

Newsletter of the

DIVECHA CENTRE FOR CLIMATE CHANGE

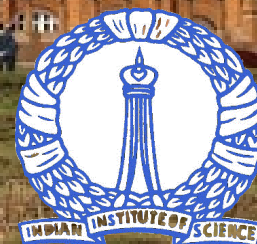
MoES awards

Shell in energy transition

Training on glacier and remote sensing

Monsoon workshop

Climate science program at The Lawrence School, Ooty





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FROM THE CHAIR

Greetings!

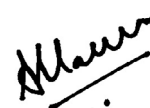
The Divecha Centre for Climate Change was established at the Indian Institute of Science in January 2009 with a generous financial contribution from Arjun and Diana Divecha and the Grantham Foundation for Protection of the Environment.

Divecha Centre for Climate Change and Sustainable Water Future Programme of 'Future Earth' (also known as the 'Water Future') are organizing an international conference on "Towards a Sustainable Water Future" during 24 - 27 September 2019 in Bengaluru, India. The main objective of the conference is to shift the focus and direction of our global science community to face the myriad of challenges affecting our water systems in real time and opening up of new frontiers for innovative solutions. The conference will focus on the current state of global water resource challenges, future pathways and scenarios and different technological solutions to accelerate the implementation of water-related Sustainable Development Goals (SDGs). This conference will create an opportunity for co-production of knowledge, incubate ideas involving scientists and different stakeholders in the SDG implementation process and develop innovative solutions.

The conference will address the global water crisis and will explore different frameworks to determine the potential for natural and human infrastructure investment. Science plays a strong role in risk-related policymaking. The conference will discuss on risks related to water resource. The focus will not only be on the techno-scientific but also on the aesthetic, cultural and historical knowledge about water and its role in nature and society, and explore how we can leverage such systematic knowledge. The conference will address different ways to integrate gender issues into different policymaking and decision-making process. This will enable women to have an effective voice in tackling issues related to water.

The Asia-specific region faces severe water security challenges, particularly in the densely populated areas, with respect to the quality and quantity of water. The conference will address the current water problems in the region as reflected in the composite challenge described above. The conference intends to play a key role in helping the science community to interact with the international policy consultation process to inform and catalyse action by key actors including policymakers, non-governmental organisations, the private sector, educators, and researchers as agents of change.

There are currently numerous water initiatives, which address water challenges from a range of perspectives. There is, however, an apparent disconnect between the knowledge generators and the knowledge users and implementers of projects, as the problems and solutions are too often discussed and designed in silos. The conference will bring the best water experts with experience and expertise and connect the end users with the relevant expertise to help co-design and co-develop solutions.



S. K. Satheesh

MoES AWARDS CEREMONY



Prof. J. Srinivasan (above) and Prof. S. K. Satheesh (below) receiving the MoES award from Dr. Harsh Vardhan, Hon'ble Union Minister, Ministry of Earth Sciences.

The Ministry of Earth Sciences celebrates its foundation day at Vigyan Bhawan, New Delhi on 27th July every year during which various awards are given for achievements by scientists in the area of earth science. The highest award called the “Life Time excellence award” was given to Prof. J. Srinivasan, Distinguished scientist at Divecha Centre for Climate Change. The citation highlighted his contribution to understanding monsoon through simple models and the establishment of the first centre for climate change in India. The national award for atmospheric science and technology was awarded

to Prof. S. K. Satheesh, Chairman, Divecha Centre for Climate change. The citation highlighted his pioneering contribution to the understanding of the role of black carbon in Earth's climate and discovering the existence of elevated layers of black carbon in the earth's atmosphere. His work has highlighted the role of both natural and anthropogenic aerosols on climate. On this occasion both Prof. Srinivasan and Prof. Satheesh delivered talks on “Monsoons: The emergence of a new paradigm” and “The enigma of light absorbing aerosols: From climate to communication” respectively.



GUJAR MAL MODI INNOVATIVE SCIENCE AND TECHNOLOGY AWARD

Mr. M. Venkaiah Naidu, Hon'ble Vice President of India, presented the Gujar Mal Modi Innovative Science and Technology Awards 2019 to Prof. S. K. Satheesh and Dr. Maharaj Kishan Bhan at Vigyan Bhawan, New Delhi on 9th August 2019. Mr. Naidu lauded the Gujar Mal Modi Science Foundation for their initiative of encouraging scientists and innovators and said that we must preserve the age-old Indian tradition of honouring excellence, to motivate the younger generations to do well. Mr. Naidu called for innovation and out-of-box solutions to formidable challenges like poverty, pollution, climate change, diseases, not-so-profitable agriculture and low-efficiency industrial processes. Hon'ble Vice President said that innovation was imperative to address these challenges and take India forward on the path to

inclusive and sustainable development at a faster pace. Hon'ble Vice President called for a reorientation of the education system to promote creativity. Asserting that foundations for the culture of innovation must be laid in our schools and colleges, he observed that a 'new model of education' was needed. "We must build on the 'best practices' we have developed over centuries as learners" he added. He argued that research in basic sciences forms the bedrock of all technological advancement, observing that innovation and entrepreneurship must hand in hand, Hon'ble Vice President said that universities must provide ecosystem for entrepreneurship to flourish. The President of the Gujar Mal Modi Science Foundation, Shri. Satish Kumar Modi, and trustees of the foundation were present on the occasion.



Prof. S. K. Satheesh receiving the Gujar Mal Modi Innovative Science and Technology award on 9th August 2019 from Mr. M. Venkaiah Naidu, Hon'ble Vice President of India.

WORLD ASTHMA DAY

The world Asthma day was observed on 7th May 2019 at Divecha Centre for Climate Change. Dr. H. Paramesh, visiting professor of Divecha Centre and Paediatric Pulmonologist, highlighted the epidemiology, reason for increase in allergic diseases like Asthma and highlighted new methods of management. Dr. K. S. Satish, pulmonologist of Vikram hospital, covered the issues related to management of Asthma in adults. Asthma is an early onset non communicable allergic respiratory disease with significant economic burden to the health care system. In 2015 more than 1 billion people around the world suffered from Asthma and this is expected to increase

to 4 billion by 2050.

