सत्यमेव जयते

Ministry of Earth Sciences
Government of India

TWO YEARS OF **PHENOMENAL ACHIEVEMENTS**

(2019-2021)

India has one of the best weather forecasting systems in the world, providing accurate advisories to multiple stakeholders.Investments in National Monsoon Mission & High Performance Computing facilities of MoES have provided estimated benefits of Rs 50,000 cr to our farmers, fisherfolk & livestock rearers.

Dr Harsh Vardhan
Hon'ble Minister of Earth Sciences
Government of India

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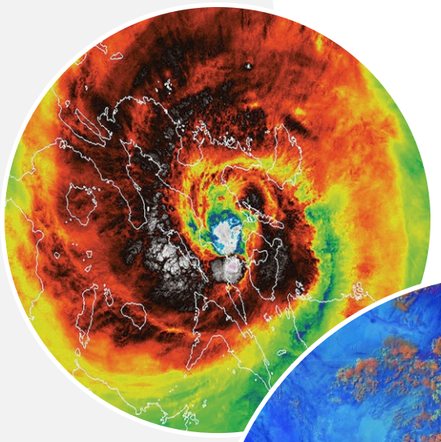
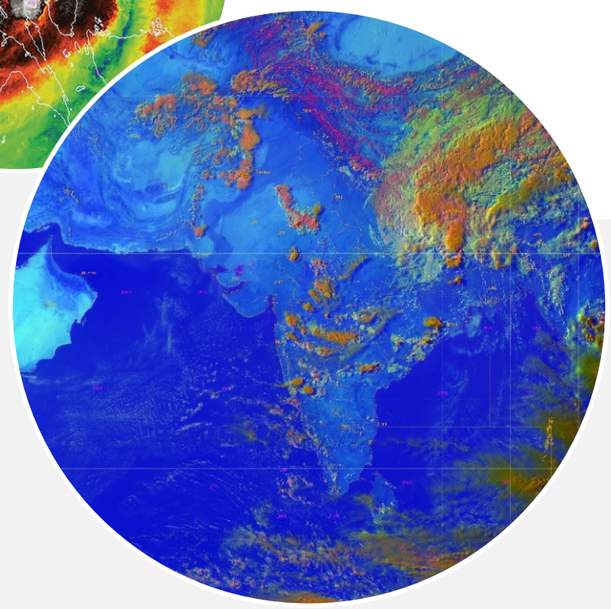
IMPROVED WEATHER FORECASTING AND SERVICE TO SOCIETY

