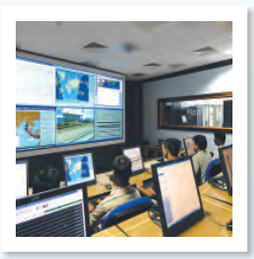
ANNUAL REPORT
2012 - 2013





INCOIS

Indian National Centre for Ocean Information Services

(An Autonomous Body under the Ministry of Earth Sciences, Government of India)
'Ocean Valley', Hyderabad - 500 090

www.incois.gov.in

Contents

1. Preface

The selfless efforts of a young and dynamic group of scientists, guided by visionaries of scientific excellence and supported by dedicated executive support staff have given ESSO-INCOIS a reputed position in the global arena of ocean services. ESSO-INCOIS serves a large user community comprising traditional fisher folk, high-tech off-shore industries, maritime security & safety agencies, shipping industry, etc. The services are provided through a wide range of dissemination systems including email, fax, telephony, short message services, electronic display boards, web services, etc. High quality services provided by ESSO-INCOIS are supported by well planned ocean observations and focused research. ESSO-INCOIS is now in the process of obtaining ISO 9001:2008 accreditation for its services so that the processes involved in the generation of these services will meet global standards. ESSO-INCOIS also continues to play a lead role in oceanographic services among the Indian Ocean Rim countries while extending its expertise and services to many of them. A brief account of the activities of ESSO-INCOIS in the period April 2012 to March 2013 is presented in this annual report. These activities include launching of several new services, improvements in many of the continuing services, enhancement of the observational network and outcomes of important in-house research and development activities as published in reputed journals. The report also deals with the augmentation in the institute's infrastructure and other activities of national and international significance.

2. From Director's Desk

It is my great pleasure to present the progress of the ESSO-Indian National Centre for Ocean Information Services (ESSO-INCOIS) in its mission, operations and R & D programmes during 2012-13. The Centre has been consistently striving to provide a wide range of ocean information and advisories to users at all levels including the fishermen of the country. The 11th Five Year Plan of the institute was targeted to provide major growth in new services to users, improvements in service accuracy and timely dissemination, manpower development and infrastructure development. I am extremely happy to report that the Centre made significant progress in meeting these targets during the 11th plan period. The year 2012-13 is the first year of the 12th Plan Period during which we have taken up several new challenges including the establishment of the International Centre for Operational Oceanography at ESSO-INCOIS.

It was a real life test for ESSO-INCOIS when two major earthquakes (8.6 M and 8.3 M) occurred in succession off the west coast of Northern Sumatra in the Indian Ocean on 12th April 2012. Though the events did not generate any major tsunami, the centre issued bulletins and kept the authorities informed as prescribed in standard operating procedures. In addition, being the Regional Tsunami Watch Provider, the Centre also provided information to 23 countries on the Indian Ocean Rim. The efficiency and professionalism of the Centre in handling this event was widely acclaimed.

For the first time in India, ESSO-INCOIS started (since March 2013) providing global ocean analysis on a daily basis, by assimilating ocean observations into an Oceanic General Circulation Model. This service provides the daily evolution of temperature, salinity and currents in the global oceans with a delay of two days. These fields are now being used as initial conditions in atmospheric models to predict the seasonal behaviour of the Indian monsoon.

While continuing to provide Ocean State Forecasts (waves, tides, surface currents, SST, mixed layer depth and depth of thermocline) to a divergent user community (fishermen, maritime industry, the Navy and the Coast Guard) in India on a daily basis, we have also started providing such services to users in the Maldives. The special bulletins on 'High Wave Alerts' issued in Tamil and Telugu during the 'Neelam' cyclone during 28th-31st October 2012 proved to be successful in preventing fishermen from venturing out to sea. Another new service was introduced during the year to provide Ocean State Forecasts along the chosen tracks of ships. This service enables navigators to derive sea state predictions along a route and select the optimum route for safe navigation.

On the Potential Fishing Zone (PFZ) advisories front, while continuing to provide the advisories on a daily basis, the network has been expanded by including more landing centres (an increase to 586 landing centres from 287 provided earlier). The project jointly initiated with CMLRE, CMFRI, and FSI, to study the environmental preference of Tuna using satellite tracked tags has started yielding useful results. Fifteen Yellowfin Tuna (*Thunnus albacares*) have been tagged during October 2012-March 2013 period. The preliminary results indicate that the Tuna prefer to stay at relatively shallow depths (<200 m) during day time and at deeper depths (200-400 m) during night time.

Last year also saw expansion in the dissemination systems network for PFZ and OSF advisories that helped in reaching a larger number of users. The dissemination systems were expanded through tie-ups with local organizations who arranged broadcast through local radio stations (for example AIR in Karwar), public address systems, village resource centres and web content in regional languages. Additionally, we have also started dissemination of customised Ocean State Forecasts to Coast Guard centres and the Coastal Security Police in Tamil Nadu, Goa, Karnataka, Lakshadweep and Andaman and Nicobar Islands.

The ocean observing network was enhanced through deployments of Argo floats, wave rider buoys, shipboard AWS, tide gauges, tsunami buoys and a mooring in the central Bay of Bengal with a suite of sensors. The analysis of data from the observing systems has resulted in several research papers.

Realizing the importance of accurate prediction of Indian waters, emphasis has been placed on developing high resolution models with improved physics and data assimilation and the use of a suite of models: MoM, Hycom and ROMS to narrow down forecasts from global to basin wide and to coastal significance. All three models are making tremendous progress in terms of better simulation and forecasts with the help of data assimilation. Modelling of biogeochemical parameters and storm surge modelling are the other new modelling activities taken up during 2012-13.

On the infrastructure front, the commissioning of the INSAT hub station to receive seismic and GPS data from 90 field stations in real time and the establishment of high speed MPLS links connecting the regional seismic data centres at NGRI (Hyderabad), NEIST (Jorhat), Survey of India (Dehradun) and the Institute of Seismological Research, Gandhi Nagar have been completed. 67 VSATs have been installed at 40 seismic, 25 GPS stations and at 2 hub locations (ESSO-INCOIS and NCMRWF) scattered over the country. The construction activities undertaken for the Phase-II expansion of the campus are close to completion.

The Centre's publication record has improved considerably. During 2012-13, ESSO-INCOIS's scientists authored/co-authored 45 research papers published in peer-reviewed journals. The cumulative Impact Factor (IF) for the year is 57.7. Thirty-three students carried out their B.Tech./M.Tech./M.Sc. dissertation/project works at ESSO-INCOIS under the guidance of ESSO-INCOIS scientists.

With the addition of 9 scientists at C and B levels, the strength of scientists in ESSO-INCOIS increased to 42. The total permanent manpower strength of ESSO-INCOIS is 70. During the year, 4 project scientists, 1 research assistant and 6 project assistants were recruited to execute the mission mode projects. 8 project scientists resigned during the year.

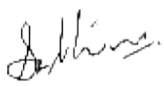
On the international scenario, ESSO-INCOIS continued its involvement with the Indian Ocean Global Ocean Observing System (IOGOOS), Regional Co-ordination of Argo Programme, the Partnership for Observation of Global Oceans (POGO), Regional Integrated Multi-hazard Early warning System (RIMES) and as part of the Intergovernmental Coordination Group (ICG) of the Indian Ocean Tsunami and other hazards Warning System (IOTWS) of the Intergovernmental Oceanographic Commission (IOC)/UNESCO. ESSO-INCOIS continued hosting the secretariats of IOGOOS and the Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER). The special data centre for Ocean Bio-Informatics System (OBIS) has been maintained and serviced, in close coordination with IODE/IOC.

ESSO-INCOIS successfully organised and hosted the biennial Pan Ocean Remote Sensing Conference (PORSEC) - 2012 in Kochi during 5th-9th November 2012. The event was attended by 544 participants from 19 countries. 275 research papers and 78 posters were presented in 25 technical sessions.

Dr. Srinivas Kumar T has been selected as a Fellow of the Andhra Pradesh Akademi of Sciences, in recognition of his contributions to setting up the Indian Tsunami Early Warning Centre at ESSO-INCOIS. Shri. R. Venkat Shesu received the Certificate of Merit and Shri. Suresh Ganti received the "Best Employee" Award on the occasion of Foundation Day of Ministry of Earth Sciences held on 27th July 2012.

I am confident that ESSO-INCOIS will continue providing quality services to society and establish itself as a World leader in Operational Oceanography. I thank my colleagues at ESSO-INCOIS for their dedication, commitment and cooperation in designing and executing projects. I take this opportunity to thank Dr. Shailesh Nayak, Chairman, Governing Council and members of Governing Council for their support and guidance at every moment. I would also like to thank the Chairmen and members of the Finance Committee and the Research Advisory Council.

The administrative support extended by the colleagues in the Ministry of Earth Sciences is gratefully acknowledged. The editorial committee chaired by Francis P. A. with M. S. Girish Kumar, Satya Prakash, K. Annapurnaiah, R. Venkat Shesu, Nimit Joshi, Celsa Almeida and Sidhartha Sahoo as members compiled the report based on the inputs from other colleagues. I am extremely grateful to all of them.



S.S.C. Shenoi

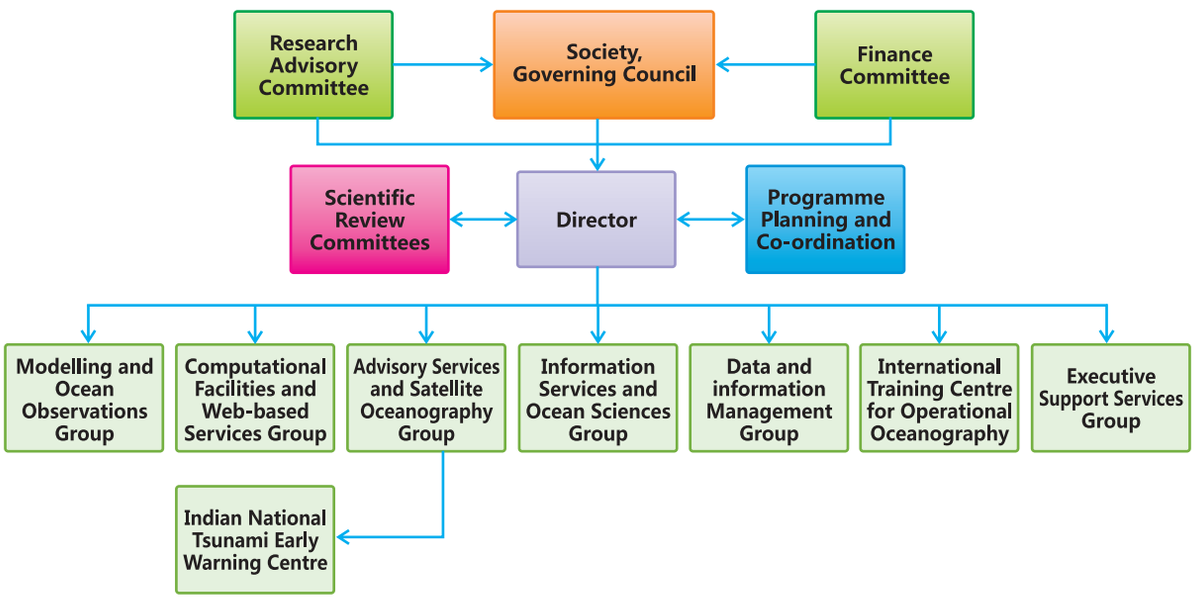
3. ESSO-INCOIS Organizational Structure

ESSO-INCOIS is an autonomous institute under the administrative control of the Ministry of Earth Sciences, Government of India and a member of the Earth System Sciences Organization (ESSO), chaired by the Secretary to Government of India for Ministry of Earth Sciences. ESSO-INCOIS is registered as a society under the Andhra Pradesh (Telengana) Public Societies Registration Act (1350, Falsi), at Hyderabad on 3rd February 1999. The affairs of the Society are managed, administered, directed and controlled, subject to the Bye laws of the Society, by the Governing Council.

ESSO-INCOIS Society

1.	Secretary, Ministry of Earth Sciences	President
2.	Director, National Remote Sensing Centre, Hyderabad	Vice President
3.	Joint Secretary, Ministry of Earth Sciences	Member
4.	Advisor, Ministry of Earth Sciences	Member
5.	Director, National Institute of Oceanography, Goa	Member
6.	Director, National Institute of Ocean Technology, Chennai	Member
7.	Director, National Centre for Antarctic and Ocean Research, Goa	Member
8.	Director, Indian National Centre for Ocean Information Services	General Secretary

Organisation Structure of ESSO - INCOIS



ESSO-INCOIS Governing Council

1. Secretary, Ministry of Earth Sciences (Chairman)
2. Dr. Harsh Gupta, Hon'ble Member, NDMA, New Delhi (Member)
3. Director, National Remote Sensing Centre, (Member)
4. Director General, India Meteorological Department, (Member)
5. Financial Advisor, Ministry of Earth Sciences, (Member)
6. Chairman, Research Advisory Council, ESSO-INCOIS, (Member)
7. Additional/Joint Secretary, Ministry of Earth Sciences, (Member)
8. Director, National Centre for Antarctica and Ocean Research, (Member)
9. Director, National Institute of Oceanography, (Member)
10. Director, National Institute of Ocean Technology, (Member)
11. Principal Advisor (S & T), Planning Commission, (Member)
12. Director, Space Application Centre, (Member)
13. Director, Indian National Centre for Ocean Information Services, (Member Secretary)
14. Programme Officer, Ministry of Earth Sciences, (Permanent Invitee)

ESSO-INCOIS Research Advisory Committee

1. Prof. B.N. Goswami, Director, Indian Institute of Tropical Meteorology, Pune (Chairman)
2. Prof. (Mrs). P. Venkatachalam, Principal Research Scientist, Indian Institute of Technology, Mumbai (Member)
3. Dr. V. K. Dadhwal, Director, National Remote Sensing Centre, Hyderabad (Member)
4. Dr. M. Dileep Kumar, Chief Scientist, National Institute of Oceanography, Goa (Member)
5. Dr. B.K.Saha, Adjunct Professor, School of Oceanographic Studies, Jadavpur University, Kolkata (Member)
6. Dr. M.Ravichandran, Head, Modelling and Ocean Observations Group, Indian National Centre for Ocean Information Services, Hyderabad (Member Secretary)

ESSO-INCOIS Finance Committee

1. Financial Advisor, MoES (Chairman)
2. Additional/Joint Secretary, MoES (Member)
3. Director, ESSO-INCOIS (Member)
4. Director/Deputy Secretary (Finance), MoES, (Member)
5. Programme Officer, MoES (Member)
6. Sri. E. Pattabhi Ramarao, Scientist, ESSO-INCOIS (Member Secretary)

4. The Mission

To provide ocean data, information and advisory services to society, industry, government and scientific community through sustained ocean observations, and constant improvements through systematic and focused research in information management and ocean modelling.

The major objectives of ESSO-INCOIS are:

- To establish, maintain and manage systems for data acquisition, analysis, interpretation and archival for Ocean Information and related services.
- To undertake, aid, promote, guide and co-ordinate research in the field of ocean information and related services including satellite oceanography.
- To carry out surveys and acquire information using satellite technology, ships, buoys, boats or any other platforms to generate information on fisheries, minerals, oil, biology, hydrology, bathymetry, geology, meteorology, coastal zone management and associated resources.
- To generate and provide data along with value added data products to user communities.
- To cooperate and collaborate with other national and international institutions in the field of ocean remote sensing, oceanography, atmospheric sciences/meteorology and coastal zone management.
- To establish Early Warning System for Tsunami and Storm Surges.
- To support the research centres in conducting investigations in specified areas related to oceanic processes, ocean atmospheric interaction, coastal zone information, data synthesis, data analysis and data collection.
- To organise training programmes, seminars and symposia to advance study and research related to oceanography and technology.
- To publish and disseminate information, results of research, data products, maps and digital information through all technologically possible methods to users for promoting research and to meet societal needs for improvement of living standards.
- To provide consultancy services in the fields of ocean information and advisory services.
- To co-ordinate with space agencies to ensure continuity, consistency and to obtain state-of-the-art ocean data from satellite observations.
- To encourage and support governmental and non-governmental agencies/organizations for furthering programmes in the generation and dissemination of ocean information.
- To undertake other lawful activities as may be necessary, incidental or conducive to the attainment and furtherance of all or any of the above objectives of ESSO-INCOIS.

5. Quality Policy

The ESSO-Indian National Centre for Ocean Information Services(ESSO-INCOIS), Earth System Sciences Organization (ESSO), Ministry of Earth Sciences (MoES) is committed to provide the best possible ocean information and advisory services to society, industry, the government and the scientific community through sustained ocean observations and constant improvement through systematic and focused research.

To achieve this, we will continue to align our actions with organizational values & shall ensure our commitment to continually improve our performance with the Quality Management System by setting and reviewing quality objectives.

6. Highlights during 2012-13

Tsunami Warning following 8.6 M earthquake off Northwestern Sumatra

The Indian Tsunami Early Warning Centre (ITEWC) detected the very high intensity (8.6 M) earthquake that occurred at 14:08 hours IST on 11th April 2012 off the west of Northern Sumatra, on the Andaman-Sumatra subduction zone, within 2 minutes of occurrence and issued the first bulletin reporting the earthquake location and intensity within 8 minutes. The second bulletin containing tsunami information, derived from the model based scenario data base was issued at 14.20 hrs. This bulletin provided a 'Tsunami Warning' for Indira Point, Little Nicobar Island, Komatra and Katchal in the Andaman and Nicobar Islands, considering that the expected tsunami height at those locations was more than 2.0 m. For areas, like the rest of the Andaman & Nicobar islands and the coastal areas of Tamil Nadu, Andhra Pradesh and Orissa, parts of Kerala Coast and the Lakshadweep Islands, where the expected tsunami height was less than 2.0 m., only 'Tsunami Alerts' were issued. There was excellent co-ordination between the National Disaster Management Authority and ESSO-INCOIS so that the information and advisories reached all stakeholders seamlessly. Being the Regional Tsunami Advisory Service Provider (RTSP) for the Indian Ocean region, tsunami advisories were also provided to 23 countries in the Indian Ocean region. The second earthquake that occurred shortly at 16:13 hrs IST, again off the west coast of Northern Sumatra (0.773°N and 92.452°E) was also detected and reported as required. This second earthquake had a magnitude of 8.2. It was noticed that the second event caused a tsunami of 20.0 cm height at Meulaboh in Indonesia. Altogether ITEWC issued 11 bulletins covering both events.

