

Ministry of Earth Sciences (MoES)
Government of India
PrithviBhavan, Lodhi Road, New Delhi - 110003

Particulars of Organisation, Functions and Duties:

Introduction:

Earth System Science deals with all the five components of the Earth System, viz., Atmosphere, Hydrosphere, Cryosphere, Lithosphere and Biosphere and their complex interactions. Prevention from natural hazards such as Earthquakes, Cyclones, Thunderstorms etc. which effects the life of people Government has resolve to take a major new initiative to integrate the national efforts in Earth sciences. On 12th July, 2006, the new Ministry of Earth Sciences (MoES) has been formed under Presidential Notification to benefit the society.

Before the formation of MoES, the Department of Ocean Development (DOD) was created in July 1981 as a part of the Cabinet Secretariat directly under the charge of the Prime Minister and came into existence as a separate Department in March 1982. The Erstwhile DoD functioned as a nodal Ministry for organizing, coordinating and promoting ocean development activities in the country. In February, 2006, the Government notified the Department as the Ministry of Ocean Development.

The Government of India further reorganized the Ministry of Ocean Development and the new Ministry of Earth Sciences (MoES) came into being vide Presidential Notification bringing under its administrative control India Meteorological Department (IMD), Indian Institute of Tropical Meteorology (IITM) and National Centre for Medium Range Weather Forecasting (NCMRWF). The Government also approved the setting up of Earth Commission on the pattern of Space Commission and Atomic Energy Commission.

Objectives:

- To excel knowledge and technology enterprise in the earth system science realm towards socio-economic benefit of the society.
- To provide services for weather, climate, ocean and coastal state, hydrology, seismology, and natural hazards.
- To explore and harness marine living and non-living resources in a sustainable way and to explore the three poles (Arctic, Antarctic and Himalayas).

The scientific programs of MoES are being carried out under the following five major schemes:

1) Atmosphere and Climate Research, Observations Science and Services (ACROSS):

- Numerical modeling of weathering & Climate
- Physics and Dynamics of Tropical Clouds
- Agro Meteorology
- Aviation Services
- Centre for Atmospheric technology
- High impact severe weather Warning System
- Metropolitan Air quality and Weather Service Monsoon Mission of India

2) Ocean Services, Modelling Application, Resources And Technology (O-SMART)

- Coastal Research
- Early warning system for tsunami and storm surges
- Integrated Ocean Information Services
- Monitoring and Modeling of Marine Ecosystems (MMME)
- Marine Living Resources Programme (MLRP)
- Ocean Research and Modelling

3) Polar and Cryosphere Research (PACER)

- Construction of Polar Research Vessel
- Construction of third research base in Antarctica
- Indian Scientific Endeavors in the Arctic
- Polar Expeditions - Antarctica
- Replacement of Maitri station
- Southern Ocean

4) Seismology And Geosciences Research (SAGE)

- Microzonation, Observation Network and NCS building
- Geodynamics and Surface Processes
- Koyna Deep drilling programme, Maharashtra
- India-International Ocean Discovery Program (IODP)
- Indian Ocean Geoid Low (IOGL)
- Facility for Geochronology
- Seismicity & Earthquake Precursors

5) Research, Education, Training And Outreach (REACHOUT)

- Centre for Advanced training in Earth system Science & Climate (CAT ESSC)
- Earth science & Technology Cells
- Establishment of India Africa for medium range weather Prediction
- National Oceanarium
- Outreach & Awareness
- Research & Capacity Building
- Training Centre for Operational Oceanography
- Training in Operational Meteorology

Organisational Set-Up:

There are total 10 research institutes under MoES under different categories which include 5 Autonomous Institutes, 2 Subordinate Offices and 3 Attached Offices and. Details of institutes are given below:

Autonomous Institutes

1. Indian Institute of Tropical Meteorology (IITM),
Homi Bhabha Road, Pashan,
Pune – 411 008
2. Indian National Centre for Ocean Information Service (INCOIS),
Ocean Valley, Pragathi Nagar BO,
Nizampet - Hyderabad – 500055
3. National Centre for Polar & Ocean Research (NCPOR),
Headland Sada, Vasco da Gama,
Goa – 403 804
4. National Institute of Ocean Technology (NIOT),
Vellacherry-Thambaram Road,
Chennai - 600 100
5. National Centre for Earth Science Studies (NCESS),
Post Box No.7250, Akkulam,
Thiruvananthapuram – 695 011