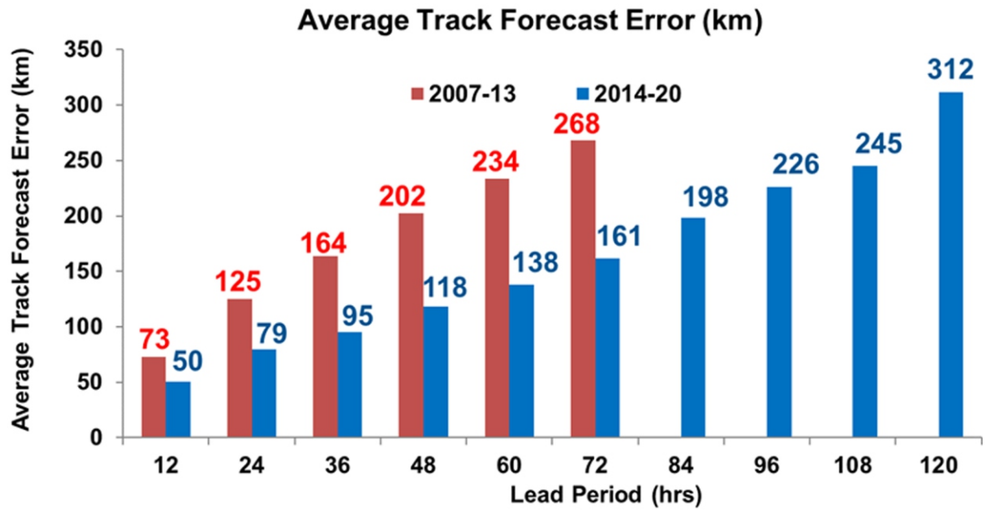




1. Timely and accurate prediction of tropical cyclones

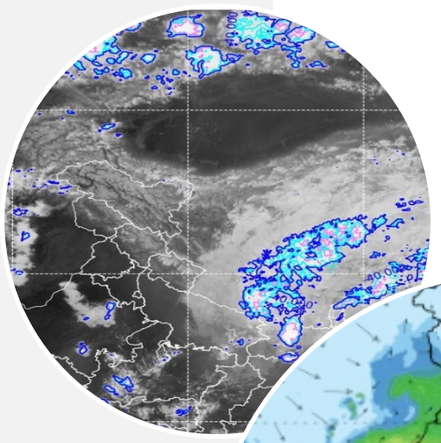
The India Meteorological Department (IMD) issued accurate and timely prediction of tropical cyclones, combined with fieldwork by disaster management agencies, that helped save thousands of precious lives of countrymen. **There were 8 Cyclonic Storms over the north Indian Ocean in 2019 and 5 in 2020 that have been forecasted accurately by IMD.**

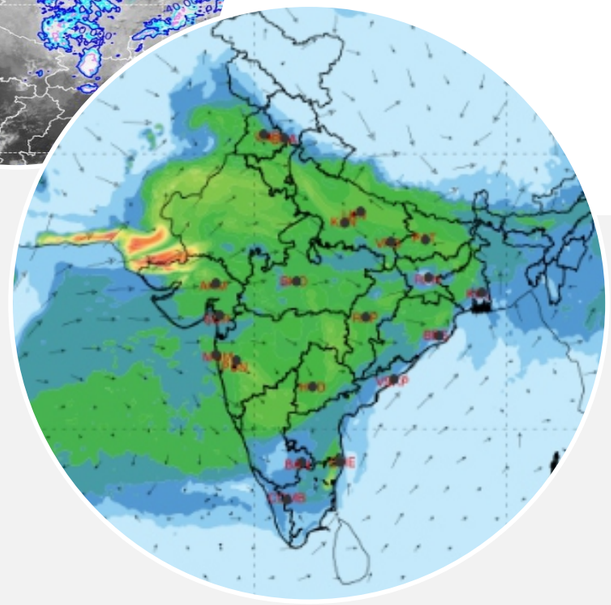
Comparison of Average track forecast errors of cyclonic storms over the Arabian Sea & Bay of Bengal during (2007-2013) & (2014-2020)



The above figure shows the comparison of the average track forecast errors spanning the 7 year period viz., 2007-2013 Vs. 2014-2020. A steady improvement in the track forecast errors and also the increase in lead period of track prediction upto 5 days are evident in the latest 7-year period. **The average track forecast error has reduced from 125 km to 79 km and from 268 km to 161 km in 24-hours and 72-hour forecasts respectively.**

IMPROVED WEATHER FORECASTING AND SERVICE TO SOCIETY





2. Commissioned Integrated Flood Warning Systems (IFWS)

MoES commissioned IFWS for Chennai in November 2019 and for Mumbai in June 2020. The systems have been handed over to the respective State Governments. They prove extremely useful in mitigating damage caused due to impending urban floods.

3. Devised Heat Action Plans

IMD collaborated with the National Disaster Management Authority to devise the National guidelines for the management of heat waves and with the states for formulating Heat Action Plans to reduce heat-related mortality and morbidity in the country.

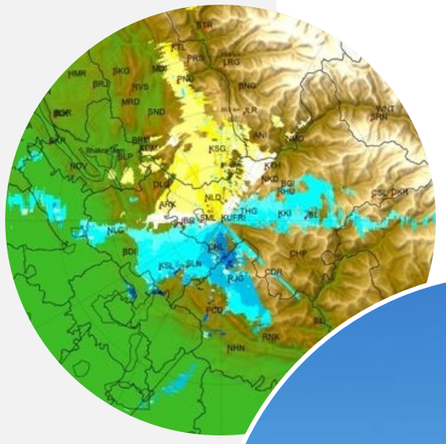
4. Commissioned a high-resolution Air Quality Early Warning System (AQ-EWS) for Delhi

MoES developed and commissioned a very high-resolution (400 meter) AQ-EWS for Delhi. It can predict extreme air pollution events in Delhi and give warnings as per a Graded Response Action Plan.

