OUTCOME BUDGET
2012-13

Government of India
Ministry of Earth Sciences
January 2012

Ministry of Earth Sciences
Outcome Budget 2012-13

Appendix-4
Annexure-I

Ministry of Earth Science
Review of Annual Plan (2010-11)
Statement of Outlays & Outcomes/Targets& Up-to-date Actual Achievement (2010-11)

No.	Name of the Scheme/ programme	Intended Objective/ Outcome	Annual Plan 2010-11 Outlay (Rs. In crores)	Quantifiable Deliverables	Processes/ Timeliness of the approvals	Achievements against Column (5)	Remarks/ Risk factors
1	2	3	4	5	6	7	8
1. ATMOSPHERIC SCIENCE AND SERVICES							
1.1	Space Meteorology	• Ground segment for INSAT-3D is to be commissioned. Metop Satellite Data Receiving & Processing System to be established. Network of GPS stations will be augmented	23.00	• Ground receiver for INSAT-3D to be commissioned for receiving & processing of high resolution data. • Establishment of more 50 Nos. GPS and peripherals • Establishment of ground receiving and processing system from NOAA/MODIS/Metopodeling	2010-2011	• Met. Data receiving and processing system for Metop Satellite established. • Ground Segment equipment for reception & processing of Met. Data from INSAT-3D commissioned.	-

		with the establishment of 50 more GPS stations.					
1.2	Operation and Maintenance.	• Maintenance a network of large number of observatories for acquisition of various types of weather data and keeping climatological statistics for operation and planning in various fields like Agriculture, water conservation, oceanography etc. • Manufacturing of weather equipments and their test, calibration and standardization for use in basic observational network. • Speedy exchange of	55.00	• High Speed Data Terminals at field stations to be installed. Satellite based data receiving system to be established. • Hydromet services of IMD will be Up graded. • Climatogical data rescue system will be established. • Base line GHGs Monitoring and Regional Grab Sampling Monitoring of GHGs will be established. • Equipment will be procured for air pollution study. • UV radiation network will be established. • Digital Barometers for observatories will be procured. • Wind tunnel and sunshine recorders to be procure. • Two Nos. indigenous DWR's at Bhuj & Kochi will be commissioned. $4	2010-2011	• Supply order placed for 10 Nos. sky radiometers Environmental Monitoring and Research. • MPLs VPN connectivity, established. • Satellite based data receiving system established and High Speed Data Terminals procured. • 100 Nos. Digital Station Barometers, procured. • 2 Nos DWR for Bhuj & Kochi procured.	-

		weather data in the Northern Hemisphere through Telecommunication Hub.Augmentation and up gradation of varioud types of observational systems with state-of-art technology. • Hydrology Project – Phase-II will be implemented in coordination with Center Water Commission, Ministry of Water Resources and participating states. Imparting of training in Meteorology, Telecommunication, Instrumentation and Seismology		Nos Disdrometers and spare for IMS-1500 Radio Theodolite to be procured. Continuation of imparting of training under WMO Programme.			

		to IMD personnel and persons from developing countries under WMO Programme.					
1.3	Aviation Meteorology	• To improve weather service for aviation by up-grading airport Met. • Instruments with state-of-art technology to render aviation services at par with world standard aviation services.	13.00	• Aviation Weather Decision Support System (AWDSS) will be set up. • Nation Aviation Meteorology centre will be established. • Integared AMIs at airports and Integrated instrument system for Helicopters to be procured.	2010-2011	• EFC Approved. Process for Aviation Weather Decision Support System (AWDSS). • Integrated Airport Met. Instrument and Integrated Instrument System procurement initiated. • Vehicle for Airport offices procured. Airport Instruments will be procured for 7 Airports.	-
1.4	Agromet Advisory Services	• Modernization of Integrated Agromet. • Advisory Services of India. • Modernization of Central Agromet Observatory Unit at Pune. • Grant-in-Aid to Research	9.00	• Instruments will be procured for Agromet Advisory Services. CagMO, Pune will be modernized. Grant-in-Aid to Research institutes/universities working on Agromet Advisory Services to farmers.	2010-2011	• Equipments procured for the project “Integrated Agromet. Advisory Services”. • Central Agromet. Observatory at	-

		institutes/universities working on Agromet Advisory Services to farmers to be continued.					
1.5	Seismic Hazard and Risk Evaluation	• Archival and digitization of old seismic analog charts. • Augmentation of NSN & NSDC. • Establishment of Optimum Seismological Network. • Augmentation of VSAT based Delhi Telemetry Network. • Establishment of VSAT based seismic telemetry network in NE India. • Establishment of National Earthquake information system (NEIS). Replacement of old equipment	25.00	• Seismic monitoring stations to be set up. Achival and digitization of seismic analog charts. • Delhi telemetry Network and its augmentation by adding nine more field stations and replacement of Data Acquisition System (DAS) and communication equipment of existing 16 field stations. • National Centre for Earthquake Information (NCEI) and Portable Micro Earthquake (MEQ) monitoring system to be established. • VSAT based seismic equipment for telemetry network for NE India to be procured, installed and commissioned.	2010-2011	• Equipments for VSAT based seismic telemetry network in NE India will be procured. • Supply order for Portable Micro Earthquake Monitoring (MEQ) system placed and activities of earthquake Risk Evaluation Centre continued. • Seismic analogue charts achieved and digitized. • Operation of VSAT based Delhi Telemetry Network continued.	-

		related to Micro Earthquake (MEQ) survey. • sCreation of Data base for Seismic Hazard & Risk Appraisal (30 Citites) including seismic microzonation. Establishment of Geotechnical/Geophysical investigation Lab. Continuation of activities of Earthquake Risk Evaluation Center.					
1.6	Mod of IMD Weather Services	• Weather services of India will be Modernized by inducting new advance technology equipments. • In the process High Performance Computing	165.00	• HPCS for global data processing and numerical weather prediction for weather forecasting services in IMD will be commissioned. • Forecasting system under MFI will be commissioned. • Maintenance Centres for ARG & AWS will be set	2010-2011	• HPCS for global data processing and numerical weather prediction for weather forecasting services in IMD commissioned. • Forecasting system under MFI commissioned. • Establishment of RMC & MC for AWS & ARG is under progress. • All 550 Nos. of AWS &	-

		System at IMD will be commissioned. Commissioning of 550 AWS and 1350 ARGs and establishment of field maintenance centres for Automatic Weather Stations (AWS) and Automatic Raingauges (ARGs). • Procurement of New Integrated and Automated Systems for 42 Airports and Wi-Fi system at 20 airports. • Installlation and commissioning of 12 No. DWRs. Lighening detection systems (10 Nos) are to be procured and installed. • National		up. New integrated and automated systems for 42 airports to be procured for installation & commissioning. • 550 Nos. of AWS & 1350 Nos. of ARG will be commissioned. • Transmissometers at LKN airport and at other six airports will commissioned. • 10 Nos. lightening detection system will be procured. • Wind Profilers will be procured and installed. • Data quality of U/A data will be improved at existing 13 stations by deployment of improved quality GPS Radiosondes and improvement of data quality through indigenous development and production. • Fabrication and design development of MEMS sensors and conditioning electronics for IMD radiosonde to be completed. All 12 Nos. DWRs will be		1350 Nos. of ARG received & commissioning started. • Fabrication and design development of MEMS sensors and conditioning electronics for IMD Radiosonde completed. • 2 Nos. DWRs commissioned.	

		Weather Radar Operation Centre (NWROC) at New Delhi to be established. • Improvement of data quality at 13 existing U/A stations through deployment of improved quality GPS Radiosondes. • Establishment of Web-based briefing system at International airports. • Installation and commissioning of Automatic message switching system (AMSS) at Guwahati and Nagpur. • MFI (forecasting system) to be commissioned. • Procurement of transmissometers at 6 airports.		commissioned by Dec., 2010. • National Weather Radar Operation Centre (NWROC) will be established at New Delhi. • Information System, Security & Video Conferencing system will be established. • Web-based briefing system at International airports and Video wall for NWFC briefing room at New Delhi to be set up. AMSS at GHT will be replaced and new AMSS at NGP to be installed and commissioned.			

1.7	Common Wealth Games & Dedicated Weather Channel	• To provide venue specific real time weather information and to provide venue/ event specific weather forecasts in medium, short and now cast range. To meet round the clock requirement of authentic weather & climate information to public. • To provide detailed customized meteorological products to various sectors. • To promote research and applications in meteorology. • To create public awareness about weather/ climate phenomenon	15.00	• C-band Polarized DWR at Jaipur to be procured and installed. • Metropolitan Weather Information and forecast system for NCR Delhi and CWG 2010 will be established.	2010-2011	Metropolitan Weather information and short range forecast procured to CWG 2010. C-Band DWR and GPS Radio sonde procured.	-

		and science of forecasting.					
1.8	Numerical Modeling of Weather and Climate .	Implementation of the UKMO end-to-end Global NWP system. Implementation of the UKMO end-to-end regional NWP system NCEP based Global Forecasting System (GFS) Evaluation of the UKMO and GFS model forecasts during the monsoon season Implementation of the mesoscale WRF model and data assimilation system with nested domains of 27, 9 and 3 kms. One of the 3 km domain will		Experimental runs with the UKMO (N320, ~ 50km resolution) forecast systems. Experimental runs with the UKMO regional forecast systems (12km) Upgrade the NCEP based GFS Real time observation Monitoring. Data assimilation experiments with new datasets. Preparation of an Evaluation report Mesoscale forecasts for the Commonwealth Games Real-time seasonal prediction for monsoon 2010. Regional data assimilation and sensitivity experiments to finalize the model		Forecast runs are being made from the initial conditions downloaded from the UKMO Forecasts were provided to IMD for their nowcasting system during the commonwealth games The resolution of model was increased to T382. Data monitoring reports provided to IMD Report to be ready by the end of December Forecasts were provided to IMD Forecasts were provided to IMD Model and its domain finalized. MME forecasts during Monsoon-2010 were generated and provided to IMD	

		be over the NCR for the Commonwealth Games Development of Seasonal Prediction system South Asian Regional Reanalysis project to understand the science of climate variability and change over South Asia Development of Multi-Model Ensemble (MME) approach for forecasting rainfall in the medium range scale Implementation of the UKMO coupled ocean - atmosphere		choice, domain, physics and assimilation options Real-time medium range MME prediction for monsoon 2010. Initiate work on the implementation of a lower resolution N96 UKMO coupled ocean-atmosphere model at NCMRWF			

		modelling system					
2.0 Climate Change Research							
2.1	Climate Variability & Dynamics	To conduct basic research in all aspects of atmosphere-ocean-land system with special reference to the tropics required to improve weather and climate forecasts of tropics.	30.85	Understand causes of the decadal variability of monsoon rainfall over the Asian domain using coupled ocean-atmosphere modelling as well as diagnostic tools and explore connections of IMR variability within the Asian monsoon domain and other monsoonal regions of the world. Develop climate forecast products tailored to suit the user requirements and to demonstrate the utility of seasonal forecasts for the decision making in the areas of agriculture, water resources, etc. Publication of research papers in peer reviewed journals with good Impact Factor	-	• Assessed the impact of ENSO on Indian temperatures. • Examined the ability of the Advanced Research WRF (ARW) based regional climate model to reproduce seasonal mean climatologies, annual cycle and interannual variability over the entire Indian subcontinent and different climate sub-regions. • Aerosol and gas phase chemistry studies have been carried out to investigate the sources, transport and distribution of physico-chemical properties of aerosols in different kinds of environment different parts of the country.	
2.2	Short Term Climate Prediction	To develop a system for seasonal and extended range prediction of Indian monsoon and improve its skills	12.65	• Development of coupling strategy and running the coupled model. • Exploring the predictability of various features of ISM in these simulations. • Providing real time	-	• For the first time in India, experimental seasonal prediction of monsoon rainfall has been done using fully coupled Ocean-Atmosphere General Circulation model (OGCM) based on NCEP Coupled Forecast System (CFS) at IITM.	

				seasonal experimental statistical forecast to IMD for its validation.			
				• Observations of winds and cloud microphysics in different seasons at different places of India and thunderstorm data. Observations in the CAIPEEX • Establishment of a System of Air Pollution Forecasting and Research for Commonwealth Games-2010 **(SAFAR – 2010)** in New Delhi in 2010 and provide air pollution forecast.		• Role of southern tropical Indian Ocean warming in unusual central Indian drought of summer monsoon – 2008 was studied. • Change in potential predictability of active and break spells were estimated by an empirical method using 104-yrs (1901-2004) long daily rainfall data.	
2.3	High Performance Computer	To establish and maintain a major supercomputing facility at IITM as a central facility to cater to the HPC needs of all the modelling groups within the Institute, and also to share the facility with other groups in the country. To establish, update and maintain an extensive database	9.22	• Establishment of the High Performance Computer (HPC) facility in the specially constructed building as a central facility to cater to the HPC needs of all the modelling groups within the Institute for the research work related to ever rising demand on various issues related to weather and climate, and also to share the facility with other groups in the country and establish, update and maintain an extensive database required for modelling and observational studies.	-	• The HPC System has been upgraded from 7.2 TF to 70 TF with 2800 TB storage along with necessary infrastructure.	

		required for modelling and observational studies.					
2.4	Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX)	• To develop expertise in understanding physics and dynamics of clouds required to improve the representation of cloud processes and their interaction with large scale environment in weather and climate models.	16.07	• Hiring of instrumented air craft and cloud seeding air craft. • Carry out precipitation enhancement experiment by artificially seeding the clouds. • Carry out randomized experiment in the monsoon and post-monsoon season based on background observations of aerosols and cloud microphysics and some test cases of seeding.		• Phase II of the CAIPEEX was carried out during September – November 2010 with two aircrafts, one C Band Doppler Radar and one S Band Doppler Radar with over 200 flying hours. The RS/RW radiosonde observations were conducted in Hyderabad. Aircraft observations of aerosols and microphysical parameters and the cloud seeding were carried out. Data have been collected for scientific studies.	
2.5	Centre for Climate Change Research	• To generate reliable answers to all science questions related to regional climate change in the backdrop of global climate change.	39.00	• Start formal functioning of the Centre for Climate Change Research (CCCR). • Develop a coupled modelling system for Climate Change Scenarios. • Generate an ensemble of high-resolution regional climate change scenarios using RCMs. Assess the Climate Change Impacts on Indian Monsoon Climate.		• Developed the high resolution climate change scenarios over India for impact studies using three ensembles from the 17 member Perturbed Physics Ensembles (PPEs), based on Hadley Centre Coupled Model. • Impact of global warming on the Indian monsoon climate was studied using the Hadley Centre's high resolution regional climate model, PRECIS. • Relationship between the	

						Indian Ocean Dipole and the Indian monsoon variability has been established using a suite of standalone atmospheric GCM and ocean-atmosphere coupled model simulations.	
2.6	High Altitude Laboratory and Monitoring	• To understand the fundamental properties of clouds, its interaction with aerosol and variations of different micro-environmental parameters and to enhance our capabilities in understanding the weather and climate of the Earth System. • To analyze the observational data for their use in research towards developing improved parameteri-zation of convection in	22.00	• Preparatory work for the establishment of the laboratory at Mahabaleshwar.	-	• Instruments for the observations have been acquired.	

		climate models.					
2.7	Advanced Training in Earth System Science & Climate	To build trained human resource in the field of atmospheric and oceanic sciences required by the country.	11.00	• Initiate a job linked performance based national level training programme for about 20 students every year. • Establish a full-fledged Training Centre in the Institute.	-	• Action was initiated regarding the establishment of the Centre. Executive Director and one faculty have been appointed. Necessary preparation was made to start the first batch of the Training in August 2011with 20 trainee scientists.	
3.0 OCEAN SCIENCE AND INFORMATION SERVICES							
A	Coastal and Ocean Advisory Services	▪ Generation and dissemination of PFZ Advisories weekly thrice on Mission Mode. ▪ Establish an Ocean State Forecast and Information system to provide forecast and real-time information on ocean parameters to individuals, organizations	7.40	Potential Fishing Zone Advisory Services ▪ Operational generation ○ Sustain integrated PFZ (SST+ Chl+Wind) ○ Experimental based Tuna Fishery Forecast System (TUFFS) ▪ Dissemination ○ Installation of 50 Electronic Display Boards (EDB's) ○ SMS dissemination to all the sectors ○ Operationalisation of IVRS System through various service providers		Potential Fishing Zone Advisory Services Operational generation ▪ Sustained integrated PFZ (SST+ Chl+Wind) ▪ 146 integrated wind based PFZ (IPFZ) advisories were generated for the sectors of east and west coast of India on every Monday, Wednesday and Friday during Apr 01, 2010-Apr 30, 2011 ▪ Tuna Fishery Forecast System (TUFFS) was made operational. 87 (during April 01, 2010 – April 30, 2011) tuna fishery forecasts were generated and disseminated by	▪

		, administration and industry who deal with oceans. ▪ Providing value added services		▪ Validation, Awareness & Training ○ Conducting User Awareness Programmes/User Interaction workshops in West Bengal, Andhra Pradesh, Tamilnadu, Karnataka, Kerala, Goa, Mahastra, Gujarat and Andaman & Nicobar Islands ○ Publishing of a scientific paper from all the PFZ Validation Projects ▪ R & D ○ Initiate Fish Tagging Experiments to understand the behavioral aspects of Target Fish Species ○ Incorporation of more parameters in the PFZ forecast ○ Pursue R&D and modeling to improve the forecast		providing maps and text information similar to PFZ advisories on every Tuesday, Thursday and Saturday except during the ban period. Dissemination ▪ Installed of 45 new generation Electronic Display Boards (EDB's) ▪ SMS dissemination to all the sectors ▪ Operationalisation of IVRS System through various service providers ▪ Validation, Awareness & Training ▪ Conducted 242 small to medium level user interaction workshops all along the coastal districts [Gujarat (3), Maharashtra (13), Goa (2), Karnataka (13), Kerala (32), Tamilnadu (91), Andhra Pradesh (46), West Bengal (22), Andaman and Nicobar Islands (20)]. ▪ First INCOIS User Interaction Workshop on Feb 04, 2011 with 175 participants ▪ Provided training to two	

				▪ Publications ○ Results of the PFZ validation experiments for the year 2008-09 Ocean State Forecast Coastal Geospatial Applications • Assembly of high resolution bathymetry to improve the wave forecasts in the coastal regions • Operationalisation of Global Wave Model • Forecasts of waves, tidal currents and water level for Gujarat and Maharashtra Maritime Boards and Andman and Nicobar Port Administration • Validation of forecasted winds (NCMRWF, ECMWF, JMA, NOAA, NARL/WRF) using QuickSCAT and buoy observations. • Validation of basin wide wave forecasts with		delegates from Sultanate of Oman during January 24-28, 2011 on “Remote Sensing Applications to Fisheries” Ocean State Forecast • Started two new services in the field of ocean forecasting with “High Wave Alert” during cyclones and “Tide Prediction System” for Indian subcontinent to provide information on predicted ocean tides for five days at 178 coastal stations. The tidal information is routinely disseminated through INCOIS website (as time series plots, high and low tide listings). • High Wave Alert, a bulletin with information about risky waves for the coast of Gujarat was provided during the cyclone Phet to a wide spectrum of users through web, digital display boards and through emails in local languages. Similar alerts were issued to Tamil Nadu & Andhra coasts	

				altimeter derived wave heights. • Deployment of wave rider buoys and AWSs at four more locations • Deployment of wave height meter on board ORV Sagar Kanya (data transmission using INSAT) • Operational forecast for Currents, MLD, SST • Wave modelling workshop		during other cyclones. • Integrated “Wave height meter” with INSAT for real time data transmission for it’s use in operational wave forecasting. • Launched “Ocean State Forecast System” exclusively for Andaman and Nicobar islands and Lakshadweep Islands. This system provides wave forecasts 7 days in advance at 3 hourly intervals for the Andaman & Nicobar islands and Lakshadweep Islands. • User interaction meetings for the OSF users were conducted with NODPAC, ONGC, Coast Guard, NGOs (PMSSS, CRS), aspirant off-shore industries. • Deployed Wave rider buoy at Karwar, Port Blair and Thiruvanathapuram. The real time validation systems for coastal forecast using these data have been established.	

