mapping vegetation using high resolution imagery and semi-automated target extraction methods exceeded 90 per cent.

Mr. Shubhang Kumar

Research Scholar, Centre for Land Resource Management, Central University of Jharkhand, Ranchi

Topic: A short-term assessment of summer and winter velocities of glaciers in the Amery Ice Shelf, Antarctica

The primary objective of his study was to derive the velocity of the eastern tributary glaciers of the Amery ice shelf using C-band Synthetic Aperture Radar (SAR). The secondary objective was to compare the winter and summer velocity of the glaciers for 2017-2018. The glaciers near the Clemence Massif have low annual velocity of 100 myr–1 in the initial portion of the glacier to around 300 myr–1 near the end of the glacier where it merges with the Amery ice shelf. The velocity in summer was observed to be higher than the velocity in winter and the difference between the summer and the winter velocities was found to be between 50 and 130 myr–1.

Dr. Neelu Singh

Formerly with National Centre for Polar and Oceanic Research, Goa

Topic: Diisopropylnaphthalene in the surface sediments of an Arctic fjord: environmental significance

Dr Singh's presentation informed how the surface sediments were analysed to track the presence of DIPN in Kongsfjorden, an Arctic fjord fringing the International Arctic Research Facilities of Ny-Ålesund, Svalbard. Increasing anthropogenic impacts in the form of Persistent Organic Pollutants (POPs), related to human activities and increased use of fossil fuels have been observed at many places along the Arctic Regions. Her study suggests that the source of DIPN in the fjord could be a result of human activities at Ny-Ålesund and its environs. While its present-day concentrations may not be alarming, considering the increasing activities at Ny-Ålesund it might be prudent to exercise caution to ensure that the levels do not increase over time.

Mr. Prashant H Pandit

National Bureau of Soil, Survey and Land Use Planning, Indian Agriculture Research Institute, Delhi

Topic: Mapping Blue-Ice areas using multiple indices approach: A case of Polar Record glacier, Antarctica.

According to Dr Pandit, for the research stations in the Antarctic, BIAs is the main source of drinking water and serves as airplanes runway. His study estimated that more than 30 per cent of the total surface area of the Polar Record Glacier is covered with BIAs, and multiple factors are influencing the variation of BIAs. The total area is also depending upon the climatic and season changes, while the reliable knowledge of parameters like katabatic wind direction, the rate of sublimation and ablation, wind pattern and surface temperature, etc. can increase the accuracy of the result. His presentation also found that there is a high impact of surface albedo on the BIAs, causing significant variation in the spatial extent and total surface area of BIAs.

SESSION 7

Group photo of the speakers of Session 7

TECHNOLOGICAL INNOVATION

This session was chaired by Dr. D K Aswal, Director, National Physical Laboratory, CSIR and Dr. Rajeev Mehajan , Head, SERB.

This session included a keynote speech by Dr. D K Aswal followed by other speakers like Mr. Roar Marthiniussen, Dr. Ashwini Gupta, Dr. R Asthana, Dr. N Vedachalam and Mr. E Grimson.

The rapporteurs of this session were Mr AD Udhyaraj (WII) and Mr. Shubhang (Central University of Jharkhand).

Dr. D K Aswal

Director, CSIR-National Physics Laboratory, New Delhi.

***Topic:* Quality-Infrastructure of India.**

Dr. Aswal focused on how the quality-infrastructure of a Nation is comprised of internationally recognised metrology, standards and accreditation, which essentially is the basic enabling system of a nation for providing the conformity assessment. He emphasised the need for accurate and precise measurement being the foundation and fundamental in scientific research. He also stressed on the need for a strong quality infrastructure contributions to the national economy which will bring prosperity, health and well-being to the population of the country. He highlighted the recent contributions made by National Physical Laboratory, which is the National Metrology Institute of the country, in establishing several primary/national measurements essential for the national quality-infrastructure.