Attached Office

1. Centre for Marine Living Resources and Ecology (CMLRE),
6th Floor, Block-C, Kendriya Bhawan,
P.O. Kochi Special Economic Zone,
Kochi – 2682037
2. National Centre for Coastal Research (NCCR),
NIOT Campus, Vellacherry-Thambaram Road,

Pallikaranai Village,
Chennai – 600 100

3. National Center for Seismology (NCS),
IMD Campus,
Lodhi Road,
New Delhi – 110003

Subordinate Office

1. India Meteorological Department (IMD),
Mausam Bhawan, Lodhi Road,
New Delhi – 110003
2. National Centre for Medium Range Weather Forecasting (NCMRWF),
A-50, Industrial Area, Phase – II,
Sector-62, Noida UP – 201307

Indian Institute of Tropical Meteorology (IITM):

The need to study the fundamental atmospheric problems and understand the mechanism of monsoon, weather systems and climate related processes in the tropical region, particularly over the monsoon region, became acute for India in 1950's when the country's post Independence economic development program was launched. Considering this urgent need the World Meteorological Organization (WMO), in its Third Congress, recommended the creation of meteorological research and training institutes in the tropical countries.

The proposal was formally approved by the Government of India in February 1962 as one of the schemes under its Third Five Year Plan and finally the Institute was founded as the Institute of Tropical Meteorology (ITM) on 17 November, 1962 at Pune (the then Poona), as a distinct unit of the India Meteorological Department (IMD). Consequent upon the recommendation of the Committee for Organization of Scientific Research (COSR) appointed by the Government of India the Institute was transformed into an autonomous organization on 1st April 1971 under the name Indian Institute of Tropical Meteorology (IITM).

In the initial years, along with the IMD, the Institute functioned under the Ministry of Tourism and Civil Aviation, but later in 1985, it was brought under the Department of Science and Technology (DST) of the Ministry of Science & Technology and now, with effect from 12 July 2006 the IITM has been under the administrative control of the specially formed Ministry of Earth Sciences (MoES).

Objectives:

- To develop outstanding research talent capable of understanding and exploring enlightened and effective Atmospheric sciences.
- To further the advancement of Research in Ocean-Atmosphere by undertaking relevant scientific programmes.
- To collaborate with other similar research institutions, in the development and application of climate study.

Products provided by Institute are as follows:

- System of Air Quality and Weather Forecasting and Research (SAFAR) online
- Short Range Ensemble Prediction System, Seasonal Prediction System
- Extended Range Prediction
- Climate data portal
- Environmental Information System Resource Partner (ENVIS data centre)
- Air Quality Early warning System

Research Activities/ Projects:

- Monsoon Mission
- Physics and Dynamics of Tropical Clouds (PDTC)
- Metropolitan Air Quality and Weather Forecasting Services
- High Performance Computing System
- Short Term Climate Variability and Prediction
- Center for Climate Change Research
- National Facility for Airborne Research (NFAR)
- Development of Skilled Manpower in Earth System Sciences (DESK)

Website: www.tropmet.res.in

Indian National Center for Ocean Information Services (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 Organization (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.

Objectives:

- To establish, maintain and manage systems for data acquisition, analysis, interpretation and archival for Ocean Information and related services.

- To undertake, aid, promote, guide and co-ordinate research in the field of ocean information and related services including satellite oceanography.
- To carry out surveys and acquire information using satellite technology, ships, buoys, boats or any other platforms to generate information on fisheries, minerals, oil, biology, hydrology, bathymetry, geology, meteorology, coastal zone management and associated resources.
- To generate and provide data along with value added data products to user communities and to cooperate and collaborate with other national and international institutions in the field of ocean remote sensing, oceanography, atmospheric sciences/meteorology and coastal zone management.
- To establish Early Warning System for Tsunami and Storm Surges.
- To support the research centres in conducting investigations in specified areas related to oceanic processes, ocean atmospheric interaction, coastal zone information, data synthesis, data analysis and data collection and to provide consultancy services in the fields of ocean information and advisory services and to co-ordinate with space agencies to ensure continuity, consistency and to obtain state-of-the-art ocean data from satellite observations.
- To undertake other lawful activities as may be necessary, incidental or conducive to the attainment and furtherance of all or any of the above objectives of ESSO-INCOIS.