						• Completed the installation of ship mountable automatic Weather Station, integrated with INSAT to receive the met-ocean data at INCOIS. Data is used for validation of input parameter for OSF • Successfully completed the value added project for demarcating IV limit for Andaman Nicobar Port Administration. • Completed project for identifying the potential area for establishment of offshore wind farms along the Indian coast. ▪ On line dissemination of wind wave and swell wave was provided to Maharashtra and Gujarat Maritime Board and Port Authority of Andaman and Nicobar Islands Coastal Geospatial Applications ▪ Coastal Vulnerability Indices (CVI) for the entire coastline of India was completed. ▪ Completed the mapping and database creation of	

						coral eco-morphology for Andaman and Nicobar, Gulf of Kutch, Gulf of Mannar and Malvan. The atlas of the coral eco-morphology comprising 156 maps was prepared	
B	Computational Facility (High Performance Computing System, Ocean Portal)	Computational Facility ▪ Technical support for various programmes / projects of INCOIS, Systems Administration, IT planning and implementation, Development and Maintenance of INCOIS Website & Ocean Portal, Maintenance of various communication facilities, networking Ocean	9.41	Computational Facility ▪ Development and Maintenance of INCOIS Website ▪ Maintenance of IT Infrastructure, Communication Facilities, Computer Networking, etc. ▪ Installation of data processing systems for Oceansat-2 OCM data processing Ocean Information Bank ▪ Establishment of Oceansat-2 Ground Station ▪ Upgradation of the HRPT/MODIS Ground Station for METOP data reception ▪ Generation of Indian		Computational Facility ▪ Development and Maintenance of INCOIS Website ▪ Maintenance of IT Infrastructure, Communication Facilities, Computer Networking, etc. ▪ Installed data processing systems for Oceansat-2 OCM data processing ▪ Well maintained HPC facilities during the period. ▪ Concluded CAMC contracts of INCOIS IT Infrastructure (hardware & software) for three years period starting from May 01, 2011. ▪ Developed application software for on-site recruitment of scientists under ESO and hosted it	▪

		Information Bank ▪ In-situ and satellite observation systems and reception ▪ Ocean Data Management ▪ Generation and Validation of Satellite Products ▪ NODC, Indian Ocean (Argo & IO-GOOS) Data Centre		Ocean Hydrobase for DMQC ▪ DMQC of Indian Argo floats ▪ Remote sensing database management ▪ Biogeochemical data management ▪ QC and database generation for the new data sets ▪ Development of new data products ▪ LAS updation with remote sensing data generated at INCOIS ▪ Networking of Marine Data Centres ▪ QC and archival of RAMA moorings data ▪ Serve as the National and Regional Data Centre		from INCOIS website. Ocean Information Bank Establishment of Oceansat-2 Ground Station ▪ Civil works for the Ground Station building were completed. ▪ Oceansat-2 Data Processing systems were successfully installed ▪ Ocean Data and Information System (ODIS) was further strengthened by adding new data sets. ▪ A web-interface was developed for visualising and downloading the HF Radar data and integrated into the ODIS. ▪ The INCOIS Live Access Server (I-LAS) was upgraded with the latest version New data sets viz. weekly OCM Chl-a climatology, MLD climatology from Argo, daily passes of MCSST from NOAA AVHRR were added to I-LAS. ▪ Released a DVD (Ver 2.0) on Argo and products	

						which contains ~1,40,000 Temperature and Salinity profiles and data products. ▪ Data Search and Rescue: Initiated efforts to assemble all the CTD data collected by various institutes under MoES for development of Indian Ocean Hydrobase. Obtained 2431 raw CTD data from CMLRE collected by FORV Sagar Sampada. ▪ New data sets for station were added to COMAPS database. ▪ Served as the National Argo Data Centre and Regional Argo Data Centre. ▪ Organised user interaction workshop to promote the data products developed by INCOIS.	
C	INCOIS Operations and Maintenance (Infrastructure Development)	▪ Residential, Guest House and Hostel Accommodation ▪ Acquisition of Adjacent	7.69	▪ Execution of construction works under Campus Development Phase-2: ○ Extension of INCOIS Building		▪ Finalised the Project Management Agency and the Construction Agency through tendering process for works envisaged under Campus Development Phase-2:	•

		Land ▪ Administration, Finance & Accounts, Stores and Purchase		○ Residential Quarters ○ Guest House ▪ Hostel Accommodation		○ Extension of INCOIS Building ○ Residential Quarters ○ Guest House • Hostel Accommodation	
3.1 Ocean Observation and Information System (OOIS)							
A	R & D in ocean sciences, INDOMOD and SATCORE	▪ To enhance basic understanding and knowledge base on oceanic and atmospheric processes for predictability of ocean climate and catastrophic weather events and improve operational prediction by the respective national agencies ▪ Implementation of Global and Indian Ocean Regional Model and coastal wave forecast using SWAN nested with	8.71	Ocean Modelling activities at INCOIS ▪ Ocean Modelling and Data Assimilation ▪ Improvements in the ROMS model resultion to 1/12th degree ▪ Develop comprehensive software to prepare the files required to set up the model at very high resolution. ▪ Focussed research to improve the simulations of subsurface features. ▪ Publications in the scientific peer reviewed journals. Indian Ocean Modelling and Dynamics (INDOMOD) ▪ Support the activities envisaged under various		Ocean Modelling activities at INCOIS ▪ Implemented Global Ocean Data Assimilation System (GODAS) adopted from NOAA/NCEP on HPC at INCOIS. ▪ Provided ocean analysis products to IITM to initialize couple ocean-atmosphere model. ▪ Ocean analysis and SST anomaly for each month for the Global Ocean are made available in INCOIS Live Access Server. ▪ Successfully ported the Indian ocean regional model developed in collaboration with NOAA/GFDL on INCOIS HPC and experimentation is in progress. ▪ Hycom 2.2.18 was	▪

		WAM ▪ Gene ration of binned products of Chlorophyll-a, SST, and Kd-490 from satellite data and in-situ measurement of Chlorophyll and SST for the validation of satellite data		modules viz. ocean and climate, coastal ocean, hazard weather event and validation of ocean models by the participating agencies. Publication of results in journals. ▪ Publications in the scientific peer reviewed journals. Satellite Coastal and Oceanographic Research (SATCORE) ▪ Modelling underwater light field using HYDROLIGHT ▪ Application of all existing ocean colour algorithms to satellite data (MODIS – Aqua) under different atmospheric correction schemes and validation with *in situ* data ▪ Regular cruises in northern Arabian Sea during bloom events ▪ Understanding the variability in AOP's associated with bloom events ▪ Development of norms to check the quality of		configured on HPC at INCOIS and has been used to simulate Indian Ocean on inter-annual timescales using NOGAPS winds for the period of 2003 to 2010. ▪ A high resolution (1/16 x 1/16 degree) three-dimensional, baroclinic circulation data assimilative model, CUPOM is used to simulate and forecast SST for the application of Potential Fishing Zone (PFZ) identification. Indian Ocean Modelling and Dynamics (INDOMOD) ▪ Supported the activities envisaged under various modules viz. ocean and climate, coastal ocean, hazard weather event and validation of ocean models by the participating agencies. Publication of results in journals. ▪ Several papers were published in scientific peer reviewed journals. ▪ Scientific review was conducted to know the	

				data acquired through Hyperspectral Radiometer ▪ Preparation of ATLAS of satellite derived and *in situ* ocean colour products		progress of each sub-project Satellite Coastal and Oceanographic Research (SATCORE) ▪ While continuing the time-series measurements initiated along nine transects in Indian coastal waters, one more transect at Gulf of Mannar was added to the SATCORE project. ▪ A revision was carried out on the sampling strategy document as well as the sampling frequency along with protocols for calibration of spectrophotometer and fluorometer using standard chlorophyll-a solution. ▪ The Automatic Data Processing Chain (ADPC) setup at INCOIS was further enhanced by incorporating the ability for domain scaling, spatial resolution scaling and addition of new satellite sensor supported by SeaWiFS Data Analysis System (SeaDAS)	

						software. OCM-2 processing was also added in ADPC along with MODIS-Aqua. Three new standard products, namely Quasi True Colour Composite (QTCC), CDOM index and Aerosol Optical Thickness (AOT), were added in ADPC. 3 day, 7 day, 30 day standard rolled products as well as 30 days rolled anomaly products of chlorophyll and sea surface temperature (SST) were also added in ADPC. Two value added products such as total suspended matter (TSM) and Bloom Indices (BI) were also incorporated in ADPC. ▪ A conceptual frame work was designed, using outputs from ADPC, for detection and monitoring of Harmful Algal Blooms (HABs). The proposed methodology integrates the three bloom indicators: BI, Rolling Chlorophyll Anomaly (RCA) and SST anomaly and it is being implemented as a pilot	

						project for six areas: Mangalore, Kochi, Nagapattinam, Gulf of Mannar, Kakinada and Visakhapatnam.	
B	Ocean Observing System	To measure oceanographic parameters over Indian Ocean using different insitu plat forms to understand the Indian Ocean dynamics and validation of ocean and atmospheric models. Measuring temperature and salinity profiles up to 2000 m.	9.06	• Deployment of 40 Argo floats including few floats for Antarctic waters. • Deployment of 30 SVP-B drifters, analysis of trajectories • XBT / XCTD deployments & sea surface data collection • Servicing of 7 equatorial moorings in September-October, 2010. • Bay of Bengal mooring servicing and additional mooring will be deployed. • Support RAMA moorings depending on the availability of shiptime • Organise cruise programmes of Sagar Nidhi, Sagar Kanya and Sagar Sampada for the year 2010 to plan the deployments of Argo,		• Deployed 31 Argo floats were deployed in the Bay of Bengal, 3 in the Arabian Sea and 3 in the equatorial Indian Ocean. Three Argo floats carried oxygen sensors. • Deployed of 24 SVP-B drifters, analysis of trajectories • Carried out 316/102 XBT/XCTD observations & sea surface data collection along the ship tracks • Serviced and redeployed of 7 equatorial moorings in September-October, 2010. • Serviced and redeployed of 8 coastal ADCPs. • One wave rider buoy was deployed off Karwar coast. • Bay of Bengal mooring was retrieved and the data are being analysed • One Wave Hight Meter was installed on board	▪

				drifters and XBT. • Validation of sensor drift using float-to-float and float-to-CTD • Analysis of Argo data, long term temperature trends (decadal) in the Bay of Bengal and its impact on regional climate • Deriving new relation/equations for XBT/XCTD fall rate and temperature • Analysis of the ADCP data and RCM data to understand intraseasonal variability, semi-annual variability in the zonal velocity, deep-sea circulation in the equatorial Indian Ocean and comparison with the model simulations. ▪ Analysis of data from RAMA and BoB moorings to understand the subsurface intra-seasonal variability		ORV Sagar Kanya. • One Sediment Trap was deployed in the Equatorial Indian Ocean. ▪ INCOIS completed the installation of Automated Weather Stations (AWS) on board MoES ships.	
3.2 Early Warning Systems for Oceanographic Disasters							
A	Tsunami and Storm	▪ Early Warning Centre for	11.75	Tsunami Early Warning		Tsunami Early Warning	

	Surges Warning System	Tsunami and Storm Surges on 24 operational basis ▪ Collection, monitoring & archival of real-time data from Seismic, tide gauge, BPR and ▪ other sub-systems for use in operational early warning ▪ Developing Decision Support System (DSS) ▪ Set up and maintain communication facilities for data reception as well as dissemination ▪ Tsunami and Storm surge Modelling ▪ Creation of High Resolution Bathymetry dataset by conducting surveys. ▪ R & D in		Centre – Operations and maintainance. ▪ 24x7 operations ▪ Maintain / replace / upgrade sub-systems such as DART, Tide Gauges, Radar Network, Communication Systems, Computer Systems, etc ▪ Periodic Rehearsals Involves exercising the individual sub-systems and the total system to ensure that the system is functioning normally Improve Redundancy of observing systems ▪ Deploy 1 BPRs ▪ Install Tide gauges at 11 locations with 33 sensors Modelling ▪ Acquire ALTM data from NRSA ▪ Use of Carto DEM and ALTM data for inundation modelling		Centre – Operations and maintenance. ▪ TEWC was operational 24x7 basis ▪ TEWC reported 73 earthquakes of magnitude 6.5 during May 2010 - April, 2011 ▪ Out of 73 events during the last one year, three large (M>7) earthquakes happened in Indian Ocean viz.: (i) M7.4, 09-May-2010 in Northern Sumatra (ii) M7.5, 12-Jun-2010 in Nicobar Island and (iii) M7.5, 25-Oct-2010 in Southern Sumatra. Model simulations were analyzed for all these events and SL-2 bulletins were issued for India. While for Sumatra events, “No Threat” Bulletins were issued, in case of Nicobar Event a “Tsunami Watch” was issued for Nicobar, followed by cancellation within one and half an hour after no significant changes were observed	

		Seismology and Ocean sciences ▪ Capacity building, Training and Education ▪ Up gradation and maintenance of the equipments ▪ Periodic Rehearsals		▪ 3 D GIS mapping for vulnerable areas Communication ▪ Initiate the project for integrated real-time communication network of Seismic and GPS stations. (10 RT stations and 1 hub station) Application Software ▪ Fine-tune application software ▪ Operationalies Version 2 of the DSS International Activities ▪ Provide Service Level 2 (ETA, EWH, Sea-level Verification) as part of IOTWS Pursue R & D Projects in Tectonic Modelling & Paleo Tsunamis Efforts for achieving multi-hazard capability, especially for Storm Surges Capacity Building & Awareness ▪ Training Programmes to		in sea level gauges. ▪ Periodic Rehearsals were conducted that involves exercising the individual sub-systems and the total system to ensure that the system is functioning normally ▪ COMMs test was held on March 16, 2011, during which INCOIS disseminated tsunami notifications to the NTWC and RTWP contacts through email, fax, GTS as well as website. Improve Redundancy of observing systems ▪ Deployed one Tsunami Buoy in the Bay of Bengal and one in the Arabian Sea ▪ 63 tide gauge sensors were installed by INCOIS at 21 coastal location Modelling ○ As an improvement to the existing scenario database, INCOIS now	

				keep the technical manpower abreast with the standard operating procedures as well as latest developments; ▪ Periodic Workshops for User Community ▪ Publicity Material for the Public		uses 1000 unit sources covering all the tsunamigenic regions in the Indian Ocean. Communication ▪ Tender process completed and initiated the implementation of the project for integrated real-time communication network of Seismic and GPS stations. Application Software ▪ Version 2 of the in-house developed DSS software has been operationalised International Activities • SL-1 earthquake bulletins have been sent by email to Australia, Indonesia, Iran, Malaysia, Thailand, PTWC, JMA and IOC. • Developed SL-2 capability for the Indian Ocean region as part of the ICG/IOTWS Capacity Building & Awareness	

						▪ The first user interaction workshop was held in February, 2011 for which MHA, NDMA, Media delegates and Coastal States disaster management officials were invited. ▪ INCOIS hosted the NTWC training workshop at INCOIS, Hyderabad during February 8-9, 2011. ▪ NTWC & RTWP user guides have been prepared which includes detailed information to the users on ITEWC's facilities, procedures, criteria for action, along with sample messages.	

4.0 Polar Science & Cryosphere							
4.1	Expedition to Antarctica	• Planning, co-ordination and execution Indian Scientific Expedition to Antarctica.	85.64	• Planning, co-ordination and execution of the XXX Indian Scientific Expedition to Antarctica. • Refurbishing of Maitri and	Critical to the success of the Pro	All targeted objectives/tasks were achieved in full within the envisaged timeframe	

				replacement fo the summer huts	gra m		
4.2	Establishment of the new research base in Antarctica	• Establishment of third permanent base in Antarctica: initiation of construction work of new stattion.	64.97	• Procurement of machinery and equipment • Arrival of the expedition vessel closest to the station site as per schedule • Initiation and completion of the Phase I construction activities as per the schedule • Floating of a global EoI and identification of a contractor to undertake Phase II activities during the austral summer of 2011-12.		• Phase I construction activities were initiated and completed as targetted. • Contractor identified for undertaking Phase II construction activities	
4.3	Scientific studies in the Indian Ocean sector of the	• Planning, co-ordination and launching of the 5th multi-institutional and multi-disciplinary expedition to the	7.14	○ Initiation and completion of the targeted scientific projects mounted		• The Fifth expedition was successfully launched on 20th January 2011. • All targeted objectives were met.	.

	Southern Ocean	Southern Ocean. • Physical, biological and seabed sampling during the proposed expedition. Analysis of samples in the laboratory. Interpretation of results. ○ R & D output in the form of Scientific Publications.					
4.4	National Centre for Antarctic and Ocean Research	• Day-to-day rumming of the Centre • Continuation of In-House research programmmes at NCAOR in the realms of Ice core studies, Paleoclimatology, Polar Environment & Ecology, Sea ice-atmosphere interaction and modeling, Polar Remote Sensing, Biological studies and Southern Ocean Oceanography. • Initiation of Phase III Civil works at NCAOR	10.08	• The smooth functioning of the day-to-day activities of the Centre, including its various technical and non-technical sections/ divisions, augmenting the existing facilities, both in terms of infrastructure and human resources. • Initiation and continuation of in-house R& D activities • Implementation of the Phase-III civil works.		All targeted activites were completed within the scheduled time	
4.5	Construction and	•Appointment of a consultant for	0.71			▪ Floated a global tender for the appoint-ment of a	

	commission-ing of a Polar Research Vessel	finalization of the design specifications • Finalisation of the details of the onboard laboratories and sampling equipment				consultant in January 2010 ▪ Consultant appointed on the 15th October ▪ Action initiated to draw up the design specs of the vessel	
4.6	Scientific Expeditions to the Arctic	• Initiation of full-fledged scientific programmes in different disciplines in the Arctic • Procurement and installation of basic instrumentation for data collection and sample processing, at the Indian research base.	1.79	• Initiation of planned scientific activities • Movement of men and material from India to Artci and back as per schedule • Maintenance and upkeep of Himadri.		• Project weer initaited in the fields of atmospheric sciences, crustal deformation, Quaternary geology, biology and microbiology, glaciology, and long - term monitoring of Kongsfjorden System of Arctic region. • Initiation fo action for identification of projects to be mounted in the Arctic during the late spring through the summer of 2011.	
5.0. OCEAN RESOURCES							
5.1	Legal Continental Shelf Program (CLCS)	• To establish outer limits of Indian continental shelf under UN Convention on Law of the Sea and to make a submission on the extended continental shelf of India to the	0.84	• Defense of India's submission before the CLCS as and when the submission comes fro examination. • Developemnt of the data centre geophysical data centre		• India made its first formal presentation on the partial submission before the CLCS on 16 August 2010. • Thestate-of-the-art marine geophysical	

		Commission on the Limits of Continental Shelf (CLCS). • To initiate major geoscientific programs in the continental margin of India utilising the data collected for the above purpose. • To develop state-of-the-art national marine geophysical data archival, processing and interpretation facilities.		• Initiation of scientific projects.		data centre was commi-ssioned within the stipulated time and well within the funds allocated. • Two new projects, one centered on the Laccadive Ridge-Basin and the other one on the Gulf of Mannar were initiated.	
5.2	Deep Ocean drilling in the Bay of Bengal and Arabian Sea through the Integrated Ocean Drilling Program	• Finalisation of a National Science Plan for deep sea drilling in the northern Indian Ocean under IODP • Finalisaton and submission of a project for deep sea drilling in the Arabian Sea sector to the IODP. • Participation by Indian scientists in various programmes of the IODP.	6.00	• Finalization of National Science Plan for deep-sea drilling • Finalisaton and submission of a project for deep sea drilling in the Arabian Sea sector to the IODP. • Participation by Indian scientists in various programmes of the IODP		The National Science Plan as well as the proposal for deep sea drilling in the Arabian Sea sector were finalised as schduled and submitted. Four scientists were nominated to participate in the drilling activities under IODP elsewhere.	-
5.3	Comprehens ive Swath Bathymetric Survey of Indian EEZ	• To carry out the swath bathymetric survey of entire EEZ	1.00	• Initaition and completion of EEZ surveys inpre-identified blocks.		*All targeted surveys completed within the timeframe. ●Processing and inter-pretation of the data	

				• Processing and interpretation of the collected data, data archival.		in progress.	