Mr. Roar Marthiniussen

Subsea Division at Kongsberg Maritime, Norway

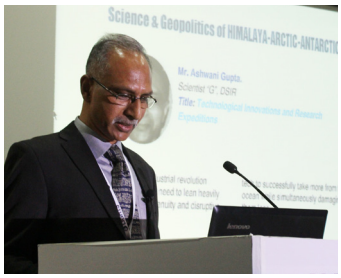
***Topic:* Integrated solutions for Research Vessels including use of Autonomous technology with AUV's and USV's.**

Mr. Roar spoke about the new technologies with respect to Polar research. He spoke about the need for precise measurements of Polar seas for mapping them in addition to focusing on the need for better technologies for advanced sea bed mapping for transportation, under sea mineral explorations, fishing etc. He also spoke about the challenges that are encountered while installing sophisticated tools in the polar research vessels like that of acoustic sensors. He hoped India would make investments in the Research vessels in the future.

Dr. Ashwini Gupta

Scientist G, Dept. of Science & Industrial Research, Ministry of Science and Technology, Delhi.

***Topic:* Innovations and Industry Interface in CSIR.**



Dr. Gupta stressed the need for understanding of ocean ecology and its various chemical and biological aspects to understand future prospects in discovering new sources of medicinal drugs, food, minerals and understanding of the hazards from oceans. He advocated the need for sustainable development of oceans by both India and global communities like UN, and the contributions made by them so far. He focused on the role of India with respect to India's "Deep Ocean Mission", focusing on development of technologies in 6 major areas like deep sea mining, underwater robotics, sustainable use of marine resources etc.

Dr. Rajesh Asthana

Deputy Director General, Geological Survey of India, Lucknow.

***Topic:* Challenges during Construction of Bharati: lessons learned.**

Dr. Asthana spoke about the site of Bharati station and how it has several advantages in terms of logistics, such as absence of ice shelf, proximity to an ice Runway and comparatively better weather conditions. The transportation of heavy equipments and manpower and abiding to the legal terms and conditions of the construction firms were a challenge. The construction of the station that commenced in Austral season 2009-10 was completed by 2012-13 enabling a maiden wintering of team of scientists and logistic personnel in 2012-13- a record achievement. Some of the major issues that required in-depth planning as also on-site decision making, such as wind tunnel test, minor changes to approach of station, attempts to place a barge at the entry point, placing heavy Mantis crane at the construction site and intake of potable water etc. were tackled successfully.

Dr. N Vedachalam

Senior Scientist, NIOT, Chennai

***Topic:* Underwater Vehicles for Polar Research.**

Dr. Vedachalam spoke about the need for underwater vessels for studying the spatio-temporal variations of the oceans. These vessels are also required for near-eyes inspections, boundary inspections, satellite data validation, human sampling, cavities studies, physical oceanography etc. He also spoke about the new modifications in underwater vessels and Polar Remotely Operating V (PRO-V) vehicles and how they have been a success. He mentioned that new modification done in these underwater vehicles would help in achieving better output in various oceanographic expeditions.

Mr. Emil Grimson

Director, Arctic Trucks Pvt. Ltd.

***Topic:* Operational Benefits of 4*4 vehicle over conventional Belt Vehicle in Antarctica.**

Mr Grimson spoke about how during and after the second world war, Icelander's learned to use the 4x4 vehicles to their benefits. Due to the poor infrastructure, the 4x4 vehicles quickly revolutionised transportation in the rural areas. But snow, big rivers and harsh terrain conditions created limitations. However, in the 1970s experiments with larger tyres under the 4x4 drive conditions, were started which became more popular during 80's and sought after both for utility and recreation. He mentioned how his company manufactures cars and tyres, that can be modified on-site depending upon the snow type. He also informed that his cars were used by First Indian South Pole Expedition during 2010-11.

SESSION 8

Group Photo of the speakers of Session 8

NEW MAITRI STATION

This session was chaired by Dr. K N Rai, Former Chief executive, DRDO and Dr. Javed Beg, Programme Director, NCPOR.