5. Flash Flood Guidance system

IMD Launched the Flash Flood Guidance Services, the first of its kind for South Asian countries namely India, Bangladesh, Bhutan, Nepal and Sri Lanka

AGRO-METEOROLOGICAL SERVICES AND UP-GRADATION OF OBSERVATIONAL NETWORK



6. Agro-Meteorological Advisory Services (AAS)

The MoES worked towards the goal of setting up District Agro-Met Units (DAMUs) in all districts of the country. Presently 310 DAMUs have been established issuing AAS to 690 districts and 2256 blocks.

7. Launch of meteorological centre in Leh

Meteorological Observatory (MO) Leh was upgraded into full-fledged Meteorological Centre (MC) after Ladakh became a union territory on 31 October 2019. The Meteorological Centre at Leh was inaugurated on 29th December 2020 by Hon'ble Minister for Earth Sciences, Dr Harsh Vardhan

The centre is a world-class facility for high altitude meteorology. It will cater to various weather and climate needs of the people and the administration of Ladakh.

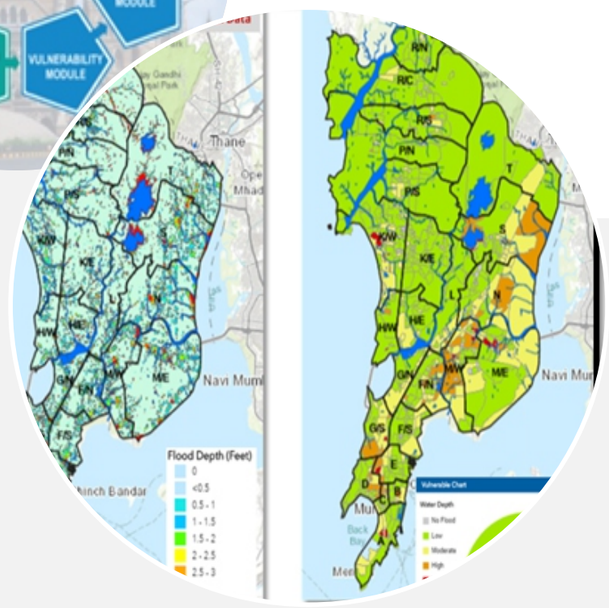
8. Installation of High Wind Speed Recorders

17 High wind speed recorders were installed along the coastlines of India.

9. Commissioning of new Doppler Weather Radars (DWRs)

The MoES commissioned four new DWRs at Srinagar, Sonamarg, Kufri, and Mukteshwar. The radars will provide information on severe weather events and support disaster management authorities. It will also help the authorities mitigate risk to pilgrims of Kailash Manasarovar and Char Dham yatra.

AGRO-METEOROLOGICAL SERVICES AND UP-GRADATION OF OBSERVATIONAL NETWORK



10. Established Multi-Mission Meteorological Data Receiving and Processing System

IMD has established Multi-Mission Meteorological Data Receiving and Processing System (MMDRPS) for INSAT-3D, INSAT-3DR and INSAT-3DS satellites through a MoU with M/s Antrix Corporation Ltd., ISRO. Dedicated New Earth stations have been setup under MMDRPS Project, which have the capability to receive the data from INSAT-3D, INSAT-3DR and upcoming INSAT-3DS satellite.

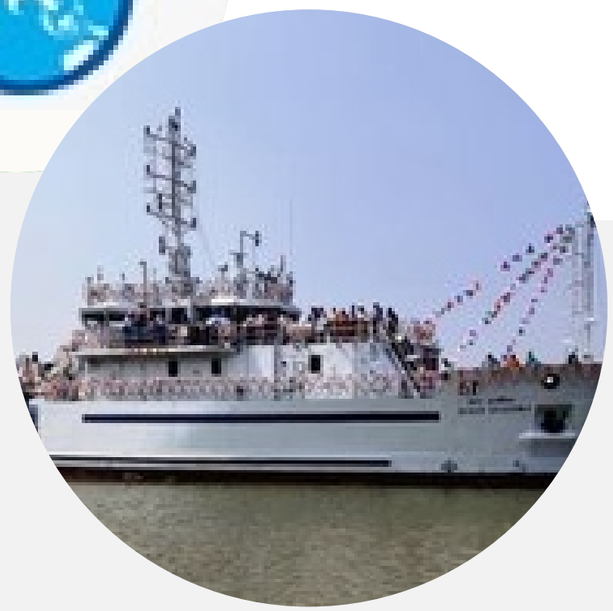
National Centre for Medium Range Weather Forecasting has started receiving and utilizing many new observations in its global and regional atmospheric data assimilation system during this period.