Ocean State Forecast Service for Maldives

ESSO-INCOIS launched the Ocean Forecast Service for the islands of the Maldives on 8th March 2013. This service includes the 5-day forecasts of waves (height and direction), surface currents, sea surface temperature, mixed layer depth and depth of thermocline around the islands. The forecasts are being disseminated through the ESSO-INCOIS web site. ESSO-INCOIS has entered into an agreement with the Thailand based Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) to disseminate value added products based on these forecasts to different agencies in the Maldives. RIMES will also obtain feedback from the users and communicate this feedback to ESSO-INCOIS.

Coastal Vulnerability Index

ESSO-INCOIS carried out an objective assessment of overall vulnerability of the Indian coast and prepared 156 maps on a 1:1,00,000 scale indicating the vulnerable portions of the coast.

Six indicators, viz., long term rise in sea level, tidal range, wave height, coastal slope, coastal elevation, shoreline changes (rate of erosion/accretion) along with the geomorphological setting of the coast were considered to determine the vulnerability. The vulnerability is then quantified in terms of the Coastal Vulnerability Index (CVI) as an indication of the likelihood of physical changes that may occur when changes in the aforementioned six parameters occur. These CVI maps are useful for making long-term plans about resources management and identifying natural threats to resources along the coast. The CVI was released by Dr. Marri Shashidhar Reddy, Hon'ble Vice Chairman, National Disaster Management Authority during the 2nd User Interaction Meeting held on 11th May 2012.

International Training Centre for Operational Oceanography

The Ministry of Earth Sciences approved the establishment of the International Training Centre for Operational Oceanography (ITCOOcean) at ESSO-INCOIS during the 12th Five Year Plan. The main objective of ITCOOcean is to conduct short and long term training courses to enhance the capacity to provide ocean services and information. ESSO-INCOIS entered into a MoU with the Intergovernmental Oceanographic Commission to extend the scope of training activities to students/researchers from the Indian Ocean Rim countries.

Establishment of an Integrated Seismic and GPS network of stations operated by various national agencies

As part of the project on the Integrated Seismic and GPS Network (ISGN), ESSO-INCOIS has completed the establishment of the network with regional data centres at NGRI, ISR, NEIST, IMD, SoI and WIHG. VSAT equipment to acquire the data from seismic/GPS stations at 55 locations and the 9.0 m HUB stations at ESSO-INCOIS and NCMRWF, Noida also are commissioned. A data centre at ESSO-INCOIS has been set up and the data centre at IMD is now being set up.

Mixed Layer and Sonic Layer depth in the Indian Ocean

Upon the request of the Naval Operations Data Processing and Analysis Centre (NODPAC) and the Project Directorate of Naval Oceanology and Meteorology (PDNOM), ESSO-INCOIS prepared an atlas containing maps of the depth of the mixed layer and the depth of the sonic layer in the Indian Ocean using temperature and salinity profiles measured by the Argo floats in the tropical Indian Ocean. Approximately 1,11,000 profiles were utilized to generate this atlas. A software application was also developed to view the maps of the mixed layer depth and the sonic layer depth in graphical format. This software, which is bundled along with the digital version of the atlas is capable of displaying the maps, animations, time series and area averages of the parameters interactively. The temperature and salinity profiles from World Ocean Atlas were also made available along with this package. The atlas and the software were handed over to NODPAC and PDNOM.

Global Ocean Analysis products from Near Real Time ESSO-INCOIS-GODAS (NRIG)

ESSO-INCOIS started providing global ocean analysis in near real time using Near Real time (ESSO-) INCOIS-GODAS (NRIG) from March 2013 onwards. The NRIG service is based on the improved version of the Global Ocean Data Assimilation System (GODAS). In GODAS, in-situ temperature and salinity profiles obtained from GTS are assimilated in the ocean general circulation model (Modular Ocean Model, MoM4p0d) to generate the analysed fields of temperature, salinity and circulation on a daily basis. At present, the analysis results are available with a delay of 2 days. Atmospheric analysis (winds and atmospheric fluxes like, short and long wave radiation, etc.) from NCMRWF are being used to force the ocean model.

The Pan Ocean Remote Sensing Conference (PORSEC), 2012

ESSO-INCOIS hosted the biennial 'Pan Ocean Remote Sensing Conference (PORSEC) -2012 in Kochi during 5th-9th November 2012. 544 participants including 200 students from 19 countries attended the conference. 275 research papers and 78 posters were presented at 25 technical sessions. Dr. K. Radhakrishnan, Chairman, Indian Space Research Organisation and Secretary, Department of Space and Dr. Shailesh Nayak, Secretary, Ministry of Earth Sciences, and Chairman, Earth System Sciences Organisation inaugurated the conference in the presence of Dr. Jim Gower, President of PORSEC Association.

7. Ocean Services

ESSO-INCOIS retained its national and international reputation and relevance not only by continuing its flagship ocean services such as Tsunami Early Warnings, Ocean State Forecasts (OSF), Potential Fishing Zone (PFZ) advisories and data services but also through systematic improvements in these services driven by the user needs and supported by focused research and development activities. A few important milestones achieved in these services are given below.

7.1. Tsunami Early Warnings

Indian Tsunami Early Warning Centre (ITEWC) had monitored 54 earthquakes of magnitude ≥ 6.5 during the period 1st April 2012 to 31st March 2013. Out of the 54 high magnitude earthquakes, the centre issued tsunami advisories for the 3 that occurred in the Indian Ocean. On each occasion, ITEWC assessed the situation carefully and declared that there would not be any tsunami threat for India due to those earthquakes. Being the Regional Tsunami advisory Service Provider (RTSP), the earthquake bulletins were also sent to Indian Ocean Rim Countries, PTWC, JMA and IOC through email, GTS, FAX and SMS. The performance statistics of these tsunamigenic Indian Ocean events are listed below.

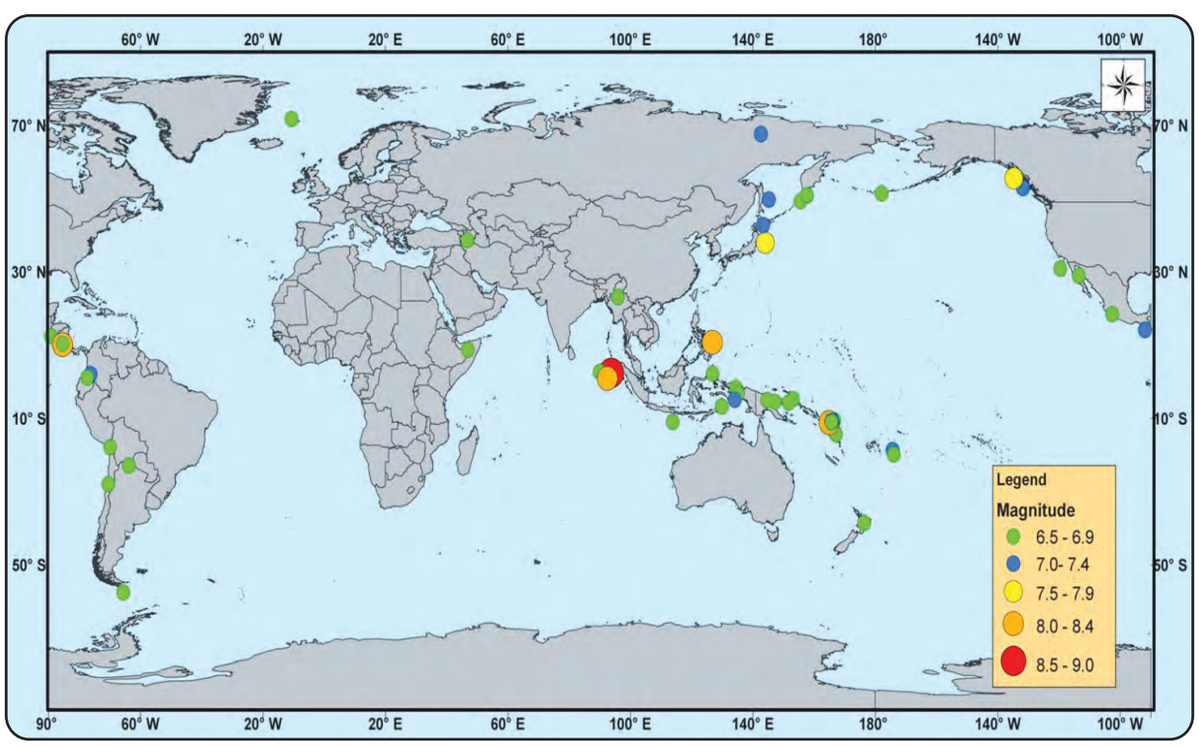


Figure 7.1. Map indicating geographic location of earthquake epicenters and their respective magnitudes during 2012-13.

Table 7.1
Performance indicators of ITEWC

S. No.	Parameter	Targets	Performance
1	Elapse Time from EQ to Initial EQ info issuance (Local/Distant)	10/15 min	07 Min
2	Probability of Detection of IO EQ with Mw >= 6.5	100 %	Achieved
3	Accuracy of Hypocentre Location	within 30 km	9.5 km
4	Accuracy of Hypocentre Depth	within 25 km	19.3 km
5	Accuracy of Earthquake Mw Magnitude	0.3	0.26
6	Reliability of RTWP Operations (Power, Computer, Communications)	99.5%	Achieved
7	Contact Information updated & Quarterly Communication Tests		COMMs Test held on 13 June, and 12 December, 2012

8.5 M Earthquake off Northern Sumatra on 11th April 2012

The most notable earthquake during this reporting period was the 8.5 magnitude earthquake that occurred off the west coast of Northern Sumatra at 2.40°N and 93.07 °E on 11th April 2012 at 14:08 IST. Within two hours of occurrence, this was followed by another earthquake of magnitude 8.2 that occurred in the same region at 0.87 °N and 92.49 °E at 16:13 IST. Both high magnitude earthquakes had potential to generate a basin wide tsunami similar to that on 26th December 2004. ITWEC swung into action quickly after detecting the first earthquake at 14:10 IST and the first tsunami bulletin was issued within 8 minutes of the occurrence. Three islands in Andaman Nicobar region, Indira Point, Little Nicobar Island, Komatra & Katchal Islands were put under 'Tsunami Warning' because the expected tsunami wave heights based on the mathematical model simulations at those locations were found to be more than 2.0 m. The coastal areas of Tamil Nadu, Andhra Pradesh, Odisha, parts of Kerala coast and Lakshadweep Islands, Islands of Nicobar and little Andaman etc were put under 'Tsunami Alert' as the expected tsunami wave height at those locations was less than 2.0 m. Simultaneously, ITEWC also coordinated with national and state disaster management authorities so that the information and advisories reached stakeholders seamlessly. The sea level observations at various sea-level stations and bottom pressure recorders (Figure 7.2) showed that the tsunami wave height was 30 cm at Campbell Bay, 12 cm at Nancowry, 18 cm at Chennai and 10 cm at Visakhapatnam. The Indonesian sea level stations recorded sea level variations of 35 cm at Sabang, 106 cm at Meulaboh and 18 cm at Telukdalam. The tsunami buoy (STB1) deployed in the southern Bay of Bengal observed a tsunami wave of 6 cm height. Being the designated RTSP, ITEWC disseminated regional tsunami advisories to 23 countries in the Indian Ocean region.

The occurrence of the second earthquake of 8.2 M at 16:13 IST at 0.87° N and 92.49° E off the West Coast of Northern Sumatra was treated as an independent event for the purpose of issuing tsunami warnings because of its high magnitude. ITEWC closely monitored both events and issued 5 separate tsunami bulletins for this event. It was also noticed that this earthquake generated a local tsunami of 20 cm height at Meulaboh on the Indonesian coast. The timelines of the bulletins issued by ITEWC for the two earthquakes on 11th April 2012 is explained in detail in the table below.

Table 7.2. Details of the two earthquakes in the Indian Ocean and the timelines of their bulletins issued by ITEWC for the two earthquakes on 11th April, 2012

Mag of EQ	Time (IST)	Latitude	Longitude	Depth (Km)	Geographical Region
8.5	11 April 2012 14:08	2.40°N	93.07°E	10	Off the west coast of Northern Sumatra
8.2	11 April 2012 16:13	0.87°N	92.49°E	10	Off the west coast of Northern Sumatra

Bulletin No.	Issue Time (IST)	Advice / Message
01	14:16	Earthquake information (8.7 M) along with tsunami evaluation that earthquakes of this size have potential to generate tsunamis
02	14:20	Warning for Car Nicobar, Komarta & Katchall and Indira Point Alert for few areas in North Andaman, Andhra Pradesh & Tamil Nadu
03	15:21	Revised Earthquake information (8.5 M) Warning for Indira Point, Komarta & Katchall Alert for remaining areas of Andaman & Nicobar, Orissa, Andhra Pradesh, Tamil Nadu, Kerala and Lakshadweep Watch for remaining areas
04	15:48	Warning for Indira Point, Komarta & Katchall Alert for remaining areas of Andaman & Nicobar, Orissa, Andhra Pradesh, Tamil Nadu, West Bengal, Kerala, Goa and Lakshadweep Watch for remaining areas
01	16:19	Earthquake information (8.5) along with tsunami evaluation that earthquakes of this size have potential to generate tsunamis Revised Earthquake information (8.2 M)
02	16:46	Warning for Indira Point, Komarta & Katchall Alert for remaining areas of Andaman & Nicobar, West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Goa and Lakshadweep Watch for remaining areas

Bulletin No.	Issue Time (IST)	Advice / Message
05	17:02	Warning for Indira Point, Komarta & Katchall Alert for remaining areas of Andaman & Nicobar, West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Goa and Lakshadweep Watch for remaining areas
03	17:08	Alert for Indira Point, Komarta & Katchall, Car Nicobar Watch for remaining coastal areas
04	17:33	Alert for few areas in A & N Islands, Andhra Pradesh, Tamil Nadu & Kerala Watch for Karnataka, Goa, West Bengal & Orissa No Threat for Other coastal areas.
06	18:18	ALL CLEAR
05	18:29	ALL CLEAR

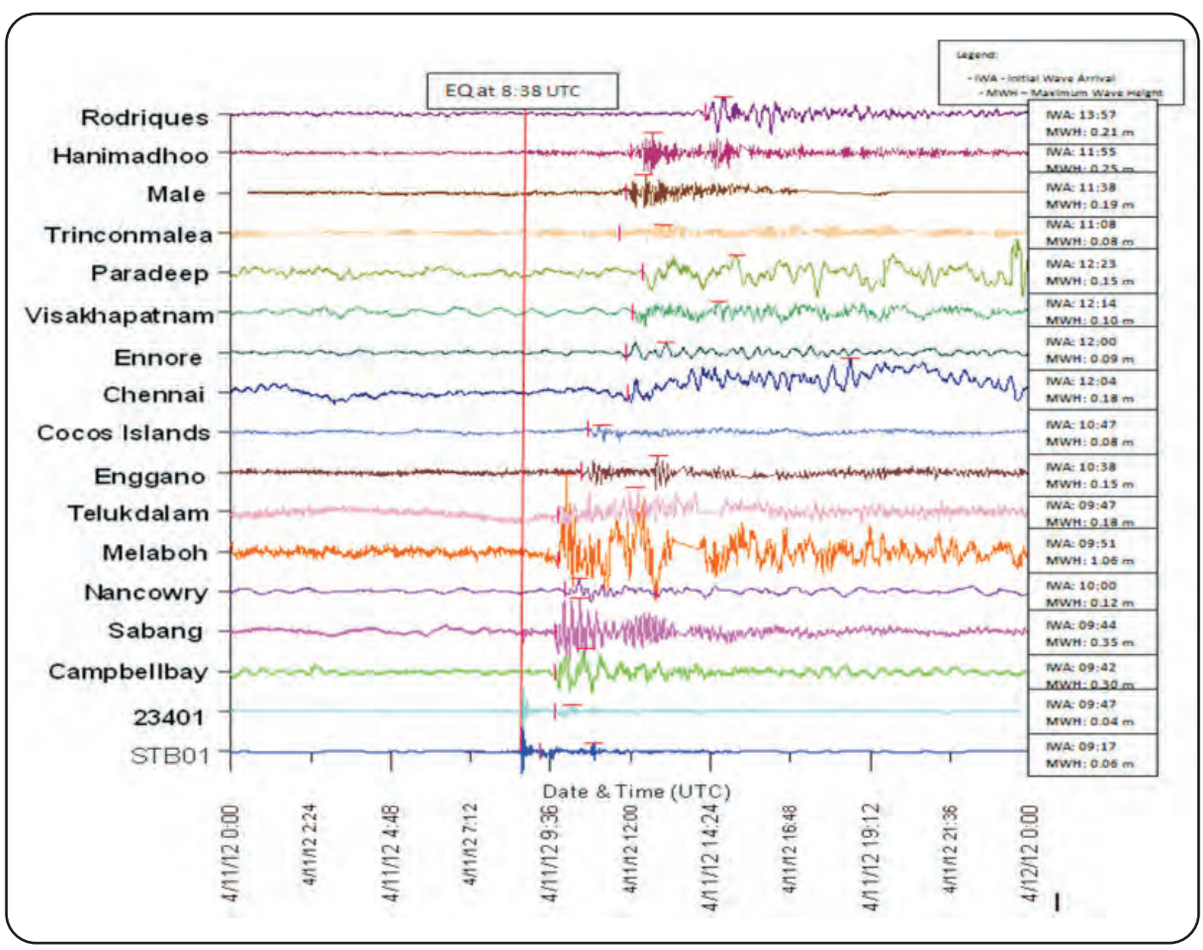


Figure 7. 2. Tide gauge observations at different stations for 11th April, 2012 tsunami event

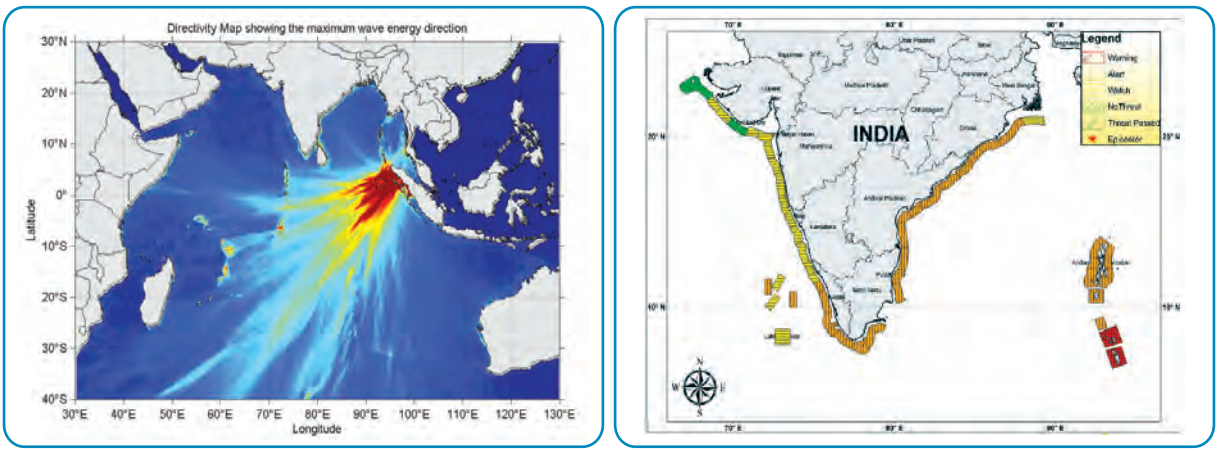


Figure 7.3: Directivity (left) and threat (right) maps for the 8.5 M earthquake occurred off the west coast of Northern Sumatra on 11th April 2012. Colour codes on the threat map indicate regions categorized under 'Tsunami warning, alert and watch' depending on the expected tsunami wave heights at those locations. The expected heights of tsunami waves were determined based on mathematical model simulations.