The key note address was jointly delivered by Dr. Rasik Ravindra and Dr. Javed M Beg. The other speakers included Dr. Raghava G, Mr. Shri Verma, Dr. Ajay Dhar and Mr. J Silveira.

The Rapporteurs of this session were Dr. Yogesh Ray (NCPOR) and Dr. Avinash Kumar (NCPOR).

Dr. Rasik Ravindra and Dr. Javed M Beg

Former Director, NCPOR

***Topic:* The alternate site and conceptual design for new Maitri Station.**

The Indian research station Maitri, located in an ice frees Schirmacher Oasis and built with indigenous material and expertise during 1987-91 has lived its stipulated life. An expert team comprising structural and environmental engineers that inspected the station pointed out cracks in several telescopic columns supporting the station, sagging of cap plates and problems of leakages etc. India has more than once made known its intentions of building a replacement of Maitri Station. The speakers deliberated in detail about the alternate site for the new Maitri Station. They also spoke about the challenges faced during 1987-91 when the existing Maitri was constructed. The site selected north of the Priyadarshini lake, that has since been confirmed by many visiting experts, has several advantages such as intake of potable water from upstream lake and discharge downstream after the treatment, minimum road construction involved, use of existing scientific and logistic infrastructure facilities can be continued, etc.

Dr Beg joined Dr Ravindra by stating that he became a part of the Maitri project in the final lap and enlightened the audience on the necessity of having a new Maitri station and the pros and cons of establishing it in the new proposed location in the northern side of Priyadarshini lake. The proposed location, according to him is much rugged, but it has more opportunities of developing the area in a better way.

Dr. Raghava G

Former Chief Scientist, CSIR-SERC, Chennai

***Topic:* Structural assessment of the second Indian Research Station 'Maitri' in Antarctica and need for immediate replacement.**

Since the Maitri station had outlived its stipulated life , two scientists from CSIR-SERC and Engineers India Ltd. were asked to carry out the structural assessment of the Maitri Station during January-March 2004. Dr. Raghava spoke about the structural assessment of the second Indian Research Station Maitri in Antarctica and need for its replacement. During the visual examination of the supporting structure, cracks were identified in some supporting columns. An evaluation of safety of cracked columns was made and possible repair measures were suggested. The analysis showed that the structure was sensitive to dynamic wind action.

Mr. Shree Verma

CEO, CN Technologies, New Delhi

***Topic:* New Maitri Station: Concept Feasibility and conceivability**

The weather data of Maitri region shows strong westerly wind that can reach a maximum speed of 322 Km/s. The minimum annual average wind speed is 120 Km/s while the temperature is of the order of -23.1. Being an inland research base, it's waste disposal policy has to be entirely different from a coastal station like Bharati. The new station should be able to use heat generated from the generators for heating the station. The use of fossil fuels should be minimised by increasing renewable energy and maximising the indoor use of natural sunlight and recycling the waste heat. In view of large distance of sea from the station, the disposal of liquid and degradable waste has to be planned. A large capacity bio-treatment and incineration plant will be required for waste treatment. Mr Verma spoke about the New Maitri station complex formation. He stressed on the need for taking all factors like accessibility, water intake and disposal, energy efficiency, wind tunnelling effects and future expansion provisions etc. in to consideration, while designing the new station.

Dr. Ajay Dhar

Retd. Scientist/Technical Officer IV, Indian Institute of Geomagnetism, Navi Mumbai.

***Topic:* Logistic difficulties in construction of New Maitri Station.**

The Government of India decided to go for a new Antarctic Station in 2003-04 and a committee was chosen to select the site under the leadership of Dr Rasik Ravindra. The committee undertook reconnaissance of the coastal area between India Bay and Davis station in the eastern Antarctica, finally selecting the site in Larsemann Hills, where Bharati station now stands. However, construction of new station at Maitri is going to be more challenging for logistic reasons. The site is separated by a vast ice shelf of ~100 km from the ship's berthing point and all the heavy materials need to be transported over land to the new construction site. Over the years, the ice shelf has started breaking up and new crevasses have come up on the convoy route.