5.4	Polymetallic Nodules Programme	• Develop technology for mining nodules from the sea bed • Development of Compact Soil Tester for 6000 m	2.50	• Completion of sea trials off Angria Bank at 500 m depth • Parallel Validation of Developed Soil tester with commercial shallow water CPT • Theoretical studies and preliminary Design of Integrated Deep-sea Mining System (Phase I)		• Completion of sea trials off Angria Bank at 512 m depth • Validation trials completed at Ennore harbour (Chennai) • Completion of preliminary Design of Deep-sea Mining System	

6.0	**OCEAN TECHNOLOGY**					

6.1	**Marine Sensors & Electronics** • Under water electronic support facility	• Establishment of shock & vibration test facility, environment chamber, corrosion testing chamber	2.50	• Establishment of Shock & vibration test facility, environmental chamber, corrosion testing chamber	• Established facilities like Environmental chamber, Corrosion Chamber, shock and vibration system for standard tests.	- .
	• Underwater Component development	• Development of 250kW under water motor in shallow waters		• Testing of 250kW under water motor in shallow waters.	• Preliminary test protocol has been finalized •	
		• Development of 6.5 kVA underwater transformer		• 6.5 kVA underwater transformer	• Completed • Initiated	-
		• Development of Underwater Electrical slip ring		• Underwater Electrical slip ring	• Completed and Indian Patent application has filed for the 2-18 kHz sub bottom profiler transducer	
	• Marine Sensors & Technology Developmen	• Development of new shallow water sub bottom profiler transducers • Development of		• Realization of Transducers for shallow water sub bottom profiling. • Buried Object Scanning Sonar	• Preliminary design document with each sub components of BOSS has been prepared. The realization of various subsystems of BOSS	

	t	sensor technologies to detect, classify and identify buried objects under seabed using Acoustic and Magnetic Detection of Objects for shallow water and deep-water applications • Development of user based bio-sensors and sensors (NIOT Projects) for oceanographic applications		(BOSS) for 2D/3D imaging. • Optical biosensor for the detection of Arsenic trioxide.	including the hardware and the algorithm development are under progress. • Design of an indigenous miniaturized linear towed array using cymbal transducers has been completed and fabrication for the same is under progress • Development of an optical biosensor for detection of Arsenic trioxide with the help of metalloproteins like Haemoglobin and Myoglobin has been initiated.	
6.2	**Inter-Institutional R&D and in house developments** • Soil-Machine Interaction Studies on Deep Sea-bed Poly-	• Co-ordination of R&D works with institutions with active participation.	3.52 – Dev. tech for mining polymetallic nodules 7.30 – Dev. of upgraded version	• Literature survey • Collection of field data on existing mining technologies, mining nodule collectors, pick up devices, etc	• Literature survey completed • Collection of field data completed • Softwares for rock & soil mechanics viz KUBRIX and 3 DEC were identified.	•

	metallic Nodule Mining Systems • Modeling and Analysis of Sub Sea drive systems • Aluminium structures for Deep Sea Mining Machine • Studies on Hydraulic Lifting and Plugging of Large Solids in hoses		soil tester	• Identification of software • Modifications to be done on design parameters and modeling and analysis to be followed. • Second batch of Welding trials to be done. • Pressure loss and plugging studies of large solids	• Modifications completed and design parameters finalized. • Second batch of Welding work done and preparation of test specimens using EDM is completed. • Installation & commissioning of set up at IITM was completed. • Pressure loss studies for one set of bend angles were completed.	
6.3	**Technology development – Renewable Ocean Energy and fresh water from the sea**	• To generate freshwater using LTTD technology by utilizing the waste heat at Thermal Power Plants.	2.50	• Continuous generation of fresh water and is being used by the power plant for the construction activities of Phase-II.	• Continuous generation of fresh water in the plant at NCTPS, Ennore.	

		• To install a floating wave powered device to power small loads.		• Realization of suitable turbine / alternator and design of power module for Wave Powered Data buoy.	• Fabrication of impulse turbine for Backward Bent Ducted Buoy (BBDB) completed. It was fitted on BBDB and sea trial was conducted off Ennore Port in April 2011. The device was performing well and the data was continuously logged and sent to the base station.	
	Offshore structures	• Submarine pipeline for Rutland	1.50	• Feasibility studies for laying submarine pipeline	• Feasibility report submitted to Andaman administration for laying submarine pipeline between Rutland and South Andaman.	
	Gas Hydrates	• Development of Technological tools for Gas Hydrate exploration	11.10	• Shallow water trials of Autonomous Coring System • Winch modification in Sagar Nidhi for ACS	• Shallow water trials of Autonomous Coring System were been conducted in Bay of Bengal and 35 m core has been obtained. • MCS survey completed and data analysis is underway.	
	ROSUB 6000	• To develop an unmanned Remotely Operable		• Deployment of ROSUB 6000 at PMN site in CIOB	• ROSUB 6000 was successfully deployed at depth of 5289 metres at PMN	

		Vehicle and prove it at PMN site in CIOB		and hand over the data to NIO Goa.	site in CIOB and the data was given to NIO Goa.	
	Manned Submersible	• To develop a manned submersible with a depth capability of 4000 metres		• To identify the joint partner and for developing the submersible	• Technical evaluation of the bids was completed and commercial evaluation of shortlisted firms in progress	
	Ocean Science and Technology for Islands	• Development, deployment and demonstration of open sea cage culture of fin fish • Isolation, screening and development of mass culture micro algal system for biochemical and nutraceutical production.	6.72	• Design and development/procurement of sea cages suitable for Indian condition • Experiment on feeding with various type feed and growth monitoring • Demonstration and training of coastal fisher in open sea cage culture • Experiments on different method of mass culture of marine micro algae • Development of photobioreactor for mass culture of marine micro algae • Training to R&D	• Deployed two numbers of HDPE cages at Olaikuda village, Rameswaram. • Juvenile parrot fishes of 200 - 300 g were cultured and a total of 48.6 kg of live Scarus ghobban was harvested and sold at rate of Rs.150/kg by the beneficiary • Development and installation of tubular photobioreactor, raceway and bubble column reactor for mass micro algal culture was completed at Lakshadweep. • The effect of different nitrogen sources on the heterotrophic production of lutein by the micro alga strain CH-An-3 in progress. • Experimental electrolytic	•

		• Isolation and culture of deep sea bacteria • Development and testing of materials and coatings for biofouling control and antifouling measures		institute for micro algae mass culture for biochemical and nutraceutical production • Metagenomic studies of deep sea environmental samples • Island Resource Information System • Laboratory trials & evaluation of materials, coatings, composites &synthetic foam • Development of newer and advanced technology for biofouling control and antifouling	flocculation of one and ten litre algal culture has been completed • Twenty five deep sea bacterial strains were isolated and being maintained. • Two crude extract from seaweed (Stoechospermum marginatum, Turnbinaria conoides) has shown positive antimicrobial test, further purification of active compound is in progress.	
	Technical Criteria Atlas	• Develop a reference for engineering design of coastal	3.00	• Field Observations Updating of	• Different global data on tidal constituents tested	•

		infrastructure and coastal protection along the coast of India, providing seasonal extreme value estimates of hydrodynamic loads in the form of waves, currents and water levels at 10 locations, for different return periods such as 5,10,25,50 and 100 years.		secondary data base. • Model set up and simulation using the updated database. • Second level sensitivity analysis based on the model results with updated database. • Validation of the model results with field measurements and climatological data	• Updated the secondary data base with ETOPO1, NCEP wind data and cyclone tracks • Carried out sensitivity analysis with updated secondary data base. • Validated the preliminary model results with secondary data	
6.4	**Demonstration of Shore Protection Measures through Pilot Projects**	• To characterize littoral transport phenomena along key sites of the Indian coast for sustainable coastal infrastructure planning and management • Prioritization of sites	5.00	• Field data collection (oceanographic, hydrographic, geophysical geo-technical, water quality, long shore current, sediment etc.) for modelling. • Estimation of	• Desktop study has been carried out to assess the mass loading of pollutants from various industries • The water and sediment quality of Buckingham canal, Korattalyar river and Amullavoyal canal were analyzed to assess the loading of pollutants to the Ennore creek system.	

		based on development proposals in consultation with the stakeholders and / or state governments • Demonstration of the performance of environmentally friendly shoreline stabilization measures at high priority sites		sediment budget using different available formula at measurement site. • Detailed engineering measurements and designs for site – specific solutions using geotextiles, gabions submerged dikes, groynes	• Carried out the extraction of backscatter information out of test data from Multibeam sonar. • Optimised procedures for multibeam data processing using the new PDS2000 software.	
	Ocean Acoustics	• Design and Development of Vector sensor • Ambient noise	4.85	• Vector sensor for shallow water applications. • Validation of Algorithms for Vector sensor array source localization and signal estimation.	• Sensors based on CTA technology is abandoned due to handling difficulties and alternate sensors for particle velocity measurement is explored. Sourcing of 3-D vector hydrophones from SUASIS Turkey is under consideration. • Field measurements made and validation is being carried out.	•

		measurement systems in shallow waters. • Low frequency setup for calibration of transducers • Modules of numerical solution for sound propagation with benchmark problem. • Development of Algorithms for sea floor back scatter.		• Ambient noise measurement stations in shallow water. • Facility for low frequency calibration • Sound propagation model • Algorithm for analysis of sea floor back scatter data	• Deployment of ambient noise systems off Cuddalore and Cochin for time series measurements • Tender process completion and commencement of work for facility • Bench mark problems completed using model • Case studies using the algorithm completed	
	Offshore Structures • Material studies for cold water pipe for desalination • Suction pile anchor	• Material studies and testing for cold water pipes for desalination and renewable energy applications. • Development of suction pile anchor		• Different material studies and testing for cold water pipes for desalination and renewable energy applications • Demonstration of Suction pile anchor	• Material studies for cold water pipe for island desalination initiated • Suction pump design has been completed.	

	• Interface design and testing • Platform for supporting the wind turbine	• Interface design and testing • Platform for supporting wind turbine		• Development of the interface connection concepts, design and fabrication • Fabrication, erection, installation of platform with turbine.	• Pile design has been completed based on the soil data available up to 35m depth off Ennore Coast • Studies are under progress	
	Maintenance of Buoy Network	• Maintenance of 8-12 buoy network.	7.25	• Collection of Oceanographic & Meteorological data from 8-12 Met ocean buoy systems and disseminate data to INCOIS	• Successfully established 12 Buoy network by January 2011. • Successful trials of OMNI buoys Among the 12, two were OMNI (Ocean Moored buoy Network for Indian monsoon) buoys deployed with surface & sub-surface sensors. • Deployed two coastal region buoys in Andaman & Off Agatti. • Indigenized data buoy CPU developed for industry standard was deployed at BD06 location is functional and providing data from July 2010 to till date and collected data during JAL cyclone.	
6.5	**Establishment of**	• Maintenance of Tsunami buoy	-	• To collect water level data in deep	• Seven Tsunami buoys were deployed & maintained in Bay	

	National Tsunami Early Warning System and storm surges in the Indian Ocean	System		sea using Bottom Pressure Recorder (BPR) and desseminate data to INCOIS for Tsunami Early warning system	of Bengal during April, July & November 2010 in TB10, TB08, TB05, TB07, TB04 locations 7 retrieval operations were done during this period. • NIOT & INCOIS SAIC (Science Applications International Corporation) Tsunami Buoys were deployed and maintained. • In-house developed Tsunami Surface buoy CPU which was deployed in TB04 location on April 2010 successfully worked for a period of 4 months & captured the underwater seismic event on 12th June 2010. • Initiated developmental activity of Indigenous Tsunami CPU	
6.6	**Polymetallic Nodules Programme**	• Develop technology for mining nodules from the sea bed • Development of Compact Soil Tester for 6000 m	2.50	• Completion of sea trials off Angria Bank at 500 m depth • Parallel Validation of Developed Soil tester with commercial shallow water CPT	• Completion of sea trials off Angria Bank at 512 m depth • Validation trials completed at Ennore harbour (Chennai) • Completion of preliminary Design of Deep-sea Mining System	

				• Theoretical studies and preliminary Design of Integrated Deep-sea Mining System (Phase I)		

7. COASTAL MARINE ECOLOGY							
7.1	Coastal Ocean Monitoring and Prediction Systems	To assess the health of the seas	Rs.7.00	Continued assessment of status of marine pollution at 76 locations	Project Document 5 years	Completed	
				Development of GIS based Information System for 5 locations and database for 15 locations			
				Completion of field data for development of oil spill models at Chennai, Dahanu and Goa			
				Dissemination of marine pollution database for 25 more locations through WEB			
				Undertaking 6 intercalibration exercises on nutrients and trace metals			

7.2	Integrated Coastal and Marine Area Management	Application of scientific tools and techniques like mathematical modeling for Integrated Coastal Zone Management	10	Development of hydrodynamic wave and sediment transport model for Gopalpur (Orissa), Muthalapozhi (Kerala) and Alivekodi, Pavinkurve, Kundapurkodi and Devbagh (Karnataka)	Project Document 5 years	Manpower inadequate to conduct field activities. Mostly depend on project fellows of other institutions. Project	
				Completion of field data collection at Marad, Thoppayil, Puthiyakadavu, Puthiyangadi (Kerala) and Gangavaram (Andhra Pradesh) required for hydrodynamic modeling		manpower often leave the project due to lack of employment guarantee.	
				Ecosystem Modelling for Kochi and Chilka – Development of hydrodynamic and water quality model for Kochi Backwaters and Chilka lake			
				Continued collection of field			
				data at Sundarbans			
				Marine Ecotoxicology experiments for arsenic, cadmium, lead and zinc			

				completed and Draft Sea Water Quality Criteria developed			
				Software code for storm surge inundation developed and testing commenced at Machilipatnam (Andhra Pradesh)			

8. Disaster Support

8.1.	Early Warning System for Storm Surge and Tsunami	Operation and maintenance of Tsunami Warning centre on 24X7 basis. Providing advisory services to the concerned authorities on the Tsunami advisory services.	12.00	24x7 operations Multi-hazard vulnerability mapping of the Indian coast R&D in ocean science, seismology & modeling Procurement and deployment of tsunami systems similar to NOAA for comparison purpose. Maintenance of Tsunami systems will be carried out. Evolve and sanction projects for Andaman and Nicobar region in order to understand the geodynamics of the region. Strengthening of school level programme, which is aimed at imparting education, development of skill and create awareness.		The Tsunami warning system was made successfully operational by 24x7 for issue of warnings to the Indian coast as well as to other countries of the Indian ocean region with 10 minutes of the occurrence of major earthquake in the Indian Ocean region.	

8.2	Multi-hazards Early Warning Support System		5.00	• Establishment of volcanic observatory in Barren Island. • Delineate the sub-surface geological structures to understand their geometry and seismogenic potential, through seismic tomographic and seismic reflection studies. • Setting up of a few permanent GPS stations for near real time analysis of GPS data. • Estimation of strong ground motion for selected urban areas with a view to develop damage scenarios. • Mapping of active faults. • Geotechnical investigation of selected cities as an input for seismic Microzonation studies. • Estimation of long-term plate motion on Indo-Burmese arc in order to assess the seismic risk of Andaman region.		Completed developmet 3-D GIS on pilot scale from cuddlore to nagapatnam of Tamil Nadu coast.	

				• Continue the research on the seismic activity in Kachch and Koyna region.			
9.0 EXTRAMURAL RESEARCH							
9.1	R& D in Earth and Atmospheric Sciences	• To carry out basic research activities in the field of ocean and atmospheric science and develop human resource	15.00	• Enhance the forecasting capability of the country through well supported R&D programs. • Support R & D projects that address issues of National importance • Building indigenous capability through Joint developmental work with other institutes and/or organization. • Human resource development in Atmospheric and Earth Sciences		• Supported and funded 3 multi-institutional, multi-disciplinary projects in the area of weather, marine and climate science (IIT Delhi, IIT Kharagpur, CEPT University) • To encourage indigenous development have funded a project on "Biofuel from Microalgae" under an MoU with NMITLI (CSIR) • Funded writing of Text-book series in Earth Sciences for Graduate students. • The 1st recipient of Sudhansu Kumar Banerji MoES Outstanding Faculty has joined IIT Delhi • The lecture series by the Sir Gilbert Walker MoES Chair at IIT Delhi has been adopted as 1 credit course in the IIT	

						curriculum. • Under the MoU with NoAA, USA; 4 more Implementing Arrangements have been signed Tropical Cyclone Research, INSAT 3D, Tsunami Science, Detection, Analysis, Modeling & Forecasting , Dynamical Seasonal Prediction of Indian Summer Monsoon Rainfall	
9.2	Seismicity Programme, And National programme on Earthquake Precursors	Establish V-SAT connectivity to all the permanent GPS stations and seismological observatories. Hazard assessment studies for some selected cities. To strengthen GPS network	30.00	All standalone broadband seismographs and permanent GPS stations working in project mode would be connected through V-SAT t o a Central receiving station. Preparation of liquefaction map etc. as an input for microzonation of selected cities 4-5 GPS stations to be established. Establishment of Muliti-parametric observatories would be initiated at Imphal and strengthening		V-SAT connectivity to 40 permanent GPS stations and 50 seismological observatories is being provided. A project is being supported for carrying out such studies in Kolkata. A manual, describing all the steps for carrying out field investigation, data processing and analysis etc. is being finalized along with the hand book on seismic microzonation. Support is being provided for establishing 20 more GPS stations at selected	

		in the country as per the recommnedations made in the GPS document. Setting-up of Multi-parametric observatories in identified regions Support to ongoing projects.		Multiparmetric observations at Tapoban (Uttarakhand) & Himachal Himalayas		locations for strengthening the GPS network in the country. A project has been sanctioned to Manipur University for establishing MPGO at Tamenglong, Manipur. Project has been supported for setting-up strainmeters at 3 identified locations, namely, Ghuttu, Tapoban, and Dharamshala. Site preparation is going to be completed for establishing the Multi-parametric geophysical observatory at Port Blair. Projects have been supported for monitoring geochemical precursors and electromagnetic precursors. About 55 projects are being supported.	
9.3	Assistance for Oceanographic Research	• Providing assistance to 9 OASTCs and		9 OASTCs and the CoE received financial assistance			

		supporting research projects outside OASTCs					
9.4	Outreach (Exbition & Fairs Seminar)	To support Seminar, Symposia .National Awards		To support Seminar, Symposia including IITF, and other scientific conferences, and workshop organized by the Ministry and other academia in the field of ocean and atmospheric research.			