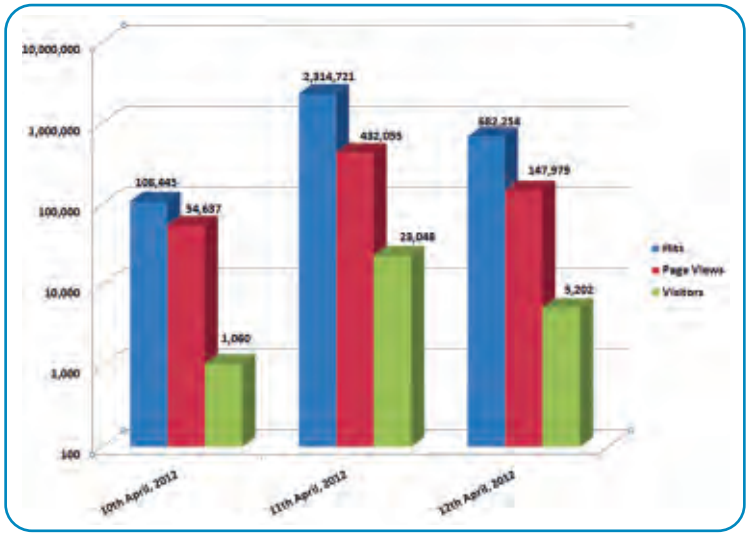


Figure 7.4: Statistics of the ESSO-INCOIS web site hits during the tsunami event on 11th April 2012

Figure 7.5: ITEWC team monitoring the 11th April 2012 Tsunami event.

7.1.1. Communication Test (COMMs Test)

In the past one year period, ITEWC participated in two communication tests held on 13th June 2012 and 12th December 2012. This is part of the periodic exercise to test the communication channels with national disaster management offices, the National Tsunami Warning Centres (NTWC) of countries in the Indian Ocean region and with other RTSPs in the region. The communication tests were coordinated by the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS). The COMMs test succeeded in validating the process of the Regional Tsunami advisory Service Provider' s dissemination to National Tsunami Warning Centres (NTWCs); the reception of the messages by NTWCs; their access to RTSP password-protected web sites etc. ITEWC successfully disseminated notification messages to 23 NTWCs and the other RTSPs (Australia & Indonesia) in the Indian Ocean and also received the notification messages from other RTSPs of the Indian Ocean Region.

The COMMs test mock drill on 13th June was run considering a 9.0 M earthquake of Sunda Strait, Indonesia with epicentre at 6.94 °S, 104.70 °E. The COMMs test mock drill was also run on 12th December considering a 9.0 M event of Andaman Islands, India with epicentre at 12.65 °N, 93.50 °E. During both the tests, five bulletins were issued via SMS, Email, GTS and FAX to all the recipients.

7.2. Ocean State Forecasts

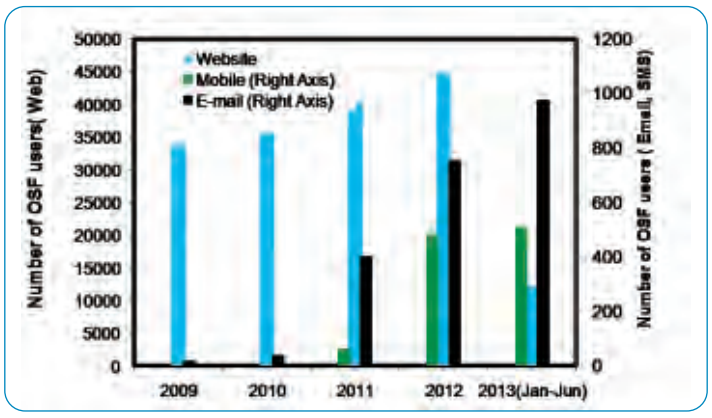


Figure 7.6: No. of OSF users in various media

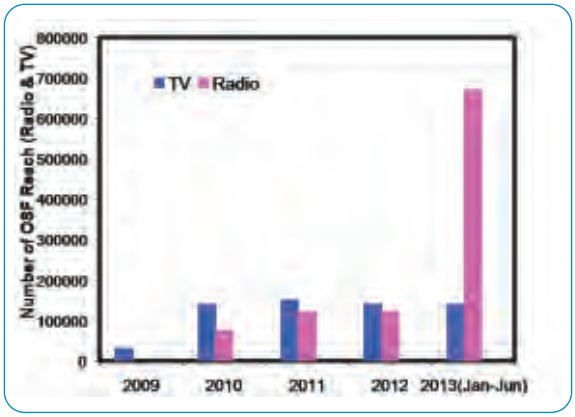


Figure 7.7: Reach of OSF Forecasts

7.2.1. Ocean state Forecast for the Maldives

In response to requests from the Maldives government through the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) of which India is a founding member, ESSO-INCOIS set up the numerical models to provide forecasts on waves, surface currents, SST, MLD and ILD on a daily basis for the waters around Maldives Islands.

A dedicated webpage (http://www.incois.gov.in/Incois/osf_rimes/index.jsp) was also set up for the dissemination of forecasts directly as well as through RIMES. Location specific information/forecasts on ocean state at 21 locations around the Maldives islands are provided on a regular basis. It is expected that this service, which is also being provided in the local language of the Maldives will benefit a wide spectrum of users including fishermen, local administration, the Navy, the Coast Guard and port authorities.

Figure 7.8: Director of Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES), Bangkok, Dr. A.R. Subbiah inaugurated the special forecasting service for Maldives during the UIW2013 on 08-03-2013.

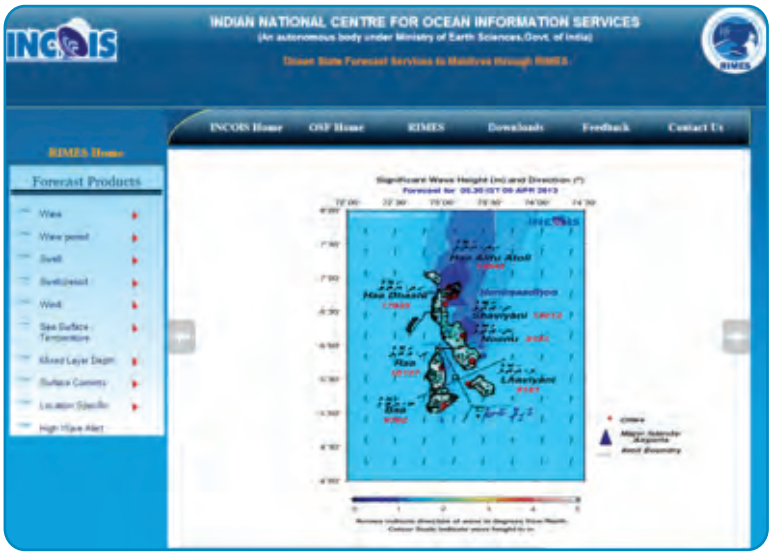


Figure 7.9: OSF Web service for the Maldives

7.2.2 High Wave Alerts

During the past year, ESSO-INCOIS issued 44 'High Wave Alerts' for different areas along the Indian coast. One of the most noted events was during the cyclone "Neelam" which occurred in the Bay of Bengal during 28th-31st October 2012. The cyclone made landfall along the Puducherry coast on 31st October (midnight) 2012. ESSO-INCOIS had provided high wave alerts well in advance of the landfall to the users along the Puducherry, Tamil Nadu and Andhra Pradesh coasts. This helpful alert was particularly useful in minimizing the loss of life and property during the cyclone.

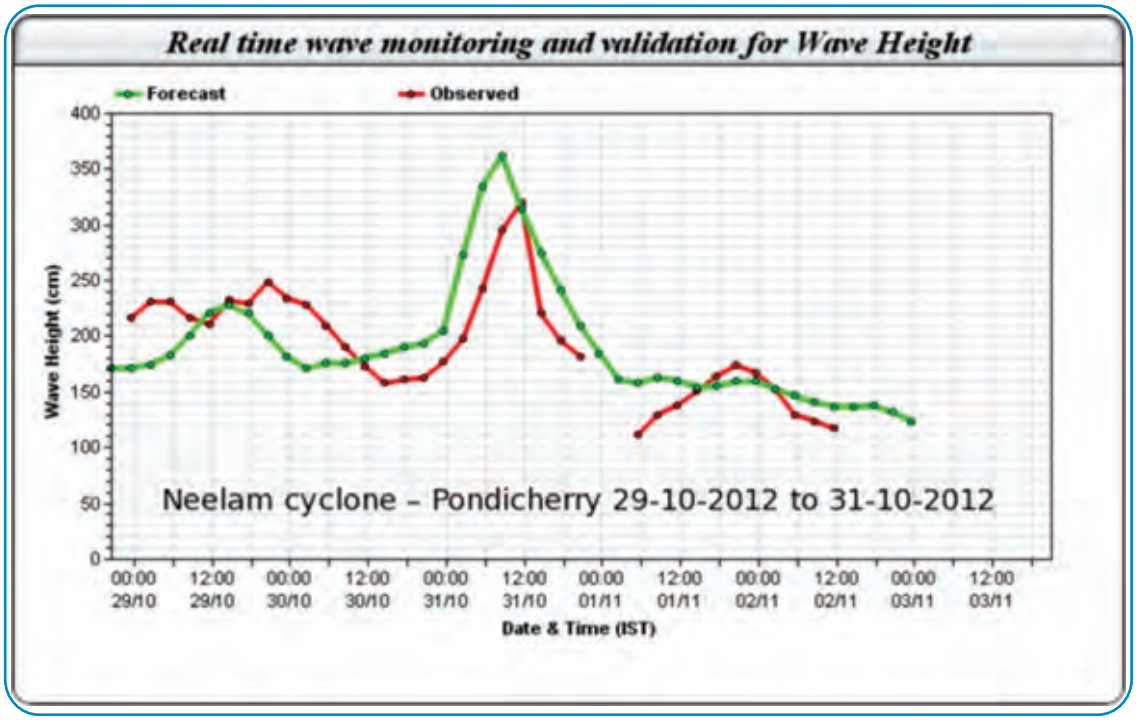
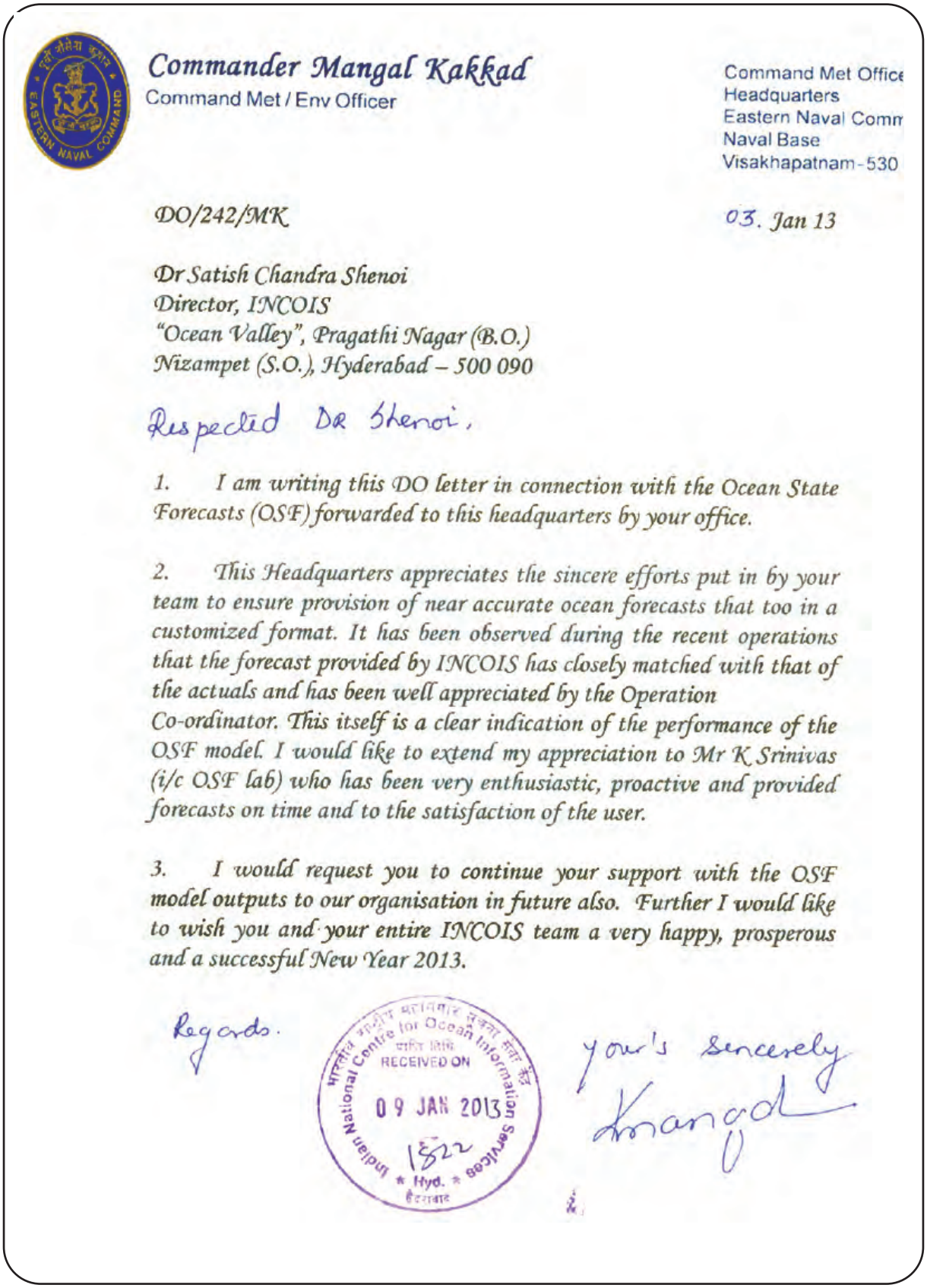


Figure 7.10: Observed (red) and forecasted (green) wave height at Puducherry during the passage of cyclone Neelam that had a landfall at Puducherry coast on 31 October (midnight), 2012.

7.2.3. Ocean State Forecasts to Eastern Naval Command

In order to support the special naval exercises conducted by the Eastern Naval Command of the Indian Navy during 8th December – 25th December 2012, ESSO-INCOIS provided customised four-day forecasts of winds, waves and currents to Indian Navy. They were useful for the planning of the exercises. The Command Met/Env. Officer appreciated the quality of forecasts.



Commander Mangal Kakkad
Command Met / Env Officer

Command Met Office
Headquarters
Eastern Naval Comm
Naval Base
Visakhapatnam-530

DO/242/MK

03. Jan 13

Dr Satish Chandra Shenoi
Director, INCOIS
"Ocean Valley", Pragathi Nagar (B.O.)
Nizampet (S.O.), Hyderabad – 500 090

Respected Dr Shenoi,

1. I am writing this DO letter in connection with the Ocean State Forecasts (OSF) forwarded to this headquarters by your office.

2. This Headquarters appreciates the sincere efforts put in by your team to ensure provision of near accurate ocean forecasts that too in a customized format. It has been observed during the recent operations that the forecast provided by INCOIS has closely matched with that of the actuals and has been well appreciated by the Operation Co-ordinator. This itself is a clear indication of the performance of the OSF model. I would like to extend my appreciation to Mr K Srinivas (i/c OSF lab) who has been very enthusiastic, proactive and provided forecasts on time and to the satisfaction of the user.

3. I would request you to continue your support with the OSF model outputs to our organisation in future also. Further I would like to wish you and your entire INCOIS team a very happy, prosperous and a successful New Year 2013.

Regards.

Indian National Centre for Ocean Information Services
RECEIVED ON
09 JAN 2013
1822
Hyd.

Yours Sincerely

Kkad

Figure 7.11: Letter of appreciation received from the Eastern Naval Command on the usefulness of ocean state forecasts.

7.2.4. Navy DG Varsha project

Upon the request of the Indian Navy, ESSO-INCOIS undertook a consultancy project titled DG Varsha to determine the wave climate around Kakinada-Visakhapatnam coast. Numerical models Wave Watch-III (to simulate the waves in offshore areas) and MIKE-21 were used to simulate the waves in the area for 20 years (1992 to 2011). The model derived wave parameter values were first validated using available observations before constructing the wave climate along the coast. Histograms and rose diagrams of wind and waves statistical tables were utilised to understand the Wave Height vs. Wave Direction and Wave Height vs. Wave Period relationships. Extreme value analysis to determine the Extreme Wave Heights and Joint Probability Analysis between Water Levels and Wave Heights also were carried out. The report was submitted to the Naval Head Quarters.