Mr. Joseph Silveira

Member of the Expert Committee of NCPOR for ISEA missions. Former Chief Engineer (i/c) and Technical Adviser (Engineering), Mormugao Port Trust, Goa.

***Topic:* The Bharati Experience and Reconstruction of Maitri 2.**

Mr Silveira shared his experience about his association with the Bharti since 2007 and he suggested the location and the logistical possibilities in the region. The landing point of the actual Bharti station is almost at the same point what he had envisaged.

Bharti station was constructed in two phases and he had been a part in both of them. He described to the audience how in the first phase the helipad, fuel station, approach roads and site camps were built. The second phase spanned across 130 days but in 127 days the station was made liveable, though the sea water was not usable till that point. The station at present has the lowest footprint in the continent, according to him.


Science & Geopolitics of HIMALAYA-ARCTIC-ANTARCTIC
Science & Geopolitics of HIMALAYA-ARCTIC-ANTARCTIC

SESSION 9

Group Photo of the speakers of Session 9

MANNING EXPEDITIONS

The last session was chaired by Dr. Ekaterina Kim, Associate Professor, Norwegian University of Science and Technology and Dr. Vijay Kumar, Advisor, Ministry of Earth Sciences, Govt of India.

The keynote speaker of this session was Dr. Javed Beg, followed by other speakers like Dr. Pradip Malhotra, Dr. Yogesh Ray.

The Rapporteurs of this session were Ms Rajoli Ghosh (LIGHTS) and Ms Anulekha Prasad (LIGHTS).

Dr. Javed M Beg

Group Director (Expeditions and Operations), National Centre for Polar and Antarctic Research, Goa.

***Topic:* A Peep into Logistic Operations in Antarctica.**

Dr. Beg spoke about the logistics, which is the art of careful organisation of a complicated activity in a successful and effective way. Managing logistics in civilised areas of the globe is relatively simpler compared to harsh, unsympathetic, desolate and forsaken place like Antarctica perhaps, because of lack of opportunity for year round connectivity. With rapid advances in technology, though the delivery systems have become faster but the expectations have been astronomically elevated and the processes have become more complex. Process design and its implementation has always been a challenge especially for the most beautiful and most unforgiving continent of Antarctica. He stressed on a 12 nation association or logistics networking, under the COMNAP umbrella.

Dr. Pradip Malhotra

Director, Live Savings Society, Kolkata

***Topic:* Value of Detailed Medical check- up and Pre Antarctic Training in National Antarctic Expedition.**

The value of detailed medical check- up and pre Antarctic training depends upon its members, their involvement, sincerity, experience and expertise. Training in various sectors helps to improve the output. The efforts in the pre-expedition medical check-up and training are to screen the members for any potential health hazards, inculcate the hygienic habits among the members and to make them aware of preventive health aspects so that they can avoid various diseases and tackle health issues specific to Antarctica. An elaborate psychological assessment is very important specially for wintering team members. Dr. Malhotra, through his presentation, provided a glimpse into how to make the participants mentally and physically ready for the Antarctic expeditions. The participants also stay in Auli, Uttarakhand to acclimatise with the Antarctic climate and develop mutual friendly relations with team members.

Dr. Yogesh Ray

Scientist D, ESSO-National Centre for Polar and Antarctic Research, Goa.

***Topic:* The Science of Logistics: Insight to logistical challenges faced during 37th ISEA.**

The Scientific and the logistics activities in Polar Regions require advance planning, coordination and execution at right time and at right place. The right time in the broader context refers to

the weather and the sea ice conditions. As the task is mammoth and the time is short, timely delivery of all heavy machinery and construction material over the sea ice is crucial and has to be carried out in an unflawed manner. Any setback or loss of equipment can jeopardise the whole mission and force to shift the activities to next season. Dr. Ray spoke about how heavy machineries were transported during the Antarctic winter, which was also time taking and they had to use GPR (Ground Penetrating Radar) to overcome the challenge of fast melting ice, hence he stressed on the need for a mandatory advance planning and right execution.