Research Activities/ Projects:

- Provides round-the-clock monitoring and warning services for the coastal population on tsunamis, storm surges, high waves, etc. through the in-house Indian Tsunami Early Warning Centre (ITEWC). The Intergovernmental Oceanographic Commission (IOC) of UNESCO designated ITEWC as a Regional Tsunami Service Provider (RTSP) to provide tsunami warnings to countries on the Indian Ocean Rim.
- Provides daily advisories to fisher folk to help them easily locate areas of abundant fish in the ocean while saving on both fuel and time used to search for the same. Short term (3-7 days) Ocean State Forecasts (waves, currents, sea surface temperature, etc.) are issued daily to fisher folk, the shipping industry, the oil and natural gas industry, the Navy, the Coast Guard, etc.

- Conducts systematic quality checks and archives all observational, satellite and other oceanic data at the INCOIS Data Centre and then makes such data available to students, researchers and any other users.
- Generates Global Ocean Analysis data using mathematical models and observations on a daily basis to provide the initial conditions to ocean-atmosphere coupled models used for the prediction of the monsoon and to understand oceanic processes and to carries out Research and Modelling to optimize the performance of mathematical models used for ocean state forecasts, prediction of tsunami waves, storm surges, etc. along the coast.
- Established a national network (Indian Seismic and GNSS Network (ISGN)) that integrates Seismic and GNSS stations and provides high quality data for research and operational use and also to established a VSAT aided Emergency Communication System (VECS) (a fail-safe satellite-based communication system) to provide tsunami warnings with the least possible time delay even when there is a failure in conventional communication systems and also to established high performance computing systems and data communication networks at ESSO-INCOIS with 100% redundancy and reliability to support the computational requirements of ocean state forecast models etc.

Website: www.incois.gov.in

National Centre for Polar and Ocean Research (NCPOR):

National Centre for Polar and Ocean Research (NCPOR) is India's premier R&D institution responsible for the country's research activities in the Polar and Southern Ocean realms. The National Centre for Polar and Ocean Research (NCPOR) was established as an autonomous Research and Development Institution of the Ministry of Earth Sciences (formerly Department of Ocean Development), Government of India on the 25th May 1998.

Year-round maintenance of the two Indian stations (Maitri& Bharati) in Antarctica is the primary responsibility of the Centre. Maitri (1989) and Bharati (2011) were established, for carrying out research by the Indian scientists in all disciplines of polar research. These stations have been provided with comfortable living accommodations, state of the art laboratories and well-equipped library and communication systems.

Objectives:

- Leadership role in niche areas of scientific research in the domain of polar and ocean sciences.

- Lead role in the geoscientific surveys of the country's EEZ and its extended continental shelf beyond 200M, deep-sea drilling in the Arabian Sea basin through the IODP, exploration for ocean non-living resources such as the gas hydrates and multi-metal sulphides in mid-ocean ridges.
- Facilitatory role in the scientific research activities being undertaken by several national institutions and organizations in Antarctica, the Arctic and in the Indian Ocean sector of the Southern Ocean.
- Management role in implementing all scientific and logistics activities related to the Annual Indian Expeditions to the Antarctic, Arctic and Southern Ocean.
- Management and upkeep of the Indian Antarctic Research Bases "Maitri" and "Bharati", and the Indian Arctic base "Himadri".

Management of the Ministry's research vessel ORV SagarKanya as well as the other research vessels chartered by the Ministry are Polar and Ocean Sciences, Geoscientific surveys, Extended continental shelf, Deep sea drilling in the Arabian Sea, Gas hydrate, Multi-metal sulphide, Annual Scientific Expeditions, Maitri, Bharati, Himadri, ORV SagarKanya.

Research Activities/ Projects:

- **Research Program in Antarctica:**

Antarctica "the white continent" is the fifth largest continent in the world with its unique wildlife, extreme coldness, dryness, windiness and unexplored territories. The word Antarctica is derived from the Greek word antarktike, which means "opposite to north" i.e., opposite to the Arctic.

It is situated within the Antarctic Circle and is surrounded by Southern Ocean. James cook discovered Antarctica when he was crossing the Antarctic Circle. The world's largest ocean current, the Antarctic circumpolar current circumvents the Antarctic continent. Of the 14 million-sq.km area, 98% is covered with thick ice sheets that formed 25 million years ago and holds 75% of the earth's fresh water.

- **Research Program in Arctic:**

India's Arctic research includes atmospheric, biological, marine and earth sciences and glaciological studies. The atmospheric research encompasses investigations into aerosols and precursor gases with respect to their radiative, physical-chemical and optical properties and studies of the effects of space weather on the auroral ionosphere. Biological studies include sea-ice microbial communities; and in marineresearch, phytoplankton pigments, nutrients, pH, DO, sea-water salinity and other ecological parameters have been investigated. Earth sciences and

glaciological observations include studies of snow-pack production of carbon monoxide and its diurnal variability.