10.0. INFRASTRUCTURE DEVELOPMENT/OUTREACH ACTIVITIES

10.1	National Oceanarium	Identification of suitable partner to execute the work. Initiation for acquisition of land and appoint consultant for preparation of a document	5.00	Negotiation with State Government are underway			
10.2	Headquarter Building	to construct a new modern building having required	25.00	Completion of construction of the building in 2 years		Commission of the new building.	

		amenities to house the headquarters					
10.3	Seminars and symposium	To participate in national and international symposium, workshops and seminars to showcase the activities of the ministry		Pariticpation in the national and international symposiums including the Indian National Congress.			
11.0 CLIMATE CHANGE STUDIES							
11.1	Centre for Climate Change Research including Program on Global and regional Climate Change	To make ground preparation for the Centre at IITM.				Develop national assessment and response capabilities with skills in different areas of climate change, to build a strong science base and to synergize the research efforts on climate change by networking the national Institutions.-	
		TOTAL	**1000**				

Appendix-4
Annexure-II

Ministry of Earth Science

Review of Annual Plan (2011-12)

Statement of Outlays & Outcomes/Targets & Anticipated Achievement (2011-12) Appendix-4

No.	Name of the Scheme/ programme	Intended Objective/ Outcome	Annual Plan 2011-12 Outlay (Rs. In crores)	Quantifiable Deliverables	Processes/ Timeliness of the approvals	Achievements against Column (5)	Remarks/ Risk factors
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1.0 ATMOSPHERIC SCIENCE AND SERVICES 352.00 Cr.							
1.1	Space Meteorology	· Ground segment for INSAT-3D is to be commissioned. Metop Satellite Data Receiving & Processing System to be established. · Network of GPS stations will be augmented with the establishment of 50 more GPS stations.	23.80	· Ground receiver for INSAT-3D to be commissioned for receiving & processing of high resolution data · Establishment of ground receiving and processing system from NOAA/MODIS/Metop satellites.	2011-2012	Ground receiver for INSAT-3D commissioned Established ground receiving and processing system from NOAA/MODIS/Metop satellites	
1.2	Operation and Maintenan	· Maintenance a network of large number of observatories for	85.00	· Upgradation of Hydromet services of IMD initiated.. Climatogical data rescue	2011-2012	Under implementation	

	ce.	acquisition of various types of weather data and keeping climatological statistics for operation and planning in various fields like Agriculture, water conservation, oceanography etc · Manufacturing of weather equipments and their test, calibration and standardization for use in basic observational network. Speedy exchange of weather data in the Northern Hemisphere through Telecommunication Hub. · Augmentation and up gradation of various types of observational systems with state-of-art technology. · Hydrology Project – Phase-II will be implemented in coordination with Center Water Commission, Ministry of Water Resources and participating states. · Imparting of training in Meteorology,		scheme implemented. · Base line GHGs Monitoring and Regional Grab Sampling Monitoring of GHGs equipment procurements to be completed established. sky radiometer. · surface ozone analysers procured and installed. · Digital Station Barometers for observatories will be procured. Wind tunnel and sunshine recorders to be procure. · BEL DWR at Mumbai installed DWR at Bhuj will be installed commissioned. · 4 Nos Disdrometers and spare for IMS-1500 Radio Theodolite to be procured. · Continuation of imparting of training under WMO Programme.		To be completed Procurement under process Installation under process	

		Telecommunication, Instrumentation and Seismology to IMD personnel and persons from developing countries under WMO Programme.					
1.3	Aviation Meteorology	· To improve weather service for aviation by up-grading airport Met. Instruments with state-of-art technology to render aviation services at par with world standard aviation services.	57.50	· Aviation Weather Decision Support System (AWDSS) procurement process .	2011-2012	Nation Aviation Meteorology centre established.	
1.4	Agromet Advisory Services	· Modernization of Integrated Agromet. Advisory Services of India. · Modernization of Central Agromet Observatory Unit at Pune. · Grant-in-Aid to Research institutes/universities working on Agromet Advisory Services to farmers to be continued.	17.70	· Grant-in-Aid to Research institutes/universities working on Agromet Advisory Services to farmers. · Agromet Advisory Bulleting continued to be supplied to formers and other issues.	2011-2012	Servies have been covered upto 550 districts and all districts will be covered by March 2012	
1.5	Airborne Platforms and FDPs	· Forecast Development programme for cyclone, fog and thundersterme will implement.	21.00	· Implementation of FDP for fog, thundersterme & Cyclone will be continued.	2011-2012	Experiments on FDP is being carried out	

1.6	Seismic Hazard and Risk Evaluation	· Archival and digitization of old seismic analog charts. Augmentation of NSN & NSDC. · Establishment of Optimum Seismological Network. · Augmentation of VSAT based Delhi Telemetry Network. Establishment of VSAT based seismic telemetry network in NE India. Establishment of National Earthquake information system (NEIS). Replacement of old equipment related to Micro Earthquake (MEQ) survey. · Creation of Data base for Seismic Hazard & Risk Appraisal (30 Citites) including seismic microzonation. · Establishment of Geotechnical/Geophysical investigation Lab. · Continuation of activities of Earthquake Risk Evaluation Center.	23.00	· Achival and digitization of seismic analog charts. ·	2011-2012	VSAT based seismic equipment for telemetry network for NE India procured, installed and commissioned.	
1.7	Mod of IMD Weather Services	· Weather services of India will be Modernized by inducting new advance technology	112.00	· Maintenance Centres for ARG & AWS in process. · 550 Nos. of AWS will be commissioned. 800 Nos will be	2011-2012	HPCS for global data processing and numerical weather prediction for weather	

		equipments. In the process High Performance Computing System at IMD will be commissioned. · Commissioning of 550 AWS and 1350 ARGs and establishment of field maintenance centres for Automatic Weather Stations (AWS) and Automatic Raingauges (ARGs). · Procurement of New Integrated and Automated Systems for 42 Airports and Wi-Fi system at 20 airports. · Installation and commissioning of 12 No. DWRs. Lighening detection systems (10 Nos) are to be procured and installed. · National Weather Radar Operation Centre (NWROC) at New Delhi to be established. Improvement of data quality at 13 existing U/A stations through deployment of improved quality GPS		commissioned. Transmissometers at LKN airport and at other six airports commissioned. · 10 Nos. lightening detection systems will be procured. Wind Profilers will be procured. Procurement of 13 Nos improved quality GPS Radiosondes will be procured. Improvement of data quality through indigenous development and production. Fabrication and design development of MEMS sensors and conditioning electronics for IMD radiosonde completed. 8 DWRs will be commissioned. · Web-based briefing system at International airports and Video wall for NWFC briefing room at New Delhi to be set up. AMSS at GHT will be replaced and new AMSS at NGP to be installed and commissioned.		forecasting services in IMD commissioned. Forecasting system under MFI commissioned.	

		Radiosondes. · Establishment of Web-based briefing system at International airports. · Installation and commissioning of Automatic message switching system (AMSS) at Guwahati and Nagpur. · MFI (forecasting system) to be commissioned. Procurement of transmissometers at 6 airports.					
1.8	Common Wealth Games & Dedicated Weather Channel	· To provide venue specific real time weather information and to provide venue/ event specific weather forecasts in medium, short and now cast range. · To meet round the clock requirement of authentic weather & climate information to public. · To provide detailed customized meteorological products to various sectors. · To promote research	12.00	· C-band Polarized DWR at Jaipur will be installedand commissioned. Metropolitan Weather Information and forecast system for NCR Delhi Services continued. · Procurements of GPRS AWS and other equipments will be done.	2011-2012	Sucessfully commissioned the system and demonstrated during the common wealth games of October 2010.	

		and applications in meteorology. · To create public awareness about weather/ climate phenomenon and science of forecasting.					

2.0 Climate Change Research							
2.1	Climate Variability and Dynamics	To conduct basic research in all aspects of atmosphere-ocean-land system with special reference to the tropics required to improve weather and climate forecasts of tropics.	14.30	• Understand the mechanisms responsible for Indian monsoon variability. • Simulate the observed variability on time scales using the climate models and improve the model. • Carry out various diagnostic studies leading to identification of climate precursors for monsoon and other indices pertaining to different sectors (agriculture, water resources, and public health). • Analyse the observed data for the study of spatial, temporal, seasonal and long-term variation of air pollutant and CFCs on strategic locations. To compare the modelled output with measurements. • Develop deposition models with baseline air quality and meteorological input. • Attempt source apportionment of atmospheric pollutants and carry out model simulations.	-	• Studied the mechanisms responsible for Indian monsoon variability. • Used the climate models and improved for simulation of the observed variability on time scales. • Carried out various diagnostic studies leading to identification of climate precursors for monsoon and other indices pertaining to different sectors. • Studied sensitivity as well as predictability aspects of monsoon variability through GCM simulations. • Studied the association between Southern Ocean climate and the sea ice variability with that of ENSO phenomena. Built a system for air pollution monitoring to provide accurate information on the level of atmospheric pollutants near the industrial source regions and to delineate the sources. • Studied thunderstorms and relationship of lightning activity with the development of microphysics. • Published research results in peer	

				• Study the properties of thunderstorm and the effect of electrical forces on microphysical processes of water drops suspended in a vertical wind tunnel. • Publication of research papers in peer reviewed journals with good Impact Factor.		reviewed journals.-	
2.2	Short Term Climate Predictio n	□□To develop a system for seasonal and extended range prediction of Indian monsoon and improve its skills. •To study urban air pollution, chemical transport modelling and middle atmosphere dynamics.	10.95	□□□Develop coupling strategy and run the coupled model. □□ Evaluation of global and monsoon climate simulation in the coupled models. □□ Develop an optimal forecasting scheme for the prediction of seasonal mean summer monsoon rainfall by combination of statistical/dynamical methods with coupled model simulations. •Develop a System of Air Quality Forecasting and Research (SAFAR) for metro cities. □Publication of research results in peer reviewed journals with good Impact Factor.		•Developed an optimal forecasting scheme for the prediction of seasonal mean summer monsoon rainfall by combination of statistical and dynamical methods with coupled model simulations. • Transferred the model to IMD for operational forecasting. • Improved the skill of dynamical models in predicting the ISO phases at extended range by using coupled models. • Developed an optimal extended range prediction scheme of the Indian summer monsoon by combining the statistical approaches with the dynamical models. • Provided real time extended range experimental statistical forecast to IMD for its validation. • Developed a System of Air Quality Forecasting and Research (SAFAR) for 24 hrs forecast and real time air quality information during the Commonwealth Games 2010 in Delhi in October 2010.	

						• Published research results in peer reviewed journals-	
2.3	High Performance Computer	• To establish and maintain a major supercomputing facility at IITM as a central facility to cater to the HPC needs of all the modelling groups within the Institute, and also to share the facility with other groups in the country. • To establish, update and maintain an extensive database required for modelling and observational studies.	01.36	• Using the HPC for undertaking various climate related problems that involve running of coupled models for hundreds of years and utilizing data from the global land ocean and atmosphere. • Use the HPC for ensemble modelling required for the studies that are computationally exhaustive.	-	• Upgraded the High Performance Computer (HPC) facility from 7TF to 70 TF and necessary infrastructure to cater to the HPC needs of all the modeling groups within the Institute including CCCR and the observational programs. • Used the HPC System for the all the research and modelling activities. • Established, updated and maintained an extensive database required for modelling and observational studies.	
2.4	Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX)	• To develop expertise in understanding physics and dynamics of clouds required to improve the representation of cloud processes and their interaction with large scale environment in weather and climate models.	23.55	• Carry out randomized airborne observations with the instrumented aircraft. • Carry out artificial clouds seeding based on background observations of aerosols and cloud micro-physics and some test cases of seeding. Archive and analyze the observational data. • Organize ground observations.	-	• Carried out randomized airborne observations with the instrumented aircraft. • Carried out artificial clouds seeding based on background observations of aerosols and cloud microphysics and some test cases of seeding. • Archived the observational data. • Published research results in peer reviewed journals.	•
2.5	Centre for Climate Change Researc	• To generate reliable answers to all science questions related to regional climate change in the backdrop of global	58.50	• Develop coupled modelling systems for Climate Change Scenarios and generate ensemble of high-resolution regional	-	• Attempts were made to assess the Climate Change Impacts on Indian Monsoon Climate; India's water resources, agriculture etc. and developed a Climate Change Data	

	h	climate change.		climate change scenarios. • Provide probability estimates of projected climate changes along with quantified reliability levels. • Publish research results in peer reviewed journals of good Impact Factor.		Archive and Retrieval system. • Provided probability estimates of projected changes along with quantified reliability levels. • Improved the methods to quantify uncertainties of climate projections and scenarios, including long-term ensemble simulations using complex models. • Published research results in peer reviewed journals.	
2.6	High Altitude Laboratory and Monitoring	• To understand the fundamental properties of clouds, its interaction with aerosol and variations of different micro-environmental parameters and to enhance our capabilities in understanding the weather and climate of the Earth System.	10.00	• Organize observational campaigns in Mahabaleshwar for understanding the fundamental properties of clouds, their interaction with aerosols and variations of different micro-environmental parameters. • Acquire suitable land for the laboratory. • Enhance and renovate the existing laboratory facilities at IITM, Pune. • Develop necessary infrastructure and facilities at IITM, Pune.		• Organized observational campaign in Mahabaleshwar for understanding the fundamental properties of clouds, their interaction with aerosols and variations of different micro-environmental parameters. • Acquired instruments for the observations. • Enhanced and renovated some of the existing laboratories at IITM, Pune. • Action has been in progress to acquire suitable land for the laboratory at Mahabaleshwar.	•
2.7	Centre for Advanced Training in Earth System	To build trained human resource in the field of atmospheric and oceanic sciences required by the country.	11.00	• Recruitment of faculty scientist. • Selection of Trainee Scientists. • Start running the courses. • To search a suitable land for the buildings.	-	• Recruitment of faculty scientists and Trainee Scientists was made. • Started running the courses. • Action has been in progress to acquire suitable land for the buildings of the Centre.-	•

	Science and Climate (CAT ESSC)						
3.0 OCEAN SCIENCE AND INFORMATION SERVICES							
A	Coastal and Ocean Advisory Services	▪ Generation and dissemination of PFZ Advisories weekly thrice on Mission Mode. ▪ Establish an Ocean State Forecast and Information system to provide forecast and real-time information on ocean parameters to individuals, organizations, administration and industry who deal with oceans. ▪ Providing value added services	7.25	Potential Fishing Zone Advisory Services ▪ Sustain Integrated PFZ forecast (SST + CHL + Wind) ▪ Sustain Tuna Fishery Forecast System (TUFFS). ▪ Operationalisation of the PFZ Advisories using alternative SST / Chl data sets for overcoming the cloud limitation ▪ Procurement of another 25 EDBs to meet the user requests ▪ Initiate efforts for migration of satellite connectivity to the EDBs from WorldSpace to INSAT ▪ Signing of MoU's with other mobile service providers / agencies for dissemination of PFZ,		Potential Fishing Zone Advisory Services ▪ 59 integrated wind based PFZ (IPFZ) advisories were generated for the sectors of east and west coast of India on every Monday, Wednesday and Friday. ▪ Installed of 02 new generation Electronic Display Boards (EDB's) Kerala (Vizhinjam) and North Tamilnadu (Thengaithittu) ▪ Conducted 57 validation campaigns in Gujarat (02), Maharashtra (04), Karnataka (02), Goa (01), Kerala (10), Tamilnadu (01), Andhra Pradesh (17), West Bengal (09), Andaman (07) ▪ Conducted 18 small to medium level user interaction workshops all along the coastal districts [Maharashtra (02), Tamilnadu (03), Andhra (09),	▪

				OSF and Tsunami information through their mobile applications. (Target: Handygo, IFFCO, Spice Digital, Nokia Talk, etc.) ▪ Operationalisation of SMS dissemination to all sectors Ocean State Forecast OSF- INDOFOS-Water Quality ▪ Operationalize the higher resolution (1/8^{o}) ROMS set-up for the regional forecast ▪ Implement a suitable data assimilation scheme in ROMS setup for the regional forecast ▪ Experimentation with SWAN using WWIII boundary conditions to simulate the coastal wave conditions. Regional a Forecast: ▪ Sustaining the generation and dissemination regional forecasts for the Arabian Sea, Bay of Bengal, South China		West Bengal (02), Andaman (02)]. Carried out 238 field visits for fish catch data collection [Gujarat (08), Maharashtra (06), Karnataka (06), Goa (03), Kerala (49), Tamilnadu (44), Andhra Pradesh (47), West Bengal (15), Andaman (60)] Ocean State Forecast ▪ Operationalized very high resolution (1/8^{o}) regional forecast system using ROMS ▪ Data assimilation based on optimal interpolation technique is being tested. As a first step, the merged sea level anomaly data from AVISO is assimilated. Analysis of the simulations shows that there is considerable improvement in the surface current and temperature simulations. ▪ Wave parameters are simulated using SWAN model with boundary conditions from WAVEWATCH III model for two selected regions (viz, Pondicherry and Karwar). The analysis of the simulations suggests that there is considerable improvement in	

				Sea, Persian Gulf, Red Sea and also, Global forecast. ▪ Improving the open ocean forecast using multigrain Wave Watch III (3.14 V) model ▪ User Interaction: Improve the collaborations with NGO's and other agencies for forecast utilization. ▪ Awareness campaign on Ocean State information system for port and harbors, shipping and oil industry. Coastal Forecast: ▪ Sustaining coastal and location specific forecast. ▪ Improving spatial resolution of coastal forecast. ▪ Experimental coastal and location specific coastal wave and swell forecast using WWIII and SWAN ▪ Validation of the wave and Swell Forecast using buoy spectrum. ▪ Deployment of IRAWS for real-time validation and		the simulation of wave parameters when SWAN is nested with WaveWatch III. ▪ An exclusive ocean state forecast service for the southern districts of Kerala state (Thiruvanandapuram, Kollam and Alapuzha) has been set-up. The forecasts are disseminated in local language (Malayalam) through INCOIS website as well as electronic display board installed at the harbour. ▪ Started broadcast of location specific ocean state forecast for Karnataka coast though All India Radio in Kannada. ▪ Completed preparation of Wind Power Density (WPD) maps along the Indian coast to identify the potential sites for offshore wind energy farms. ▪ Installed Automated weather station in ORV Sindhu Sankalp (managed by National Institute of Oceanography) to measure surface wind speed and direction, rainfall, radiation, sea surface temperature and surface pressure along the cruise track. The AWS	

				monitoring. ▪ Procurement and augmentation of AWS with additional water quality sensors. ▪ Deployment of wave rider buoys and wave height meter for Coastal and open ocean wave/swell monitoring and real time validation. ▪ Experiments with Oil spill models and initiation for oilspill monitoring and trajectory forecasting system ▪ Improvement of dissemination system (more EDBs, Mobile phones, DTSI (Direct to ship through INSAT etc.) ▪ Value - added Services and consultancy Services: Take up value added services and consultancy services (IV limits, Wave climatology, customized forecast) for the coastal and offshore applications ▪ Analysis of Dissolved oxygen data from Argo and manuscript		transmits data INCOIS directly. ▪ A Three day workshop on data assimilation has been organized at INCOIS during which assimilation expert Dr. Laurent Bertino from NERSC has given lectures on data assimilation. ▪ Awareness program for the coastal community in Valiyathura/Vizingam area for the effective usage of OSF information was conducted in Thiruvananthapuram dist. (Kerala). ▪ Trajectories of six incidents of oil spills in the Arabian Sea and Bay of Bengal were simulated with GNOME model forced with both surface winds and surface currents. Majority of the cases showed very good agreement with the observed trajectories. ▪ A manuscript in which the results of the analysis of dissolved oxygen data from Argo is under first revision. ▪ ROMS model with bio-geo-chemical component (based on Fennel et. al. 2006, 2008) is being set-up.	

				preparation ▪ Background study for water quality forecast ▪ Setting up model (ROMS with Biogeochemistry component) Coastal Geospatial Applications ▪ Fine tuning CVI maps with additional parameters ▪ Continuing multi-hazard mapping for the Indian coast ▪ Coral reef Health Modelling studies to generate health bulletins ▪ Assessment of the historical bleaching events to understand the changes in the bio-physical changes in the coral environs ▪ Initiate the reef bleaching warning system ▪ Optical Characterization of Coral Reefs: Spectral Library, Multi-parameter based reef response model, Approach/algorithm for automated zoning of		▪ Successfully integrated the UHF transmitter to communicate the data from wave rider buoys deployed by INCOIS via INSAT 3E. Laboratory test was conducted on 29th September 2011. Environmental tests are in progress. Coastal Geospatial Applications ▪ CVI mapping for the entire Indian coast is completed and the atlas has been prepared. ▪ EOI has been received from various firms upon request for carryout various components of the Multi-hazard vulnerability mapping. ▪ Historical bleaching carried out for the two case studies for the events summer months of 2005 and 2010. ▪ Coral Bleaching Alert System (CBAS) has been initiated since February 2011 as part of the health bulletins. The bleaching warning products will be generated biweekly basis and available on our website. ▪ The work on the optical characterization of the coral reefs is in progress. The in-situ sampling of the reef radiometer	

				coral reefs. ▪ Improved classification techniques for the eco-morphological Zonation		spectra has done. The assessment of the environmental parameters is in progress.	
B	Computational Facility (High Performance Computing System, Ocean Portal)	Computational Facility ▪ Technical support for various programmes / projects of INCOIS, Systems Administration, IT planning and implementation, Development and Maintenance of INCOIS Website & Ocean Portal, Maintenance of various communication facilities, networking Ocean Information Bank ▪ In-situ and satellite observation systems and reception ▪ Ocean Data Management ▪ Generation and Validation of Satellite	8.91	Computational Infrastrcuture ▪ Establishment of Communication Network & Data Centre for Integrated Nationwide Seismic/GPS project ▪ Augmentation of Tsunami IT Infrastructure with Intel Xeon Blade Servers to meet the additional requirements of data acquisition & processing of various sensors, maintain two level redundancy and to improve the performance of Tsunami Warning System ▪ Operationlisation of		Computational Infrastrcuture ▪ Developed an on-line application for the purpose of ESSO recruitment and report generation and hosted the same on INCOIS web-site. ▪ Data processing systems for the Oceansat-2 data acquisition and processing were setup ▪ Installation and configuration of Blade servers for Tsunami Early Warning System. ▪ Development and Maintenance of INCOIS Website and IT Infrastructure including HPC, Communication Facilities, Computer Networking, etc.	▪

		Products ▪ NODC, Indian Ocean (Argo & IO-GOOS) Data Centre		Tsunami DR site at TCS, Hyderabad ▪ Development and Implementation of INCOIS Intranet Application for Admin. Areas ▪ Maintenance of IT Infrastructure, Communication Systems, Electrical, etc ▪ Development and Maintenance of INCOIS Website ▪ Maintenance of HPC Facilities ▪ Mirror sites for INCOIS Web-site and Data Centre at IITM Ocean Information Bank ▪ Establishment of Oceansat-2 Ground Station ▪ Upgradation of the HRPT/MODIS Ground Station for METOP data reception ▪ Generation of Indian Ocean Hydrobase for DMQC ▪ DMQC of Indian Argo floats		Ocean Information Bank ▪ Ground Station for Oceansat-2 was established and made operational for acquisition and processing of Ocean Color Monitor data in real-time. ▪ Acquired data from in-situ and remote sensing ocean observing systems in real-time and provided data services to in-house operational activities and other operational agencies in the country. ▪ Received Mean Sea Level data from 25 stations from Survey of India.	