During the year, NCMRWF has released 39 years of high-resolution reanalysis atmospheric data including daily and hourly data for weather and climate research. The data can be downloaded at https://rds.ncmrwf.gov.in

IMD Global Ensemble Forecast System (GEFS) T1534 forecast for 21 members and for 10 days lead time, are being shared with TIGGE (The International Grand Global Ensemble) archive at ECMWF since 1 July 2020.

OCEAN SERVICES

DIGITAL OCEAN



11. Issuing weather and ocean-related alerts and warnings to fisherfolk

A satellite-based system named GEMINI was devised to alert deep-sea fisherfolk about extreme weather events. A pilot mission to distribute GEMINI to fisherfolk under the Pradhan Mantri Matsya Sampada Yojana was launched in October 2019. Such alerts help to prevent and mitigate any impending dangers to the lives and property of fisherfolk of the country.

12. Tsunami ready communities

IOC-UNESCO conferred the Certificate of Recognition and Certificate of Appreciation as Tsunami Ready communities to Venkatraipur and Noliasahi village communities and OSDMA Officials, through a virtual event organized on 7 August 2020, which is first of its kind in the Indian Ocean region.

13. Launch of Digital Ocean

The Indian National Centre for Ocean Information Services (INCOIS), Hyderabad, launched the Digital Ocean, a one-of-its-kind web-based platform for ocean data management in India. The portal will make ocean-related data available to a wide range of users, including research institutions, operational agencies, strategic users, academia, maritime industry and policymakers.

14. Commissioning of two coastal research vessels

Two new coastal research vessels—Sagar Tara and Sagar Anveshika—joined the MoES fleet of research vessels after successful and satisfactory harbour and sea trials. The project was conducted in partnership with India's private sector, boosting the vision of 'Make in India'.

15. Potential fishing zone advisories

The flagship service of INCOIS - Potential Fishing Zone (PFZ) advisories are disseminated continuously for the period of January

OCEAN SERVICES

to November 2020 in smart map and multilingual text form on daily basis subject to satellite data availability, fishing-ban period and adverse sea-state. Small Vessel Advisory and Forecast Services System (SVAS) was launched to provide Ocean state information to numerous small fishing vessels that ply the coastal waters of India.

16. Monitoring coral reef health at Gulf of Mannar

The National Center for Coastal Research (NCCR), Chennai has been monitoring coral reef health at Gulf of Mannar since 2018. The scientific endeavour assesses the total live and dead coral coverage, community structure of reef-building corals, anthropogenic influences and threats faced by the coral ecosystem. NCCR has published two extensive technical reports entitled a) Coral Reef Health Monitoring and b) Coral Health Index. The reports provide valuable information about the present health status of coral reefs of Gulf of Mannar, statistical update on their health status, threats faced by the reef ecosystems, and recommendations for their long-term conservation. The reports would hugely benefit academicians, policymakers, and researchers in making effective conservation and management plans for Gulf of Mannar and Palk Bay.

17. Measuring shoreline change rate for the Indian coast

The National Center for Coastal Research (NCCR), Chennai has analysed shoreline change rate for the Indian coast using Indian satellite images and field measurements. A comprehensive web-based coastal change information system has been developed to facilitate coastal managers in the development and management of coast-related processes. In addition, seasonal monitoring of beach morphology and coastal changes, observations of sediments and littoral environment have been conducted at 14 sites to understand sediment dynamics, which would aid estimating shoreline change due to climate change.

