COMMENTARY

The climate change programme of the Department of Science and Technology

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We analyse here achievements of DST's Climate Change Programme run by a small team of science administrators. The programme was run in a campaign mode in which DST science administrators not only made several young scientists interested in the programme, but also played a role of co-partner in developing the project concept and plans. The main features of the programme are: (i) several young scientists have taken lead role in carrying out research in climate change; (ii) creation of research networks; (iii) a remarkable rise in quality research papers; (iv) training of over 35,000 personnel, and (v) a marked change in the style of running a programme in which DST science administrators, committee members and researchers worked together with more trust and understanding, involving frequent interactions.

The Climate Change Programme is executed by a team of science administrators in the Department of Science and Technology (DST), Government of India. Its leader Akhilesh Gupta is profoundly committed to bringing about a major change in the country's science while managing a programme under two national missions as part of the National Action Plan on Climate Change (NAPCC), related to strategic knowledge for climate change and sustainability of the Himalayan ecosystems. Himalayas were referred to as a 'white spot' in the third assessment report of the Intergovernmental Panel on Climate Change (IPCC), to emphasize the lack of data in the field of climate change from this region. The knowledge about climate change at the country level was scarce at that time. To address these weaknesses, the Government of India launched NAPCC with eight national missions, of which two were entrusted to DST, namely National Mission on Strategic Knowledge for Climate Change (NMSKCC) and National Mission for Sustaining the Himalayan Ecosystem (NMSHE). Here we analyse how a small team of science administrators achieved remarkable progress in scientific output in the field of climate change, particularly in relation to the Himalayan ecosystem.

The first phase of the programme was launched in 2010 after a detailed bibliometric analysis of Scopus data on Indian institutions and individual scientists working in the climate science-related areas. Proposals were invited from the top 30 institutions in the country for positioning major programmes in climate change research. There was an overwhelming response to this call. After several rounds of screening, review and evaluation process, DST established four Centres of Excellence (one each at IIT Bombay; IIT Madras; ICRISAT, Hyderabad and Divecha Centre for Climate Change, IISc, Bengaluru), a dozen Major R&D Programmes at various national institutions and universities; two National Network programmes, one each on Climate Modelling with eight projects and Climate Change and Human Health with nine projects and two State CC cells, one each at Madhya Pradesh and Punjab during 2011–2013.

Having initiated a system in place, the members of the DST team visited relevant institutes and research centres to explore capacity and interest of researchers. The idea was to involve all talented scientists with an interest in climate change research. DST provided its inputs about important research questions, possible collaborators and scope of networking in relation to each research area. The practice of developing a project in tandem with project investigators was rather unusual and something which researchers were not used to (Table 1).

The spread of research projects that DST is supporting shows that the efforts are Pan-India (Figure 1).

The DST officials became partners with researchers working in institutes and universities under NMSKCC and NMSHE.

Figure 2 shows cumulative progress of the number of projects sanctioned under the programme during the past seven years. As many as 151 projects were sanctioned by the Climate Change Programme of DST since 2011. Overall, there was an increasing trend in the number of projects sanctioned under CCP. The years 2011–2013 witnessed the first phase. There was a period of consolidation during 2014–2016 (22 projects), which was followed by a marked rise in the number of projects in operation during 2016–2017 (60 projects) and 2017–2018 (31 projects).

Nothing else, but a strong desire to promote science in the chosen field dominates the present DST efforts. The team has now begun to take advantage of collaborating with major international institutes outside India like ICIMOD, Kathmandu and several institutions in Germany, USA and Switzerland. The partnership with Swiss Group SDC/IHCAP has resulted in imparting training to several young scientists in glacier studies. A doctoral and post-doctoral fellowship programme called Fulbright-Kalam Climate fellowships was launched in collaboration with USA, two years ago. An Indo-German collaborative programme was initiated recently to support Indo-German Centre of Sustainability at IIT Madras.

Research in our country has mostly been an initiative by isolated individuals and their students. Somehow, collaboration and networking were missed, though their advantages are now well established. Generalizations and conclusive findings particularly in field research call for multi-site, multi-disciplinary and multi-partner research programmes. DST has taken a notable initiative to promote collaboration and network development.