				▪ Remote sensing database management ▪ Data Search and Rescue operations ▪ Biogeochemical data management ▪ QC and database generation for the new data sets ▪ Development of new data products ▪ LAS updation with remote sensing data generated at INCOIS ▪ Serve as the National and Regional Data Centre ▪ Sustaining in situ data archival, processing, quality control from platforms viz., Argo, XBT, Moored Buoys, Drifters, Current Meters, ADCP, Indian Ocean Cruises			
C	INCOIS Operations and Maintenance (Infrastcture Development)	▪ Residential, Guest House and Hostel Accommodation ▪ Acquisition of Adjacent Land ▪ Administration, Finance & Accounts, Stores and Purchase	7.68	▪ Execution of construction works under Campus Development Phase-2: o Vertical Extension of INCOIS Building o Residential Quarters o Guest House		▪ Project Management Agency for undertaking the execution of the project, finalized. ▪ Technical specifications, Tender documents etc. were finalized and work has been awarded to a suitable Agency for a value of Rs. 32.24 Cr. (Composite Contract inclusive	▪

						of Civil, PH, Electrical, HVAC and other allied works) ▪ Soil investigation, finalization of layout of buildings, site clearances etc; completed. ▪ Foundation work for the residential buildings is in advance stage of progress. ▪ For vertical extension of the Amenity Building, work pertaining to extension of the existing columns is in progress. ▪ For vertical extension of the Main Building, preliminary work pertaining to the extension of the existing columns is in progress. ▪ For new 10 acre land, contour survey work completed and construction of the compound wall is in progress.	
3.1 Ocean Observation and Information System (OOIS)							
A	Ocean Observing System	To measure oceanographic parameters over Indian Ocean using different insitu plat forms to understand the Indian Ocean dynamics and validation of ocean and atmospheric models. Measuring temperature and salinity profiles up to 2000 m.	8.40	▪ Deployment of 30 Argo floats ▪ Deployment of 15 drifting buoys ▪ XBT/XCTD (100 deployments) ▪ Retrieval and deployment of equatorial current meter moorings (7) ▪ Retrieval and		▪ Deployed Argo floats (28), Drifting Buoys (14), XBT /XCTD (115), Wave Rider Buoy (1) in the Indian Ocean during May-Jul 2011. ▪ Two 30 days cruise was organized to service 8 RAMA moorings and to deploy 2 new RAMA moorings during June-July 2011 using ORV Sakar Kanya and ORV Sagar Nidhi.	

				deployment of ADCP current meter moorings ▪ Deployment of Bay of Bengal moorings with ddditional current meters ▪ Retrieval and deployment of 15 RAMA mooringsSet up Mirror server at INCOIS for RAMA mooring data reception			
B	Research and Modelling (INDOMOD, SATCORE and R&D PROJECTS)	▪ To enhance basic understanding and knowledge base on oceanic and atmospheric processes for predictability of ocean climate and catastrophic weather events and improve operational prediction by the respective national agencies ▪ Implementation of Global and Indian Ocean Regional Model and coastal wave forecast using SWAN nested with WAM ▪ Gene ration of binned products of Chlorophyll-a, SST, and Kd-490 from satellite data and in-situ	7.63	Ocean Modelling activities at INCOIS ▪ Validation of MOM with GODAS for Indian Ocean reanalysis from 2002 to present. ▪ Assimilation of Indian moored buoy data and XBT data for improvement of Ocean Analysis. ▪ Assimilation of Altimeter data in MOM ▪ Validation of Ocean winds from Scatterometers (Oceansat and ASCAT) ▪ Test experiment to evaluate the impact of Moorings and Argo floats in the Indian Ocean region		Ocean Modelling activities at INCOIS ▪ An important pre processing component of the proposed 1/12 degree Hycom forecasting system has been setup at INCOIS, ▪ Global Ocean analysis products were generated using MOM-GODAS and the same updated in INCOIS Live Access Server. ▪ Sensitivity experiments to know the impact of each (argo, xbt, and moorings) observing system using GODAS-MOM were performed. ▪ Three day workshop on data assimilation was organized at INCOIS during which assimilation expert Dr. Laurent Bertino from NERSC	▪

		measurement of Chlorophyll and SST for the validation of satellite data		▪ Setup high resolution Ocean model for Bay of Bengal region using MOM ▪ Deliver improved Ocean reanalysis for the Indian Ocean region with assimilation of Argo, moored buoy, satellite derived SST and altimeter data ▪ Deliver surface currents for the Indian Ocean using scatterometer and altimeter Indian Ocean Modelling and Dynamics (INDOMOD) ▪ Simulate fields of climatological circulation, temperature and salinity of the Indian Ocean and chlorophyll distribution in the Indian Ocean ▪ Mapping the region in the Bay of Bengal that has a shallow fresh near-surface layer and deep isothermal layer, and the response of the Bay to cyclones ▪ Impact of remote forcing		has given lectures on data assimilation. Satellite Coastal and Oceanographic Research (SATCORE) ▪ Carried out validation studies using Medium-spectral Resolution Imaging spectrometer (MERIS) and MODISA with the in-situ measurements from Satlantic™ hyperProII sensor. The results were communicated for publication. ▪ Analysed the Chla time series data to study the variability within empirical (OC3M) and semi-analytical (GSM) algorithm and also spatio-temporal dynamics of Chla in Indian coastal waters. The results showed significant variability in Chla within different algorithms, both spatially and temporally. The results were communicated for publication ▪ Analysed the MODISA data during post-monsoon (01 October 2009 to January 2010) and pre-monsoon (01 February 2010 to 31 May 2010) by applying OC3M algorithms and identified two	

				on the oceanic processes and basin scale dynamics of the coastal processes Satellite Coastal and Oceanographic Research (SATCORE) ▪ Improve Automatic Data Processing Chain with addition of new sensor such as OCM-2 & MERIS, Value added products from OCM-2 & MERIS and generate Satellite derived geophysical values, for each products, at each time series station. ▪ User interactive database of bio-optical parameters generated from SATCORE time-series stations. ▪ Detection and Monitoring of HABs. ▪ Automatic Detection of Fronts from Ocean Colour Satellite Data. ▪ Initiate Productivity and Ecosystem Modeling.		stable Chla fronts in the Arabian Sea. ▪ A meeting was conducted to review the projects funded under the SATCORE project	
3.2	Early Warning System for	▪ Early Warning Centre for Tsunami and Storm Surges on 24 operational basis	11.75	▪ Sustain Tsunami Early Warning Service ▪ Maintenance of 2 SAIC Tsunami Buoys and Tide		▪ Tsunami early warning centre reported 96 major (M>6) earthquakes. ▪ INCOIS has participated in	

	Tsunami and Storm Surges	▪ Collection, monitoring & archival of real-time data from Seismic, tide gauge, BPR and ▪ other sub-systems for use in operational early warning ▪ Developing Decision Support System (DSS) ▪ Set up and maintain communication facilities for data reception as well as dissemination ▪ Tsunami and Storm surge Modelling ▪ Creation of High Resolution Bathymetry dataset by conducting surveys. ▪ R & D in Seismology and Ocean sciences ▪ Capacity building, Training and Education ▪ Up gradation and maintenance of the equipments ▪ Periodic Rehearsals		gauges at 21 locations ▪ Fine tune & generation of remaining scenarios for Indian Ocean and Global sources using TUNAMI F2 ▪ Fine tune DSS for Service Levels as per National & Regional SOP ▪ Fine tuning the tsunami website ▪ Validation and use of CartoDEM & ALTM data for tsunami modelling ▪ Initiate setting up of stand-by coastal inundation models ▪ Pursue Storm surge modelling ▪ Operationalisation of professional version of DSS software through industry ▪ Work out mechanisms for interacting with public and media during an event ▪ Efforts to become full-fledged RTWP by providing service level-2 for the Indian ocean region		the second international communication test (COMMs Test) conducted by ICG/IOTWS on 15 June 2011. 20 recipients from different organizations viz. National Disaster Management Authority (NDMA), Battalions of National Disaster Relief Force (NDRF), Coastal State disaster relief commissioners, Indian Navy, Disaster Management Administrators from Andaman & Nicobar Islands etc. were involved in the test. INCOIS disseminated the test messages through Email and Fax. The participants are requested to send their feedback on the reception of the messages and are documented.	

				▪ Participate in the COMMS Test and IOWave11 exercises ▪ Implementation of the Seismic Networking Project			
4. 0 ***POLAR SCIENCE/ CRYOSPHERE***							
4.1	*A. Expedition to Antarctica*	• Planning, co-ordination and execution of all scientific and logistics tasks related to the XXXI Indian Scientific Expedition to Antarctica.	86.50	Launching schedule of the Expedition, the no. of field studies initiated, the spatial coverage of field data acquisition, and the number of samples/sampling stations vis-à-vis the corres-ponding targets	Crit ical	• Finalised the focus areas of study, the scientific projects to be mounted, and the team composition. • MV Ivan Papanin, the chartered vessel sailed off from Cape Town for Larsemann Hills on the 26 October 2011 with 40 expedition members including construction team and helicopter crew and 292 containers on board. • NCAOR played host to the 12th Meeting of the Asian Forum for Polar Sciences from 24th to 26th August 2011 at Goa.	The schedule of the expedition totally dependent on the vagaries of weather and the availability of a suitable vessel

4.2	*Establishment of a new research base in Antarctica*	• Initiation and completion of Phase II construction activities	185.00	% of construction activities carried out vis-à-vis the target	Very critical	• Procurement of machinery and equipment • The vessel sailed off from Cape Town for Larsemann Hills on the 26 October 2011 with 40 expedition members including construction team and helicopter crew and 292 containers on board.	
4.3	*Scientific studies in the Indian Ocean sector of the Southern Ocean*	Launching of a multi-disciplinary and multi-institutional expedition to the Indian Ocean sector of the Southern Ocean.	9.00		Initiation and completion of the targeted scientific projects mounted	The sixth multi-institutional expedition to the Southern Ocean is proposed to be launched under the aegis of NCAOR from Goa during December 2011. Scientific propsoals have already been sought at a national level and based on the peer-review by a duly-costituted Group of Experts and presentations by the PIs, the final list of projects to be initiated would be drawn up for seeking the requisite approvals.	
4.4	*NCAOR-Manpower,*	• The smooth functioning of the day-	15.00	Quantum of civil work carried out vis-à-vis the target	critical	Continuation of construction activities reated to Phase III	

	maintenance and infrastructure	to-day activities of the Centre, including its various technical and non-technical sections/divisions, augmenting the existing facilities, both in terms of infrastructure and human resources. • Phase III constructions				civil works at NCAOR.	
4.5	*In-house R&D activities at the NCAOR*	• Continuation of In-House research programs at NCAOR in the realms of Ice core studies, Paleoclimatology, Polar Environment & Ecology, Polar Remote Sensing, Biological studies and Southern Ocean Oceanography.		The number of projects taken up and completed, the number of samples analysed vis-à-vis the target	Critical	Continuation of In-House research prog-rams at NCAOR in the realms of Ice core studies, Paleoclimatology, Polar Environment & Ecology, Sea ice-atmosphere interaction and modeling, Polar Remote Sensing, Bio-logical studies and Southern Ocean Ocean-ography.	
4.6	*Construction and commission-ing of a Polar Research Vessel*	• Finalisation of the EoI for identification of a ship builder • Finalisation of the details of the onboard laboratories and sampling equipment • Evaluation of the RFP, selection of the builder and awarding	69.00			▪ Finalisation of the EoI document for identifying and short-listing the ship builders and floating the same (Completed) ▪ Finalisation of the concept design, and majorspecifications of the vessel such as the propulsion system, the ice-	

		of the contract				breaking capability etc. (Completed) ▪ Short-listing of the ship builders through the EoI (Completed) ▪ Preparation of the RFP and issuance of the same to the short-listed builders (In progress) ▪ Evaluation of the RFP, selection of the builder and awrading of the contract (To be taken up)	
4.7	*Scientific Expeditions to the Arctic*	• Initiation/continuation of scientific projects in the fields of atmospheric sciences, quaternary geology, biology/microbiology, long-term monitoring of the Kongsfjorden, glaciology and Crustal studies • Maintenance and upkeep of Himadri station	8.00	No. of days of field studies, the number of studies carried out, the spatial coverage, the number of samples generated/observations made vis-à-vis the corresponding targets	Critical	Between April and October 2011, following studies were taken up centred on Ny-Ålesund: Long-term monitoring of Kongsfjorden; Diversity of Arctic Cyano-bacteria; Investigation of atmospheric aerosols and their character-ization; diversity of heterotrophic bacteria in arctic water and sediment with special reference to phosphate solubilizers; Establishment of cryophilic cyanobacteria culture collect-ion; Multi-proxy geological quaternary geological studies; glacio-logical studies	
5.0 OCEAN RESOURCES							
5.1	Legal continental shelf	• Defense of India's	1.00	Finalisation and	Crit	• The scientific projects	Defense of

	Program (CLCS)	submission for an extended continental shelf before the UN-CLCS • Finalisation of India's second partial submission for an extended continental shelf under the provisions of the Statement of Understanding.of UNCLOS, based on the suggestions by MEA and its resubmission. • Initiation of new scientific projects as multi-institutional endeavors utilizing the data acquired in connection with the Continental Shelf Program.		submission of India's second partial submission	ical	initiated during 2010-11 to be continued.	India's submission dependent on when the submission comes up in the queue
5.2	Deep Ocean drilling in the Bay of Bengal and Arabian Sea through the Integrated Ocean Drilling Program (IODP)	➢ Continuation of IODP activities	9.00	Completion of targeted activities within the envisaged timeframe.	Crit ical	• A two-day international workshop on Scientific drilling in the Indian Ocean was organised during October 2011 in Goa jointly by India (NCAOR), Australia, and IODP-MI.	

5.3.	Comprehensive Swath Bathymetric Survey of Indian EEZ	• To carry out the swath bathymetric survey of entire EEZ	5.09	• Initaition and completion of EEZ surveys inpre-identified blocks. • Processing and interpretation of the collected data, data archival.		*All targeted surveys completed within the timeframe. ●Processing and inter-pretation of the data in progress.	
	Polymetallic Nodules Programme	• Develop technology for mining nodules from the sea bed (6000 m) • Development of Soil Tester for 6000 m and Delineation of Indian Mine Site	0.5 0	• Configuration Design and Procurement of Subsystems, Concept Variants of Deep-sea Mining System for 6000 m • Delineation of the Indian Mine Site using two Soil Testers developed		• Completion of Configuration Design of Deep-sea Mining System • Solids pump developmental testing done upto 1032 m depth • Configuration of hydraulic mining head as a concept variant • Fully electrical soil tester was developed and tested at 5462 m depth in CIOB	

6.0 OCEAN TECHNOLOGY							
6.1	Technology development – Renewable Ocean Energy and fresh water from the sea	• To generate freshwater / DM water requirement using the LTTD technology by utilizing the waste heat at Thermal Power Plants.	2.00 for Ocean energy & desalin ation 4.00 for 10MLD	• Continuous generation of freshwater / DM water requirement.		• Selection and procurement of suitable wire mesh demister to obtain high quality water in NCTPS – LTTD plant completed and replacement of existing demister is in progress.	

		• Laboratory module for closed cycle OTEC principle and desalination cycles in progress. • Deployment of Backward Bent Ducted Buoy and collection of data. • Turbine for harnessing ocean energy. • Studies on heat exchangers for developing low cost and energy efficient flash evaporator in NCTPS LTTD Desalination plant. • Design of multi effect desalination system using solar energy under DST sponsorship • Establishment of LTTD plant in coastal thermal		• Suitable working fluid for establishing a laboratory module. • Floating wave powered device Back ward Bent Ducted Buoy (BBDB) • Suitable turbine for harnessing energy from ocean currents. • Low cost and energy efficient flash evaporator. • Fabrication follow up of Solar MED system, installation and initial testing of the components. • Installation of LTTD plant at Tuticorin thermal power station.		• Selection of suitable working fluid for establishing a laboratory module for closed cycle OTEC principle and desalination cycles in progress. • BBDB along with a wave rider buoy was deployed at off Ennore Port and analysis of collected data to further improve the hydrodynamic as well as turbine efficiency is in progress. • Testing of working models with different blade configuration and permanent magnet alternator at NCTPS outfall channel is in progress. • CFD analysis for optimizing turbine blades is in progress. • Fabrication of various current turbine models with different configurations is in progress.	

		power plants using industry participation. • Establishment of 10 MLD offshore LTTD plant using industry participation.		• Detailed Project Report (DPR) for establishing of 10 MLD offshore LTTD plant.		• Fabrication and integration of 6 m3/hr, 6 effects MED unit is completed for testing at Coimbatore. • Commissioning of the MED system with solar field is under progress at Coimbatore. • Tender document was prepared and issued to the potential vendors. Bid evaluation completed and awarding of contract for installation is in progress. • Evaluation of bids for preparation of Detailed Project Report (DPR) completed and awarding of contract to prepare the DPR is in progress.	
6.2	Offshore Structures	• Analysis, design, model studies for suction pile anchors • Material Studies and testing for submarine pipelines for Desalination	1.20	• Sea trials for deployment of suction pile anchors • Materials studies for submarine pipeline using composite materials for			

				varied hydrodynamic conditions			
6.3	Inter-Institutional R&D and in house developments • Soil-Machine Interaction Studies on Deep Sea-bed Poly-metallic Nodule Mining System • Modeling and Analysis of Sub Sea drive systems" • Aluminium structures for Deep Sea Mining Machine • Studies on Hydraulic Lifting and Plugging of Large Solids in hoses	• R&D for Deep Ocean Mining Research	1.00 – Dev. tech for mining polymetallic nodules 2.42-upgraded version soil tester	• Theoretical studies • Infrastructure development • Laboratory studies • Configuration having a current source inverter (CSI) at the surface will be developed for the Integrated Mining System • Welding studies of 5083 Aluminium Alloy using 5183 as filler material in association with L&T Hazira		• Theoretical studies are in progress using 3DEC software. • Infrastructure development of a test tank facility has been initiated in Anna University Chennai. • Pull out test in bentonite tank is in progress • Configuration of CSI has been done • Welding studies have been completed for 5083 Aluminium Alloy using 5183 as filler material in association with L&T Hazira • Pressure drop studies were completed for various bend angles at the Hydrotransport Tower IIT Madras.	