The climate change will be the defining issue for health system in the 21st century. It was estimated by a commission of Govt. of India that Asthma will be increased in India from 45 million in 2005 to 57.2 million by 2016. In Bengaluru, Asthma in children under 18 years has increased from 9% in 1979 to 25.5% in 2009. The reason for this increase in higher exposure to triggers like air pollution, increase in respiratory viral infections, less access to health care facilities.



Dr. K. S. Satish delivering the talk on 7th May 2019.

SHELL IN ENERGY TRANSITION

Prof. Dirk Smit, Vice President Research Strategy, Shell Energy and Chairman, Shell Science Council delivered a talk on how Shell energy proposes to provide cleaner energy solutions to the world. He outlined a new scenario, called the Sky scenario, which provides possible pathways to a net zero emission energy system around 2070.

This scenario defines clear targets for a reduced net carbon footprint. The present energy system is dominated by fossil hydrocarbons. Coal produces fine particulate matter that is believed to kill more than one million people per year. The first step will be to replace coal with

natural gas in the power sector because that would avoid a lot of undesirable effects that are a result of burning coal. This is not a permanent solution but that would give us some time to develop an alternative solution

Shell was the first company to embrace the Paris agreement to control global warming. Shell will transform from a fossil fuel company to an energy company. This will not be easy. The first step is to build a scenario. This scenario is driven by the desire to reduce carbon emissions to zero by 2070. There are many challenges to meet this goal.



Prof. Dirk Smit delivering the talk on 9th May 2019.

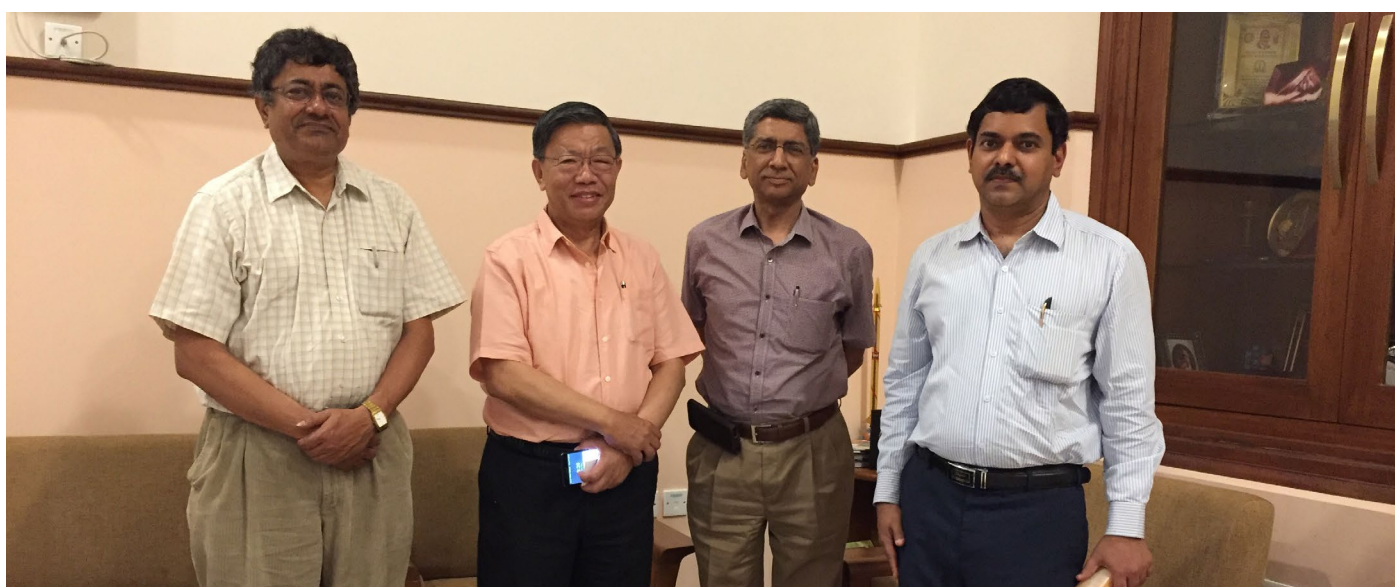
VISIT BY MEMBER OF PARLIAMENT, SIKKIM



Mr. P. D. Rai, Hon'ble Member of Parliament, during his visit to Divecha Centre on 13th May 2019.

Mr. P. D. Rai, Hon'ble Member of Parliament, visited Indian Institute of Science on 13th May 2019. He met Prof. Anurag Kumar, Director Indian Institute of science, Prof. Vikram Jayaram, Chairman, Mechanical Sciences Division and Prof. S. K. Satheesh, Chairman, DCCC to discuss the various ways in which Divecha Centre for Climate Change can help the government of Sikkim to deal with the impact of climate

change. He highlighted the threat posed by glacier lake outburst floods and disappearance of springs (when small glaciers retreat rapidly). He indicated that a team from Sikkim will interact with "water solution laboratory" at DCCC to discuss these problems. He promised to bring a delegation from Sikkim to participate in the world water conference organized by Future Earth and DCCC during 24 to 27 September 2019 in Bengaluru



Left to Right: Prof. Vikram Jayaram, Chairman, Mechanical Sciences Division, Mr. P. D. Rai, Hon'ble Member of Parliament, Prof. Anurag Kumar, Director Indian Institute of science, and Prof. S. K. Satheesh, Chairman, DCCC.

SCIENTIFIC STEERING COMMITTEE MEETING FOR MAIRS-FE, CHINA

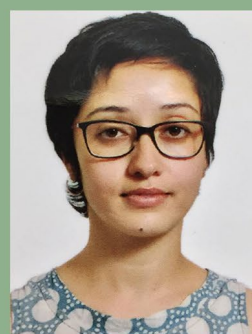


Participants who took part in the Future Earth program at Langzhou University, China during 22 to 25 May 2019.