DELEGATES OF SaGHAA-5

LIST OF OTHER DELEGATES

HE Juan Angula
Ambassador of Chile to India

Mr. Christian Agustin Davsi
Third Secretary, Chilean Embassy

Xue Qinzhao
First Secretary, Sci-Tech Affairs
Chinese Embassy in India

Mr. Bai Jie
Counsellor of Science and Technology
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Ms. Marta Gjortz
Second Secretary,
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Ms. Shivani Sharma
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Mr. Naveen Kumar Shah
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Dr. Jagvir Singh
Scientist F, MoES

Dr. Naresh Kumar
Scientist E, IMD

Dr. Siddharth Singh
Scientist E, IMD

Dr. Amit Dharwakar
Director, Geological Survey of India

Dr. B R Arora
Former Director, WIHG

Ms. Malti Goel
President and Chief Executive, Climate Change
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Mr. Anant Verma
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Ms. Priyanka Saha
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Ms. Himanshi kapoor
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Ms. Avneet Kaur
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Mr. Pradeep Bharadwaj
CSIR, Science Centre

Mr. Anand Pathak
Kongsberg Maritime India

Mr. Oddvar Midtkandal
Former CEO, Kings Bay
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Assistant Professor, Dept of Geology
Ram Lal Anand College

Dr. Rajesh Sachdeva
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Ram Lal Anand College

Dr. Sarbari Nag
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Ram Lal Anand College

Dr. Seema Gupta
Assistant Professor, Dept of Statistics
Ram Lal Anand College

Mr. Vivek Kumar
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Norwegian Embassy , New Delhi

Mr. Ravi Kant Sharma
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Research Scholar, Mangalore University

VALEDICTORY SESSION

This session was chaired by Dr. P S Goel and included panellists namely: Dr. B. Meenakumari, Dr. Nalan Koc, Dr. Ravichandran, Dr. Rasik Ravindra and Ms. Sulagna Chattopadhyay. It was concluded that legacy of the SaGHAA must be carried on.

Dr. Ravichandran was appreciative of SaGHAA for bringing together a galaxy of experts from different domain of science and policy. In the coming years, he recommended that there should be more discussions on the geopolitical aspects of the three poles as science and technology has other platforms for discussions.

Dr. Nalan Koc commented on the need to highlight the relation between resources from ocean and food security. She further stated that the society is facing a vast variety of challenges and of them food insecurity is a major one. Therefore, attention may be diverted to concerns on how that growing population may be supported using the ocean resources.

Dr. Meenakumari spoke about the future of Antarctic, as the food bowl of millions of people apart from drawing attention to the need for benefit sharing and burden sharing of the polar resources, given the geopolitical compulsion to be present in the Antarctic. She also enquired if politics has a common language like science does? And stressed on the need for science to act as a platform to sort differences of opinions. She said that she was impressed by the number of papers being presented in this 2 day conference, which made her felt like she was personally taking a real life visit to the poles. She also focused on the need to bring on board new emerging topics for the upcoming SaGHAA like microbes of polar regions, importance for bio-prospecting, drawing attention to the thaw of permafrost which will unleash previously dormant viruses to mankind, menace of microplastics in polar regions, calling for urgent research and dealing with them, apart from calling for the initiative for generating awareness in popular journals and reports on these threats.