				• Plugging studies of solids handling pump for various feed rates of solids carried out by varying the feed rate of solids.			
6.4	Marine Sensors & Electronics	• Testing of Sub bottom profiler using off- the shelf hardware/NIOT transducers • Indigenous miniaturized linear towed array using cymbal transducers • Design and fabrication of tow body for the BOSS system • Design and development of an Oil spill detection system and a pressure sensor with antibiofouling technique.	2.50	• This will provide raw data for underwater imaging using off the shelf as well as indigenous transducers • Can be utilized for future imaging systems. • Tow body to carry the transducers and electronics in the BOSS system. • Laboratory level test or the oil spill detection system has been completed. Development of pressure sensor with anti biofouling technique is under	•	• The transducers have been interfaced with off the shelf hardware and raw data have been collected off Chennai and Tuticorin coast	-

				progress.			
6.5	Ocean acoustics	• Improvement of system for Time series measurements of ambient noise • Low frequency acoustic calibration setup • Development of prototype vector sensor	2.15	• Improved system deployment, time series measurements off Goa and cochin and characterization of noise field • Technical bid evaluation completion and placement of order. • Acquisition of vector sensor from SUASIS, functionality test		• Time series data collected by deploying improved system off Cochin and Goa. • Technical bid evaluation completed and order will be placed shortly • The vector sensor from SUASIS, has been acquired by Keltron, Kuttipuram and the functionality test in progress	
6.6	Technical Criteria Atlas	• Develop a reference for engineering design of coastal infrastructure and coastal protection along the coast of India, providing seasonal extreme value estimates of hydrodynamic loads in the form of waves, currents	2.10	• Field Observations [wave, tide and current] at 30m at two locations for one year duration, setting up wave and tide model and validation. • Extreme wave analysis using various methods • Preparation of		• Field measurements made and wave and tide models have been set up.	

		and water levels at 10 locations, for different return periods such as 5,10,25,50 and 100 years.		specification document for the Graphical User Interface of Atlas • Start production run of wave model			
6.7	Demonstration of Shore Protection Measures through Pilot Projects	**There are three Objective in this Project** A. To characterize littoral transport phenomena along key sites of the Indian coast for sustainable coastal infrastructure planning and management. B. To demonstrate the performance of environmental friendly shoreline stabilization measures at high priority sites. (Engineering Intervention-EI) C. Water quality monitoring and management studies (Waste Load Allocation)	5.00	• Beach profile and surf zone measurement to be carried out at selected sites along Tamil Nadu, Pondicherry and Andhra Pradesh coast. • Wave, current and tide measurements at two sites for one year. • Numerical model studies and action plan for implementation			

		in tidal creeks, estuaries and inlet stabilization measures.					
6.8	Ocean Science and Technology for Islands	• Demonstration and training of open sea cage culture of marine finfish. • Training of mass culture of marine micro algae for biochemicals production. • Development of new material and nanotechnology for antifouling measures.	4.05	• Experimental open sea cage culture in different location. • Training and demonstration of open sea cage culture. • Experimental scale micro algal mass culture in different types of culture system. • Training to R & D institute on mass culture for micro algae for biochemical and nutraceuticals. • Development and testing of new material and nanomaterial for biofouling control.	•	• Ten open sea cages of (9 m diameter) were designed, developed and deployed in three sites • An average growth of 263 g with 26 % survival was achieved in sea bass cultured in Kothachatharam • Tubular Photo Bioreactor with process control and Monitoring system was designed, developed and installed in NIOT. • Marine micro algal strain 5F-1 (NIOT -45 was tested for large scale production of lutein in bubble column photobioreactor in outdoor mixotrophic culture conditions • MoU has been signed with the Water and Steam Chemistry Division, Bhabha Atomic Research Centre (BARC), at the BARC facilities, Kalpakkam for development and testing	

						of advanced technology for biofouling control.	
6.9	Moored Buoy network	• Maintenance of 8-12 buoy network.	19.00	• Collection of Oceanographic & Meteorological data from 8-12 Met ocean buoy systems and disseminate data to INCOIS	•	• Established 12 moored buoy network with few of them having additional subsurface sensors for measurements in Arabian Sea and Bay of Bengal during June 2011. Six OMNI buoys were ordered and were deployed by May-June 2011 functional in Bay of Bengal. • Indigenization of Buoy Data Acquisition System (i-DAS) MET had worked successfully for more than one year at sea and i-DAS Wave was also successfully deployed and working from August 2011. • Extended support to INCOIS On RAMA buoys ARGOS and other activities	
6.10	Establishment of National Tsunami Early Warning System and storm surges in the Indian Ocean	• Maintenance of Tsunami buoy Systems	10.00	• To collect water level data in deep sea using Bottom Pressure Recorder (BPR) and disseminate data to INCOIS	•	• Four Tsunami buoys were deployed and were functional at TB05, TB06, TB08, TB08_A, in Bay of Bengal and Arabian Sea during August –September	

				for Tsunami Early warning system.		2011 as committed • Supported INCOIS for SAIC Tsunami buoy deployment and servicing activities • Indigenization of Buoy Data Acquisition System (i-DAS)	

7. COASTAL MARINE ECOLOGY							
7.1	Integrated Coastal and Marine Area Management	Application of scientific tools and techniques like mathematical modeling for Integrated Coastal Zone Management	11	Completion of development of hydrodynamic and sediment transport models and suggestions for possible solutions to control problems of erosion at Muthalapozhi, Thottapalli and Kozhikode in Kerala, Uliargrili Padukere, Pavinkurve, Kundapurkodi and Devbagh in Karnataka and Gopalpur in Orissa	Project Document 5 years	In progress	NIL
				Development of hydrodynamic and wave models for Gangavaram in Andhra Pradesh and development of hydrodynamic model for North Chennai		In progress	

				Completion of experimental studies for determination of Sea Water Quality Criteria for arsenic, zinc, lead and chromium and continuation of similar experiments for monocromotopos		In progress	
				Completion of hydrodynamic and water quality modeling for Chilka; Initiation of ecological modeling in Chilka lake; Completion of nutrient uptake experiments, photosynthetic experiments etc. required for development of co-efficients for Ecosystem Modelling for Chilka lake		In progress	
				Completion of development of hydrodynamic and water quality modeling for Kochi Backwaters and determination of eleven co-efficients, especially for zooplankton, grazing, nutrient uptake and photosynthetic characteristics	Project Document 5 years	In progress	NIL
				Collection of third season data required for modeling in Sunderbans		In progress	

				Completion of development of draft indigenous software for storm surge inundation models and testing the model for Machilipatnam in Andhra Pradesh		In progress	
				Conducting six training programmes on vulnerability mapping, satellite oceanography, marine pollution and application of GIS in coastal research		Completed	

7.2	Coastal Ocean Monitoring and Prediction System (COMAPS)	To assess the health of the seas	8	Continued assessment of status of marine pollution at 19 locations	Project Document 5 years	In progress	NIL
				Development of GIS based Information System for 5 locations and database for 15 locations		In progress	
				Completion of field data for development of oil spill models at Chennai, Dhahanu and Goa		In progress	
				Dissemination of marine pollution database for 72 more locations through WEB		In progress	
				Undertaking 6 intercalibration exercises on nutrients and trace metals		In progress	

8. Diaster Support							
8.1	Early Warning System for Storm Surge and Tsunami	Operation and maintenance of Tsunami Warning centre on 24X7 basis. Providing advisory services to the concerned authorities on the Tsunami advisory services.	42.00	Sustain Tsunami Early Warning Service Maintenance of 2 SAIC tsunami buoys and tide gauges at 21 locations Fine tune and generate additional scenarios for Indian Ocean and global sources using TUNAMI F2 model. Fine tune DSS for service levels as per national and regional SOP Fine tuning the tsunami website Validation and use of CartoDEM & ALTM data for tsunami modelling Initiate setting up of stand-by coastal inundation models Pursue Storm surge modelling Operationalisation of professional version of DSS software through industry Work out mechanisms for interacting with public and media during an event Efforts to become full-fledged RTWP by providing service level-2 for the Indian ocean			

				region			

8.2	R& D in Earth and Atmospheric Sciences	• To carry out basic research activities in the field of ocean and atmospheric science and develop human resource	36.00	• Enhance the forecasting capability of the country through well supported R&D programs. • Support R & D projects that address issues of National importance • Building indigenous capability through Joint developmental work with other institutes and/or organization. • Human resource development in Atmospheric and Earth Sciences			
8.3	Seismicity Programme , And National programme on Earthquake Precursors	To study the slow earthquakes in seismically active regions of the country. Establish V-SAT connectivity to all the permanent GPS stations and seismological observatories.	50.00	Projects would be supported to study the slow earthquakes in NW Himalayas All standalone broadband seismographs and permanent GPS stations working in project mode would be connected through V-SAT t o a Central receiving station.		A project has been supported for studying the slow earthquakes in the NW Himalayas Towards linking the Broadband seismic observatories and permanent GPS stations through V-SAT, site survey has been	

		To strengthen GPS network in the country as per the suggestions made in the GPS document. Continue support to the projects related to site response studies, soil dynamics, active faults and crustal deformation studies in Himalayan region. Hazard assessment studies for some selected cities. Setting-up of Multi-parametric observatories in identified regions. Support to ongoing projects		4-5 GPS stations to be established. Preparation of liquefaction map as an input for microzonation of selected cities. Establishment of Muliti-parametric observatories would be initiated in central Himalayas About 65 projects are to be supported.		completed. Foundation work for the Hub antenna at INCOIS & IMD (NCMRWF) has been completed. Equipment is being installed at INCOIS. Permanent GPS Stations have been installed in Diglipur, Mayabunder, Port Blair, Havelock, Hut Bay in Little Andaman, Arong in Car Nicobar and are being installed at Campbell Bay in Great Nicobar and Baratang in Andaman One project has been supported to delineate the active faults in Kashmir valley using GPR. Two projects have been supported to study the crustal structure of the Ganga basin and Cambay basin using magnetotelluric technique. Two projects have been supported to continue studying crustal deformation studies in Himalayas and other	

						regions. A manual along with the hand book on seismic microzonation has been brought out for systematically carrying out field investigation, data processing and analysis etc A project is being evolved for setting-up MPGO in central Himalayas. About 55 ongoing projects were supported	
9.0 EXTRAMURAL RESEARCH							
9.1	R& D in Earth and Atmospheric Sciences	• To carry out basic research activities in the field of ocean and atmospheric science and develop human resource	36.00	• Enhance the forecasting capability of the country through well supported R&D programs. • Support R & D projects that address issues of National importance • Building indigenous capability through Joint developmental work with other institutes and/or		• Supported and funded a national coordinated programme which is multi-institutional, the area of monsoon research. • To encourage indigenous development have funded a project to CDAC, DIT under an MoU with NCMRWF, to bring out the capability of the high performance computing cluster system developed by C-DAC in real time weather forecasting.	

				organization. • Human resource development in Atmospheric and Earth Sciences		• Supported the PhD programme of National Institute of Advanced Studies (NIAS) with an annual grant for 5 years. • Established MoES Chairs at IIT Kharagpur and IIt Gandhinagar • A Center for Cryosphere studies is envisaged to be opened at Delhi University for carrying out cryosphere research. • Supported 6 research projects of national Interest • Have supported establishment of 3 facilities as National Facilities at IUAC, CESS and IISER Kolkata respectively.	

10.0 INFRASTRUCTURE DEVELOPMENT/OUTREACH ACTIVITIES							
10.1	Assistance for Oceanographic Research	Providing assistance to 9 OASTCs and supporting research projects outside OASTCs		85 MoES funded ongoing research projects are underway in universities/institutes and IIT, Kharagpur which includes 9 Earth Sciences and Technology Cells (ESTC) .- International travel support was given to 7 scientists.			

10.2	National Oceanarium	Identification of suitable partner to execute the work. Initiation for acquisition of land and appoint consultant for preparation of a document	5.00	Placing purchase order for establishment of Oceanirium in appropriation location, with the consent of coastal state.			
10.3	Headquarter Building	to construct a new modern building having required amenities to house the headquarters	25.00	Operation of New building and Campus of the Ministry			
10.4	Seminars and symposium	To participate in national and international symposium, workshops and seminars to showcase the activities of the ministry	10.00	Participation in the national and international symposiums including the Indian National Congress.			
11.0 CLIMATE CHANGE STUDIES							
11.1	Centre for Climate Change Research including Program on Global and regional Climate Change	Develop national assessment and response capabilities with skills in different areas of climate change	**58.50**	• Build a strong science base and synergize the research efforts on climate change by networking the national Institutions.	-		-
11.2	Program for Advanced Training Centre in Earth Science and Climate	Starting the first batch of the job linked national level integrated M. Tech..- Ph.D. Training Program with a stipend to each of the selected candidates.	**10.00**	• The program will be run through a Training Centre which is being set-up, under the leadership of IITM, as a national capacity building facility in Earth System			

		Starting the construction work of Hostel, Housing, Training Centre and Building for office, faculty and laboratories Recruitments of faculty, outsourcing of the Administrative Staff and inviting the visit		Sciences and Climate covering atmospheric, oceanic and geosciences including biosphere-geosphere studies with latest technologies. • This will be a world-class state-of-the-art Training Centre and will be aimed at addressing the scarcity of trained and skilled scientists required for improving the quality of weather and climate forecasts in the country through the unique integrated M. Tech. - Ph.D. program.			
	Grand Total		**1220**	•			

Appendix-5

Ministry of Earth Science

Statement of Outlays & Outcomes/Targets (2012-13) Appendix-5

No.	Name of the Scheme/ programme	Intended Objective/ Outcome	Annual Plan 2012-13 Outlay (Rs. In crores)	Quantifiable Deliverables	Processes/ Timeliness of the approvals	Remarks/ Risk factors
1	2	3	4	5	6	7
1. 0 ATMOSPHERIC SCIENCE AND SERVICES : India Meteorological Department						
1.1	Space Meteorology	To acquire, process satellite data and generate products for operational needs as per the needs from time to time To establish a dedicated dissemination system of satellite data and products using INSAT transponders To set up a countrywide network of GPS Stations for measurement of integrated precipitable water vapour for use in nowcasting and NWP models To augment and enhance Satellite Data Centre	10.00	•Real Time generation systems of satellite derived products with redundancy for continuous monitoring of weather systems over India and neighbouring seas •Building a dedicated satellite data broadcast infrastructure for the Indian geostationary meteorological satellites	2012-2013	--

1.2	Atmospheric Observation Systems (Earlier Operation and Maintenance)	Sustenance of observational networks covering DWRs, ARGs & AWSs, Upper air, surface and environmental observatories etc on 24x7 basis. Provision of adequate communication system for data and product transmission. Maintenance of operational forecast system, delivery system for forecast and other services. Conduct of special campaigns for improving Cyclone, Thunderstorm and Fog forecasting, etc. Planning of new observations and augmentation of existing observation system. Planning and sustenance of specific process related observing systems over India	110.00	Establishment of sustained observational network for process studies specific to India viz. cloud microphysics and aerosols. Efficient upkeep of commissioned observing systems Ensuring fast and efficient acquisition of national and global observational data in a fail-safe environment Up-gradation of Test and Calibration Facility of surface meteorological instruments. The study of Antarctic Meteorology will be under taken for meteorological and atmospheric processes and develop forecasting models/tools. Hydrometeorology studies would include rainfall summary, Probable Maximum Precipitation (PMP) Atlas, development of QPF using rainfall predictions with very high resolution models. Speedy exchange of Numerical Weather Prediction (NWP) data and products for the day-to-day forecasting work. The maintenance of website and upgradation activities are to be continued	2012-2013	--
1.3	Aviation Meteorology	Improved Aviation support services in major airports of India. Implementation of QMS in Aviation Meteorological Services. Up gradation of Airport	70.00	Upgradation of 42 airports to be accomplished. A multi-observational facility will be set up at 50 additional Aerodrome Meteorological Offices for monitoring meteorological parameters relevant to aviation safety.	2012-2013	--

		Meteorological Instruments at runway locations for the major airports. Aviation Weather Decision Support System (AWDSS) for four metro airports. Implementation of Aircraft Meteorological Data Relay (AMDAR).		Quality management system should be in conformity with the International Organisation for Standardisation (ISO) 9000 series of quality assurance standards will be established at Eighteen international airports meteorological offices		
1.4	Agromet Advisory Services	To improvise the existing district level Agromet Advisory Services (AAS) to deliver crop and location specific AAS to farmers at block level advisories. To design optimum observatory network for issuance of villagelevel advisories for implementation of crop weather insurance. To establish District Agromet Units as nodal centre for catering to needs of agriculture services To provide customized advisory bulletins through last mile connectivity to farmers with personalized agromet advisory services. To extend the weather based advisory service to the allied areas like	50.00	Improved district scale agromet advisory services and experimental generation of sub-district scale agromet advisories Development of customized advisories for livestock and grazing of farm feed (in drought prone areas) District Agromet Units (DAUs) would be set up to address the objectives at block level. It is proposed to start issuing the forecast, particularly for the agromet service at relatively smaller areas at sub-districtt level. The studies will be undertaken to observe whether weather based advisories have a positive impact on the overall yield and also how best can help in decreasing the cost of cultivation. Establishment of Centre for Research Excellence in Agro-Meteorology for conducting R &D activities	2012-2013	--

		livestock, grazing of farm feed etc. To establish appropriate dissemination and support system for weather-based crop insurance in the country.				
1.5	Integrated Himalayan Meteorology Programme	To improve and upgrade mountain weather and climate monitoring and forecast services over the Himalayan region by establishing additional and critical state-of-the-art surface and upper air observatories for generating real time observations. Interfacing the Indian side observational network for integration with those of neighbouring countries in the Himalayan region for a comprehensive analysis of mountain weather phenomena. To establish a robust mechanism to exchange scientific analysis based meteorological information towards the holistic Himalayan development through customized weather, climate,	30.00	Commissioning and operation of full scale observing systems (AWS, ARG, Atomatic Snowgauges, RADARs, LIDAR, GPS Radiosonde, GPS, Wind profilers and Microwave radiomenters) over the Indian Himalayas Building appropriate local/valley scale numerical weather analysis-assimilation and prediction models To operate exclusive mountain meteorological services for the Himalayan states of India In the first year, it is proposed to establish the network over central Himalayas to meet the requirements of ARMY/SASE by the creation of 03 Upper Air Stations with GPS Sonde at Shimla, Dehradun/Mussoorie and Pithoragarh and 15 Surface Field Observatories in central Himalayas. Procurement and commissioning of.	2012-2013	

		hydrological, ecological and environmental services. To build enhanced understanding of weather and climate processes over complex Himalayan terrain and render quality forecasting services. To build improved understanding of physical processes along with rapid intensification of valley scale high impact weather phenomena leading to heavy rainfall, heavy snowfall leading to cloud burst, flash floods, avalanches etc. towards the development of early warning systems. To develop exclusive Himalayan climatology database for the region to capture the significant climate variability indices to meet the requirements of all users.				
1.6	Seismic Hazard and Risk Evaluation	(Monitoring of seismic activity in the country on a 24X7 basis and provide earthquake information to various user agencies in the least possible time.	22.00	Uninterrupted round-the-clock monitoring of seismic activity in the country, so as to provide earthquake information to various user agencies in the least possible time. Generation and systematic archival of	2012-2013	--