- **Research Program in Himalaya:**

- To study the dynamics and the rate of change in glaciers to understand its impact on hydrology, ecology and climate.
- To assess the climate change using ice as an archive of information on past climate and its future implications.
- To study the biogeochemical aspects of Himalayan ice and compare it with the polar environment.

As part of the Indian government's initiatives for better understanding of glacier – climate inter-relationship and quantify the Himalayan glacier responses towards the climate change, National Centre for Antarctic and Ocean Research (NCAOR), Goa, under the Ministry of Earth Sciences has established a high altitude research station in Himalaya called HIMANSH. HIMANSH is a dedicated Research Station established at Sutri Dhaka, Chandra Basin, Lahaul-Spiti valley of Himachal Pradesh which has an altitude of 4080m amsl. The station was unveiled on Sunday 9th October 2016 and since then the station has made for functioning round the year however for 2016 it have plan to closed during winter (15th November to April 2017).

- a) **International Ocean Discovery Program (IODP):**

The International Ocean Discovery Program (IODP) is a global marine research collaboration that explores Earth's history and dynamics using ocean-going research platforms to recover data recorded in seafloor sediments and rocks and to monitor sub-seafloor environments.

- **Scientific studies in Southern Ocean:**

The Indian Southern Ocean Research Program was initiated in 2004 when the pilot expedition took place onboard ORV SagarKanya. This program was initiated by the Ministry of Earth Sciences (MoES) to pursue multi-disciplinary, multi-institutional research activities addressing various key scientific components including Hydrodynamics, Biogeochemistry, Biodiversity (Plankton and higher marine organisms), Air-sea interactions, Lower atmospheric processes, Palaeoclimatology etc. Since its inception in 2004, NCAOR as the national nodal agency for planning, coordinating and executing all facets of SO research program, has carried out 7 expeditions addressing some of the above mentioned research components.

Website: www.ncaor.gov.in

National Institute of Ocean Technology (NIOT):

The National Institute of Ocean Technology (NIOT) was established in November 1993 as an autonomous society under the Ministry of Earth Sciences, Government of India. NIOT is managed by a Governing Council and the Director is the head of the Institute. Major aim of starting NIOT under the Ministry of Earth Sciences, is to develop reliable indigenous technologies to solve the various engineering problems associated with harvesting of non-living and living resources in the Indian Exclusive Economic Zone (EEZ), which is about two-thirds of the land area of India.

Objectives:

- To develop world class technologies and their applications for sustainable utilization of ocean resources.
- To provide competitive, value added technical services and solutions to organizations working in the oceans.
- To develop a knowledge base & institutional capabilities in India for management of ocean resources & environment.

Research Activities/ Projects:

- **Deep sea technology**

Deep Sea Mining: Polymetallic nodules have economically valuable metals such as Copper, Cobalt, Nickel and Manganese in them and are viewed as potential resources to take care of the depleting land resources and increasing demand of these metals.

Gas Hydrates: This group was created to cater to the sustained development of technology towards harnessing the enormous potential offered by the ocean towards the energy sectors and also to the industries related to offshore activities with particular reference to gas hydrates.

Submersibles: The Deep Sea Technologies group is involved in developing manned and unmanned underwater vehicles along with allied technologies such as homing and docking system, sensor fusion, etc for the exploration and exploitation of deep ocean mineral resources such as poly-metallic manganese nodules, gas hydrates, hydrothermal sulphides etc. and other oceanographic, polar and industrial applications.

- **Energy and fresh water**

The program focuses on developing technologies for tapping renewable energies and generating fresh water from the ocean. A small rating Backward Bent Ducted Buoy was studied and its field trials are under progress. Operation of the LTTD plant principle is also suitable for power plant cooling water discharge where the temperature difference around 10°C is available.

The setup of such experimental waste heat desalination plant is under progress at NCTPS, Chennai.

- **Vessel management system**

The main function of Vessel Management Cell (VMC) is the Operation, Maintenance and Management of vessels such as Coastal Research Vessels (CRV) Sagar Purvi and Sagar Paschimi, Buoy Tendering Vessel (BTV) Sagar Manjusha and Oceanographic Research Vessel (ORV) Sagar Nidhi.

- **Ocean acoustics and modelling**

Acoustics offers an exciting way to study ocean. Since electromagnetic waves propagate very poorly in sea water, sound wave provides the most efficient means of probing below the sea surface. Sound transports us across ocean waters and into the depths, allowing us to examine, record, and analyze their mysteries.