OCEAN TECHNOLOGY– POLAR SCIENCES

18. Successful completion of 40th Indian Scientific Expedition to Antarctica (40-ISEA)

The National Centre for Polar and Ocean Research (NCPOR), Goa, successfully concluded the 40-ISEA in April 2021. The crew of the 40-ISEA started from Goa on January 7, 2021, and reached the Bharati station on February 27, 2021, and Maitri station on March 8, 2021. Voyage team deployed four autonomous Ocean Observing Directional Wave Spectra wave drifters. In the spirit of international cooperation in Antarctic science, the Antarctic expedition vessel MV Vasiliy Golovnin retrieved two remotely operated Norwegian Ocean observing instruments in March 2021. These Ocean observing systems will help to fill in the gaps in information in the Indian Ocean sector of the Southern Ocean. The achievement marks four decades of India's successful scientific endeavor in the ocean of peace and cooperation.

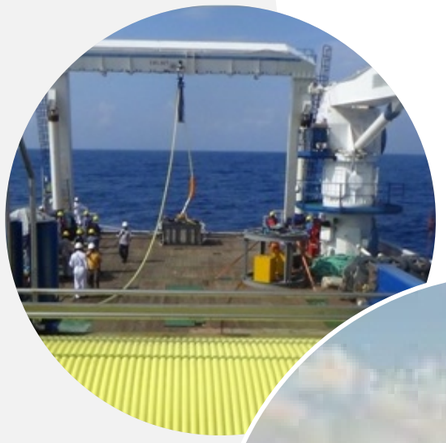
19. Shore protection in Puducherry and Tamil Nadu

The National Centre for Coastal Research (NCCR) and the National Institute of Ocean Technology (NIOT) in Chennai implemented innovative coastal engineering techniques to restore beaches lost to erosion in Puducherry and Tamil Nadu.

20. Setting up of desalination plants to provide potable water to island communities

The MoES set up a desalination plant at Kalpeni in Lakshadweep Islands that started generating potable water in January 2020. Five more desalination plants are being set up in the Lakshadweep islands of Amini, Androth, Chetlat, Kadamat, and Kiltan. The desalination plants would provide clean potable water to island communities by utilizing seawater and will enhance the quality of life of local dwellers significantly.

OCEAN TECHNOLOGY– POLAR SCIENCES



21. Deep-sea underwater Mining Machine

Locomotion trials of Underwater Mining Machine V1 and V2 was successfully demonstrated in depths of 5270 m in the Central Indian Ocean, for the first time ever by any nation.

22. NCPOR devises an effective eco-friendly method of synthesizing promising drug molecules from Antarctic lake bacterium

Researchers at the National Center for Polar and Ocean Research (NCPOR), Goa have devised a highly efficient and eco-friendly method of synthesizing gold nanoparticles from ionic gold using an Antarctic lake bacterium that is tolerant to extreme cold conditions. The method allows scientists to produce high-quality gold nanoparticles without adding synthetic chemical additives such as stabilizing or reducing agents. Such gold nanoparticles hold immense promise as effective therapeutic anti-microbial agents or in composite therapy with anti-cancer, anti-viral, and cholesterol-lowering drugs. The research was published in the 2021 issue of the Journal of Preparative Biochemistry and Biotechnology and was done in collaboration with Goa University.

SEISMOLOGICAL SERVICES AND GEOSCIENCES

23. Upgradation of the seismological network in India

The MoES upgraded the country's seismological network to 115 stations and implemented a state-of-the-art auto-location software called SeisComp3. This network would provide a more accurate estimate of preliminary earthquake parameters, which will enhance the scientific understanding of earthquakes.

24. Establishing National Geochronology Facility

The MoES worked towards setting up the National Geochronology Facility at Inter-University Accelerator Centre in New Delhi. It will enable Indian scientists to generate high precision quality geochemical and isotopic data. It will allow researchers to estimate the geological age of Earth's formations, rocks, sediments, etc. and improve understanding of the evolution of the Indian lithosphere.