Almost all Himalayan states have climate change cells, and they not only owe them to the DST for their establishment, but also for their growth. The DST team encourages state level workers and some

Table 1. A summary of climate change programmes and projects under different categories of DST, India

Institution spearheading	Themes/Topics
Programme category: Centre of Excellence and Major R&D Projects	
	Climate change (hereafter referred to as CC) science and adaptation areas, IIT Bombay; Building resilient systems in the face of CC, IIT Madras; CC Research for Plant Protection, ICRISAT, Hyderabad; Glacier studies, capacity building in CC science and adaptation areas, IISc, Bengaluru; Development of an India-centric climate model for creating scenarios for different regions of the country, IIT Delhi; Studies on climate inflicted vector borne diseases, National Institute of Malaria Research, Delhi; Sea level rise and ocean acidification, National Institute of Oceanography, Goa; Forest ecosystems, National Botanical Research Institute, Lucknow; CC adaptation in agriculture, Indian Agricultural Research Institute, Delhi; CC and livelihood, Institute of Rural Management, Anand; Palaeoclimate, Birbal Sahni Institute of Palaeosciences, Lucknow; Himalayan ecosystem, Delhi University; Regional Climate Models, IIT Delhi; CC adaptation in agriculture, Tamil Nadu Agricultural University; CC and extreme events, Allahabad University; Himalayan ecosystem, IRADe, Delhi; Palaeoclimate, ISSER, Pune; Geo-engineering research in India, IISc, Bengaluru; CC impact on hydro-meteorological processes and extreme events, IIT Bhubaneswar; Regional climate assessment for the Indian subcontinent, Andhra University; Regional climate assessments and monsoon studies, Cochin University of Science & Technology; Field measurements of biogenic volatile organic compounds, ISSER, Mohali; CC impact assessment on crop water requirements in northeast India, IIT, Guwahati.
Programme category: National Network Programme	
	CC and human health – Phase-I (9 projects); Climate modelling Phase-I (7 projects); CC and coastal vulnerability (10 projects); CC and aerosols (8 projects); CC and human health – Phase-II (20 projects); Climate Modelling Phase-II (13 projects); Urban climate (being evolved).
Programme category: Global Technology Watch Group	
	Renewable energy, National Institute of Advanced Studies, Bengaluru (lead institution); Advanced clean coal technology, IIT Madras (lead institution); Enhanced energy efficiency, sustainable habitat, green India, water, agriculture, manufacturing, TIFAC, Delhi (lead institution).
Programme category: Thematic Task Force	
	Natural and geological wealth, Wadia Institute of Himalayan Geology, Dehradun; Water, ice, snow, including glaciers, National Institute of Hydrology, Roorkee; Micro flora and fauna, wildlife and animal population, Wildlife Institute of India (WII), Dehradun; Forest resources and plant biodiversity, GB Pant National Institute of Himalayan Environment and Sustainable Development, Almora; Himalayan agriculture, Indian Council of Agricultural Research, Delhi; Traditional knowledge system, JNU, Delhi.
Programme category: State CC Cells	
	In 22 Himalayan and non-Himalayan states.

of the officers participate actively in workshops they organize. The idea is to understand state level realities to provide appropriate support. Over a dozen non-Himalayan states too have state CC cells established by DST mainly to act as climate change knowledge centres to help their state governments pursue climate change data and knowledge generation and address elements of state action plans on Climate Change.

What works in our country in its scientific arena? Do the DST's climate change and Himalayan ecosystem programmes shed any light on it? The answer is difficult to formulate, but in many cases, tasks have been accomplished.

Excelling globally in studies on climate change and Himalayan ecosystems, may not give immediate benefits, such as boosting export or solutions to energy problems. But such studies can contribute a lot to long-term sustainability of developmental activities and flow of the life supporting ecosystem services. Understanding what is going to happen in future with a given activity level is of immense importance for averting disasters. Then, studies on Himalayan ecosystems can result in easy and convenient solutions to vulnerability and carbon mitigation. For example, the potential for storing additional carbon by restoring our forest ecosystems can be immense, may be nearly one-third of the CO_2 which the country is releasing through fossil fuel burning.

More importantly, we can see that DST is playing an important role in bringing about a quantum jump in scientific output and creating a scientific culture in a very important research area, with a direct relevance to human survival. From a very small footprint in the field of climate change, the DST-sponsored programmes have already resulted in a large number of useful publications in international journals. As many as 850 research publications have come out of these programmes so far, that include over 550 in SCI journals, of which nearly half of them are in international journals of high impact factors. Interestingly, more than half of these research papers (~450) were published by Centres of Excellence.

Obviously, it is difficult to sustain such a growth in publication for long, but a strong base like this could go a long way in establishing the country's major scientific contribution to knowledge of this global change.