Smriti Basnett, coordinator of South Asia Future Earth program at Divecha Centre for Climate Change visited China for a Future Earth Program on 22nd May 2019 in Nanjing and the Water-Energy-Food Nexus working group meeting during 22-25 May 2019. The workshop brought together scientists from more than 12 Asian Countries and USA. She presented the research carried out by

the scientists at DCCC. She spoke about air pollution and health, water solution laboratory, glacier monitoring and the Water Future Conference in Bengaluru in September 2019. She delivered a talk in Langzhou University on a decarbonization scenario for India. She highlighted the health benefits for India if it reduced coal combustion and switched to renewable energy.

时间： 2019年5月28日（周二）
9:00—10:30
地点： 齐云楼1017报告厅
主讲人： Smriti Basnett 博士



邀请“未来地球”南亚地区办公室高级研究员/项目协调员Smriti Basnett 博士，于5月28日作内部学术交流，欢迎大家参加。

Announcement of Smriti's talk.

WORLD ENVIRONMENT DAY



Dr. S. Chandrashekar Shetty, Vice Chancellor, Adichunchanagiri University, inaugurating the event on 4th June 2019.

Divecha Centre for Climate Change (DCCC) and Adichunchanagiri University in Mandya (Karnataka) observed the world environment day at the faculty hall in the Indian Institute of Science on 4th June 2019. Prof. S. Chandrasekhar Shetty, Vice-Chancellor, Adichunchanagiri University in his inaugural talk highlighted the need to ensure that the environment is not degraded in the process of meeting the goals of national development. Prof. Satheesh, Chairman, DCCC indicated that theme of the world environment day this year was on the impact of air pollution on health and hence all the presentations were related to this theme.

In the first talk, Dr. Paramesh showed the impact of urbanization and deforestation on air quality. He pointed out that during the past 25 years communicable diseases

have declined while non-communicable diseases have increased in India. The prevalence of Asthma has increased dramatically in Bengaluru during the past 20 years. He showed that air pollution has impact on lung performance of children, traffic police and street vendors. He discussed the prevalence of indoor air pollution and measures to combat them.

Prof. Basavaraj Ingalageri from Adichunchanagiri University highlighted the need for promoting traditional values to combat air pollution. He advocated the use of electric vehicles to combat air pollution. Prof. Viraj Kumar, DCCC pointed out that the large spatial variation of air pollution complicates attempts to relate air pollution to health. He discussed the trade-off between quality and cost when deploying many air pollution sensors.



Dr. H. Paramesh delivering the talk on 4th June 2019.

Prof. T. Mahadevaiah from Adichunchanagiri University enumerated the impact of burning agricultural waste on air pollution. He estimated that about 1000 million tons of agricultural waste is produced per year in India. He called for new technologies to reduce the need for burning of agricultural waste

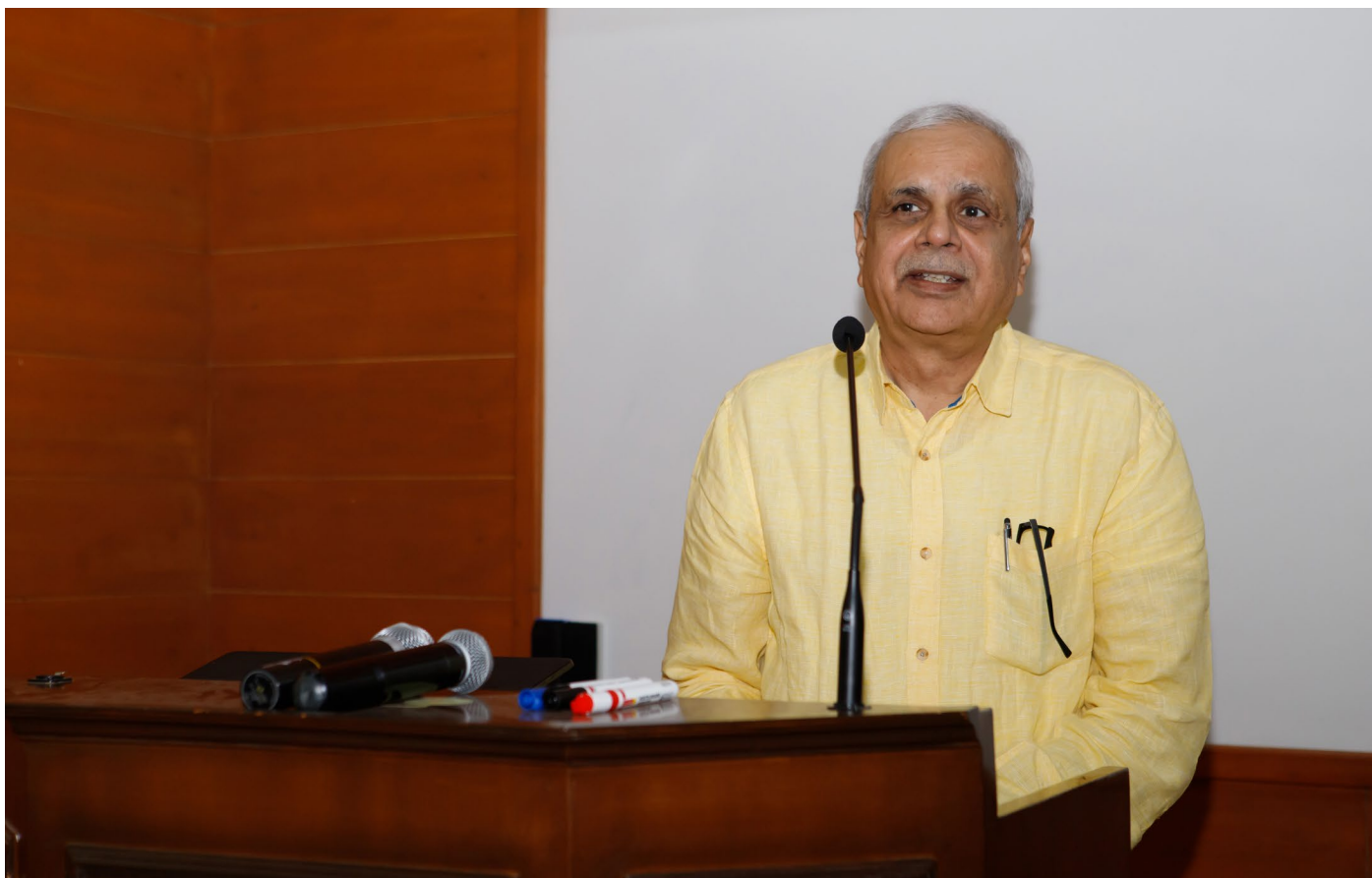
the presentations were followed by interaction with about 300 students and faculty from both universities.