Dr. Rasik Ravindra spoke about the legacy of SaGHAA and its evolution since 2011 and how it has kept pace with the new contemporary changes and development in the field of polar research, slowly adding broader dimensions over each passing conferences. He also tried to draw attention of the audience about the renaming of SaGHAA from Science and Geopolitics of Himalayas, Arctic and Antarctic to the new name: Sustainable Action Group for Himalaya, Arctic and Antarctic, keeping the acronym same while transforming the SaGHAA from a initiative to a full fledged science theme action group. Dr. Ravindra also recommended about the need for a one theme-one conference format from the next SaGHAA conferences and allowing for more focused brainstorming.

Dr. Goel, the chair of this session concluded that there was a need to focus more on Geopolitics and science, as there are forums available for other scientific deliberations, but a confluence of policy and science is being done only through this forum. He also proposed for the need of a new format for the upcoming SaGHAA conferences, welcoming the suggestion from the panellist and the audience.

Ms. Sulagna Chattopadhyay, President LIGHTS and Founder-Editor, Geography and you shared her overwhelming experience of the two-day ceremony with the participants of SaGHAA-5.

There were suggestions of theme based detailed deliberations/brain storming sessions during year long period. The acronym SaGHAA (Science and Geopolitics of Himalaya-Arctic-Antarctic) was retained for the new Action Group SaGHAA (Sustainable Action Group for Himalaya-Arctic –Antarctica) and participants were invited to express their willingness to become the founding Members of the Group. The need for the new Sustainable Action Group for Himalaya-Arctic and Antarctic was reiterated to act as an advisory body for policy formulations.

FEEDBACK

Dr. K N Rai, DRDO
It was a great learning experience for me. A very meticulously managed programme. Keep it up SaGHAA.

Dr. Rahul Mohan, NCPOR
Thanks to SaGHAA- 5 team, with special thanks to Rasik Ravindra, Ms Sulagna and Mr. Prasad. Had a great time.

Dr. Baldev Raj Arora, WIHG
A very happy to see the growth of cryospheric research in India. SaGHAA-5 team has done a tremendous job and should be entrusted to organise such meets with much bigger participation. My felicitation to the team which was headed by Rasik ji.

Dr. M R Bhutiyani
Thanks a lot Ms. Sulagna. It was really a wonderfully organised event where we have many take home points. Please keep the good work on.

Dr. Ashit Kumar Swain, GSI, Sikkim
Thanks for organising this conference where the galaxy of polar research community could meet and interact. Yet another successful story. Wonderful coordinated efforts by volunteer and team work is highly appreciated. Third Pole is getting attention.

Dr. M Ravichandran, NCPOR
On behalf of NCPOR, I thank all for participating in the SaGHAA-5. Great efforts by Dr. Rasik, Ms. Sulagna and Mr. Prasad to bring polar enthusiastic under one roof.

Dr. Aswagosha Ganju
Thanks Dr Rasik and Ms Sulagna for organising this wonderful and informative event.

Dr. Rajeev Mehajen, SERB
An incredible show of organisational acumen, scientific inclusion and deep sense of aesthetics reflected in SaGHAA-5 is a symbol of professionalism par excellence. Good show ! Keep it up, Dr Rasik, Sulagna and your team.

Dr. Avinash Kumar (NCPOR)
Thank you so much to all organising members of SaGHAA-5 for making it possible to meet the veterans of polar research. This was one of the well organised conferences which had given the platform to present our research findings and ideas. Backdrop of this success attributes to Dr. Rasik sir's visionary thought and hard work of the wonderful organising team.

Dr. S. K. Nandi
I must thank Dr. Rasik and Sulagna and the team for this excellent conference. We wish you and your team all the best. Thanks for the warm hospitality as well.

Dr. Ajay Dhar
Thank you the organisers of SaGHAA for a wonderful event which gave an opportunity to many of the polar researchers to come on a platform. Sincere thanks to Dr. Rasik and Ms. Sulagna for a wonderful arrangement and hospitality. We wish you all the best for the future meetings.

Mr. Shree Verma, CN Technologies
Thank You Rasik saab, Sulagna and Mr. Prasad for your hospitality and concern. As always the event was well organised and attended. It has certainly grown into a prestigious gathering event and I wish it gathers more momentum in the years to come.