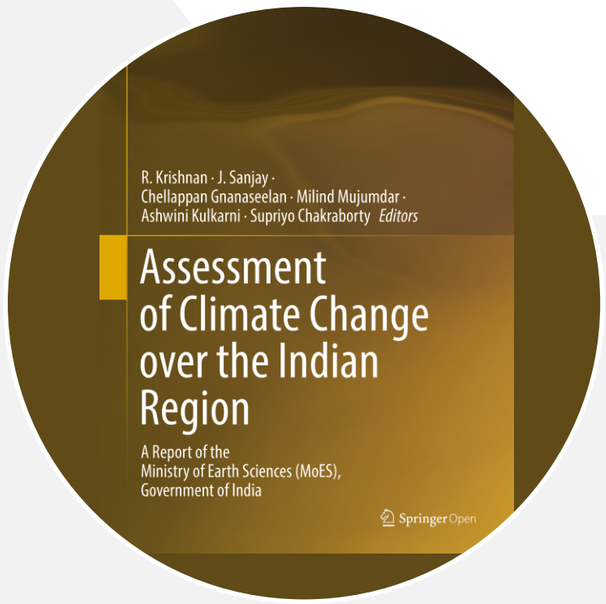
25. Conducting seismic microzonation

Seismic microzonation helps categorize earthquake-prone areas into risk zones that provides the basis for site-specific risk analysis, which can assist in the mitigation of earthquake-related damage. MoES has executed seismic microzonation of Bhubaneswar, Chennai, Coimbatore and Mangalore, which are in an advanced completion stage. In eight more cities (Patna, Meerut, Amritsar, Agra, Varanasi, Lucknow, Kanpur and Dhanbad), work has been initiated.

ESTIMATING ECONOMIC BENEFITS OF MoES SERVICES TO THE COUNTRY

26. India's investment of nearly 1,000 crores through the Monsoon Mission and High-Performance Computing yielded benefits worth rupees 50 thousand crores to ~10.7 million below poverty line (BPL) agricultural households and 0.53 million BPL fisherfolk households over a period of five years. About 26.6 per cent of this benefit is attributed to womenfolk. The findings were published in a recent report by the National Council of Applied Economic Research (NCAER), an independent, non-profit economic policy research institute in New Delhi.

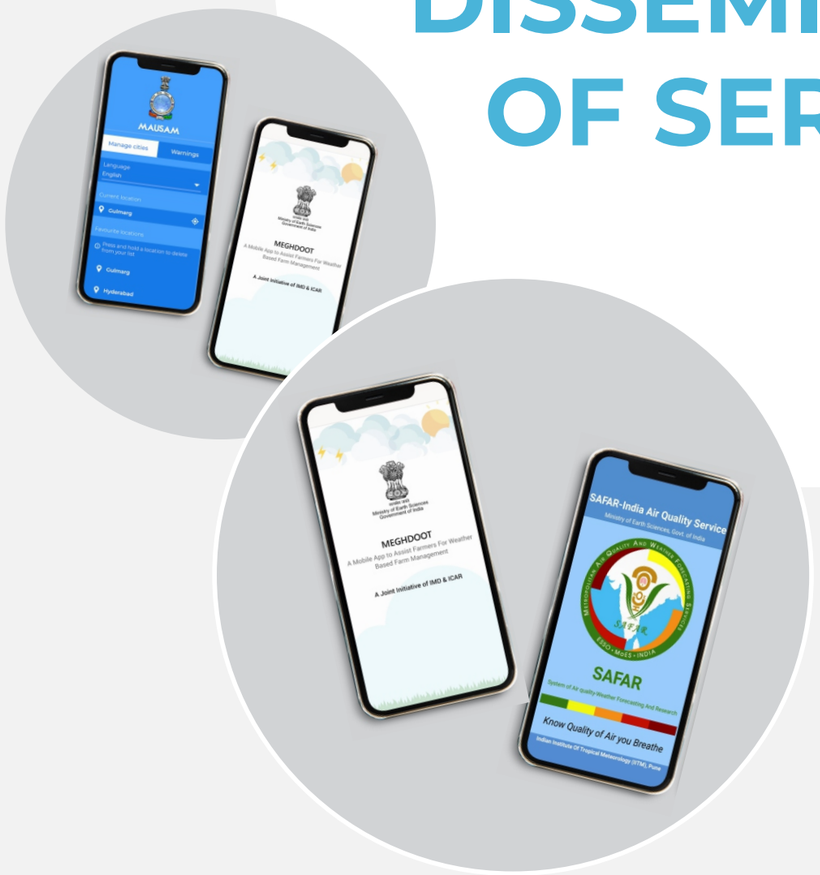
RELEASE OF THE NATIONAL CLIMATE CHANGE ASSESSMENT REPORT



27. A new open access book on Assessment of Climate Change over the Indian Region has been published in June 2020. This is the first climate change report for the Indian region from the Ministry of Earth Sciences, and discusses the influence of human-induced global climate change over the Indian subcontinent, the adjoining Indian Ocean, the Himalayas and on the regional monsoon. It also briefly discusses policy relevant information based on robust scientific analysis and assessments of the observed and future projected climate change over the Indian region.