7.2.5. Assessment of wind energy potential in the western offshore ONGC oil fields in Bombay High

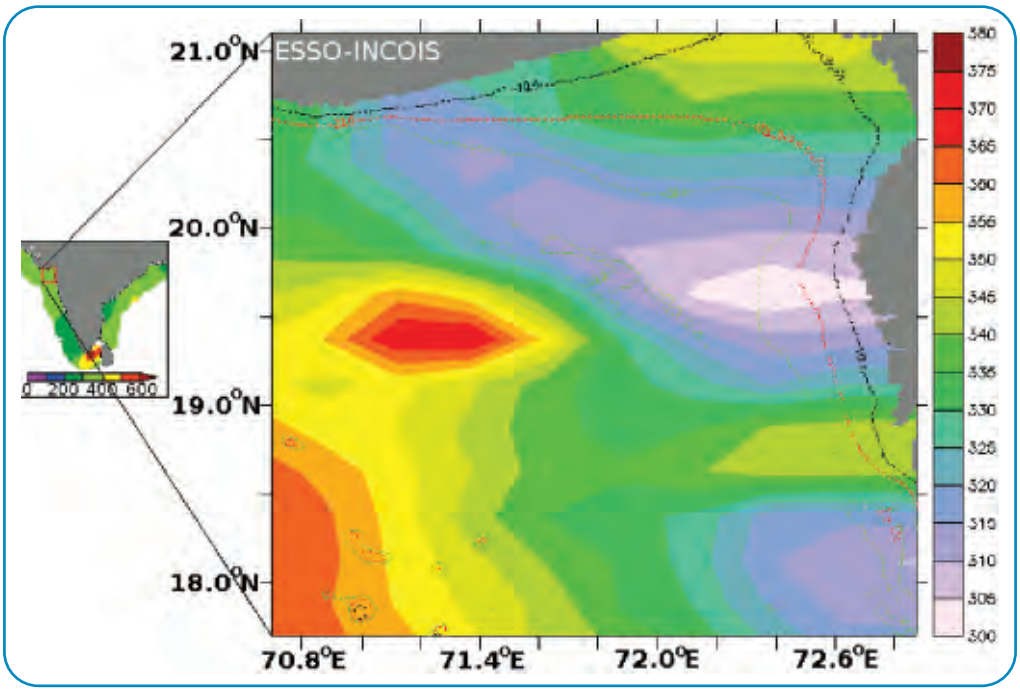


Figure 7.12: Distribution of wind energy potential in the Bombay High region

Wind energy potential was assessed using 10 years of satellite data after validation and correction against the data from moored buoys in the offshore regions of the west coast of India. The assessment was carried out on the request of the Institute of Oil and Gas Production Technology, ONGC, Mumbai. An Automatic Weather Station (AWS) was also installed onboard one of the oil platforms belonging to ONGC in the Mumbai High region. The AWS which is installed at a height of 60 m from the sea level, is equipped with an INSAT satellite transmitter to provide data in real time to ESSO-INCOIS.

Figure 7.13: AWS installed by INCOIS on the ONGC platform in Bombay High region.

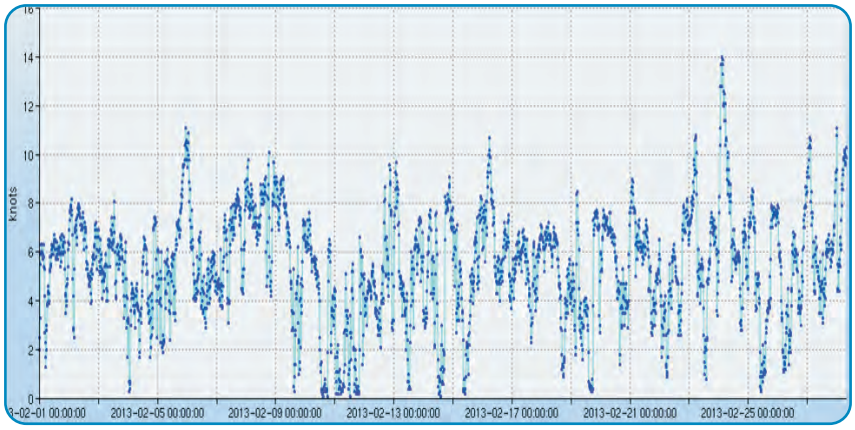


Figure 7.14: Time series of zonal wind (knots) meseaured by the AWS installed on the ONGC platform in Bombay High region

7.2.6. Ocean State Forecasts along ship tracks

A new custom made service has been designed and launched to provide Ocean State Forecasts along a chosen track of ships. The service was formally launched by Dr. B. Battacharjee, Hon'ble member of NDMA, on 10th May 2012 during the 2nd User Interaction Workshop at ESSO-INCOIS. This service enables navigators to obtain sea state predictions (such as wave height and direction, SST and surface currents) for the selection of an optimal route by providing information such as current location (latitude, longitude), bearing of vessel and vessel speed.

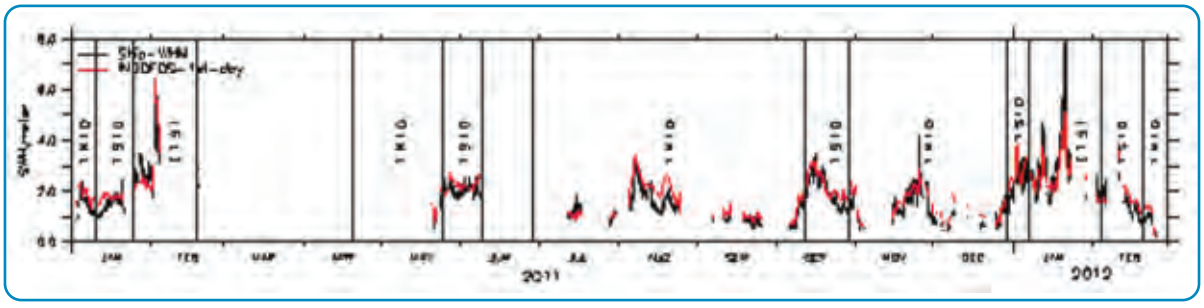


Figure 7.15: Comparison between forecast (INCOIS OSF) and observed (using wave height meter) significant wave heights along the ship-route of TDV-Sagar Nidhi, an MoES ship [Tropical Northern IO (TNIO), Tropical Southern IO (TSIO) and Extra Tropical Southern IO (ETSI)].

Figure 7.16: Inauguration of various OSF services

7.3. Potential Fishing Zone Advisories

ESSO-INCOIS continued to provide multi-lingual Potential Fishing Zone (PFZ) Advisories based on Sea Surface Temperature (SST) and Chlorophyll to the fishing community on a daily available data from all satellites that pass over the region viz., NOAA-18, NOAA-19, METOP 1 & 2 (including the night passes) as well as MODIS Aqua and OceanSat-2 satellites acquired by the ground station at ESSO-INCOIS. The use of data from all available satellites enabled an increment of the number of advisories by an average of 61% during April 2012 – Mar 2013 as compared to the previous year. Another improvement brought in the PFZ advisories was the overlay of wind vectors on the PFZ maps for the benefit of users.

For the better coverage of smaller fish-landing centres and to pursue an overall inclusive approach additional 319 fish-landing centres have been added to the existing 267 landing centres along the Indian mainland and islands. Currently, ESSO-INCOIS is providing PFZ advisories referring to 587 fish landing centres.

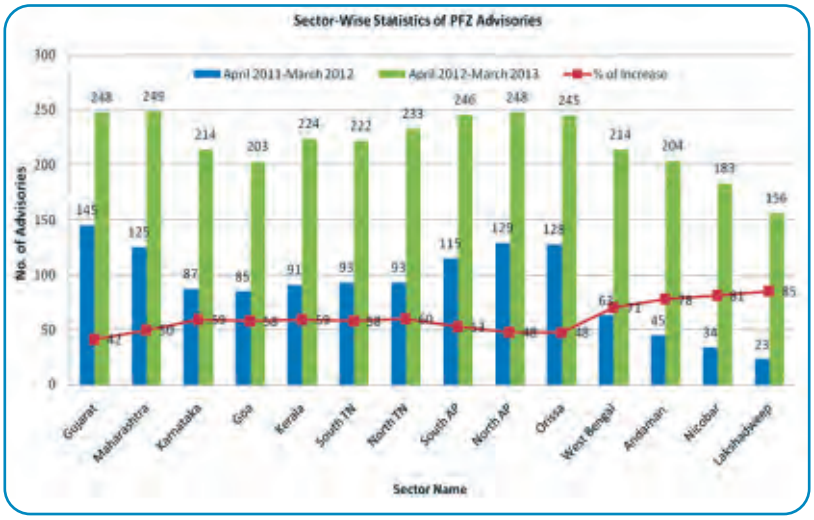


Figure 7.17: Percent increase in number of PFZ advisories by harnessing multiple satellite sources

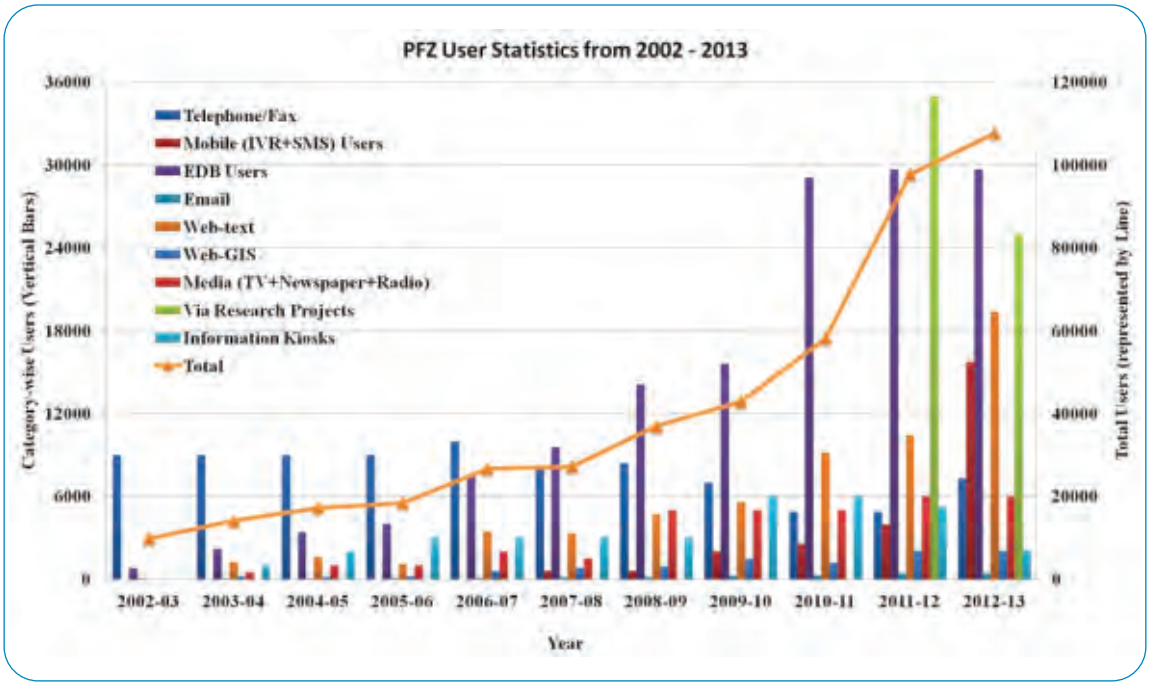


Figure 7.18: Graph showing categorised statistics of estimated PFZ advisory users (total no. of users on right-hand axis)

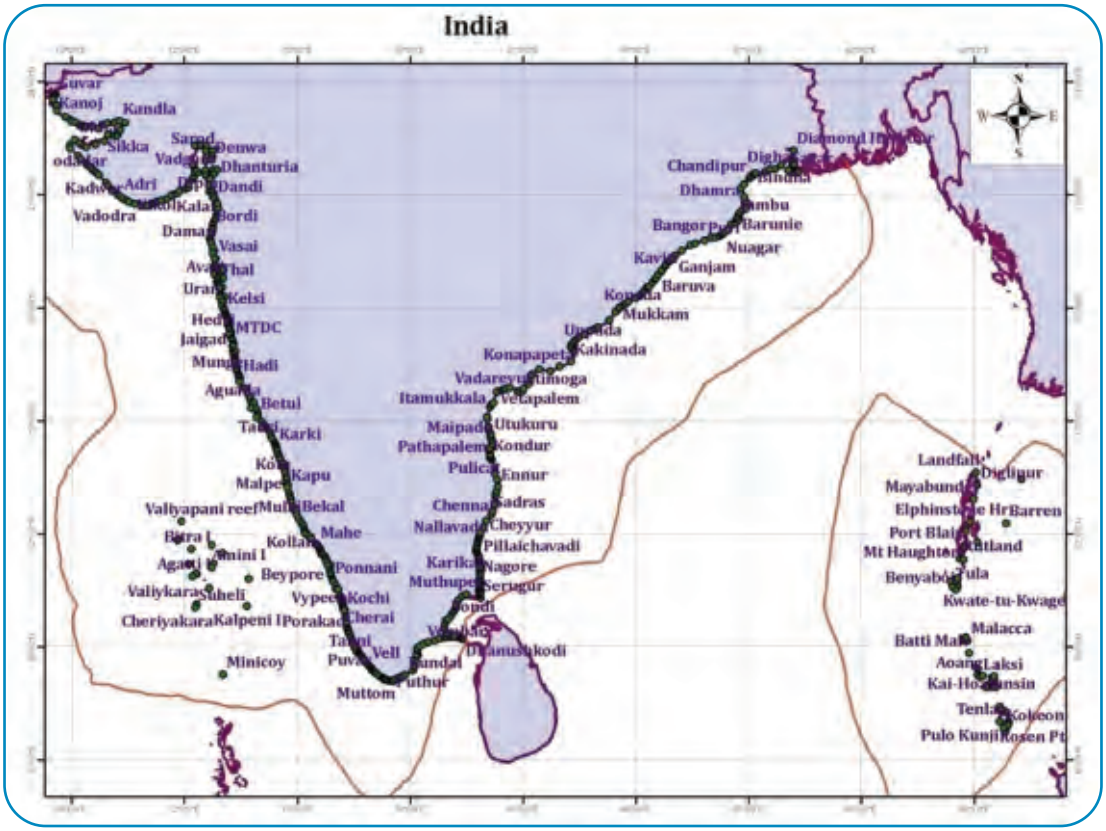


Figure 7.19: Map showing 586 fish-landing centres being covered in new version of PFZ advisories

7.3.1. Tuna Fishery Advisories

ESSO-INCOIS has streamlined the operational generation of Tuna Fishery Advisories using satellite derived parameters viz. Sea Surface Temperature, Chlorophyll and Kd490 (Water Clarity). The advisories are being sent to the tuna long liners through the website (WebGIS) and through email.

Considering the gaps in knowledge of the migratory routes of Tuna in the Indian Ocean, a R & D project entitled 'Satellite Telemetry studies on migration patterns of Tunas in Indian Seas (SATTUNA)' was initiated in collaboration with CMFRI, CMLRE and FSI. Accordingly, the first batch of 15 Yellowfin Tuna *(Thunnus albacares)* were tagged (15 PSAT (Pop-Up Standard Archival Tags) tags) during October 2012 – March 2013.

Figure 7.20: Tagging operations by CMFRI, off Lakshadweep, under the project on SATTUNA

The tagging experiment also suggested that Tuna prefer to stay at a relatively shallow depth during day time and dive down to deeper depths during the night. Primary studies show that Tuna in the region prefer to stay mostly in the upper seventy meters of the ocean and where the temperature mostly ranges from 26 to 30 degree Celsius. Such data is very useful to understand the environmental preferences of Tuna and hence contributes to improvement and sustainability of Tuna fishery. Further analysis of data from the first set of tags is in progress.

7.3.2. Subprojects funded under PFZ Mission

During 11th five-year plan period (2007-2012) ESSO-INCOIS funded many projects for the validation of PFZ advisories. The main aim to fund these projects was to validate PFZ advisories and at the same time create a pilot database on environmental parameters that favours conditions suitable for better fishery.

To continue the legacy of PFZ Advisory services improvement, ESSO-INCOIS has funded new projects during 12th five-year plan period (2012-17). This phase of research aims less towards conventional validations and aims to scale up harnessing data from satellites and models in order to improve the efficiency of PFZ advisories generated at ESSO-INCOIS. A step towards this major inclination of these sub-projects will be to create a database of ecological parameters along the Indian shores for better understanding of coastal ecological processes.

7.4. Global Ocean Analysis products from Near-Real time INCOIS-GODAS (N-RIG)

ESSO-INCOIS started providing global ocean analysis in near real time using the Near Real time INCOIS-GODAS (N-RIG) from March 2013 onwards. The N-RIG service is based on the improved version of the Global Ocean Data Assimilation System (GODAS). In GODAS, in-situ temperature and salinity profiles obtained from GTS are assimilated with the Ocean General Circulation model (Modular Ocean Model, MoM4p0d) to generate the analysed fields of temperature, salinity and circulation on a daily basis. At present, the analysis is available with a delay of 2 days. Atmospheric analysis (winds and atmospheric fluxes like, short and long wave radiation, etc.) from NCMRWF are being used to force the ocean model. Compared to the earlier version of INCOIS-GODAS that was providing the ocean analysis with a delay of 30-days the N-RIG produces daily 3-dimensional analysis of global ocean with a delay of two days. The outputs from N-RIG are shared with public through the ESSO-INCOIS Live Access Server and over the File Transfer Protocol (FTP) servers of ESSO-INCOIS.