Dr. Paramesh gave a talk on impact of air pollution on human health at Toyota Kirloskar Motor, on 17th July 2019.



Dr. H. Paramesh delivering the talk on 17th July 2019 at Toyota Kirloskar Motor Pvt. Ltd., Bengaluru.

TRAINING ON GLACIER AND REMOTE SENSING



Dr. Anil V. Kulkarni of Divecha Centre for Climate Change during Inaugural session.

Himalayan cryosphere is the major reservoir of freshwater in the form of seasonal snow, ice and glaciers. A large volume of glacier stored water makes Himalayan rivers perennial and has helped to sustain and flourish the Indian civilization along their banks. Since glacier extent is changing under the influence of climate change, continuous monitoring of Himalayan glaciers is important to assess future availability of water. However, monitoring of Himalaya is difficult using conventional field-based methods due to rugged terrain and extreme climate. Therefore, remote sensing has been extensively used to collect information on glaciers. However, due to limited number of well-trained manpower in India, reliable information is difficult to generate. Therefore, Divecha

Centre for climate change organizes training in the field of glaciology.

The Centre has organized the ninth training program from July 4 to 14, 2019. The training was sponsored by Science and Engineering Board, Government of India, New Delhi and Divecha Centre for Climate Change, IISc Bengaluru. The training received overwhelming response from the students and more than 100 applications were received. We selected 56 participants representing 39 institutes across India, depending on educational qualifications and research objectives.

The curriculum included (1) Distribution of Glaciers and snow cover (2) overview of cryosphere (3) Morphology of glaciers (4) Transformation of snow to ice (5) Paleo

glaciation (6) Distribution of temperature in glaciers (7) Flow and sliding of glaciers (8) Glacier Mass Balance using remote sensing techniques (9) Ice and Snow ablation (10) Fundamentals of remote sensing (11) Optical properties of snow and ice (12) Response of glaciers to climate change (13) Aerosol and climate change (14) Snow and glacier studies in SASE (15) Glaciological programs of ISRO (16) Isotopes of Oxygen and Hydrogen in Precipitation and glacier studies (17) Observational techniques in meteorology (18) Geo-Engineering.

In addition to lectures, practical sessions were also conducted on runoff estimate in Himalaya, depth estimate, estimation of Supra glacier debris cover, climate change and mass balance, topographic corrections of reflectance and glacier flow modelling.

The training was inaugurated by Prof. S. K. Satheesh, Chairman, DCCC. Faculties from Divecha Centre for Climate Change (DCCC) and Centre for Atmospheric and Oceanic Sciences (CAOS) delivered numerous lectures.

In addition, experts working in the field of cryosphere and remote sensing such as Dr. Ashwaghosha Ganju, Ex- Director, Snow & Avalanche Study Establishment (SASE), Chandigarh, Dr. Gulab Singh, IIT Bombay, Dr. Krishnan, Indian Institute of Tropical Meteorology, Pune, Dr. Akhilesh Gupta, DST, Dr. R. Navalgund and Dr. Babu Govindh Raj from ISRO were also invited as guest faculty.



Participants who took part in the training workshop on 4 to 14 July 2019.

SEMINAR ON FUTURE OF SUSTAINABILITY

Prof. Surya P. Sethi, UNESCO Chair Professor, TERI school of Advanced studies, New Delhi, delivered the talk on the future of sustainability at Divecha Centre for Climate Change on 22nd Jul 2019.

Prof. Sethi argued that global emissions continue to rise and even the two-degree centigrade warming-bound looks increasingly to be surpassed. Global partnership for eradication of poverty and the primacy of development for the bottom half of the world has been floundering because of the absence of finance, technology and capacity. At least 60% of the Indians remain highly vulnerable and lack the adaptive capacity to bear the consequences of global warming. The access to modern commercial

energy to these people remains a major determinant of such adaptive capacity. He showed that top 51% of people in the world contribute to 86% of the global CO₂ emissions while the bottom 49% contributed just 14% of the global CO₂ emissions.

The bottom 49% of the human population has less capacity to adapt to changes such as increase in extreme rainfall events, heat waves, droughts and rise in sea level. He related the ability to adapt to the human development index. He argued that the availability of commercial energy to the bottom 49% of the population is critical to reduce the vulnerability of the poor people to the vagaries of climate change.



Prof. Surya P. Sethi delivering the talk on 22nd July 2019.

WORKSHOP ON ONSET OF INDIAN SUMMER MONSOON: THEORY AND PREDICTION

Divecha Centre for Climate Change and the Future Earth South Asia Program jointly organized a workshop on the onset of Indian summer monsoon on 25-26 July 2019 at the Divecha auditorium. The main goal of the workshop was to take stock of our present understanding of the phenomena of monsoon onset including the basic theory and methods of prediction. Prof. Arindam Chakraborty, Centre for Atmospheric and Oceanic Sciences and Divecha Centre for Climate Change highlighted the need for predicting monsoon onset accurately.

Several experts in this field from India and abroad delivered lectures in this two-day workshop. The presentations were on synoptic scale perspectives, global teleconnection, dynamic and thermodynamic factors and skills of

forecast, changes in monsoon onset in future. Prominent scientist Prof. P. V. Joseph delivered the inaugural lecture on the monsoon onset over Kerala and its interannual variations. Apart from lectures, there were poster presentations by the students from various institutes in the country.

The program ended with a discussion on the results presented and possible way forward. The main discussion was on whether onset should be considered as an increase in rain rate or a sudden transition of the large-scale thermodynamic and dynamic conditions. This workshop could be a starting point to many future collaborations among researchers working on the onset of the summer monsoon.