- **Ocean structures, Ocean electronics**

NIOT has been developing several offshore components for various programs like desalination, mining, data buoys etc. These include pipelines/risers, moorings in deep water for small buoys as well as large vessels. The need for developing several offshore components has been felt for most of the projects handled in NIOT. The group addresses such needs.

The group is involved in the development of Deep Ocean Bottom Pressure Recorder (DOPR) & surface buoy data logger for Tsunami Early Warning Systems, Autonomous Underwater Profiling Drifter (AUPD), Drifter and technologies for data communication using INSAT satellites.

- **Coastal and environmental engineering**

Coastal and Environmental Engineering (CEE) program aims to bring the state of the art technology in coastal infrastructure development through field observation, numerical modelling and engineering application.

- **Marine sensor systems**

Marine Sensor Systems group at NIOT was established in September 2005 to develop transducers and imaging systems for civilian oceanic applications. The group caters the mandate of NIOT to develop and demonstrate acoustic transducers and systems for underwater applications.

- **Marine biotechnology**

Monitoring the health of seas, analysis of data on ocean parameters, enhancement of Marine Living Resources through mariculture and study of biofouling control, etc. were the other activities of MB.

Website: www.niot.res.in

National Centre for Earth Science Studies (NCESS):

Centre for Earth Science Studies (CESS) Thiruvananthapuram became an autonomous institution under Ministry of Earth Sciences (MoES) with effect from 1st January, 2014 and was renamed as National Centre for Earth Science Studies (NCESS).

Objectives:

- Promote and establish modern scientific and technological research and development studies of importance to India and to Kerala in particular, in the field of Earth Sciences.
- Carry out field surveys and laboratory research of academic and economic significance in Earth Science related field.
- Train Government officials in planning and project evaluation in the field of mineral resources on land and offshore.
- Carry out studies in river basin evaluation, ground water management, coastal erosion, natural disaster management and mitigations and other special problems.
- Carry out promotional studies in the field of mineral development and develop techniques and design tools for Earth Science Studies.
- Contract for and undertake studies and to provide consultancy services for central and state agencies, international autonomous bodies, private sector etc.
- Establish, maintain and operate research laboratories and to construct or obtain on lease / hire and to maintain any or all equipment / machinery for effective fulfilment of the general objectives of the Centre.

Research Activities/ Projects:

Research activities are being carried out under one major theme i.e. Geodynamics and Surface Processes. The details of programme have been given below:

Crustal Processes

- Evolution of Indian lithosphere as an ensemble of differentially evolved Archaean-Early Proterozoic cratons, overlain by mid to late Proterozoic platform basins.
- Tectonic and temporal evolution of craton, mobile belts and cover sequences.
- Dynamics of plate motion in relation to lower and upper crustal rheology and Phases of acid/basic magmatism.
- Development of economically rich mineral deposits like iron, copper, chromium, manganese, gold, PGE and graphite.
- Evolution of hydrocarbon reservoirs.
- Investigations on natural hazards, particularly the earth tremors and landslides

Coastal Processes

- Integrated study on estuarine, coastal, near shore and Inner shelf dynamics. Estuarine process studies, Estuarine Management Plan, Coastal morphology & shoreline processes, Submarine groundwater discharge, Surf zone dynamics, Estuarine-Surf zone interaction, Mudbank dynamics, Inner shelf processes and its influence on nearshore and surf zone dynamics.
- Placer Mineral Deposits, Sediment (heavy mineral) budgeting, Mineralo-geochemistry of beach placers and their source-sink relationship, Investigation of various buried placer deposits in the barrier coast and shelf region for grading, standardization and value added products, Development of flow sheets for placer grading for commercial exploitation by the industry.

Atmospheric Processes

- Observational and modelling studies of cloud microphysical processes and rainfall over tropics, Setting up of observations sites at geographically important regions (near coastal, mid land and high land areas in Western Ghats), Microphysics of monsoon rainfall over coastal, mid and high altitude regions, Diurnal cycle in monsoon clouds and its thermodynamic variation over Western Ghats, Raindrop size distributions studies, Vertical structure of

shallow and mixed phased clouds, Simulation of regional scale variations in the cloud microphysical properties in relation to monsoon.