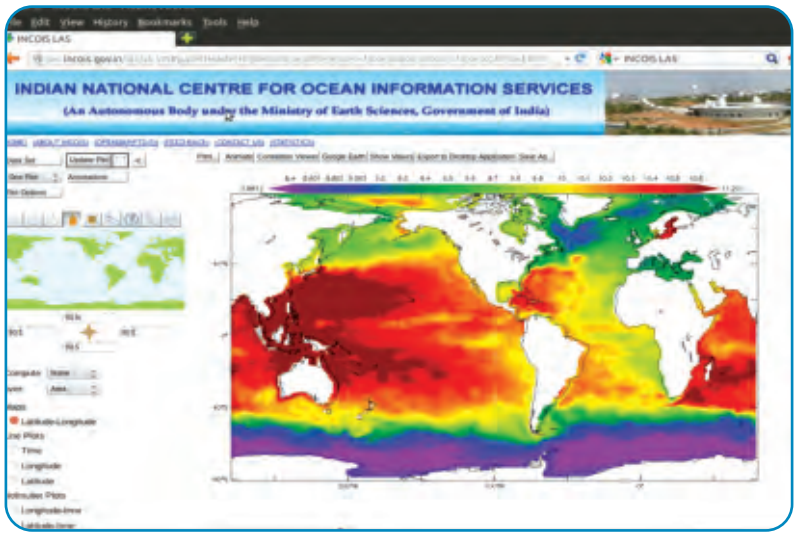


Figure 7.23: A snapshot of Live Access Server that provides the daily analysis of global oceans

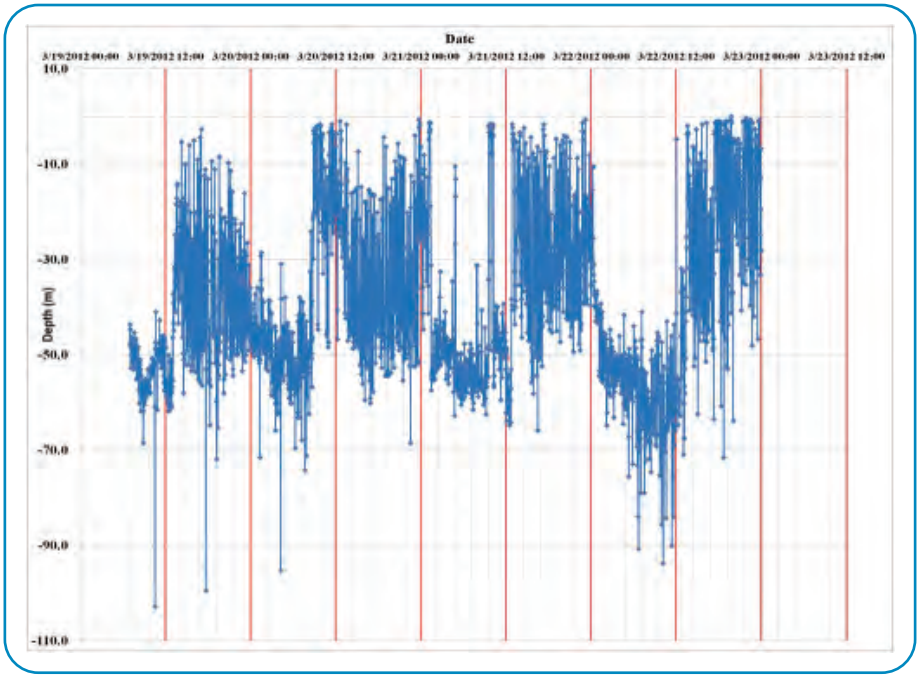


Figure 7.21. Vertical rhythmic movement of Tuna during day and night time

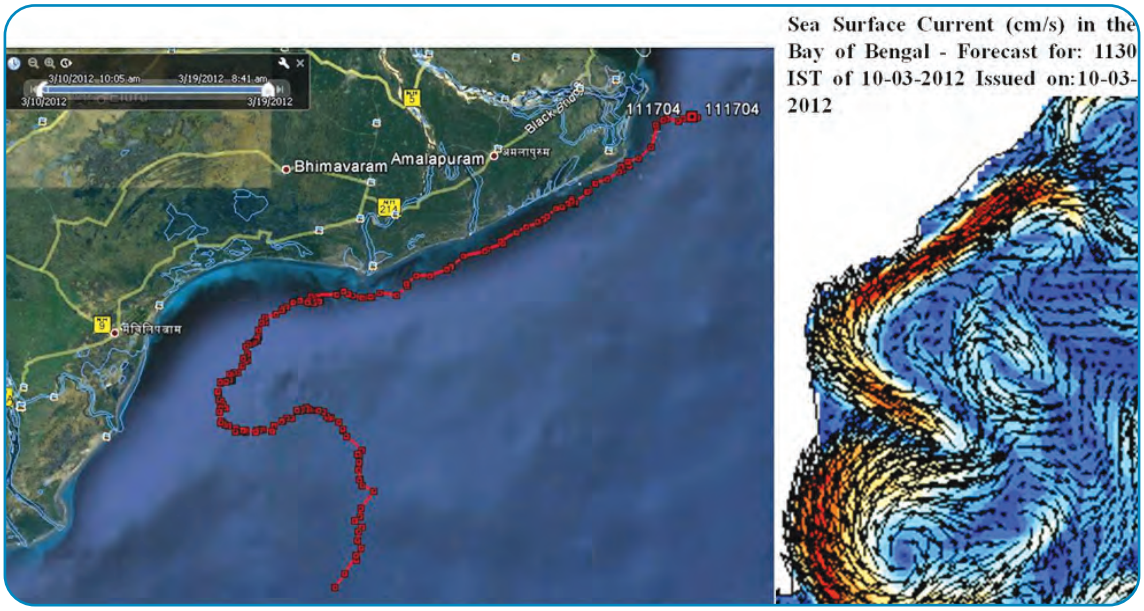


Figure 7.22: Trajectory plot of a recovered tag (left) and the forecasted near-shore currents. Note the similarity of tag drift and the meandering currents forecasted along the east coast of India off Andhra Pradesh.

One such tag has popped up in the western Bay of Bengal during March 2012. The data obtained from this tag while it was drifting along the surface current showed that the surface current predicted by Ocean State Forecast (OSF) service of ESSO-INCOIS was very accurate. Similarly, the in-situ temperature values reported by the tags were found to correlate well with the satellite based observations.

7.5. Geospatial Services

7.5.1. Coastal Vulnerability Index

Figure 7.24: Release of CVI Atlas

Having a coastline of more than 7500 km, which is vulnerable for natural disasters of several kinds, India should be prepared to mitigate the eventualities. Keeping this requirement in mind, ESSO-INCOIS carried out a coastal vulnerability assessment along the Indian coasts and prepared state level maps comprising of 156 maps at 1:100000 scale. The main purpose of the assessment was to objectively determine the risks due to future sea-level rise, shoreline change trends, high waves due to tsunamis and storms considering the physical and geological setting of the Indian coast. The Coastal Vulnerability Index (CVI) prepared by ESSO-INCOIS quantifies the likelihood of physical changes that might occur due to the tides, storm waves, coastal slope, coastal elevation, shoreline changes, geomorphology and historical rate of relative sea-level change. The CVI combines a coastal system's susceptibility to change with its natural ability to adapt to changing environmental conditions and yields a relative measure of the system's natural vulnerability to the effects of sea-level rise. Hence, these CVI maps (see Fig) are useful for decision makers in long-term planning and management and to identify the threats to the coast. The CVI atlas was released by Dr. Marri Shashidhar Reddy, Hon'ble Vice Chairman, National Disaster Management Authority during the Second User Interaction Meeting held on 11th May 2012 at ESSO-INCOIS.

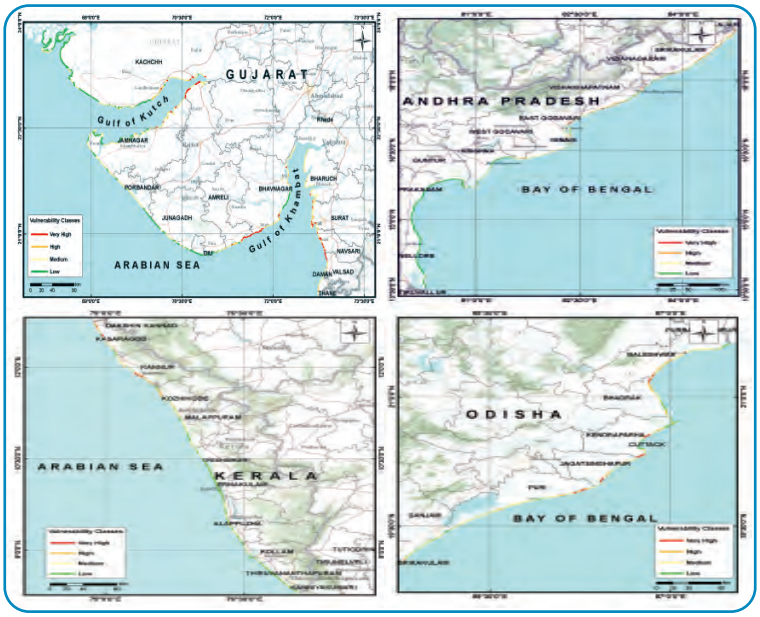


Figure 7.25: Coastal Vulnerability index for different regions along the Indian Coast

7.5.2. Coral Bleaching Alerts

A satellite based Coral Bleaching Alert System (CBAS) is in place at ESSO-INCOIS since February 2011. The advisories are generated based on the NOAA-AVHRR night time sea surface temperature data. The advisories comprising the products HotSpot, Degree of Heating Weeks and Time-Series Plots are generated on a bi-weekly basis and are being disseminated through web service. Total 121 advisories were generated and disseminated during 2012-2013. There were no warning signs recorded during this period.

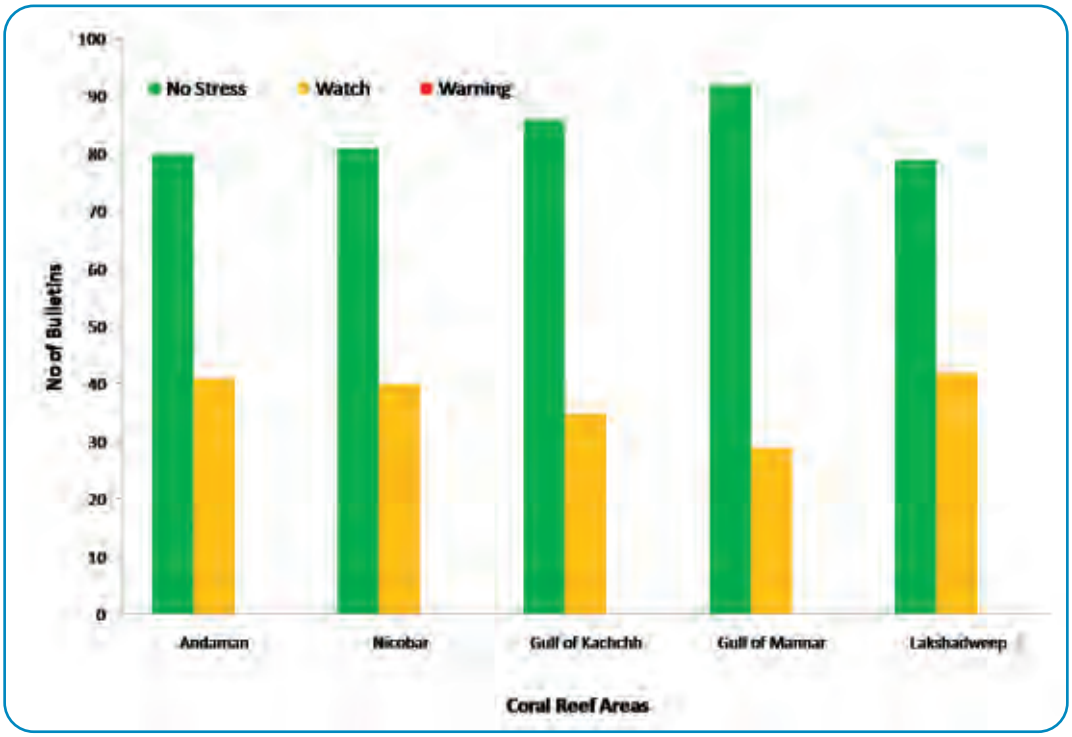


Figure 7.26: Coral Bleaching Advisories during April 2012 - March 2013

7.6. Data Services

7.6.1. In situ and Remote Sensing Data

Being the central repository for oceanographic data in the country and being the designated NODC by IODE/IOC, the data centre at ESSO - INCOIS continued to receive, archive and disseminate the oceanographic data to various users. During the First Year 2012-13 the data centre received real-time data on surface meteorological and oceanographic parameters from a wide variety of ocean observing systems - Argo floats, moored buoys, drifting buoys, wave rider buoys, tide gauges, wave height meter, ship mounted autonomous weather stations and HF radars. In addition to the data received from ocean observing systems, real-time the data was also received from various agencies in delayed mode.

Table 7.3: Details of the data received/archived by NODC during the First Year 2012-13

Institute / Programme	Parameters	Period of Observation	No. of Platforms / Stations Reported	Status
NIO(XBT, XCTD)	T Profiles T & S Profiles	Apr 2012 – Mar 2013 Apr 2012 – Mar 2013	257 profiles 92 profiles	Added to the database
NODPAC (Met Observations along Ship track)	Surface met parameters	Jan 2012 – Dec 2012	6714 records	Archived
IMD (Marine Meteorological Data)	Surface met parameters	Archived	Archived	Archived
NIO (ADCP)	Ocean currents	2009 – 2012	34 moorings	Archived
ICMAM (COMAPS)	Bio-Geo-Phy-Chem	Mar 1989 – Dec 2010	11 Stations (total 88 stations are now available)	Loaded into database
NIOT - NDBP (Moored buoys)	Metocean parameters	Apr 2012 – Mar 2013	25 buoys	Added to the database
NIO (Drifting buoys)	Metocean parameters	Apr 2012 – Mar 2013	51 buoys	Added to the database
PMEL (RAMA buoys)	Metocean parameters	Apr 2012 – Mar 2013	21 buoys	Added to the database
ESSO-INCOIS (Ship-mounted AWS)	Met parameters	Apr 2012 – Mar 2013	10 stations	Added to the database
ESSO-INCOIS (Wave rider buoys)	Wave parameters	Apr 2012 – Mar 2013	10 stations	Added to the database
NIOT (HF RADAR)	Currents	Apr 2012 – Mar 2013	04 pairs of stations	Added to the database. Data in NetCDF format is also available.
ESSO-INCOIS (onboard ORV SN – Wave Height Meter)	Wave Parameters	Apr 2012 – Mar 2013	1 stations	Database generated
CTD along with Argo deployments	Temperature and salinity	May 2009 – Jul 2012	87 stations	To be processed
Argo CTD	Temperature and Salinity	Apr 2012 – Mar 2013	30278 profiles	Database generated

Apart from the in-situ observations, ESSO-INCOIS also received and archived data from several remote sensing platforms such as Metop 1 & 2, MODIS, NOAA 18 & 19, and Oceansat-2. The data received from these satellites are processed and made available on the ESSO-INCOIS website. Some of this data are processed immediately within 5 minutes, while other parts are processed within 30 minutes of reception. ESSO-INCOIS also continued to act as the Data Assembly Centre (DAC) for the OceanSITES programme of the global network of time-series stations. Meta-data of moored buoy observations compliant to the OceanSITES program (CF 1.4) were generated. ESSO-INCOIS also hosted data received through the field campaigns associated with the CTCZ program.

7.6.2. Data distribution

ESSO-INCOIS provided the surface met-ocean data to various operational agencies in the country regularly through its web site, emails and Live Access Server (INCOIS-LAS). To meet the demands from the users, the INCOIS-LAS was upgraded to the latest version (version 7.2). This allows the users to display the vectors on the fly plots. The I-LAS during the report period recorded more than 1, 27,192 hits from about 9207 unique IPs. The users from various countries also accessed the datasets using Open Data Access Protocol (OpenDAP).

In addition to the regular automated dissemination, ESSO-INCOIS also provided various data sets to many other institutes/organizations such as Anna University, IMD, IISc, NIO, IITM, Nansen Environmental Research Centre, NODPAC, NRSC, RRSC-east, Jadhavpur University, IIT Kharagpur, IIT Delhi, NPOL, Mahindra Consulting Engineers Limited, Annamalai University, ICZMP Odisha and IIT Mumbai .

The data DVD on Argo data and data products for the Indian Ocean was updated (Version 2.1) by including 1,70,000 temperature and salinity profiles from the Indian Ocean obtained during 2002-2012 April. The gridded data products in ASCII and netCDF format were also included in the DVD that was released in May 2012. The DVD also has in-built software for the users to navigate, browse, extract or visualize the data contained in the DVD.

7.6.3. Mixed layer depth and Sonic layer depth atlas of the Indian Ocean

An atlas of the mixed layer depth and the sonic layer depth was prepared for the Indian Ocean on the request of Naval Operations Data Processing and Analysis Centre (NODPAC) and Project Directorate of Naval Oceanology and Meteorology (PDNOM). All the available temperature and salinity profiles (~ 111000 T-S profiles) from the Argo floats in the tropical Indian Ocean were used to prepare this atlas. A software application is also provided along with the digital version of the atlas which is capable of displaying the maps, animations, time series and area averages of the parameters interactively. The temperature and salinity profiles from World Ocean Atlas (WOA 2009) are also made available in this package.

7.6.4. Content management system

The content management system for ocean data and information system was launched to ensure the uniformity in the web pages, system compatibility and is now available bilingually (English and Hindi). This web site also facilitates the real-time validation of satellite data received at ground stations at ESSO-INCOIS with in-situ data from moored buoys. This helps in the validation of SST products in real time.