Participants who took part in the monsoon workshop on 25 to 26 July 2019.

CLIMATE SCIENCE PROGRAM AT THE LAWRENCE SCHOOL, LOVEDALE, OOTY



The Lawrence School, Lovedale, Ooty.

Divecha Centre for Climate Change, Talentspire and Eduworld foundation organized a one-day program at The Lawrence School in Ooty on 12th August 2019 to create awareness about the climate and environment. The Lawrence School is the oldest residential school in India and has produced well-known leaders in India. The program attracted students from many schools in Ooty. The headmaster, The Lawrence School welcomed the participants and highlighted the need to understand the impact of climate change on western Ghats. In his presidential address Prof. J. Srinivasan, Distinguished scientist, Indian Institute of Science, underscored the need for school students to become aware of climate change and its adverse impact on the environment. He narrated the remarkable protest outside Swedish Parliament led by Greta Thuneberg a 15-year-old school girl who called for immediate action on climate change by

politicians. Prof. Satheesh, Chairman Divecha Centre for Climate Change spoke about Mr. Arjun Divecha, one of the illustrious alumni of the Lawrence school, whose generosity led to the creation of Divecha Centre for Climate Change at Indian Institute of Science.

Prof. Srinivasan delivered a one-hour long lecture on the 'Science of Climate Change'. This lecture highlighted the difference between weather, natural climate variability and human-induced climate change. He indicated that local climate change is controlled many factors and local land-use change is more important than the increase in greenhouse gases. He argued that climate change and environmental problems are created by the humanity being dependent on fossil fuels for all their energy needs. He predicted that in the next decades humanity will begin to move away from fossil fuels and adopt renewable energy



Prof. J. Srinivasan conducting the quiz program at The Lawrence School, Lovedale, Ooty on 12th August 2019.

technology in a big way. Prof. Satheesh discussed the impact of aerosols on earth's climate. He showed that the impact of aerosols on climate depends upon whether they reflect or absorb solar radiation. He showed that there are elevated layers of soot in regions where many aircrafts fly. In the afternoon there was a climate and environment quiz. The

students participated in this quiz with great enthusiasm. This was followed by interactions with students in which they posed many interesting questions related to the future evolution of earth's climate and the how to ensure that India can become a developed society without destroying the environment.



Prof. Satheesh giving away the prize at The Lawrence School, Lovedale, Ooty.

RESEARCH HIGHLIGHTS



THE DECLINE OF SOOT OVER INDIAN REGION

About 20 years ago a lot of concern was expressed about the presence of high concentration of soot in South Asia. There was a speculation that the concentration of soot may increase further and lead to a decline in Indian monsoon rainfall. The Indian Space Research Organization (ISRO) decided to establish a network of ground observations to measure the surface concentration of soot in different parts of India. In a recent paper published in the journal *Geophysical Research Letters* jointly by scientists from Indian Institute of Science and Space Physics Laboratory, Indian Space Research Organisation have reported a steady and significant decreasing trend, in the concentration of soot in many stations in south India. The longest period of observations was in Thiruvananthapuram in the state of Kerala. At this station the concentration of soot showed a sharp decline after 2003. When the data of six stations in

peninsular India was pooled together, the concentration of soot showed a decline after 2009. The decline in concentration of soot is consistent with the decline in the concentration of column mean carbon monoxide detected from satellites. The authors also discussed the possible causes of this decline. They indicate an increased shift towards cleaner fuels for domestic and industrial applications and more stringent laws to control vehicular emissions have led to a decline in the concentration of soot in India. These results assume great importance in the context of India's global commitments to reduce its carbon emissions.

Reference: Decreasing trend in black carbon aerosols over the Indian region, M. R. Manoj, S. K. Satheesh, K. Krishnamoorthy, M. M. Gogoi and S. Suresh Babu, *Geophysical Research Letters*, 46, 2903-2910.