The first-of-its-kind open-access publication in India aims to benefit students, researchers, and policymakers. It documents the regional climate change projections based on the climate models used in the Intergovernmental Panel on Climate Change Fifth Assessment Report and climate change modelling studies using the Indian Institute of Tropical Meteorology Earth System Model and CORDEX South Asia datasets.

OUTREACH AND DISSEMINATION OF SERVICES



28. Launch of mobile applications to enhance the quality of MoES services to the public

IMD's new **Mobile App "Mausam"** was launched by Dr Harsh Vardhan, Hon'ble Minister of Science and Technology, Health and Family Welfare and Earth Sciences on 27th July 2020. This mobile app is extensively used by the users for knowing location specific forecasts.

In addition, the MoES launched several mobile applications such as Meghdoot, Damini, SAFAR AIR, SARAT, RISEQ, which have helped disseminate real-time information on weather, Ocean, and seismological services.

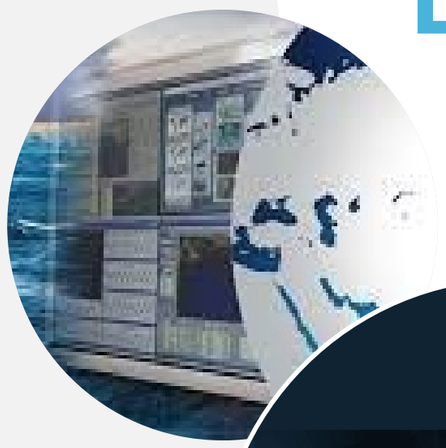
29. Dissemination of information through active engagement on social media

The MoES engaged and disseminated helpful information to the public through various social media channels such as Twitter, Facebook, Instagram, and YouTube, which has also increased the direct user base of MoES.

30. Uninterrupted and efficient data supply to stakeholders

The Data Supply Portal operationalized by IMD in March 2019 has reduced the lag in data delivery from a few months to hours and increased the user base. The stakeholders have a hassle-free web-based procurement of data within an average time of six hours.

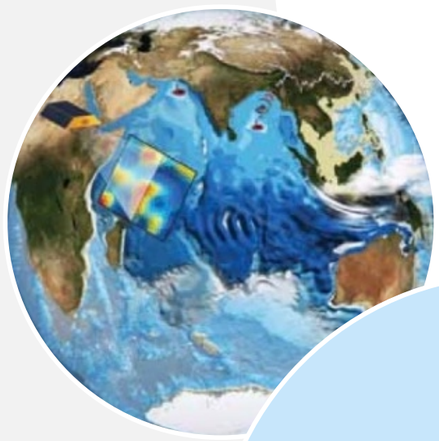
OUTREACH AND DISSEMINATION OF SERVICES



31. Digital Knowledge Resource portal - KRCNET

MoES developed a one-of-its-kind and unique portal called the KRCNET (Knowledge Resources Center Network) aligned with the Digital India initiative of the Govt of India. The KRCNET portal is accessible at https://krcnet.moes.gov.in/. It integrates all knowledge and intellectual resources of MoES and its institutes on a single digital platform for quick and easy public access available 24X7 from all across the globe. The portal makes a variety of knowledge resources such as subscribed e-journals, books, magazines, repository data under 17 item types (such as research papers, videos, awards, book chapters, thesis, documentary, etc.), MoES directory, Indian National Database on Antarctic Science, recent publications and news and events from MoES and its institutes, links to important websites, social media handles of MoES, etc, available on an integrated cyber-secure platform. All libraries at MoES and its institutes are to be upgraded to fully automated Knowledge Resource Centers (KRCs) that will be integrated on the KRCNET portal. This will help more users and the public to benefit from the knowledge resources of MoES in a big way. KRCNET was recognised as one of the 35 pathbreaking e-governance projects of the Govt of India in 2020 by Coeus Age, supported by Microsoft. It also won the Governance Now (G-Now) Data Center award for 2021.