		Generation of higher resolution seismic and geophysical data sets for better understanding of physical processes associated with earthquakes, deployment of GPS systems & borehole sensors in critical locations, field investigations relating to monitoring of aftershocks, swarms, microtremors, site response studies, etc. Systematic archival of seismic and other geophysical data sets generated by various observational networks. Raster scanning of remaining significant historical seismograms, their vector digitization and archival in electronic media. Create a modern test and maintenance facility for testing and upkeep/rectification of sophisticated equipments. To undertake earthquake hazard assessment related studies in seismically vulnerable areas in the		high resolution seismological and other geophysical data for seismically critically areas in the country to facilitate R&D in seismology. Collation of data pertaining to seismotectonics, geomorphology, geology and geotechnical frame work for identified cities. Generation of data for the gap areas for preparation of multi-thematic maps on available base map. Development of an earthquake scenario document for each city so as to know the consequences of an earthquake hazard. Integration of these maps and generation of useable product for earthquake hazard mitigation planning through interaction with local state governments and disaster management agencies to provide technical support for earthquake risk appraisal and creating awareness. Future planning for the exploration of microzonation on larger scale maps		

		country in a phased manner. To provide scientific inputs for mitigating the disastrous impacts of earthquakes towards reduction of earthquake risk.				
1.7	Mod of IMD Weather Services	Augmentation of Observing Systems and Forecast Facilities of the India Meteorological Department (IMD) Remaining Components of Mod phase-I will be completed and existing systems/ facilities will be upgraded and maintained. The modernization phase II shall enhance the coverage and density of observations for the entire country with a centrally connected digital observational data acquisition, processing and visualization systems. It will render the full benefit of the modernization in terms of automation and improved quality of service	200.00	Commissioning and sustained operation of modern observing systems for improved quality of weather, climate and early warning services for the hydro-meteorological hazards and high impact weather phenomena Implementation of improved global, regional, meso-scale and now-cast data assimilation and forecast models to cover all spatial and temporal ranges. Modernization Phase-II will be implemented after the approval of EFC. Construction of Building will be initiated and procurement of goods will be initiated. 3600 Nos. of Automatic Rain gauges will be procured and installed to boost rain gauge network of India. Surface Observational Network will be augmented. 1150 AWS will be in the remote location and data gap regions. Information Technology Cell at HQ New Delhi will be set up to cater the needs of IT related activities of IMD.	2012-2013	--

				High Performance Computing System (HPCS) for Global Data processing and Numerical Weather Prediction (NWP) for Weather Forecast will be upgraded and maintained including payment of mandatory spectrum charges and AMC. Communication of Forecasts and Early Warning Dissemination System will be established in the country to improve warning system more effectively. 10 Nos. of Radio theodolites in lieu of tracking radars will be procured. Outreach programme and more effective dissemination of warnings by Public Weather Services through media will be set up. Replacement AMSS at Guwahati and installation of New AMSS at Nagpur and Mirror of RTH at Pune. Remaining Components of Mod phase-I will be completed and existing systems/ facilities will be upgraded and maintained.		
1.8	Metropolitan advisories for Cities for sports , tourism	To provide near real time and 1-2 day advance forecast for weather and air quality information for several Metropolitan cities. To forecast weather in now-cast and short range scales over different sections of the	25.00	Installation of Meso-urban observation networks in major Metropolitan cities. Development of high resolution dynamic emission inventories of air pollutants for proposed Metropolitan cities. Wind profilers, Radiometers and Wind Lidar for continuous upper air observations.	2012-2013	--

		Metropolitan cities including severe weather warnings. To provide detailed customized meteorological products on-demand basis To study the impact of air pollution on Health and Agriculture. To develop a System of Air Quality Forecasting and Research (SAFAR) in major metropolitan cities of India under the studies of Atmospheric Chemistry and Climate.		Configuration and operationalization of meso-scale and nowcast models. Operation of Air Quality forecast services through dynamic web based portals and public display systems.		
1.9	Training in Operational Meteorology	To set up a comprehensive and continuously evolving training programme for S&T operational personnel of IMD, other Government and overseas meteorological organizations. To create infrastructure and content for enabling a system of 'continuous learning' at all stages and levels during the careers of personnel. To conduct licentiate courses e.g Aviation Meteorology etc as per needs of ICAO and /or	25.00	Trained manpower for catering to the requirement of operational need of the National Weather Services. Establishment of world class infrastructure in terms of technology and content for training international personnel associated with Meteorological and Hydrological services. Establishment of specialized courses for Aviation meteorology as per recent ICAO/WMO guidelines. Set up Training Centre with modern teaching aids and hostel facilities including Annex building at Training Center, Pune and a new International Hostel wing. Renovation of existing Trainees' Hostel at Pune. Construction of New Hostel and		

		other bodies. To broaden the teaching resource base by collaborating with other organizations and setting up e-learning facilities. To encourage, document and monitor applied research output		Training building at Delhi Capacity building in Indian context and in the context of South Asia and Africa by creating fellowships. Development of Training Faculty – creation of additional posts for Core Faculty Development of infrastructure Delhi and 2 regional centers at Kolkata and Chennai. E-learning training portal		
1.10	Climate services	To create facilities for providing Climate Services through the establishment of a Regional Climate Centre (RCC)-South Asia within IMD. To cater to the need of a comprehensive set of specialized climate services for the country and for South Asia as a region identified with the South West Monsoon climate.	10.00	Build and operate national and regional scale climate services. Continued development of statistical and hybrid Prediction models for the region. To develop high quality regional data bases climate applications in a phased manner. Support regional modeling studies To issue information pertaining to drought monitoring. To generate value added products like comfort indices, heat stress indices, air quality. To rescue and retro-convert old data and charts in a phased manner and create Web based archives.		

2.0 Climate Change Research						
2.1	Physics and Dynamics of Tropical Clouds	• Preparation of Technical document, Issuing Global Tender, Tender Evaluation, Awarding the contract.	25.00	• Preparation for procurement of Aircraft	-	-

2.2	Monsoon Mission (IITM's component)	• Set up the nodal point at IITM/NCMRWF/IMD • Set up CFS V 2.0 model at IITM and UKMO model at NCMRWF	168.05	• Use the Climate Forecasting System (CFS) model developed by the National Center for Environmental Prediction (NCEP) of USA for further development to improve the prediction skill of Indian summer monsoon rainfall. • All groups that get involved in this mission should use this model (or components of this model) for development and research activities, so that concerted efforts of different groups will result in a better tool for monsoon prediction. • Deploy/employ the proposed manpower.	EFC has approved the proposal in its meeting held on 15 October 2011	-
2.3	Short Term Climate Prediction and Variability	• Develop an Indian model based on CFS coupled model. • Carry out basic research to understand complex atmospheric/oceanic processes, parameterization schemes to improve the forecast skills.	55.00	• Adopt the state of the art Coupled Model from NCEP and, find out the systematic biases and prediction skill of the model. • Improve the model physics and resolution to reduce the identified biases. • Develop and improve the Empirical Techniques for predicting active and break phases of monsoon.	-	-

		• Disseminate forecast in real time using both empirical and dynamical models. • Develop the System of Air Quality Monitoring, Forecasting and Research (SAFAR) to predict the level of air pollutants 24-48 hours in advance and showcase the current and predicted level of air pollution in six major cities of India viz., Pune, Kolkata, Chennai, Mumbai, Bangalore, Hyderabad. • Continue ongoing efforts in identifying regional and global climate drivers for monsoon interannual variability and to identify useful predictors.		• Build a system for air pollution monitoring to provide the accurate information on the air quality in the six mega cities in India.	-	-
2.4	Centre for Climate Change Research (CCCR)	• Development of an Earth System Model (ESM) • Dynamic downscaling of monsoon rainfall using regional climate models. Through this activity, it is proposed to generate reliable climate inputs for impact assessments. • Understand past changes in monsoon climate using multiple proxy records • Reconstruct an iconic monsoon rainfall index which goes back to a few thousand years.	25.00	• Develop the in-house capacity for development of an Earth System Model. • Generate reliable climate inputs for impact assessments. • Observational monitoring of green-house gases and aerosols. • Estimate future evolution of climate. • Capacity building in climate change research and dissemination of information. • Dynamic downscaling of regional climate simulations. • High Resolution Earth System Model (ESM). • Observational Programme of CCCR.	-	-

		• Implementation and testing of Ecology and Biogeo-chemistry Module in CFS-2. • Conduct multi-century (~ 300 yr) runs of the ESM to understand the role of natural and anthropogenic forcings (GHG, Aerosols, etc) on the global and monsoon climate system; and quantify the impacts of internal and anthropogenic forcings on climate variability. • Conduct very long simulations (~1000 yr) of the ESM to understand the role of thermohaline circulation changes on the Asian monsoon climate. • Conduct very long simulations (~ 1000 yr) of ESM to understand interactions among Carbon Cycle, Climate, Ecosystem and Biogeochemistry. **Observational Programme of CCCR** ***Development of Climate Data Portal*** • Archival, analysis and dissemination of regional climate change scenarios or IPCC AR5 assessment.				

2.5	HPC (Other than Machine)	• Establish a petaflops-scale HPC facility at the Institute. • Establish, update and maintain an extensive database required for modeling and observational studies. • Provide assistance in processing the data. • Provide programming and software support for model improvement. • Maintain the facility by providing the necessary supporting infrastructure such as UPS, cooling system, Power and Generator backup. • Plan the significant investment has to be planned for maintaining the Community Facility.	04.00	• Cater the needs of modeling activities of Monsoon Mission, Climate Change Research and National Training Centre and other programs of the Institute, and also to share the facility with other groups in the country.	-	-
2.6	HPC (Machine)		10.00			
2.7	Centre for Advanced Training in Earth System Science and Climate	• Place the first batch of the trainees in IITM and other institutes of MoES who will complete the induction training in 2012-13. This will be continued in the subsequent years of the plan period. • Increase the intake of the trainees systematically to 60 nos. by the end of the 12th Five Year Plan period.	34.00	• Create a large pool of trained and dedicated earth system and climate system scientists with in-depth hands-on expertise on individual physical processes of the land, ocean, atmosphere, biosphere and cryosphere with special emphasis on modeling.	-	-

		• Complete the new campus for the Centre of Advanced Training with all the facilities for the training and locate all the training activities there. • Take up the training to the SAARC and other neighbouring countries in 2012-13 and continue it in subsequent years. • Complete recruitment of all the proposed staff. • Enter into collaboration with more institutions in the area at the national and international level for training the recruitees.				
2.8	IITM - Operations & Maintenance	Maintenance of infrastructure for HPC, System, Office buildings, laboratories, seminar/ conference halls, Training hall, laboratories, residential quarters, hostel, guest house, canteen, community hall etc. • Maintenance of AC, electricity, water, phone, fax, security, house keeping, etc. • Expenses on maintenance of New Delhi Branch of IITM and High Altitude Cloud Physics Laboratory at Mahabaleshwar.	15.00	• State of the art computing facility for MoES scientists to meet the emerging demands of reliable weather and climate forecasts. • Data Assimilation of Ocean and atmospheric data in dynamical models. • State of art laboratory and field observational facilities at IITM in Pune, New Delhi and high altitude laboratory at Mahabaleshwar. • Maintenance office buildings and other supporting infrastructure including Institute's campus.	-	-

3. 0 ***POLAR SCIENCE/ CRYOSPHERE***						
3.1	*A. Expedition to Antarctica*	• Planning, co-ordination and execution of all scientific and logistics tasks related to the XXXII Indian Scientific Expedition to Antarctica. • Initiation of new projects in the realms of Antarctica and Arctic: ▪ Satellite-based DEM for monitoring Antarctic Ice topography with Special Focus on Glaciers ▪ Assessment of Microbial diversity in Arctic and Antarctic: Past & Present ▪ Long term Monitoring and Modeling of Precipitation over Antarctica ▪ Environmental Monitoring and Health of Indian Antarctic Stations in Pursuit of Antarctica-Treaty-System and its Governance ▪ Paleoclimatic Reconstruction from Antarctic Coastal Areas ▪ Hydrodynamics of the Indian sector of coastal Antarctica ▪ Past Climate and Oceanic Variability	130.00	Launching schedule of the Expedition, the no. of field studies initiated, the spatial coverage of field data acquisition, and the number of samples/sampling stations vis-à-vis the corres-ponding targets The number of projects taken up and completed, the number of samples analysed vis-à-vis the target	Critical Critical	

3.2	*Establishment of a new research base in Antarctica*	Planning, coordination and execution of all logistics tasks realted to the completion of the new research base in its entirety and initiation of scientific studies in the Larsemann Hills and its envrons.	25.00	% of construction activities carried out vis-à-vis the target	Very critical -	
3.3	*Scientific Expeditions to the Arctic*	• Initiation/continuation of scientific projects in the fields of atmospheric sciences, quaternary geology, biology/microbiology, long-term monitoring of the Kongsfjorden, glaciology and Crustal studies • Maintenance and upkeep of Himadri station	10.00	No. of days of field studies, the number of studies carried out, the spatial coverage, the number of samples generated/observations made vis-à-vis the corresponding targets	Critical	
3.4	*Long-term monitoring of the Kongsfjorden system in the Arctic for climate change studies*	The overall objective of the studies planned is to establish a long-term comprehensive physical, chemical, biological and atmospheric measurement programme aimed at understanding: (i) The variability in the Arctic/Atlantic climate signal by understanding the interaction between the freshwater from the glacial run-off and Atlantic water from the west Spitsbergen current. (ii) The effect of interaction between the warm Atlantic	11.00		New Program	

		water and the cold glacial-melt fresh water on the biological productivity and phytoplankton species composition and diversity within the fjord. (iii) The winter convection and its role in the biogeochemical cycling. (iv) The trigger mechanism of spring bloom and its temporal variability and biomass production. (v) The production and export of organic carbon in the fjord with a view to quantify the CO_2 flux.				
3.5	*Replacement of Maitri Station*	Initiation of action for the establishment of a new research base in the Schirmacher Oasis, as a replacement of the existing Maitri research base.	30.00	Achievement vis-a-vis target	Very Critical	New Program
3.6	*Scientific studies in the Indian Ocean sector of the Southern Ocean*	Launching of a multi-disciplinary and multi-institutional expedition to the Indian Ocean sector of the Southern Ocean.	7.00	No. of days of field studies, the number of studies carried out, the spatial coverage, the number of samples generated/observations made vis-à-vis the corresponding targets	Initiation and completion of the targeted scientific projects mounted	
3.7	*NCAOR-Manpower, mainten-ance*	• The smooth functioning of the day-to-day activities of the Centre, including its various	25.00	Quantum of civil work carried out vis-à-vis the target	critical	

	and infra-structure	technical and non-technical sections/divisions, augmenting the existing facilities, both in terms of infrastructure and human resources. • Phase III constructions				
3.8	*Construction and commission-ing of the polar research vessel*	Commencement of the basic design, production drawings etc. and obtaining the requisite approvals Initiation of construction activities	200.00	Achievement vis-a-vis target	Very Critical	
3.9	*Construction and commission-ing of an oceanographic research vessel as a replacement for Sagar Kanya*	▪ Initiation of action for the construction of an oceanographic research vessel to serve as a replacement of ORV Sagar Kanya.	5.00	Achievement vis-a-vis target	Very Critical	New Program
3.10	Cryosphere Processes And Climate Change (CryoPACC):	To study the fundamental processes involved in the biogeochemical cycling (measurements of processes and factors influencing the same) within the snow packs as well as during the subsequent transformation to firn and ice in the polar and Himalayan. region.	7.00	Publications	Critical	New Program

4.0 OCEAN RESOURCES						
4.1	Legal continental shelf Program (CLCS)	• Defense of India's submission for an extended continental shelf before the UN-Commission on the Limits of the Continental Shelf (CLCS)	2.00	Target Vs. achievement	Critical	Defense of India's submission dependent on when the submission comes up in the queue
4.2	Deep Ocean drilling in the Bay of Bengal and Arabian Sea through the Integrated Ocean Drilling Program (IODP)	• To defend the Indian Drilling proposal for the Arabian Sea. • Participation of Indian Scientists in various IODP scientific expeditions around the world. • Extramural research support to R&D Projects under IODP theme	10.00	Completion of targeted activities within the envisaged timeframe.		
4.3.	Comprehen-sive Swath Bathymetric Survey of Indian EEZ	• To carry out the swath bathymetric survey of entire EEZ	25.00	• Initaition and completion of EEZ surveys inpre-identified blocks. • Processing and interpretation of the collected data, data archival.		
4.4	Studies on Hydrothermal Sulphides	• Exploration for potential sites of hydrothermal multi-metal sulphide mineralization in the central Indian Ocean Ridge • To make India's submission for initiating exploration activities	72.75	• Phase I. Short-term project aimed at prospecting for the possible target areas, leading to lodging of application with		New Program

		on the active hydrothermal vents in the central Indian Ridge for polymetallic sulphides. • Identification of locales of hydrothermal sulphide deposition in the central Indian Ridge, including determination of the resource potential. • Initiation of associated scientific research in the frontier areas of hydrothermal mineralization including the tectonic environment, host-rock composition, and development of geological models for seafloor hydrothermal systems.		ISBA for Exploration License for approval of plan of work for exploration. To be taken up on a mission-mode spread over two fair-weather seasons during 2011-13, the tasks involved in this Project would comprise, but not be limited to the following: ACTIVITY 1. Geophysical Surveys, Geological Sampling & Analyses ACTIVITY 2. Identification of Areas of Hydrothermal Sulphide Deposits ACTIVITY 3. Lodging of Application with Isba for Exploration License		

				ACTIVITY 4. Scientific Studies of Hydrothermal System		
5.0 GESOSCIENCE						
5.1	Exploring the origin of the largest Geoid low on the Earth	To study the nature and origin of the geoidal low in the Indian Ocean centered around south of Sri Lanka	8.00	Preliminary data collection and development of a workplan.		New Program
5.2	Deep crustal studies of the South West Indian margin and its interior: An onshore-offshore perspective	The project envisages high-resolution, deep-penetration seismic reflection/refraction data set along the SW Indian margin to examine the precise nature (such as magma poor or magma rich) of this rifted margin and to provide any insight into the demarcation of the continent–ocean transition (COT) of this area. Moreover, offshore interpretations would be tied up with the onshore studies carried out by extensive DSS studies.	10.00	Data collected vis-a-vis target		New Program
5.3	New facility for High Resolution Secondary Ionisation Mass Spectrometry (HR-SIMS)	• *Insitu* U-Pb dating of zircons and precise geochronology of important rock formations of the Indian shied; implications to crust evolution, and economic geology. • Hf isotopic compositions in	15.00	• Initiation of action for procurement	Critical	New Program

		zircons and ultramafic – mafic rocks with implications to crust-mantle dynamics and evolution of the Indian shield through its >3.5 billion year geologic history and the regional metallogeny. • Sr, Nd, Pb and Hf - Isotopic characterization of mafic - ultramafic rocks from the Carlsberg and Central Indian Ridge systems and the Andaman back arc basin, understanding magmatism and geodynamic processes at the Indian plate margins. • Isotopic studies on Ocean sediments, particulates and waters: implications to present and past climates and surface processes. • Geochronology and Isotopic systematics of mantle xenoliths in Indian diamond bearing kimberlites: insights into the deep mantle and diamond exploration. • Isotopic compositions of elements such as Fe, Cr, Cu and Zn to understand the genetic controls of Indian base metal deposits. • To initiate Fe isotopic studies with implications to bio-geochemical processes and				

		palaeoclimates.				
6.0 Coastal Marine Ecology						
6.1	Coastal Research	Understanding of coastal processes, ecosystem changes, assessment of health of coastal waters and impact of anthropogenic activities on quality of marine environment	20	Monitoring of seawater quality on seasonal basis at 20 locations all around the Indian coastline and providing status/trend of pollution on a quarterly basis at these locations; Development of Seawater Quality Criteria for heavy metals, aluminium and iron in Ennore coastal waters; Commencement of experiments to develop Seawater Quality Criteria for copper/cadmium/mercury in the waters of Paradeep, Kochi and Pondicherry	Project Document 5 years	
				Initiation of collection of data on sources of pollutants at creeks, rivers of two locations along the Indian coastline to understand the characteristics of pollution and their load into the coastal waters; Initiation of first field programme to collect data required for modeling to predict pollutants		
				Project planning for undertaking a project on “Development of Ecosystem Modelling for Southwest Coast of India” and collection of one season data on		

				physical and, chemical and biological parameters		
				Project planning for coastal circulation and sediment transport studies and compilation of past data on shoreline changes; Initiation of modeling using satellite based wave data to predict waves at deeper and nearshore locations and validation using the field observations	Project Document 5 years	
				Commencement of collection of field data to study the impact of climate change on shoreline changes and biogeochemistry in the Kavaratti island of Lakshadweep		
				Conducting training programmes on Coastal Management, Disaster Mitigation and Marine Pollution		
				Collection of data on polluted related parameters at 20 locations on a seasonal basis along the coastline of India		
				Initiation of assessment of pollution load in creeks/rivers draining into the coastal waters of two major polluting locations, required for the purpose of predicting		