Dr. S P Shukla, GSI
Thank you Dr. Ravindra, Ms Sulagna and their team for very meticulously planning and executing SaGHAA 2019. I had a great time in the event which provided excellent opportunity to interact with the galaxy of polar and Himalayan cryosphere researchers.

Dr. Rajesh Asthana, GSI, Lucknow
Witnessing and being a part of SaGHAA 5 for the first time has greatly impressed me like everyone else. Meticulously planned sessions on very relevant topics, active participation of stalwarts as well as young scientists of their respective fields, futuristic courses of actions and final outcomes will go a long way. Its trajectory and scope of emerging mandates

and visionary approach was clearly evident. Thanks Dr. Rasik and Sulagna and everyone associated with this wonderful event.

Dr. Rajasekhar, NIOT, Chennai

A great conference in all respects. There was a personal touch. Technically sound presentations. An extremely well organised conference. Thank you so much to Rasik Sir and Ms Sulagna. Looking forward to more and more.

Dr. R. Krishnan, IITM, Pune

Many thanks to Dr Rasik and Ms. Sulagna for great hospitality and the wonderfully organised SaGHAA 5. Greatly enjoyed the event.

Dr. G. Raghava

Dear Dr. Rasik Ravindra, Ms. Sulagna and Dr. Prasad. Sincere thanks to you for the wonderful time I had at SaGHAA-5. Could meet a few great friends. Enjoyed the hospitality and affection. My compliments to the entire SaGHAA-5 team for their sincere involvement, dedicated teamwork, which resulted in the conference becoming an effective platform.

Sarat Chandra Tripathy, NCPOR

Dear Dr. Sulagna, Greetings from NCPOR! I thank and congratulate You, Rasik Sir and Dr. Prasad once again for organising such a nice event (SaGHAA-5) successfully. Herewith please find attached the signed in form for the Founder Membership of SAGHAA. I shall try my best to associate with this and contribute more.

Ms. Kavita, A Very Special Arts India.

Dear Sulagna, On behalf of VSAI, I would like to thank you for supporting and encouraging us always. As you know our organisation works with the differently abled and the less privileged youth and endeavors to make them self reliant and confident individuals. Your help with such generous orders for the products made by our students, helps us with our vision and encourages us to keep doing the good work. Once again thank you so much!

Emil Grimson, Arctic Trucks Co. Ltd

Dear all, I would like to sincerely thank you all for inviting me to this conference and a very warm welcome. For me, I learned many new things and experienced different views and angles. Thank you again and best of luck with all the ongoing projects.

ABOUT PARTNERS

Royal Norwegian Embassy

Norwegian Embassy

Norway with its extensive scientific and technical capabilities has always been ahead when it comes to polar research in the global arena. Norwegian Polar researchers have been publishing world class research papers on the myriad changes taking place in the Arctic. Svalbard, a Norwegian archipelago between mainland Norway and the North Pole plays an important role as a research platform. The areas where Norway spearheads research includes climate system, ecosystem and biogeochemical environment. It also focuses on the glacier and ice-sheet dynamics and marine ecosystems in Antarctica. Research on wide ranging environment changes and commercialization of the polar regions are areas where the Norwegian Embassy engages with India. Norwegian polar research embarked on a new era in 2018 with the development of a state of the art 100 m long ice-breaker vessel Kronprins Haakon, which is amongst the most advanced vessels in the world.

Ministry of Earth Sciences

सत्यमेव जयते

The Ministry of Earth Sciences (MoES), formerly known as the Department of Ocean Development (DOD), was established in 1981 with the mandate to create a deeper understanding of the oceanic regime of the northern and central Indian ocean and also developed technology and technological aids for harnessing resources and understanding of various physical, chemical and biological processing in the icy realms of Arctic and Antarctica in 2006. Indian Meteorological Department (IMD), established in 1876 to provide meteorological agencies and services to the country was integrated with MoES. The MoES aims at looking at the planet in the holistic way in as much as understanding of the interplay of earth dynamics and system phenomena.