CAPACITY BUILDING, TECHNOLOGY TRANSFER AND HUMAN RESOURCE DEVELOPMENT



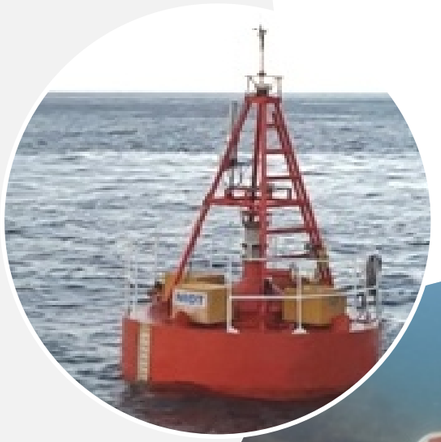
32. ITCOocean receives international recognition

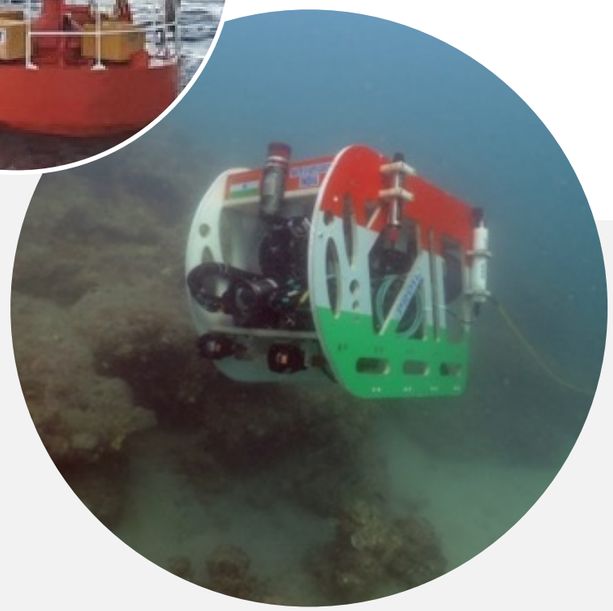
The International Training Centre for Operational Oceanography (ITCOocean) is a state-of-the-art facility at the Indian National Centre for Ocean Information Services (INCOIS), Hyderabad. It received the recognition of being a Regional Training Centre of the Ocean Teacher Global Academy project under the International Oceanography Data Exchange for 2020 to 2023. It has conducted 20 training courses, including 11 International training courses for about 2500 Indian and international participants towards capacity building in the field of ocean sciences and technology

33. Enhancing expertise in earth system science

The DESK (Development of Skilled Manpower in Earth System Science and Climate) programme of the MoES implements various schemes for capacity building in the field of earth system science. It implemented annual recruitment and training of research fellows/PhD scholars for MoES and its institutes. It facilitated and conducted summer internships, project training programmes and study tours (4), expert lecture series (3), brainstorming meetings (2), workshops, summits and conferences (3), and webinars (38) for students, scientists and faculty, officers of the Indian Air Force and Naval meteorological observatories, and meteorology professionals. It also coordinated sharing of resource persons from the Indian Institute of Tropical Meteorology (IITM), Pune, to deliver knowledge and expertise at various national and international platforms.

CAPACITY BUILDING, TECHNOLOGY TRANSFER AND HUMAN RESOURCE DEVELOPMENT





34. Technology transfer to industry

Technology licensing agreements with Indian industries through National Research Development Corporation (NRDC) and the details are given below:

- "Remotely Operable Vehicle" to L&T heavy industries and Bharat Electronics Limited. Bangalore
- "Ocean drifter" (Drifting Buoy with INSAT Communication) to M/s. Astra Microwave, Hyderabad and M/s. Azista Industries Pvt. Ltd., Ahmedabad.
- "Wave powered navigational buoy" to M/s.High Tech Elastromers, Ahmadabad M/s.Nireekshan, Chennai, M/s. Sangir Plastic Pvt. Ltd., Valsad.
- "Enterococcus faecalis multiplex PCR detection kit" to SAAI Electro Biogenic India Pvt.Ltd.
- "Lutein production from marine microalgae" to M/s.VectrogenBiologicals Pvt Ltd., Hyderabad,
- Sea surface temperature sensor, to NRDC

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