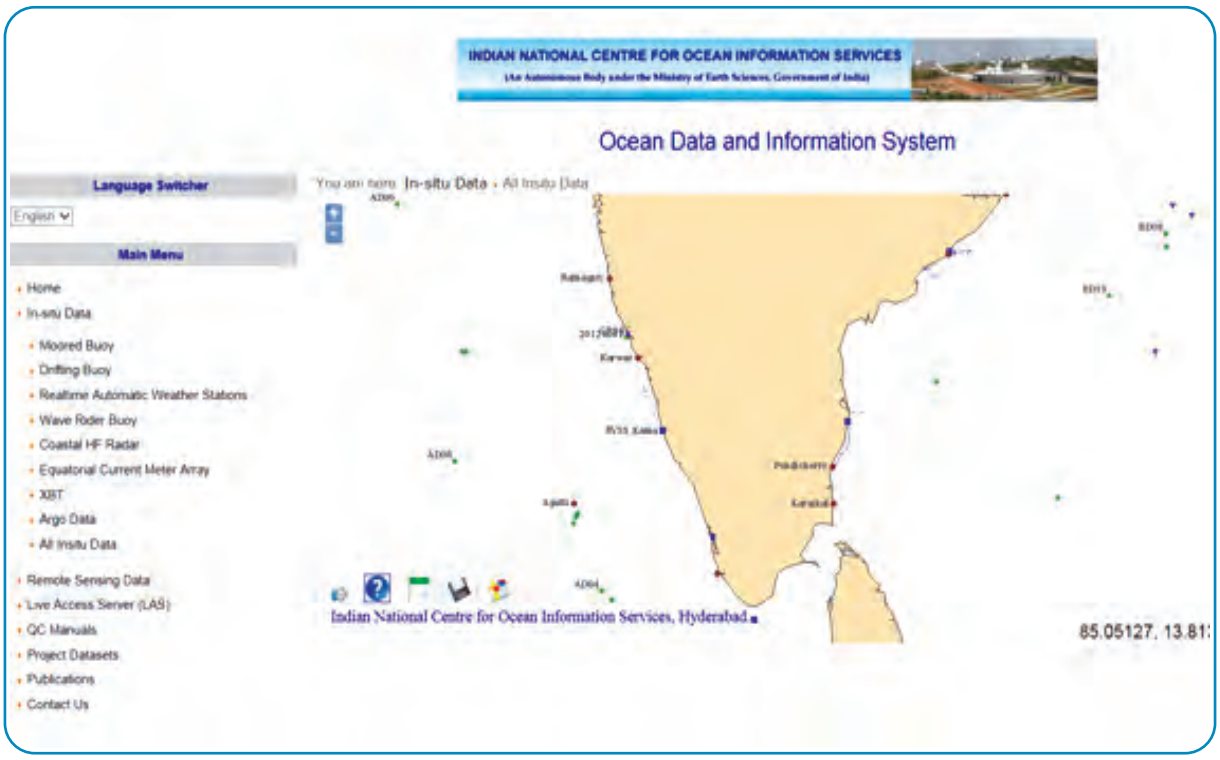


Figure 7.27: Snapshot of the content management system

7.6.5. Cloud Top Temperature

ESSO-INCOIS started generating a new data product on cloud top temperatures based on the satellite measurements of brightness temperature. The cloud top temperature is useful for the classification of clouds, identification of fog, estimate the intensity of cyclone, etc. Further the radius of maximum wind (Rmax), which is an essential input to the storm surge prediction models also can be computed using cloud top temperature. Traditionally Rmax is being obtained from atmospheric pressure data. Here, Rmax is determined as the distance between the coldest cloud top temperature surrounding the eye of the cyclone and the warmest temperature within the eye.

Table 7.4: Rmax derived based on the surface pressure estimates and cloud top temperature for three cyclones.

S.No.	Name of the cyclone	Duration	Rmax (km) based on surface pressure	Rmax (km) based on cloud top temperature
1	SIDR	11th-16th November, 2007	25	29
2	GONU	1st - 7th June, 2007	40	39
3	NARGIS	27th April - 3rd May, 2008	25	26

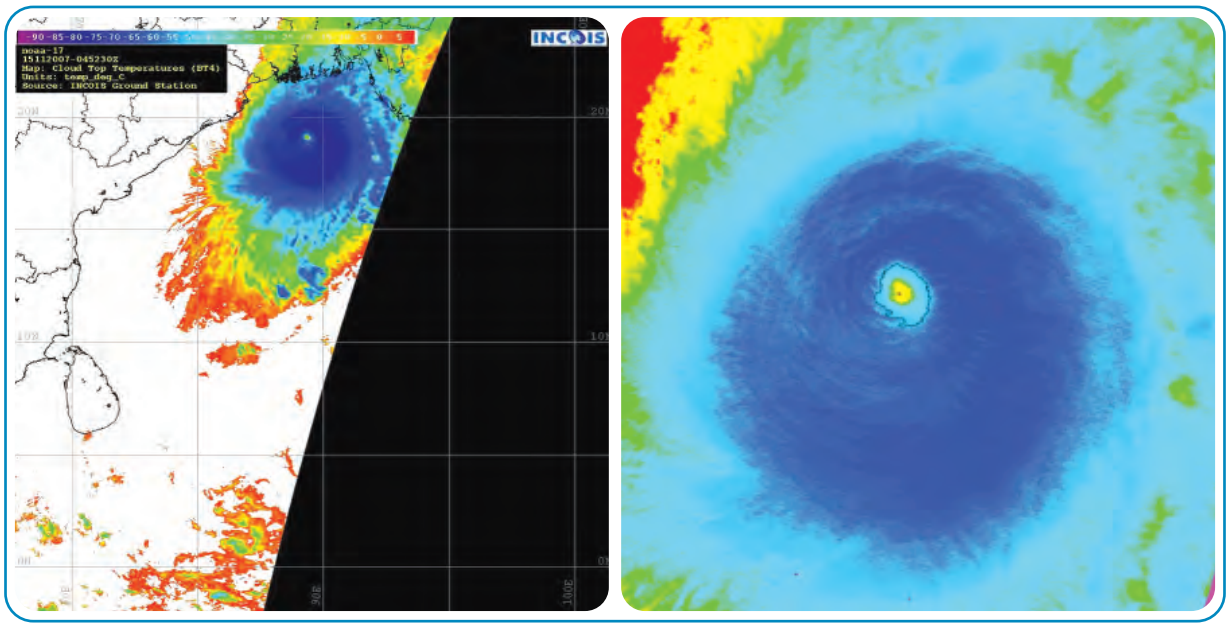


Figure 7.28a. Cyclone SIDR on 15.11.2007 at 0452Z (N17-AVHRR)

Figure 7.28b. Derived Ramx during 15.11.2007 at 0452Z

7.7. Dissemination of Ocean State Forecasts and Potential Fishing Zone Advisories

To reach out to more fishing villages, ESSO-INCOIS expanded its location-specific forecasts to an additional 38 locations in 7 districts of South Tamil Nadu in August 2012. A specialised multilingual webpage for disseminating OSF products for the coastal waters off-Rameswaram was launched by Prof. M.S. Swaminathan, Hon'ble Member of Rajya Sabha, on 7th August 2012 at a function held at M.S. Swaminathan Research Foundation (MSSRF), Chennai.

ESSO-INCOIS in collaboration with the PG Centre of Karnataka University at Karwar started the dissemination of location specific Ocean State Forecasts (wave height and direction, wind speed and direction) for Bhatkal in Uttara Kannada through All India Radio broadcasts and SMS.

ESSO-INCOIS also started to provide the location specific forecasts for three districts of Maharashtra – Ratnagiri, Raigad and Sindhudurg in Marathi and English. A webpage in Marathi was launched on 7th January 2013 at a User Interaction Workshop held at Ratnagiri.

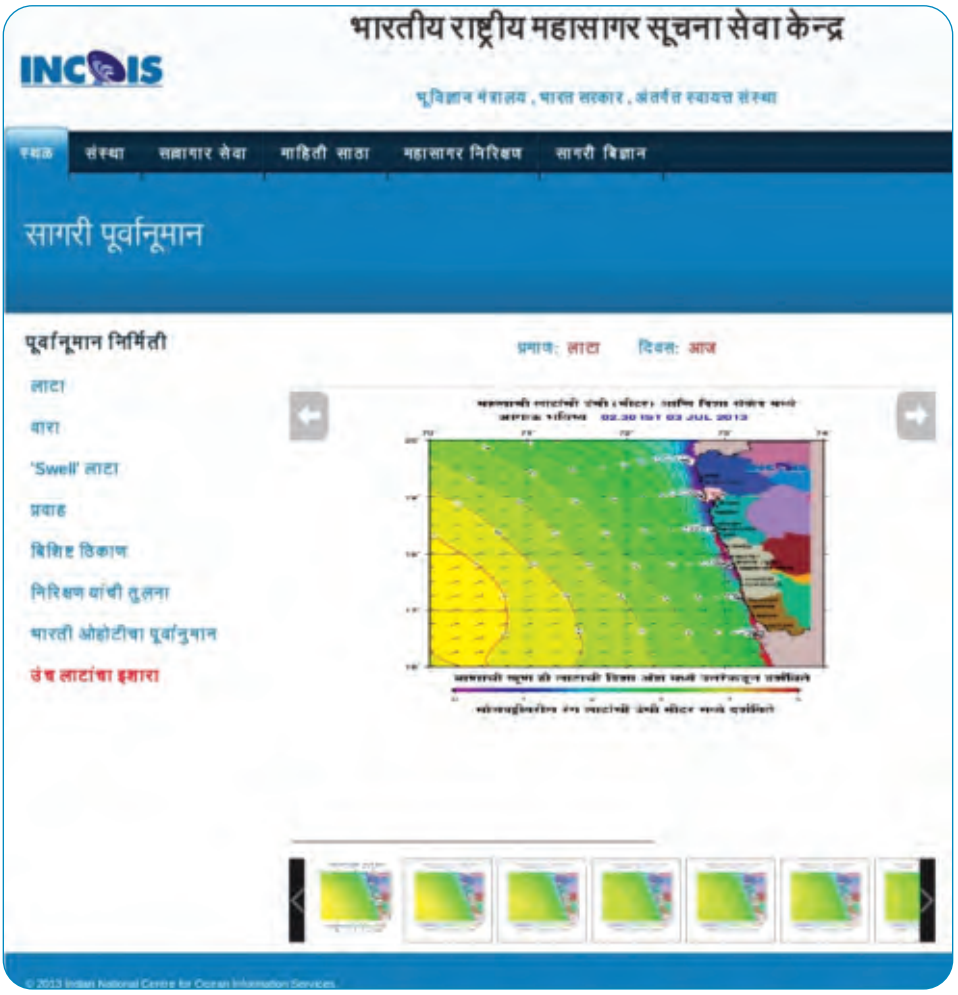


Figure 7.29: Snap shot of the content of Marathi web page, disseminating the Ocean State Forecast.

Ocean State Forecasts are now being provided in Malayalam as well. Various modes such as SMS, Village Resource Centres (VRCs) and the Public Address System are being used to disseminate the forecasts in Kollam, Kerala. This service was inaugurated at Kollam on 16th February 2013 by Shri. Shibu Baby John, Hon. Minister for Labour and Rehabilitation, Govt. of Kerala.

The redesigned web pages which allow the users to generate desired maps of OSF products using 'Web Map Services' have been updated. This facility was launched on 8th March 2013 during the 3rd User Interaction Workshop.

To ensure security at sea, ESSO-INCOIS started the dissemination of customised Ocean State Forecasts to the Coast Guard centres and the Coastal Security Police in Tamil Nadu, Goa, Karnataka, Lakshadweep and Andaman & Nicobar Islands.

PFZ advisories are provided to fishermen through timely disseminations using various new modes such as Mobile applications (mKRISHI), voice messages / audio advisories, multi-lingual SMS services, Fishermen Help-line system (for Tamil Nadu and Andhra Pradesh), FM / AIR / Community Radios, etc. in addition to the traditional and existing modes of dissemination through telephone / fax, e-mail, Web (including Web-GIS), Electronic Display Boards, Doordarshan (DD-Saptagiri).

There were requests from several users to keep the MSSRF helpline toll-free, as well as for it to be made available for all the coastal states. The present reach of MSSRF helpline is to 4066 fisher folk in 121 villages who receive 2 text messages everyday whereas 3443 fishermen from 10 districts are benefited with audio advisories. In the last two years this helpline has received 4204 queries and the present rate of calls is 15 calls per day normally while the same goes up to 300-400 calls during adverse weather or disaster. Approx. 40% of these beneficiaries are small-craft fishermen.

Similarly, mKRISHI Fisheries services are also gaining popularity in Maharashtra. mKRISHI is a mobile application developed by TATA Consultancy Services, Thane under a GEF-funded collaborative project with Mumbai Research Centre of CMFRI. However, there was a requirement identified to create more awareness about it. During the same project, it was estimated from the 13 village clusters studied, that PFZ advisories provided a saving benefit of 500 kiloliters of diesel which translates into a reduction of carbon emission by 804 tonnes per annum. This service also needs sustenance through a successful and user-centric business model.

8 Ocean Observations

8.1 Indian Argo project

India continued to contribute to global efforts in the Argo floats programme by deploying 31 Argo floats during the period from 1st April 2012 to 31st March 2013 in the Indian Ocean. Twenty one floats were of the AROVER model type, one float was an APEX model, communicating through Iridium and nine were PROVOR BIO floats. AROVER and APEX floats have CTD Sensors. The PROVOR floats are equipped with sensors for measuring Dissolved Oxygen, Chlorophyll Fluorescence and Optical Backscatter in addition to the CTD sensor. In collaboration with the University of Washington, USA, 5 more APEX floats equipped with additional biogeochemical sensors (to measure Nitrate, Chlorophyll Fluorescence, Optical Backscatter and Dissolved Oxygen) along with the conventional CTD sensors were also deployed in the Northern Indian Ocean. With these additions, the total number of floats deployed by India increased to 284; of which, 104 floats are currently active and providing data in real time.

In addition to the deployments done by ESSO-INCOIS, other countries also deployed 68 Argo floats in the Indian Ocean during the past one year, so now the total number of active Argo floats in the Indian Ocean is 700 as of 31st March 2013. Totally 30278 temperature and salinity profiles pertaining to the Indian Ocean were archived at ESSO-INCOIS in the past one year.

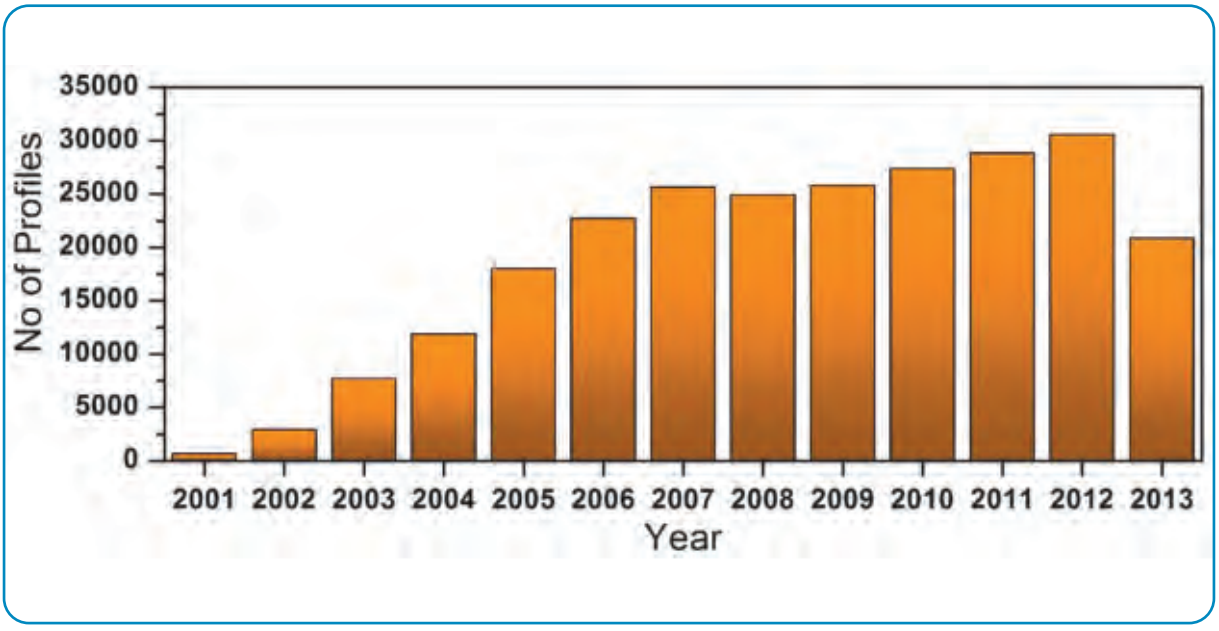


Figure 8.1: Year-wise distribution of temperature-salinity profiles measured by Argo floats in the Indian Ocean.

8.2 Bay of Bengal Mooring

The third phase of the Bay of Bengal mooring was successfully deployed at 18°N and 89.5°E on 1st January 2013. This mooring is equipped with 2 Doppler volume current meters and 8 temperature-conductivity-pressure recorders. An ARGOS beacon is fitted on the buoy to track its position in case it drifts away from the watch circle.

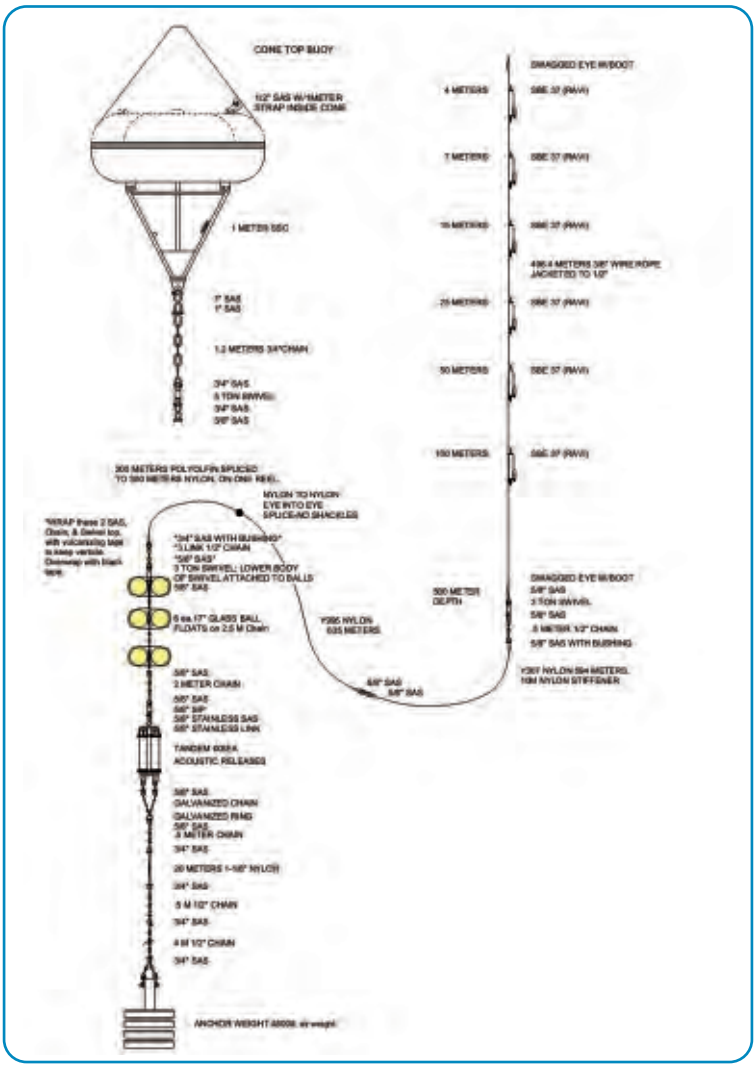


Figure 8.2: Design of the third phase of Bay of Bengal mooring

The data collected during the first phase (November 2009-November 2010) of the Bay of Bengal mooring and its comparison with moored buoy observation in the western Tropical Pacific (8°N,137°E) provided some new information. Existence of strong salinity stratification (0.3 psu across the top 15 m) due to river water at the mooring location, which is at least five times higher than mooring the west Pacific warm pool (0.06 psu in 25 m) is observed. Surface temperature and salinity span a wider range in the Bay (Fig. 4.3b) and rapid changes in surface salinity or density are

much more frequent than in the west Pacific (Fig. 4.3 c, d). For instance, the probability that rate of change of surface potential density ($\partial \sigma \Theta / \partial t$) exceeds 0.5 kg m^{-3} per day is about 10% in the Bay and 3% in the Pacific, suggesting that strong surface fronts are more frequent in the Northern Bay. Further, it is also observed that the vertical density gradient in the Northern Bay of Bengal is mainly determined by salinity rather than temperature (see Figure 4.3). It is evident from the moored observations that salinity fronts stratify the surface layer of the Northern Bay.