7.0 INDIAN NATIONAL CENTRE FOR OCEAN INORMATION SERVICES						
7.1	Ocean Information Services (OIS)	Sustain and improve the ○ Potential Fishing Zone (PFZ) advisories ○ Tuna Fishing Zone advisories ○ Global, regional, coastal state specific and location specific forecasts of waves, currents, etc. ○ Generation of coral reef bleaching alerts • Initiate species-specific advisories for commercially important species apart from Tuna. • To operationalise the district level coastal ocean forecasts for the coastal districts of India • To operationally setup WRF atmospheric model to obtain high resolution	18.14 Cr GIA-Capital-Rs.4.35 Cr. GIA-Revenue-Rs.13.79 Cr.	**Potential Fishing Zone Advisories** • Operationally generate and disseminate • Potential Fishing Zone (PFZ) Advisories Sustenance and improvements • Enhance the awareness campaigns, user base and delivery chain • Carryout concurrent validation experimentsto validate and improve the PFZ Advisories • Carry out R & D activities for providing improved and continuous PFZ Advisories and Species-Specific forecast for Tuna, Oil Sardine, Mackerel, Hilsa, etc. and for eco-system modelling • Continuation of Fish Tagging Experiments • Installation of Electronic Display Boards **Ocean State Forecast** • Sustaining the generation and dissemination regional forecasts for the Arabian Sea, • Bay of Bengal, South China Sea, Persian Gulf, Red Sea and		

		atmospheric forcings to force the district level ROMS and SWAN models. • Setup an exclusive lab for the ocean state forecast with modern dissemination systems and to streamline the real time data reception from wave rider buoys, ship borne wave height meters, current meters, satellite data and AWS data for their assimilation into the models and for the evaluation of forecast products. • Extent the coral reef health bulletins for all reef environments around India. • Setting up of a state of art 'Ocean Data Processing Lab' and the development of 'Digital Ocean' • Develop and provide the value added in situ and remote sensing data products		also, Global forecast. • User Interaction: Improve the collaborations with NGO's and other agencies for forecast utilization • Awareness campaign on Ocean State information system for port and harbors, shipping and oil industry. • Sustaining coastal wave forecast for coastal and location specific • Improvement of dissemination system (more EDBs, Mobile phones, DTSI (Direct to ship through INSAT etc.) • Value - added Services and consultancy Services: Take up value added services and consultancy services (IV limits, Wave climatology, customized forecast) for the coastal and offshore applications • Setting up Ocean Forecasting Lab. • Decentralized validation projects for various locations/states with a long term objective of establishing the local forecast centers. • Training the Ocean forecasters and service providers **Data Services, Products and Management**		

		to various users. • Setting up of a special data centre for OBIS and develop the tools for data processing, quality checking and dissemination • Enhance the dissemination of the products through EDBs, web, mobile, email, etc. • Increase the awareness among the community, increase the delivery chain and enhance the user base		• Collaborate with various institutes to receive data and archive at INCOIS. • Quality control of various parameters data obtained from the instruments. • Supply to users upon request for use in research and validation purpose. • Digital Ocean Development Data Search and Rescue • Real Time remote sensing data distribution. • Live Access Server Products • Development of data products from disseminating in situ data. • Real Time validation system. **Coral Health Bulletins/ Coastal Geospatial Applications** • Satellite Data Processing		
7.2	Computational Facilities, Web Based Services & Operations and Maintenance of INCOIS (Manpower, Travel and Administrative expenditure)	**Computational Facilities & Web Based Services** • Designing, planning, implementation and maintenance of the Information and Communication Technology (ICT) infrastructure required for various projects at INCOIS. • Designing, planning,	50.40Cr GIA-Capital-Rs.30.65 Cr. GIA-Revenue-Rs.19.75 Cr	**Computing** • Facility Management & Annual Maintenance of Hardware including HPC, Software, Networking & Internet, Peripherals including video walls, large display systems, video conference / telepresence equipment, etc. • Augmentation & Upgradation of Hardware, Software, Networking & Internet, Peripherals including video walls, large display		

		implementation and maintenance of communication infrastructure for real-time data acquisition from various observational platforms. • Providing High Performance Computing (HPC) infrastructure required for running various numerical models with-in the stipulated time lines. • Data back-ups & archival of ocean data and information. • Development and Maintenance of the website for dissemination of various ocean products. Operations and Maintenance of INCOIS (Manpower, Travel and Administrative expenditure) • Establishment expenditure of		systems, video conference / telepresence equipment, etc • Procurement of Hardware, Software, Networking & Internet, Peripherals etc • Training **Communication** • Annual Maintenance of INSAT Terminals & Associated Equipment, VSAT Terminals & Associated Equipment, Seaspace (SDAPS) Radome Antenna & Associated Equipment including Hardware & Software, VPN-DMS Terminal & Associated Video Conferencing Equipment, Oceansat-II Terminal & Associated Ground Station Equipment, L-Band NOAA Terminal, etc • Augmentation & Upgradation of INSAT Terminals & Associated Equipment, VSAT Terminals & Associated Equipment, Seaspace (SDAPS) Radome Antenna & Associated Equipment including Hardware & Software, VPN-DMS Terminal & Associated Video Conferencing Equipment, Oceansat-II Terminal & Associated Ground Station		

		INCOIS consisting the activities of Payment of Salary, Allowances, Travel, Welfare etc., for the sanctioned strength. • Operation & Maintenance of activities such as Electricity and Water, Electrical and Air Conditioning installations. • Capital Expenditure towards spill over part of the Construction of New Campus under Phase II. • Annual Contribution & Member ship to various international Bodies		Equipment, etc • Procurement of new antenna Terminals, electronics & communication components, related communication / control systems, INSAT based communication system for PFZ data, etc including establishment of Electronics Lab for attending first level trouble shooting activities of various communication systems. • Training **Web Based Services and INCOIS Intranet Application** • Development and Maintenance of INCOIS Website, Ocean Portal, Tsunami Website including augmentation of h/w & s/w • Development and Maintenance of INCOIS Intranet Application • Training **Electrical** • Annual Maintenance of Sub Station, DG Sets, AC Plants, PAC Units, , Spilt ACs, UPS, general electrical including lighting, earthing, other associated equipment, cables, etc • Augmentation & Upgradation of		

				Sub Station, DG Sets, UPS Systems, AC Plants, PAC Units, Spilt ACs, general electrical including lighting, earthing, other associated equipment, cables, etc • Procurement of DG Sets, UPS systems, AC Plants , PAC Units, Spilt ACs, general electricals, other associated equipment, cables, etc • Travel **IT Requirements for Phase-II** • Networking & IT Infrastrcuture for Phase-II campus, Data Centres construction & maintenance **Operations and Maintenance of INCOIS (Manpower, Travel and Administrative expenditure)** • The deliverables in respect of Establishment, Operational Maintenance cannot be quantified. • The New Building will provide more space to handle the requirement of various Ongoing and Upcoming Projects. • Funding support to international interface is for INCOIS participation in the international programmes of importance		

				helps to achieve its targets & goals.		
7.3	Ocean Observation Systems (OOS)	• To establish comprehensive ocean observing system with special emphasis on coastal ocean" • To collect marine meteorological and oceanographic data using different in-situ systems both from offshore and coastal ocean of Indian Seas. • Technology demonstration of newer ocean observational systems suitable to Indian waters • To undertake Inter-Institutional R&D projects at national and international level. • Capacity building to enhance and update expertise and knowledge on ocean observation systems.	31.09 Cr GIA-Capital-Rs 21.30 Cr GIA-Revenue-Rs.9.79 Cr	**INCOIS Component** • Deployment of Argo floats (40) • Deployment of Drifting buoys(30) • Deployment of XBT Probes and collecting water samples along the shipping route • Servicing and deployment of Current meter moorings at the Equator and coastal ADCP moorings • Servicing – Retrieval and deployment of Bay of Bengal Observatory • Automatic Weather Station of collection of marine meteorological and oceanographic parameters onboard Ships/Rigs (7) • Wave height meter (2) • Wave rider buoys (4) • Undnderway CTD using research vessels(1) • Facilitate RAMA moorings (60 days cruise)		
7.4	R & D in ocean sciences,	**INDOMOD:** • Ocean and Climate	14.92 Cr	**INDOMOD** • The outcome of the XI plan of		

	INDOMOD and SATCORE	• Coastal Ocean • Hazardous Weather Events • Ocean Data Assimilation • Marine Ecosystem modeling **SATCORE:** • Establishment and coordination of time-series measurements of bio-optical and water quality parameters in Indian coastal waters. • NRT processing of data from operational satellite sensors to generate ocean colour products. • Web dissemination of ocean colour data products to the Entire Indian Ocean including Global Ocean Observing System for Indian Ocean (IOGOOS) member states (MS). • *In situ*, bio-optical, data collection, processing, analysis and archiving in a	GIA-Capital-Rs. 8.94Cr GIA-Revenue-Rs.5.98Cr	INDOMOD will be assessed and some of the components will be transferred to INCOIS for improvement in Operational forecast. New proposals will be invited for the XII plan and new proposals will be sanctioned which are relevant to INCOIS mission. **SATCORE** • Sustaining dissemination of ocean colour data products to Indian Ocean Countries • Database of bio-optical and associated water quality parameters generated during SATCORE XI plan • Validation of ocean colour data products using *in situ* data • Implementation of first phase of Operational service "Detection and Monitoring of Harmful Algal Blooms" • Identification of time-series stations and sampling strategy for SATCORE XII plan **Spatio-spectral classification of coral reefs:** • Report on status of spatial distribution of corals in the proposed study area • Reconnaissance survey report on *in situ* and satellite		

		database. • Validation, improvement and development of new algorithms for the retrieval of geophysical products from ocean colour satellite sensor. • Generation of value added products and services using data products from ocean colour satellite sensor. • Develop an operational service towards detection and monitoring of HAB in Indian coastal waters. • To give a proper atmospheric correction to the remotely sensed data by analyzing the effect of atmospheric turbidity and aerosol size distribution on radiative transfer. • Modelling Primary		observations.		

		Productivity using *in situ* and satellite data. • Automatic generation of Frontal maps using ocean colour satellite data for locating PFZ. • Exploring other potential application of ocean colour research towards operational applications. **Spatio-spectral classification of coral reefs:** • Study spectral properties of the coral eco-morphological class from satellite and in-situ hyper-spectral observations. • Generation of the spectral library • Development of automated coral				

		reef classification system				
7.5	Early Warning Systems for Tsunamis and Storm Surges	• Detect, locate, and determine the magnitude of potentially tsunamigenic earthquakes occurring in the Indian Ocean and provide timely advisories on 24x7 basis • Maintain the existing core tsunami observing systems (3 NOAA-type BPRs at 2 locations, 21 tide gauges) and communication systems for data transmission • Enhance the tsunami observation networks (4 NOAA-type BPRs, 15 Tide Gauges, 35 GPS stations) • Enhancement of DSS application, Sea-level data inversion, Modeling & other associated elements for provision of services for Indian	32.89 Cr GIA-Capital-Rs.21.00Cr GIA-Revenue-Rs.11.89Cr	• Provide RTSP Services (RIMS & SIMS, Modelling for Tsunami Global Domain; DSS Upgradation, Software development) • Maintenance of Tide gauge Station, SAIC Tsunami Buoy, Computational and communication equipments, technical support facilities including bandwidth charges, etc. • Capacity building (trainings, workshops, awareness materials, etc.) • Support R & D projects (Paleotsunami, Seismotectonics, GPS, Modelling) • Procurement of BPRs (2 Nos) • Procurement of Tide Gauges (10 Nos) • Procurement of GPS Stations (20 Nos) • Hardware and S/W Procurement (Upgradation of Data Centre Facilities, Servers, Software, INSAT Communication facilities, etc) • Procurement of Bathymetry Data, Topographic Data, 3D GIS Models, Preparation of Inundation	•	•

		Ocean and Global Domains • Real time tsunami modeling and inundation mapping for vulnerable Indian coasts • Utilisation of real-time GPS data for better characterization of tsunami • Development and implementation of storm surge forecasting service. • Conducting tsunami drills at national and international level coordinating with various agencies • R & D Projects, Capacity Building, Education & Training		& Evacuation Maps		
7.6	Training centre for Operational oceanography	• Set up a permanent training facility for capacity building and long term training of manpower specialized in operational oceanography at INCOIS. • Build the faculty block and an	5.80 Cr GIA-Capital-Rs.4.50 Cr GIA-Revenue-Rs.1.30Cr	• Appointment of consultants for designing, constructing and interior of the buildings • Necessary preparatory work for acquisition of material will be done • Prepare necessary documents for recruitment of Manpower • Prepare the course plans • Sign MoU/s with universities to award degree/diploma to the	•	•

		international standard guest house cum hostel to accommodate the trainees and foreign faculty • Recruit necessary faculty to offer the training. • Sign MoU/s with universities to award degree/diploma to the students who complete the long term courses. • Conduct the short and long term training programmes.		students who complete the long term courses.		
7.7	High Resolution Operational Ocean Forecast and Reanalysis System	• Setup and test high resolution WRF for the Indian coastal region • Setup high resolution ROMS netsted in HyCOM/MOM-GODAS for the east and west coast of India with tidal forcing • Setup SWAN (coastal wave model) at several locations along the east and west coast of India • Implement 4-D var	2.52 Cr GIA-Capital-Rs.2.00Cr GIA-Revenue-Rs 0.52Cr	• High resolution atmospheric forcing using WRF model for forcing coastal ocean models • Improved initial condition for coastal forecasts using 4-D var assimilation technique. • High resolution forecasts of surface current/ SST, tides and waves for the coastal waters around India • Ocean analysis product will be generated on pentad time scales instead of monthly analysis • Impact of different ocean observing system will be evaluated.	•	•

		assimilation system in coastal ROMS setup				
8.0 INFRASTRUCTURE DEVELOPMENT/OUTREACH ACTIVITIES						
8.1	R& D in Earth and Atmospheric Sciences	• To carry out basic research activities in the field of ocean and atmospheric science and develop human resource	36.00	• Enhance the forecasting capability of the country through well supported R&D programs. • Support R & D projects that address issues of National importance • Building indigenous capability through Joint developmental work with other institutes and/or organization. • Human resource development in Atmospheric and Earth Sciences		
8.2	Assistance for Oceanographic Research	• Providing assistance to 9 OASTCs and supporting research projects outside OASTCs	9.1	- Funding of new research projects in network mode. - Establishment of new ESTCs and up-gradation of existing ones into Centers of Excellence (CoE) - Travel support to scientists for attending international conferences abroad.	8.2	

Chapter-V: Financial Review covering overall trend in expenditure vis-à-vis Budget Estimates / Revised Estimates

A Statement showing Budget Estimates, Revised Estimates and Actuals for the past two years i.e, 2008-09, 2009-10 and current year i.e. 2010-11 is on the basis of the position shown in the Statement following trends can be seen in Plan expenditure.
Major Head-wise trend of Expenditure in the recent years is as follows

Name of the Scheme	XI Plan	2007-08		2008-09		2009-10		2010-11	
	Allocation	Approved outlay	Actual	Approved Outlay	Actual	B.E.	Actual	B.E.	R.E.
2	3	5	6	7	8	9	10		
Plan									
Polar Science	556	20	28.48	35.5	57.38	94	93.96	145.00	165.00
Polymetallic Nodules Programme	319	15	8.1	15	14.59	13	11.76	15.00	13.45
Ocean Observations, and Information System (OOIS)	99.5	15	14.99	13	18	15	15.00	23.00	28.00
MRTD-CMLRE-ICMAM-COMAPS	348	25	25.68	24	27.04	65	61.84	78.50	69.00
National Institute of Ocean Technology (NIOT)*	271	20	9.24	20	30	50	50.00	45.00	45.00
Coastal Research Vessels (CRV) & other research vessels	25	5	5	5	5	5	5.00	7.00	6.00
Delineation of Outer Limits of Continental Shelf	6	1	0.63	1	1	1	1.00	1.00	1.00
Comprehensive Topographic Surveys	52	5	4.82	5	5	6	5.98	6.00	6.00
Gas Hydrates Exploration & Technology Development for Exploitation	56	10	4	12	6	35	34.90	12.00	12.00
O&M of Sagar Nidhi	234	100	106	12	20	22	22.00	20.00	24.00
Tsunami Early Warning Systems	99	35	29.6	15	10.32	15	10.56	12.00	10.00

Data Buoy programme & Operation maintenance of Sagar Manjusha	93.5	15	6	10	14.8	18	17.62	15.00	15.00
Information Technology	20	1	2.1	1	2.29	10	9.84	7.00	8.50
National Centre for Antarctic and Ocean Research(NCAOR)	67	15	14	15	8.12	15	15.00	15.00	15.00
Indian National Centre for Ocean Information Service	114	35	24	30	21.2	20	20.00	25.00	30.00
Seafront facility	105	10.05	0	10	0	0.5	0.00	0.50	0.50
Development of manned submersible	120	5	0	5	0	5	0.00	5.00	0.01
Multichannel Seismic System onboard ORV Sagar Kanya	71	5	0	5	0	0.01	0.00	0.50	0.00
Desalination Project	210	10	1	10	0	5	5.00	5.00	0.04
Expedition to Arctic	46	1	3	2	1.55	2.6	2.60	3.00	3.00
National Oceanarium	100	0.95	1	0.5	0	2	0.04	1.00	0.50
Demonstration of Shore Protection measures through Pilot project	35	1	0	0.5	0.5	5	5.00	5.00	5.00
Integrated Ocean Drilling Programme(IODP)+Arabian Sea basin studies	61	4	1	4	4.5	10	10.00	6.00	6.00
Ice class Research vessel	440	1	0	5	0	0.5	0.50	25.00	25.00
Headquarter Building	50	10	10	20	0	25	25.00	25.00	10.00
India Meteorology Department	**2616**	**297.62**	**40.76**	**432**	**190.86**	**305.4**	206.51	**306.00**	250.00
National Centre for Medium Range Weather Forecast (NCMRWF)	**69**	**11**	**5.83**	**11**	**7.68**	**20**	7.48	**25.00**	11.00
Indian Institute of Tropical Meteorology (IITM)	239	13	13.83	13	29	60	59.50	56.45	65.00
Multi-hazards Early Warning Support System	20		0	1	1	10	5.22	5.00	3.00

Centre for Climate	161	0	0	5	5	25	24.02	45.00	45.00
Dedicated Weather Channel & Commonwealth Games 2010	85	0	0	5	0	5	0.21	15.00	13.00
NIOT ext. centre West Bengal	32	0	0	0.5	0	0.01	0.00	0.05	0.00
R&D in Earth & Atmospheric Sciences	36	3.38	0	7	8.73	20	14.94	30.00	50.00
Seismicity and Earthquake precursor	148					15	13.89	15.00	15.00
SUB-TOTAL(PLAN)	7004	690	359.06	750	489.56	900	754.37	**1000.00**	950.00

Chapter VI: Review of Autonomous Bodies

Under this Ministry, currently there are 4 autonomous bodies working in the specific areas of Ocean Atmospheric Science & Technology viz., INCOIS, Hyderabad; NIOT, Chennai; NCAOR, Goa and IITM, Pune. INCOIS and NCAOR are implemented under two schemes viz., OOIS and Polar Science respectively. The review of these autonomous bodies has accordingly been projected in the respective programmes of Chapter II.