- Understanding the formation and propagation of convective thunderclouds and their electrical characteristics in Western the Ghats, Electrical nature of thunder clouds in tropics, Establishment of Lightning Location Network, Understand the characteristics of regional lightning activity including spatial and temporal occurrence, In-house development of atmospheric electricity measuring instruments, Explore the parameterization scheme for IC and CG lightning, Accident analysis of lightning strikes to understand the possible pathways of discharging to the ground

Hydrological Processes

- Geomorphic evolution and paleo-climate along selected coastal stretches of northern Kerala, Karnataka and Goa, Quaternary sea level changes, paleo-climate in sedimentary archives, evolution of coastal wetlands, Establishment of radiocarbon facilities; Optical microscope in collaboration with ARI, Pune; BSIP, Lucknow; Mangalore University, Environmental evaluation and resource assessment of river basins/ State of the environment of rivers (Kerala & Karnataka), Ecological conservation/ regeneration of lake and river systems.
- Strengthening support facilities, Input for climate change studies & pollution monitoring, Monitoring green house gas & other atmospheric emissions, Sea & estuarine water quality monitoring, Landuse/land cover changes & urban agglomeration, Strengthening Geomatics infrastructure in consonance with NSDI System, GIS, Image Processing softwares, Develop spatial and non-spatial database in conformity with NSDI, Modernization & accreditation of Chemical laboratory, Accreditation for EIA studies, Geological, terrain & land related studies, Land, atmospheric & water pollution monitoring, Strengthening geophysical instrumentation

Website: www.ncess.gov.in

India Meteorological Department (IMD):

India Meteorological Department was established in 1875. It is the National Meteorological Service of the country and the principal government agency in all matters relating to meteorology, seismology and allied subjects. The Director General of Meteorology is the Head of the India Meteorological Department, with headquarters at New Delhi. There are 6 Regional Meteorological with headquarters at Mumbai, Chennai, New Delhi, Calcutta, Nagpur and Guwahati. Under the administrative control of Deputy Director General, there are different types of

operational units such as Meteorological Centres at state capitals, Forecasting Offices, Agrometeorological Advisory Service Centres, Flood Meteorological Offices, Area Cyclone Warning Centres and Cyclone Warning Centres.

Objectives:

- To take meteorological observations and to provide current and forecast meteorological information for optimum operation activities like agriculture, irrigation, shipping, aviation, offshore oil explorations, etc.
- To warn against severe weather phenomena like tropical cyclones, duststorms, heavy rains and snow, cold and heat waves, etc
- To conduct and promote research in meteorology and allied disciplines.

Research Activities/ Projects:

To fulfil the objectives separate division has been established to deal with specialized subjects which are as follows:

- Agricultural Meteorology
- Civil Aviation
- Climatology
- Hydrometeorology
- Instrumentation
- Meteorological Telecommunication
- Regional Specialised Meteorological Centre
- Positional Astronomy
- Satellite Meteorology
- Training

Specialized Forecasts provided by IMD are the following:

Marine Forecasts, Heat wave guidance, Tourism Forecast, Thunderstorm Prediction, Fog forecasting, Air quality, Power Sector, Pilgrimage Forecast, Highway Forecast.

Website: www.imd.gov.in

National Centre for Medium Range Weather Forecasting (NCMRWF):

The National Centre for Medium Range Weather Forecasting (NCMRWF) is a Centre of Excellence in Weather and Climate Modelling under the Ministry of Earth Sciences. NCMRWF receives global meteorological observations through Global Telecommunication System (GTS) via Regional Telecommunication Hub (RTH) at

IMD, New Delhi and large volume of satellite observations through internet data services directly from various satellite data producers (NOAA/NESDIS, EUMETSAT, ISRO etc.). Continuous efforts are on to acquire and utilize maximum number of observations from various platforms, with special emphasis on Indian satellite observations.

Objectives:

- The mission of the Centre is to continuously develop advanced numerical weather prediction systems, with increased reliability and accuracy over India and neighbouring regions.
- Research, development and demonstration of new and novel applications, maintaining highest level of knowledge, skills and technical bases.

Research Activities/ Projects:

- Wind-forecast
- Rain-forecast
- Meteogram
- Dust-forecast
- Subdivisional-rainfall
- Soil-moisture and temperature etc. over the monsoon region, Indian region, and neighbouring region.
- The centre also provides products over for Southern Ocean and Antarctica.
- It also provides Severe-Weather-Monitoring Extremes Charts and also involves in MJO monitoring.