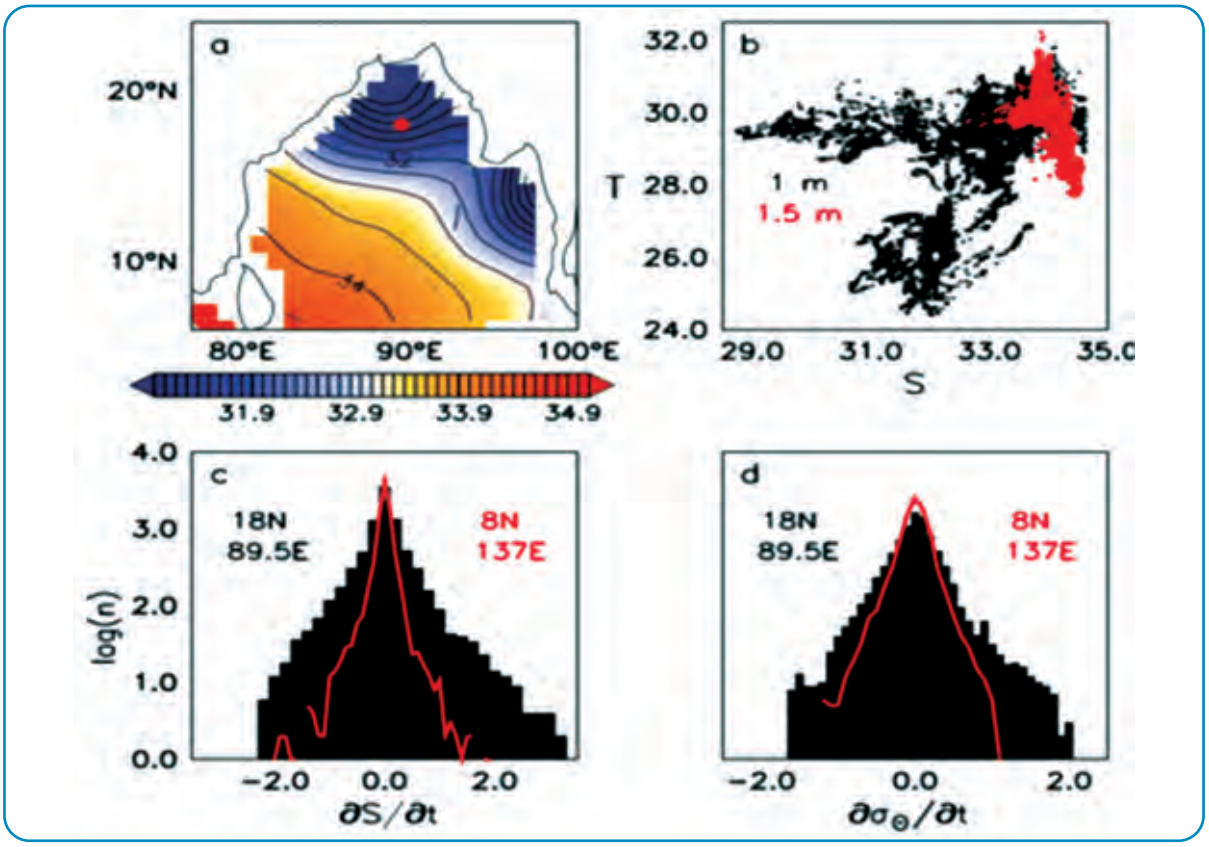


Figure 8.3: Evidence of fronts from Bay of Bengal mooring from Bay of Bengal mooring. (a) Climatological surface salinity (psu) in August (b) Hourly temperature (°C) versus salinity (psu) at 1 m depth in the north Bay (black) and 1.5 m depth in the west Pacific warm pool (red) Frequency distribution of rate of change of (c) salinity ($\partial S/\partial t$, psu day^{-1}) (d) rate of change of potential density $\partial \sigma \Theta / \partial t$ (kg m^{-3} day^{-1}) at 1 m in the Bay (black bars) and 1.5 m in the Pacific (red line) on a logarithmic scale; hourly S is smoothed by a 12-hour running mean to suppress short time scales.

8.3 Tsunami Buoys

The maintenance of two Tsunami buoys (STB01 & STB02) equipped with bottom pressure recorders and surface buoys, was completed through contract to M/s Science Applications International Corporation (SAIC), USA and in collaboration with the National Institute of Ocean

Technology (NIOT), India during the cruises on board ORV Sagar Kanya (SK 295 and SK 303). The data from both buoys are received in the Indian Tsunami and Storm Surge Early Warning Centre through satellite communication. Additionally, ESSO-INCOIS also receives data from 4 indigenous buoys deployed by NIOT, Chennai and data from 4 buoys deployed by other countries in real time.

Figure 8.4:(left) Tsunamis buoys network in the north Indian Ocean. Retrieval (middle) and redeployment (right) of the SAIC Tsunami Buoy in the Arabian Sea.

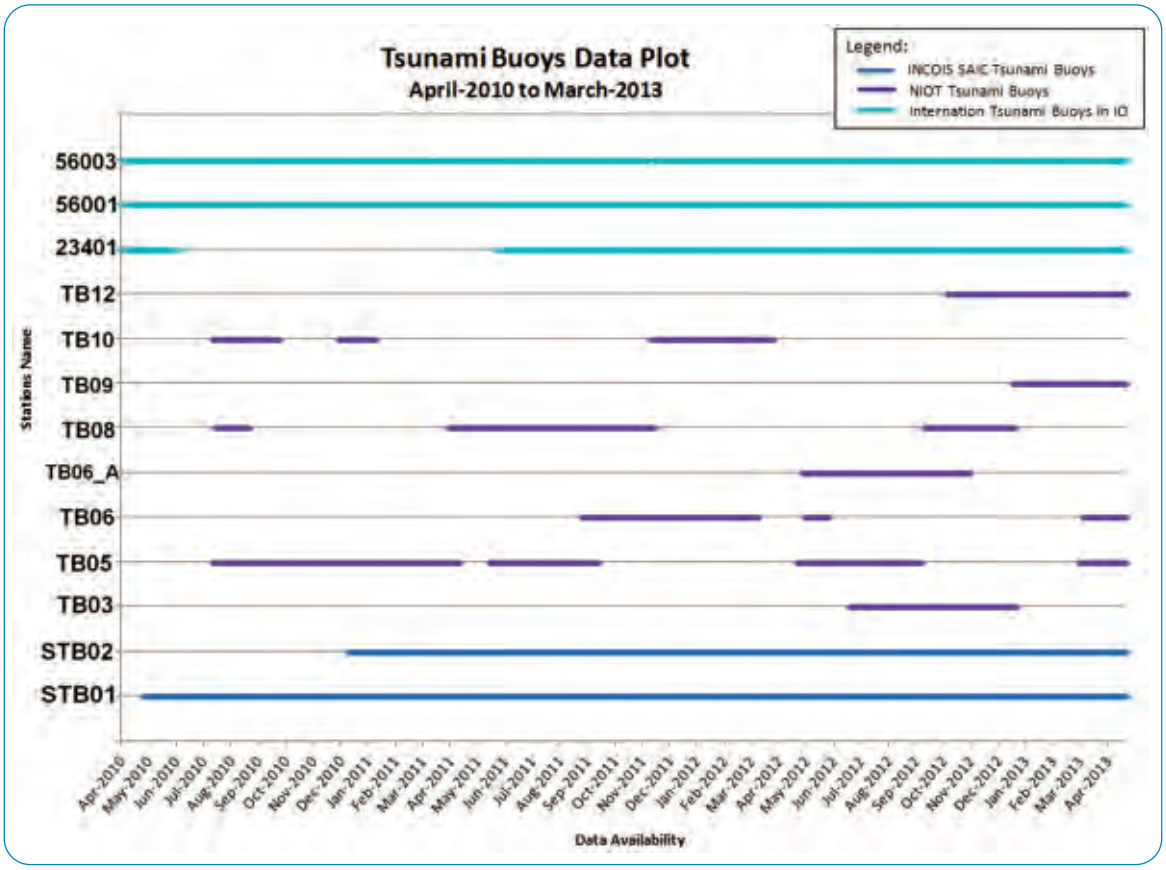


Figure 8.5: Data availability from the Tsunami buoys deployed in the Indian Ocean

8.4. Tide gauge network

The tide gauge network set up along the Indian coast functioned satisfactorily and reported data in real time. The network consists of pressure, radar and shaft encoder sensors installed at 21 locations along the Indian mainland and islands. During the last year, the annual maintenance of all 21 tide gauges has been carried out and they are reporting data in real time through INSAT and GPRS. During last year UHF transmitters were also installed at 18 tide gauge locations in addition to the existing Mobile Satellite System reporting service (MSS) transmitters to maintain redundancy. ESSO-INCOIS also receives data from 70 international tide gauges located along the coasts of the Indian Ocean in near real time through the internet.

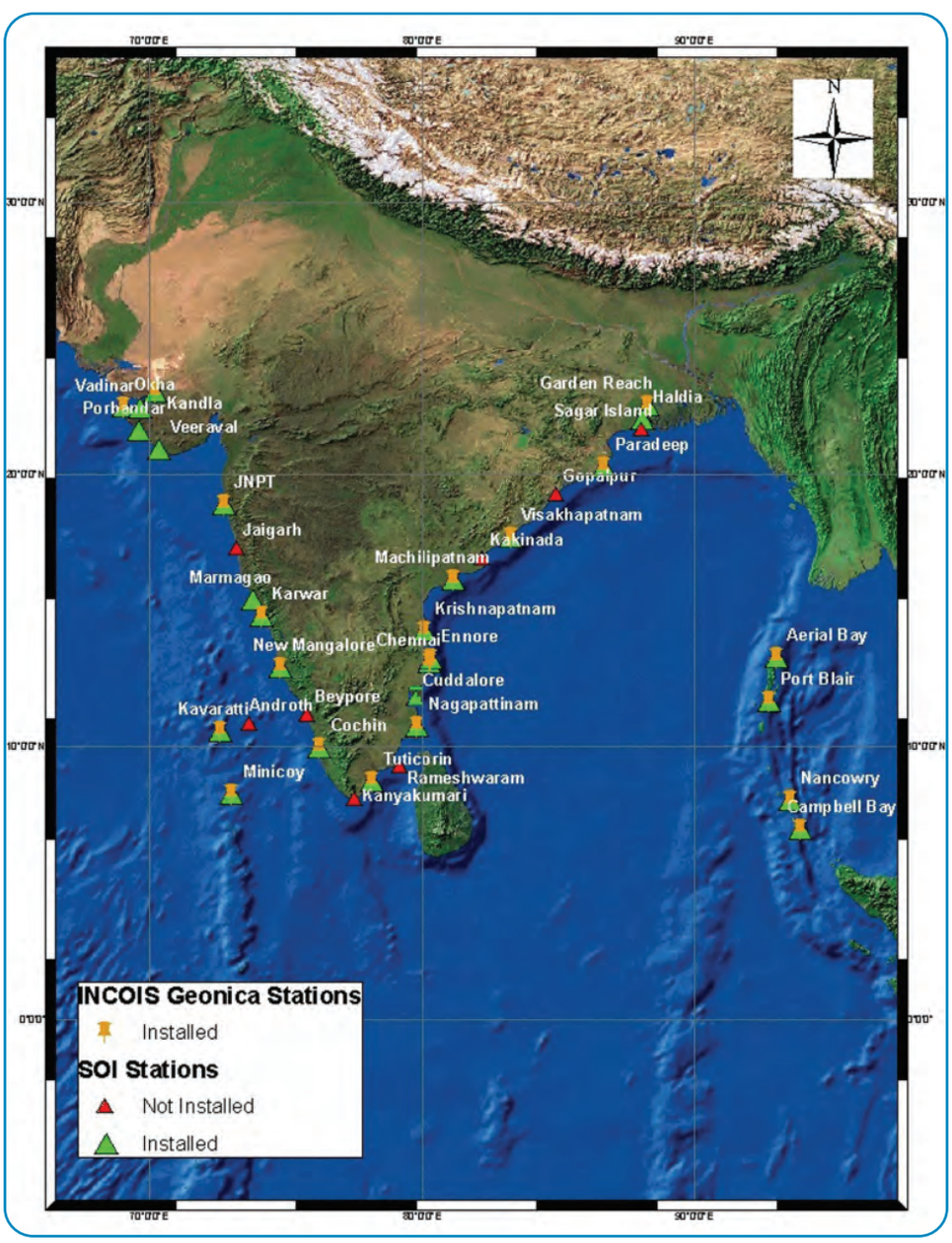


Figure 8.6: Existing Tide gauge network along the Indian coast line and islands.

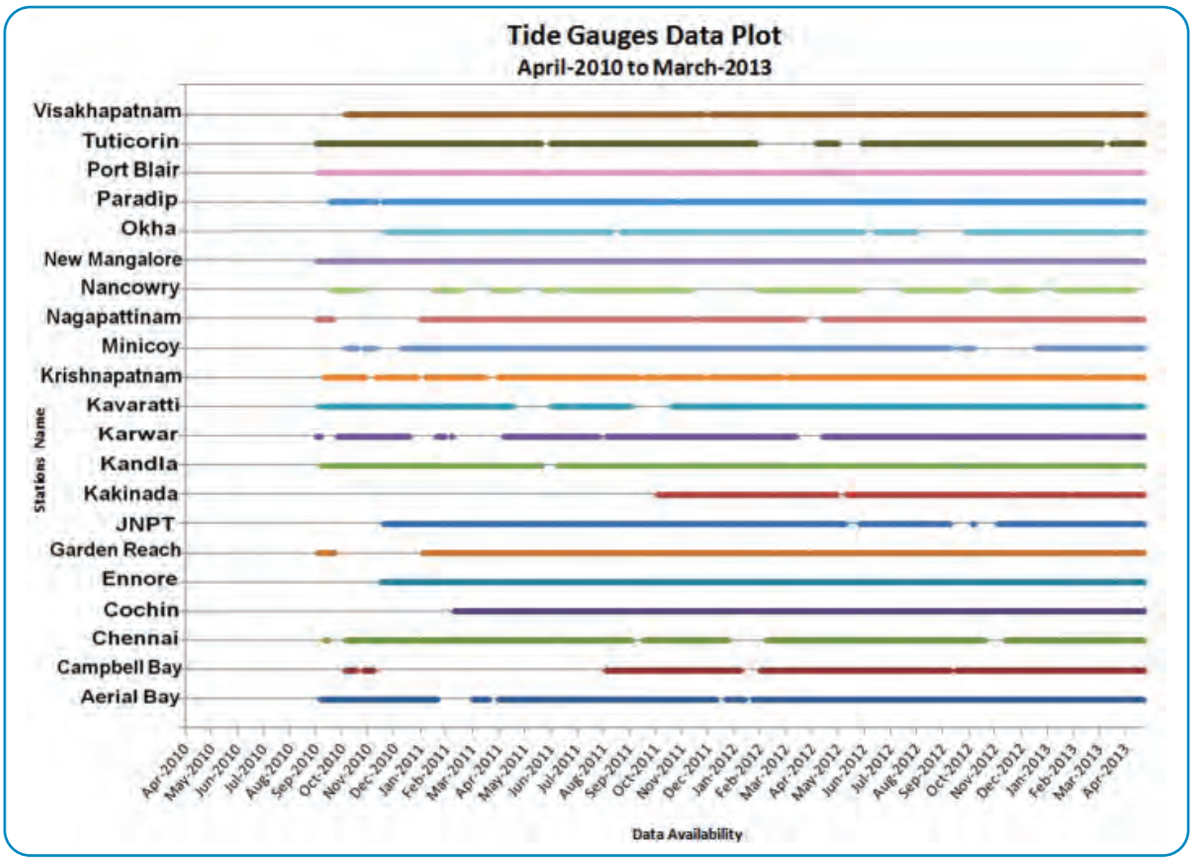


Figure 8.7: Data availability from the Tide Gauges deployed in the Indian Ocean.

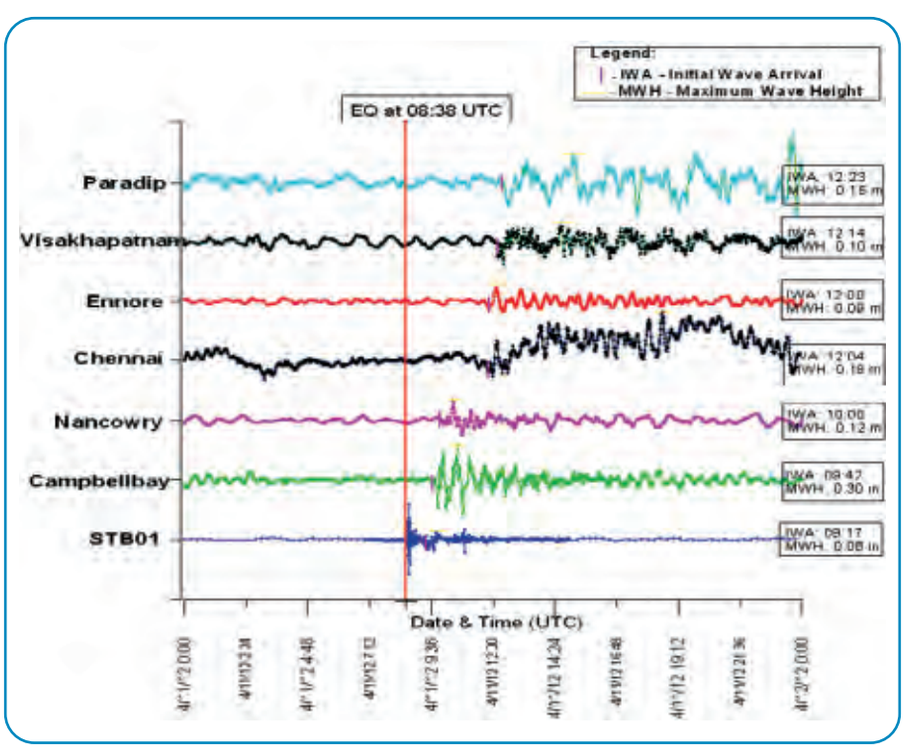


Figure 8.8: Sea level observations (Tsunami Buoys and Tide gauges) of Earthquake M8.5 originating off west coast of Northern Sumatra on 11th April, 2012.