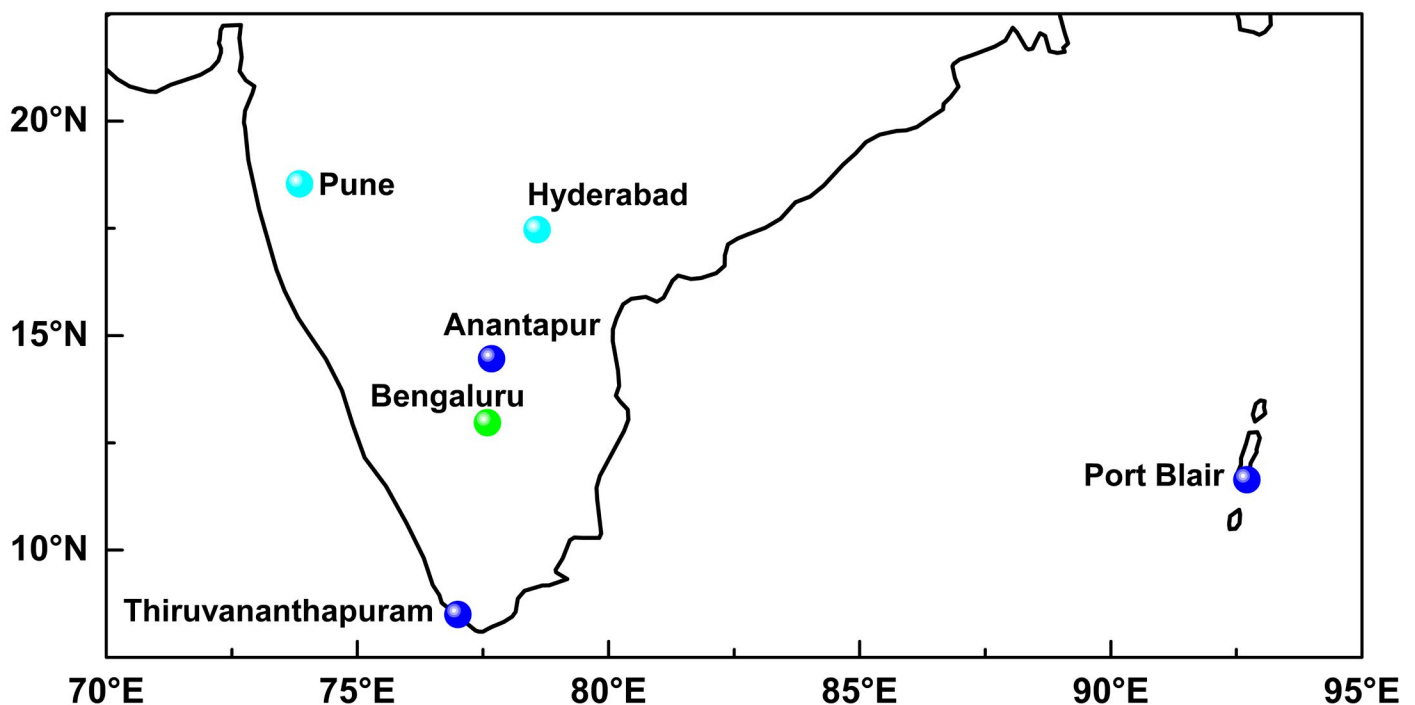


Figure 1: Cities where soot concentrations were measured.