Apart from the above mentioned products the centre also is handling The Severe Weather Forecasting Demonstration Project (SWFDP). The SWFDP is World Meteorological Organization (WMO) initiative to strengthening capacity in National Meteorological and Hydrological Services (NMHSs) in developing and least developed countries including Small Island Developing States (SIDSs) to deliver improved forecasts and warnings of severe weather to save lives, livelihoods and property. The Severe Weather Forecasting Demonstration Project-Bay of Bengal (SWFDP-BoB) includes Bangladesh, India, Maldives, Myanmar, Sri Lanka and Thailand as participants with (10S-45N/45E-110E) as the area of responsibility.

NCMRWF also provides Services such as Rainfall Information, Monsoon, Cyclone, Agromet Advisory Services, Climate Services, City Forecast.

Forecasts provided by NCMRWF includes: Short to Medium Range Model Guidance, Extended Range Model Guidance, Seasonal Forecast, Quantitative Precipitation Forecast, All India Weather Forecast Bulletin, 5-day Sub-Divisional Rainfall Forecast, 5-day District-Wise Rainfall Forecast.

Website: www.ncmrwf.gov.in

Centre for Marine Living Resources and Ecology (CMLRE):

CMLRE, Cochin under the Ministry of Earth Sciences, Govt. of India has been organizing, coordinating 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 utilization through ecosystem management and R&D in basic sciences on Marine Living Resources and Ecology. The Marine Living Resources Programme envisages survey, assessment and exploitation of the MLR and studies on the response of MLR to changes in the physical environment with the objective of developing an ecosystem model for the management of the living resources in the Indian EEZ.

The Fishery Oceanographic Vessel (FORV) SagarSampada is fully utilized for these studies. On-going MLR surveys in the EEZ focus on deep sea fishery, Tuna-resources, harmful algal blooms, Bioluminescent planktons, marine mammals, environment and the productivity patterns. These efforts are complimented through allied activities under MLR namely studies on the benthos of the continental slope area, studies on biodiversity of planktons in Andaman sea, studies on the near-shore dynamics with special reference to upwelling and mud-banks, application-oriented R&D on production of pearls from the black-lip pearl oyster, development of antifouling compounds from the marine organisms, modelling efforts and maintenance of a Data & Referral Centre on FORV collections.

Objectives:

- Carry out the R & D activities in the country which inter-alia include mapping of the marine living resources, to strengthen the knowledge base on the complex interactions in the marine ecosystems of the seas around India and vulnerable ecosystems in the Indian jurisdiction.
- The Marine Living Resources Programme envisages survey, assessment and exploitation of the MLR and studies on the response of MLR to changes in the physical environment with the objective of developing an ecosystem model for the management of the living resources in the Indian EEZ.
- The Fishery Oceanographic Vessel (FORV) SagarSampada is fully utilized for these studies in addition to the information from other sources viz; satellite remote sensing, Modelling outputs, Argo profiles and Buoy data.

Research Activities/ Projects:

- Marine Ecosystem Dynamics of eastern Arabian Sea (MEDAS):
Understanding the physical processes which control the ecosystem of the eastern Arabian Sea, Biogeochemistry of Eastern Arabian sea, Biological response including fishery resources to varying ecosystem processes over the entire Arabian Sea, Activities undertaken to address the above objectives, Biogeochemistry of eastern Arabian Sea through time-series approach, Interaction between upwelling and winter convective mixing, Relative influence of anthropogenic and offshore effects on shelf biogeochemistry, Effect of deoxygenation on nutrient cycles leading to greenhouse gases production, Biological response in terms of changes in trophic interactions due to varying upwelling source water characteristics, Pelagic-benthic interactions in trophic food supply and exchanges.
- Resource Exploration and Inventorization System (REIS):
Collection, collation and dissemination of spatially and taxonomically resolved marine species records from northern Indian Ocean region through systematic survey onboard the vessel FORV Sagar Sampada, Augment the existing marine species database (OBIS) and prepare checklist for all the species under different phyla reported from Northern Indian Ocean, Maintenance of voucher specimens and tissue samples, and development of barcodes of deep sea fauna covering major phyla.

Website: www.cmlre.gov.in

National Centre for Coastal Research (NCCR):

In 1997, Government of India implemented Environment Management Capacity Building (EMCB) programme for a period of five years, funded by the International Development Association through the World Bank. The Department of Ocean Development (DOD) established a Project Directorate i.e., Integrated Coastal and Marine Area Management (ICMAM-PD), at Chennai in January, 1998 with the approval of Cabinet Committee on Economic Affairs to implement the EMCB programme. After completion of the World Bank assignment, it was decided by DOD to continue the activities of ICMAM, as a long-term R&D activity with a mandate to promote research addressing issues related to coastal processes, ecosystems, shoreline erosion, pollution, hazards and coastal vulnerability.