Figure 3 depicts the number of yearly publications that have emanated from the projects funded under CCP-DST during the past seven years since 2011 when the climate change programme was launched. This clearly shows a gradual and consistent growth in the number of publications from a modest number of 17 in 2011–12 to 249 in 2017–18. The annual growth rate of all publications of CCP funded projects was nearly 30% (~19% for papers in SCI journals) which is much higher than the annual growth

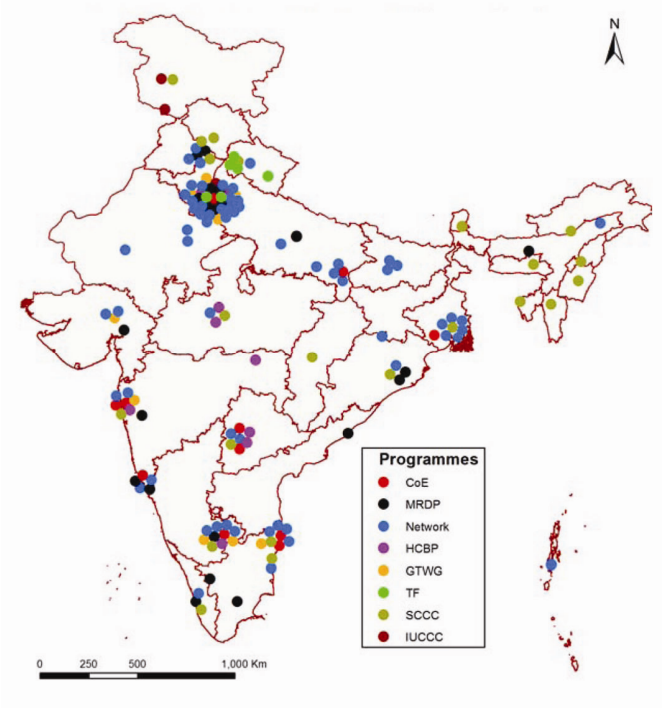

Figure 1. Locations of major projects/programmes launched under two national missions on Climate Change of DST.

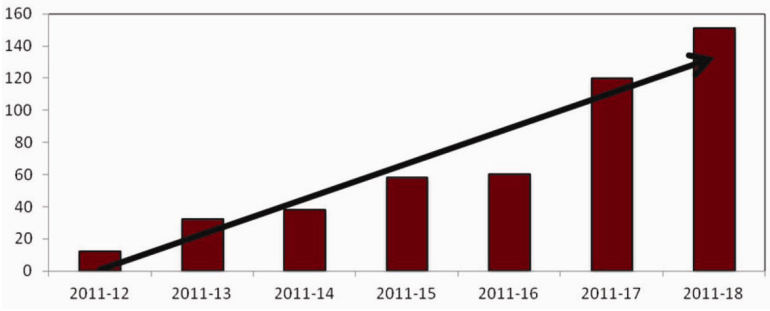

Figure 2. Cumulative number of projects sanctioned under Climate Change Programme during 2011–2018.

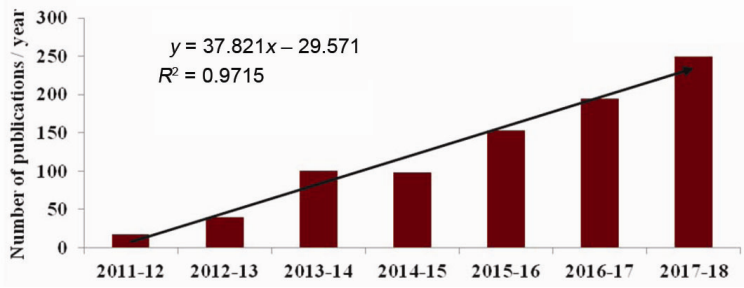

Figure 3. Number of publications from the projects sanctioned under Climate Change Programme during 2011–2018.

rate of India's science publications (~13.9%) and that of global science publications (~4.2%).

More than 60 new techniques have been developed as part of projects under two missions. Nearly 1000 scientists, experts and students and 200 institutions in the country have been associated with CCP programmes/projects. As many as 150 Ph D and PG students were enrolled as part of two missions in different projects. More than 200 workshops were organized wherein over 5500 personnel were trained. State CC centres conducted 150 training programmes wherein 20,000 personnel were trained. In addition, missions supported 40 national level events wherein over 2000 participants benefited. Overall 35,000 people were trained in climate change-related disciplines and skills under various programmes.

A generation of climate change experts is going to be created in the country; soon India will be in a better position to negotiate internationally, with a far better insight and confidence, as well as support to policy makers.

There are still some caveats, however, as the present efforts of this DST team do not ensure timely release of research grants and due consideration of problems that researchers face while conducting research, it can be very demotivating for a sincere and honest researcher. Most of the centre level initiatives are confined to national institutes and a few central universities. However, now efforts are on to bridge this gap by focusing new projects on universities in the Himalayan region. Research processes are in shambles in most state universities, many of the central universities and numerous colleges. Networking and regular seminars and workshops are expected to fill this gap, but the progress has been slow, particularly where issues require natural and social scientists to work together. Indeed, what Gupta and his associates have achieved within a short period warrants country-level interest and debate.

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