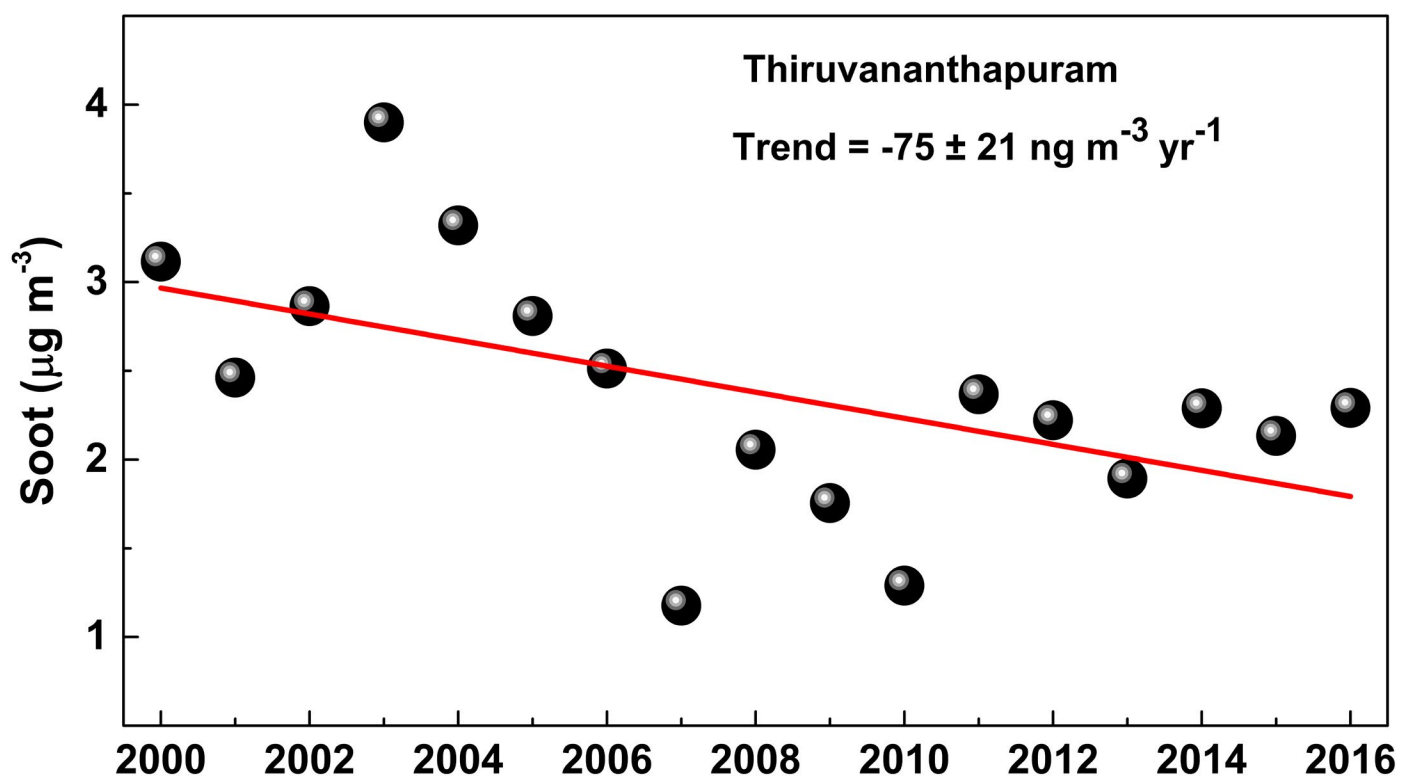
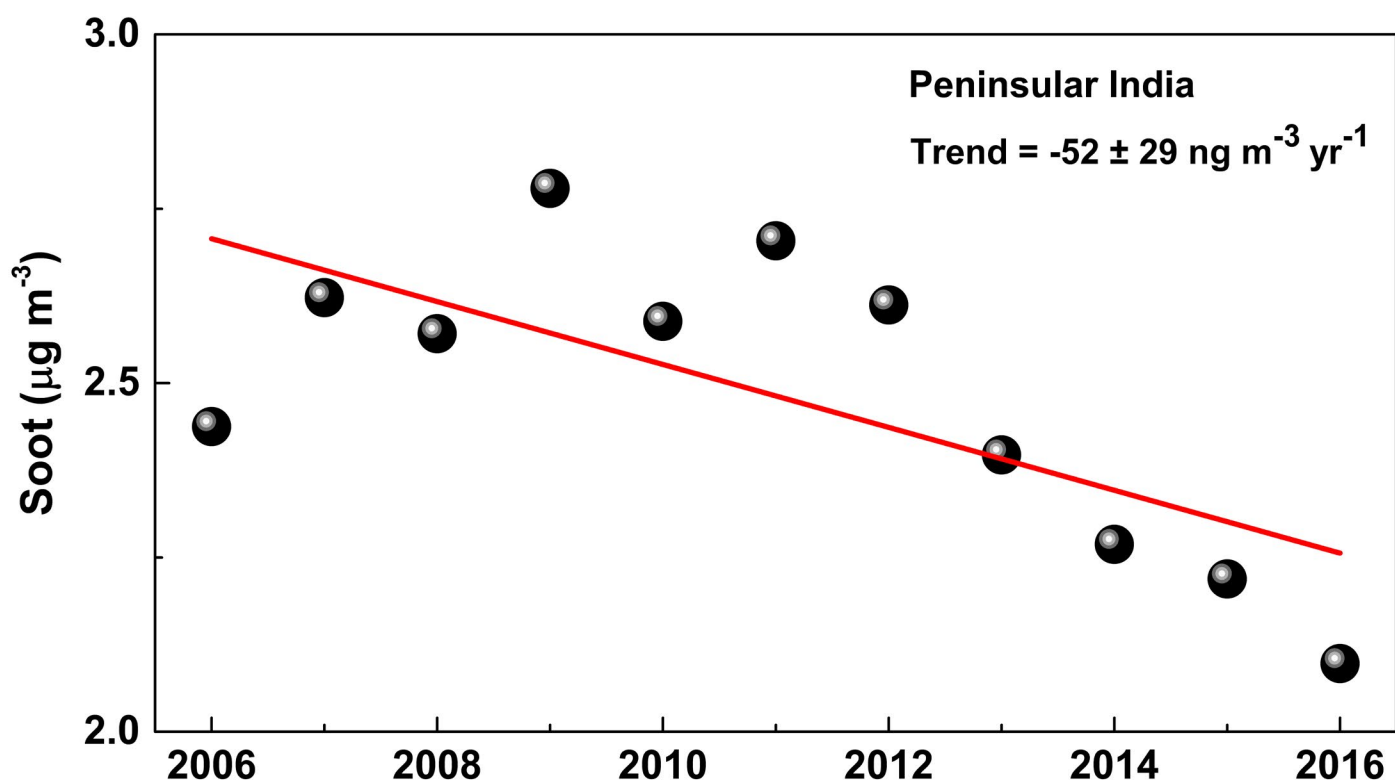