In order to provide a long-term organizational framework to continue the research activities, the Project Directorate is designated as the “National Centre for Coastal Research (NCCR)” an attached office of MoES. NCCR, is envisaged to develop and improve the country's capabilities in addressing the challenging problems prevailing in the coastal zone, which have societal, economical and environmental implications. These activities of NCCR would be an integral part of the

Ministry's mission to offer scientific and technical support to coastal communities and stakeholders for integrated and sustainable use of resources towards socio-economic benefit of the society.

Objective:

- To carry out multi disciplinary research related to coastal water quality, coastal process.
- To carry out research related to shoreline management.
- To understand coastal hazards-vulnerability and coastal ecosystems for the benefit of society and environment.

Research Activities/ Projects:

- Coastal processes and hazard:
Understanding of Coastal Processes through Monitoring, Modelling and prediction and development of Shoreline Management Plans along the Indian coast, Assessment of Coastal Vulnerability due to Climate Change, Sea Level Rise and Natural Hazards.
- Coastal Water:
To monitor the coastal water quality and alert the government and other stakeholder on the status of coastal health, To detect periodical changes in coastal water quality, predict pollution levels and provide real-time information of water quality and status of the coastal waters, To develop numerical model for the prediction of coastal water quality and dissemination of water quality information via web and mobile application, Conduct coastal clean campaign for Indian beaches in line with the Coastal Clean Seas campaign of United Nations and Environment Agency (UNEA), To develop Seawater Quality Criteria (SWQC) for coastal waters, waste disposal zones, fishing ports, harbours and ecologically sensitive habitats for protection of marine life, Derivation of environmental quality indices through ecological risk assessment of metals in estuarine and coastal waters.
- Coastal Habitats and Ecosystem:
Coastal Resource Assessment and Management, Ecosystem based services - an approach for the management of coastal areas.
- Capacity Building & Training:
To develop the resources available in coastal States through structured training programmes with an even mix of theory and hand-on sessions for

effective management of coastal areas and related issues, Strengthening institutional mechanisms for handling coastal issues related to pollution, hazards, processes and ecosystems through structured training and capacity building programmes, Promoting interaction among coastal stake holders by networking and facilitating exchange of information, experience and expertise.

The projects implemented included preparation of model Integrated Coastal and Marine Area Management (ICMAM) plans, GIS-based information for critical habitats, determination of waste assimilation capacity, development of EIA guidelines, determination of 'no impact zone', determination of use classification for coastal waters, shoreline management plans for selected locations, ecosystem modelling for coastal habitats, marine ecotoxicology and storm surge inundation modelling.

Website: www.nccr.gov.in

National Center for Seismology (NCS):

National Center for Seismology (NCS) is the nodal agency of the Government of India for monitoring of earthquake activity in the country. NCS maintains National Seismological Network of 115 stations each having state of art equipment and spreading all across the country. NCS monitors earthquake activity all across the country through its 24x7 round the clock monitoring center. NCS also monitors earthquake swarm and aftershock through deploying temporary observatory close to the affected region. Apart from earthquake monitoring, NCS is also actively involved in the Seismic Hazard Microzonation and seismological research.

The history of instrumental earthquake monitoring in India dates back to 1898, when the first seismological observatory of the country was established at Alipore (Calcutta) on 1 December, 1898 after the great Shillong plateau earthquake of 1897. The occurrence of devastating earthquakes such as, the 1905 Kangra earthquake, 1934 Nepal-Bihar, Assam and many other strong earthquakes, necessitated to strengthen the national seismological network progressively from a paltry 6 in 1940 to 8 in 1950, 15 in 1960 and 18 in 1970. Early 1960s marked a very important land mark in the history of seismic monitoring, when the WWSSN (World Wide Standardized Seismic Network) stations started functioning globally.

Objectives:

- Understanding the earthquake source processes and their effects through earthquake monitoring.
- Seismological research for the cause of earthquake-safe society.

Research Activities/ Projects:

- Earthquake monitoring on 24X7 basis.
- Operation and maintenance of national seismological network comprising of 115 stations, maintenance of seismological data centre and information services.
- Seismic hazard microzonation related studies.
- Aftershock/earthquake swarm monitoring/survey.
- Understanding of earthquake processes.
- Public outreach.

NCS also provides information on Earthquake catalogue, historical seismogram, and seismological bulletin.

Website: www.seismo.gov.in