National Centre for Polar and Ocean Research (NCPOR)

NCPOR

NCPOR, erstwhile National Centre for Antarctica and Ocean Research, is an autonomous body under the Ministry of Earth Sciences, Govt. of India, situated in Goa. The mandate of the centre is to plan, promote, coordinate and implement scientific research in the polar regions and the surrounding realms. The Centre is also designated as the nodal organisation for the co-ordination and implementation of the Indian Antarctic Programme, including the maintenance of India's permanent station in Antarctica. Besides organising expeditions, NCPOR also maintains the Indian research bases in Antarctica (Maitri and Bharati), Arctic (Himadri) and Himalayas (Himansh). Through the national polar programmes, the Institute promotes the multi-institutional and multi-disciplinary approach to enhance the quality of Indian polar research, including that in the Southern Ocean. NCPOR spearheads research on paleoclimatology (using ice and sediment cores), teleconnection between polar regions and tropics, polar biology, remote sensing, sea-ice interactions, polar environment, Southern Ocean studies, etc. Apart from polar sciences, NCPOR is also the nodal agency for geo-scientific studies which include the Extended Continental Shelf Programme, mapping Indian Exclusive Economic Zone, Deep Sea Exploration (Hydrothermal and Polymetallic Nodules) to harness the ocean's non-living resources, understanding Indian Ocean Geoid Low and the International Ocean Discovery Programme.

Defence Research Development Organisation (DRDO)

DRDO was formed in 1958 from the amalgamation of the then already functioning Technical Development Establishments (TDEs) of the Indian Army and the Directorate of Technical Development & Production (DTDP) with the Defence Science Organisation (DSO). Its vision is to make India prosperous by establishing world class science and technology base and provide our Defence Services decisive edge by equipping them with internationally competitive systems and solutions.

Indian National Centre for Ocean Information Services (INCOIS)

INCOIS

ESSO-INCOIS was established as an autonomous body in 1999 under the Ministry of Earth Sciences (MoES) and is a unit of the Earth System Science Organisation (ESSO). ESSO-INCOIS is mandated to provide the best possible ocean information and advisory services to society, industry,

government agencies and the scientific community through sustained ocean observations and constant improvements through systematic and focussed research.

National Biodiversity Authority (NBA)

The National Biodiversity Authority (NBA) was established by the Central Government in 2003 to implement India's Biological Diversity Act (2002). The NBA is a Statutory Body and it performs facilitative, regulatory and advisory functions for the Government of India on issues of conservation, sustainable use of biological resources and fair and equitable sharing of benefits arising out of the use of biological resources.

Centre for Marine Living Resources and Ecology (CMLRE)

CMLRE, Cochin is under the Ministry of Earth Sciences, Govt. of India, which has been organizing, co-ordinating and promoting ocean development activities in the country which inter-alia include mapping of the living resources, preparing inventory of commercially exploitable living marine resources, their optimum utilisation through ecosystem management and R&D in basic sciences on Marine Living Resources and Ecology.

Indian Institute of Tropical Meteorology (IITM)

IITM is an autonomous organisation under MoES. IITM strives towards development of outstanding research talent capable of understanding and exploring enlightened and effective Atmospheric sciences, along with furthering the advancement of Research in Ocean-Atmosphere by undertaking relevant scientific programmes and collaborate with other similar research institutions, in the development and application of climate study.

CN Technologies

CN Technologies (India) is primarily engaged in representing reputed overseas principals dealing in high technology systems and instrumentation, and providing them with professional and in-country support services, apart from facilitating research, logistics, survey, concept designing, data collection and more in the polar regions.


National Biodiversity Authority
NBA is involved in facilitating regulatory and
advisory functions on issues of
conservation and sustainable use of biological resources
and fairequitable sharing and access to benefits of use.


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SaGHAA Secretariat

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