Figure 2: Variation in the concentration of soot in Thiruvananthapuram and South peninsula.



LARGER LOSSES IN GLACIER AREA AND WATER AVAILABILITY, SATLUJ BASIN, HIMALAYA

Snow and ice melt contribute more than 50% of the annual flow in this river. The surface temperature in the northwest Himalaya has increased by around 0.65 degrees Celsius in the last 25 years. This has increased the rate of glacial melt and reduced the amount of snowfall. In a recent paper published in the journal Current Science, the impact of climate change on the hydrology of Satluj basin

The river Satluj, which is a major tributary of Indus river, originates in the Tibetan plateau and passes through India and reaches the Arabian sea. The Bhakra reservoir in India receives more than 70% of the water from Satluj. This river is vital for both irrigation and power generation in North India. Hence the impact of climate change on the annual water flow in Satluj is of great concern.

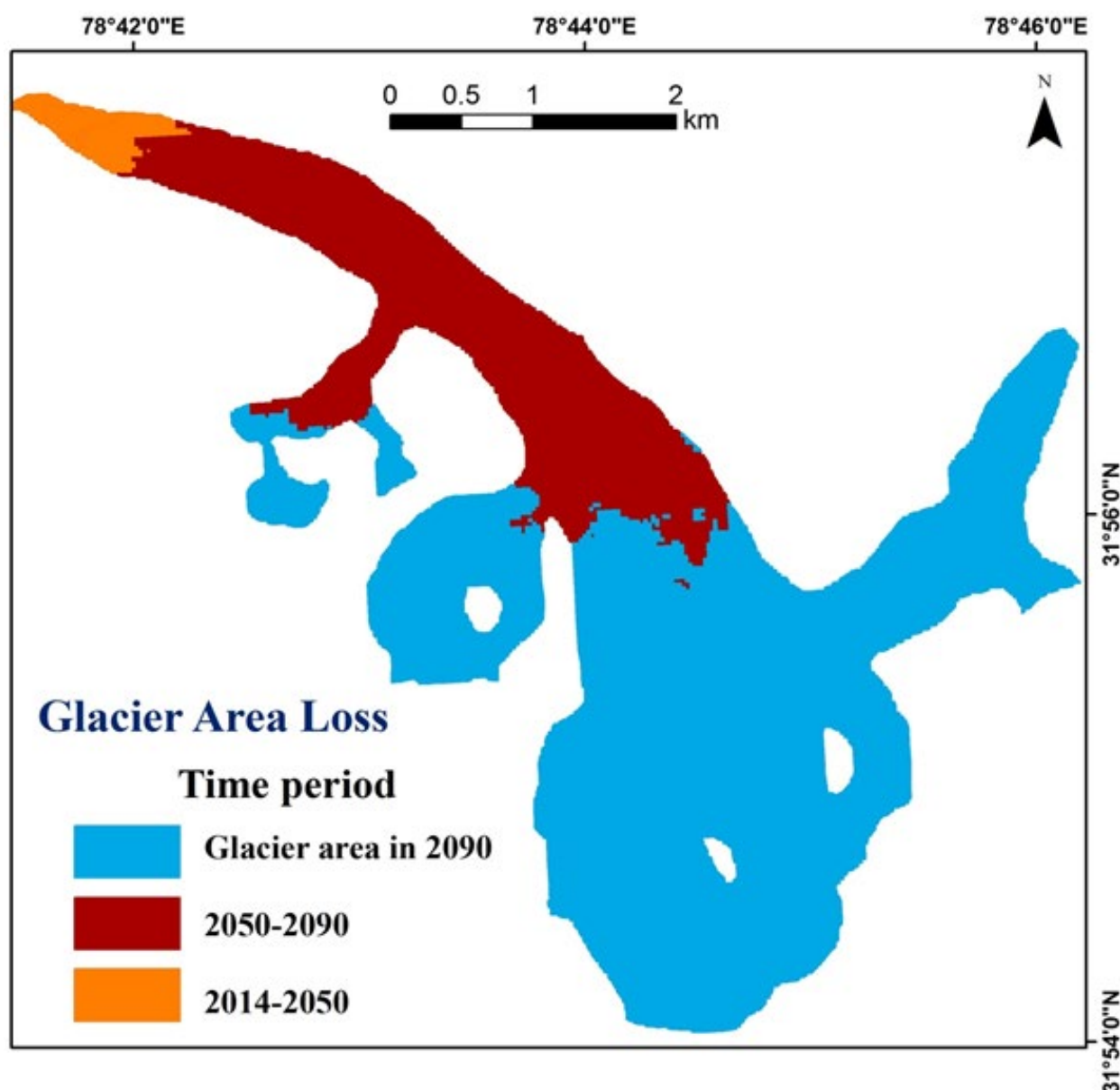


Figure 3: An example of area changes predicted under the RCP 8.5 scenario from 2014-2090 for one of the glaciers in Spiti basin, based on GFDL-CM3 output. The glacier will lose 5 square kilometers of area and fragment into four parts by 2090.

has been studied in great detail.

The authors have estimated the depth of ice in the glaciers from satellite data. They have used volume-area scaling to estimate the present volume of ice in the glaciers. They estimated the annual change in mass balance by using the accumulation area ratio method. They used two general circulation models to estimate the future climate change in the Satluj basin. They have shown that one of glaciers in the Spiti basin will fragment

into four parts by 2090 (see figure3). They estimate that the melt run-off will be highest in 2050 and decline thereafter.

Reference: Larger losses in glacier area and water availability by the end of twenty-first century under high emission scenario, Satluj basin, Himalaya. Veena Prasad, Anil V. Kulkarni, S. Pradeep, S. Pratibha, Sayli A. Tawde, Tejal Shirsat, A. R. Arya, Andrew Orr, Daniel Bannister. Current Science Vol. 116, No. 10, 25th May 2019.

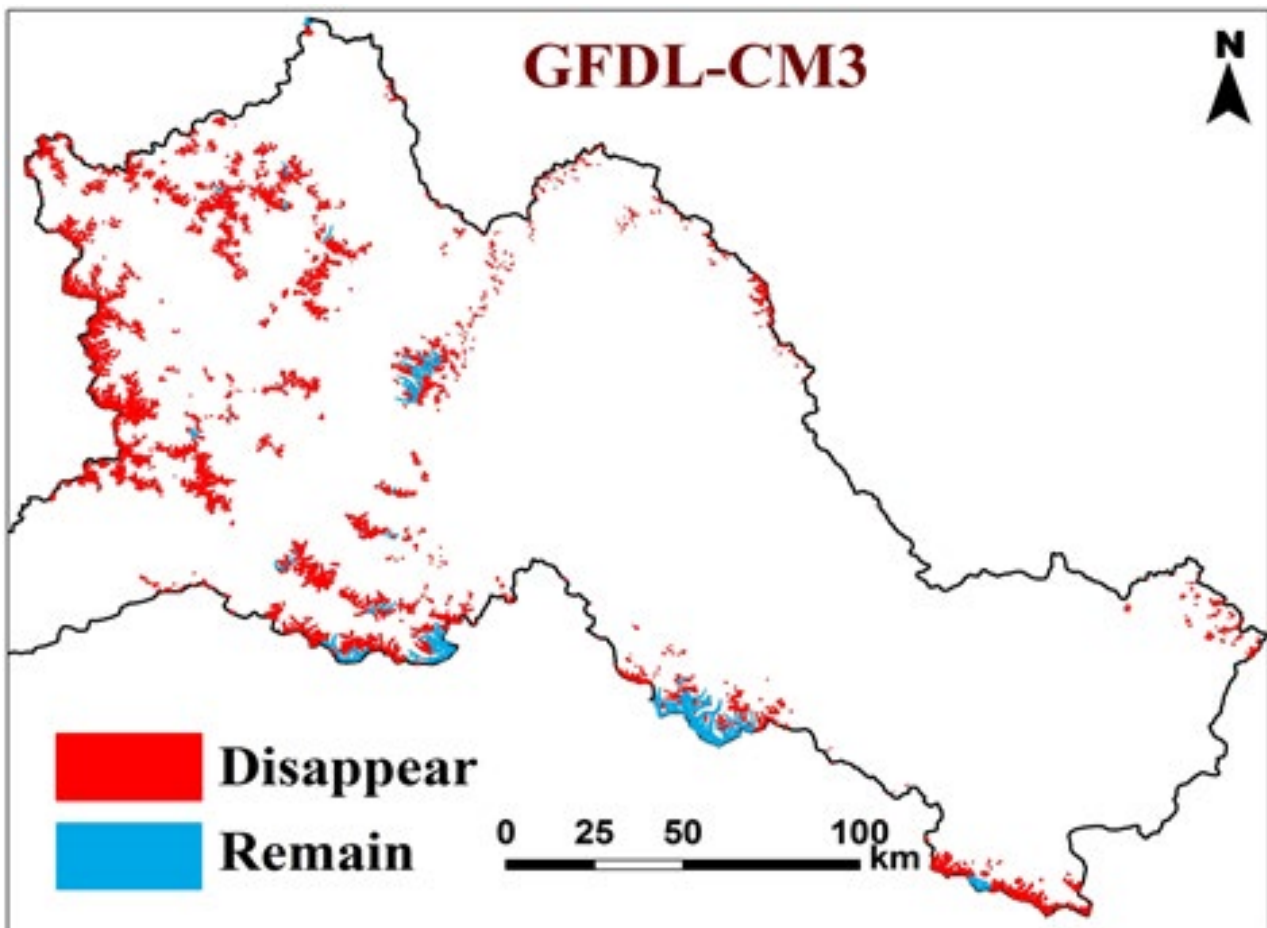


Figure 4: Projected changes in glaciers under RCP 8.5 scenario for 2090, based on output from the GFDL-CM3 model. By the end of the century, 97% of the glaciers will disappear.