8.5. Wave Rider Buoys

With the deployments of two more wave rider buoys off Agatii island in Lakshadweep and off Gopalpur in Odisha, the wave rider buoy network expanded to 12 buoys. The buoy deployed off the coast of Vedaranyam was recovered and re-deployed off Karaikkal in Tamil Nadu due to logistical issues related to the safety of buoys. The buoy deployed off the coast of Visakhapatanam with a HF transmitter was replaced with a wave rider buoy equipped with an INSAT transmitter.

Figure 8.9: Deployment of wave-rider buoy off the coast of Goplapur, Odisha.

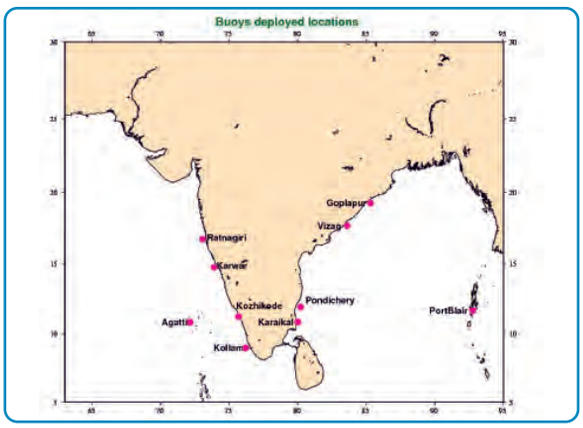


Figure 8.10: Locations at which wave rider buoys are currently deployed.

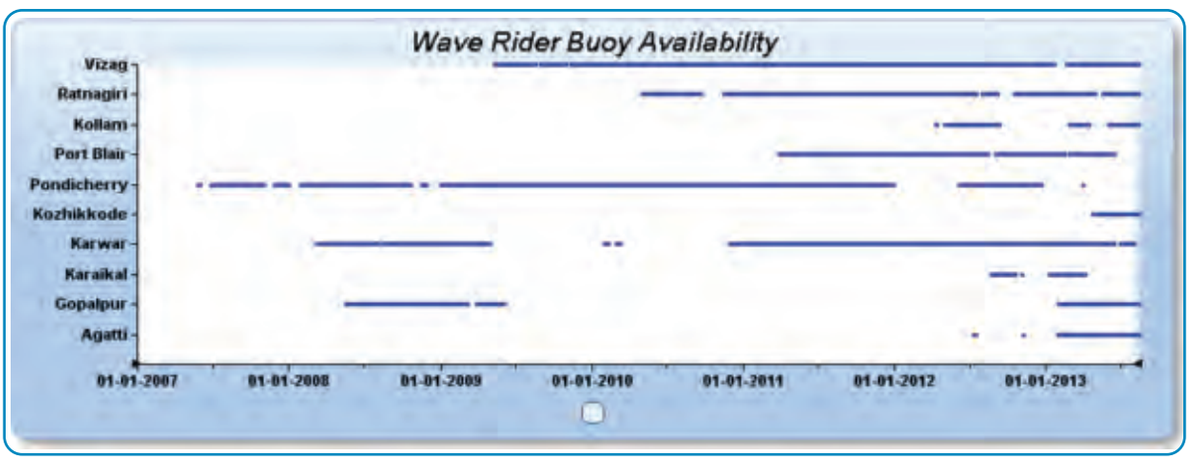


Figure 8.11: Data availability from the wave rider buoy network.

8.6. Automated Weather Station (AWS)

An Automated Weather Station (AWS) to measure surface meteorological parameters (MET) was installed at the BHS ONGC platform on 1st March, 2013. Including this particular one, at present, there are 10 AWS that are continuously providing data to ESSO-INCOIS in real time.

The primary objective of AWS is to measure the surface MET-ocean parameters in order to validate and refine the forcing parameters (obtained from different MET agencies) for the Indian Ocean Forecasting System (INDOFOS) which is being operated at ESSO-INCOIS.

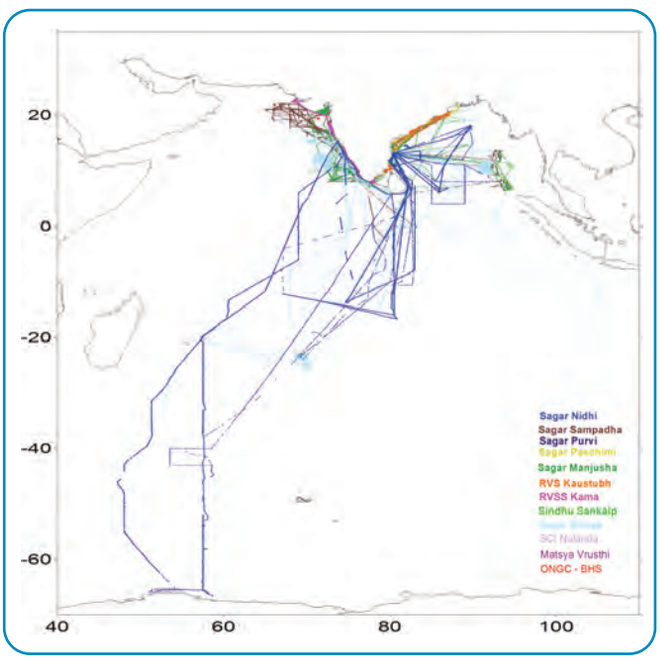


Figure 8.12: Tracks of Ships Carrying ESSO-INCOIS AWS

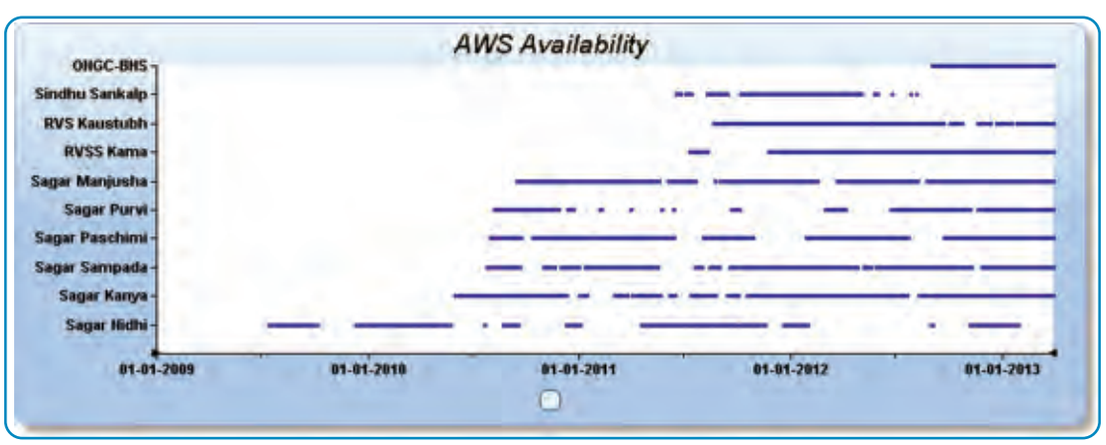


Figure 8.13: AWS Data Availability

8.7. RAMA Observational Network

The RAMA observational network is designed to address outstanding scientific questions related to the Indian Ocean variability and the monsoons. As per the MoU between MoES/ESSO-INCOIS and NOAA/PMEL, 38 operations at 18 sites were carried out which includes deployments, recovery and repair of the ATLAS, CONE type and ADCP moorings, during the past one year. At present 31 out of 46 (67%) RAMA sites were covered. Physical oceanographic and meteorological data collected within RAMA has been extensively used to understand the thermohaline structure in the Bay of Bengal (Figure 8.15) and validation of satellite derived product and model parameter values.

Time series measurements of temperature, salinity and surface meteorological parameters recorded at 8°N, 90°E in the southern central Bay of Bengal from a RAMA buoy are used to document temperature inversions and their influence on the mixed layer heat budget during the winters, defined as October to March, of 2006–2007 and 2007–2008. The analysis showed that intraseasonal and interannual variability in the thermocline significantly influences the frequency and magnitude of temperature inversions and thickness of barrier layer. The heat budget analysis of the mixed layer showed that the intraseasonal and year-to-year variability in temperature inversions and barrier layer have significant influence on SST through the modulation of the vertical heat flux at the base of the mixed layer.

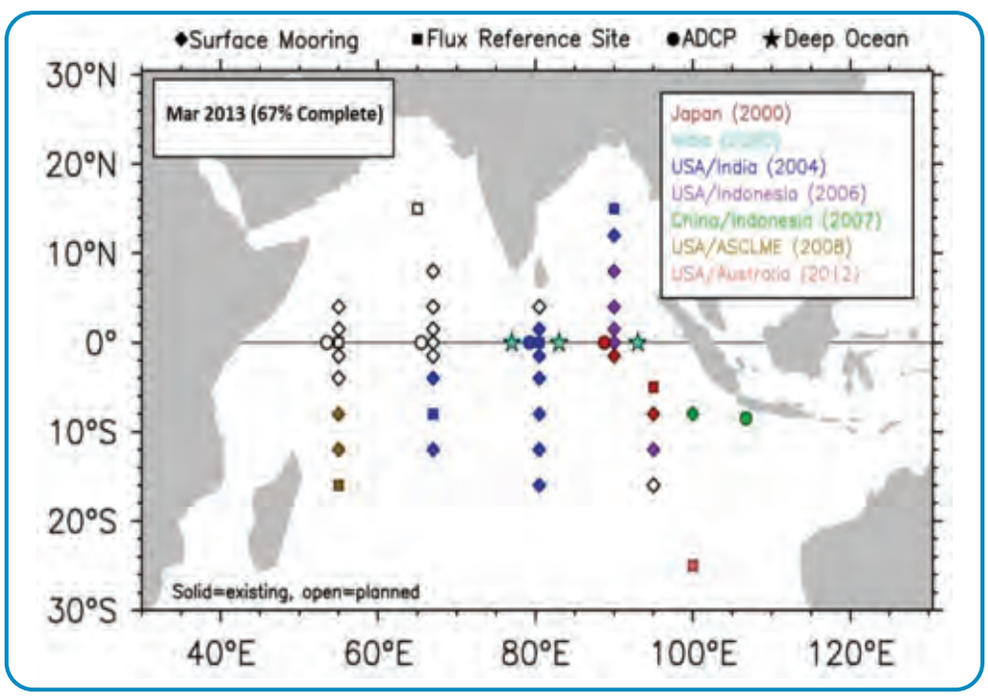


Figure 8.14. Blue dot indicates India's contribution to RAMA in collaboration with PMEL, USA.

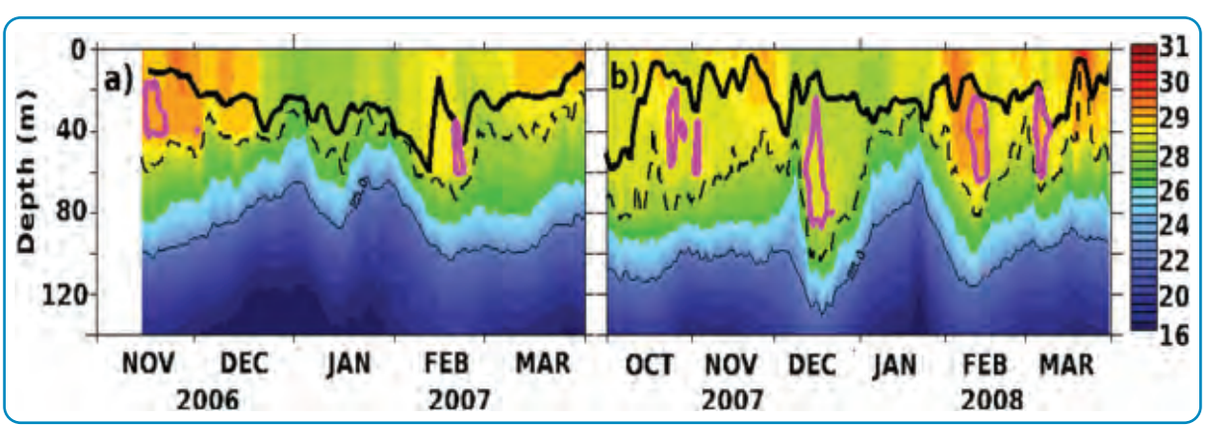


Figure 8.15. Temporal evolution of temperature (°C) obtained from (a, b) daily RAMA buoy data at 8°N, 90°E during winter (a) 2006-07 and winter (b) 2007-08. In the figure, thick, dashed and thin lines indicate MLD, ILD, and D23, respectively. Pink contours indicate temperature inversions of magnitude 0.1°C or greater.

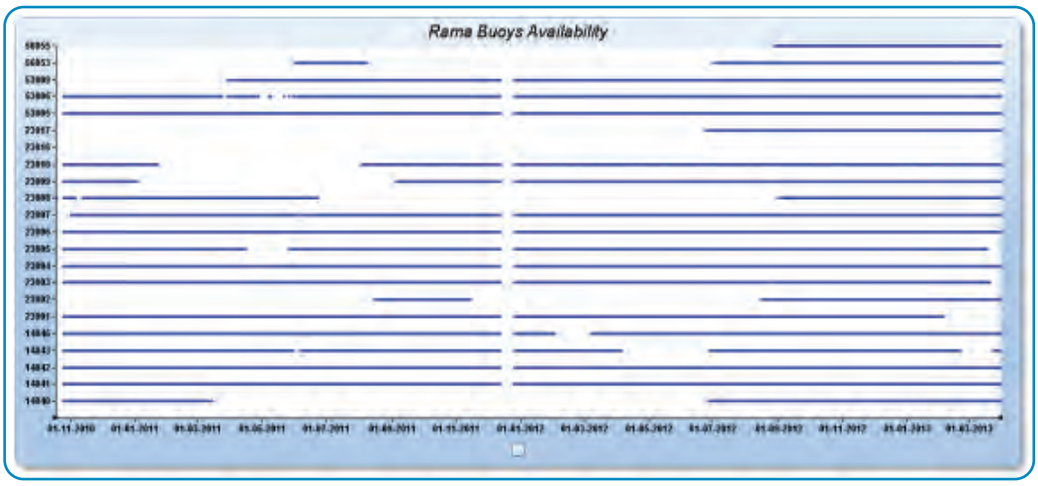


Figure 8.16. RAMA mooring data availability 2010-2013.

8.8. Coastal ADCP mooring

The coastal ADCP mooring project has been implemented by the National Institute of Oceanography, Goa deploying and maintaining a network of coastal ADCPs to generate long term data on ocean currents in the Indian coastal seas. Each pair of ADCPs includes one in the shelf region and another in the slope region. 10 such pairs of ADCPs were deployed in the east and west coast of India and 2 individual ADCPs (Paradip and Goa) are deployed so far along the Indian coast. Additionally, ESSO-INCOIS also receives data from 2 NIO-ADCPs. These ADCPs are now providing a detailed record on the currents along the Indian coast.

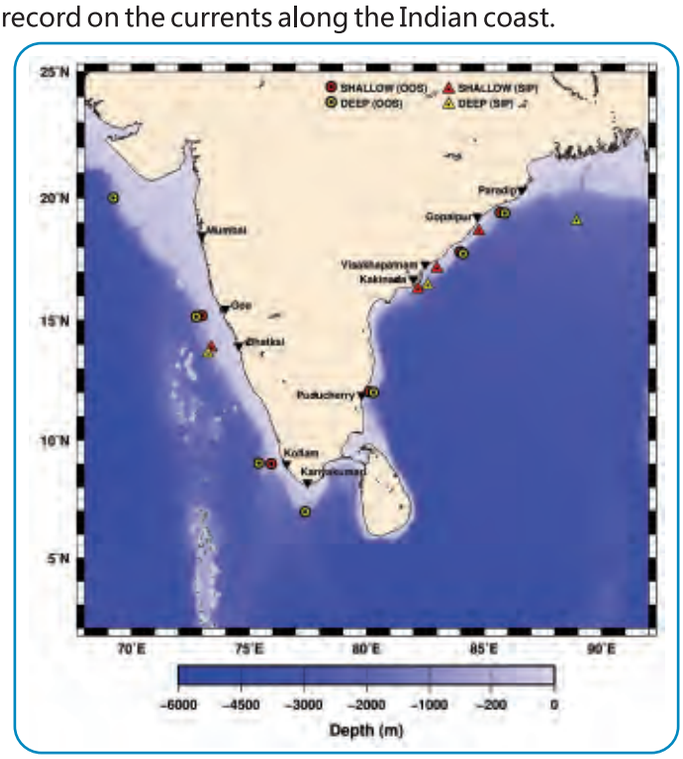


Figure 8.17. Coastal ADCP network in the Indian Coastal Seas.

8.9. Current meter moorings in the Equatorial Indian Ocean

To understand the long term variability of the equatorial currents on intraseasonal and inter-annual time scales a deep-sea mooring system was established in the equatorial Indian Ocean by NIO with financial support from ESSO-INCOIS. It consists of 3 deep-sea moorings at 93°E, 83°E and 77°E along the equator and additional 4 current meter moorings across the equator at 1.5°N, 77°E; 1.5°S, 77°E; 1.5°N, 93°E; 1.5°S, 93°E. Each mooring has one upward looking 75 kHz ADCP at 350 m and Recording Current Meters at 3 levels of nominal depths of 1000 m, 2000 m and 4000 m. The 3 deep-sea moorings at 77°E and one mooring at 83°E were serviced in 2013 and the 3 moorings at 93°E will be recovered and redeployed soon.

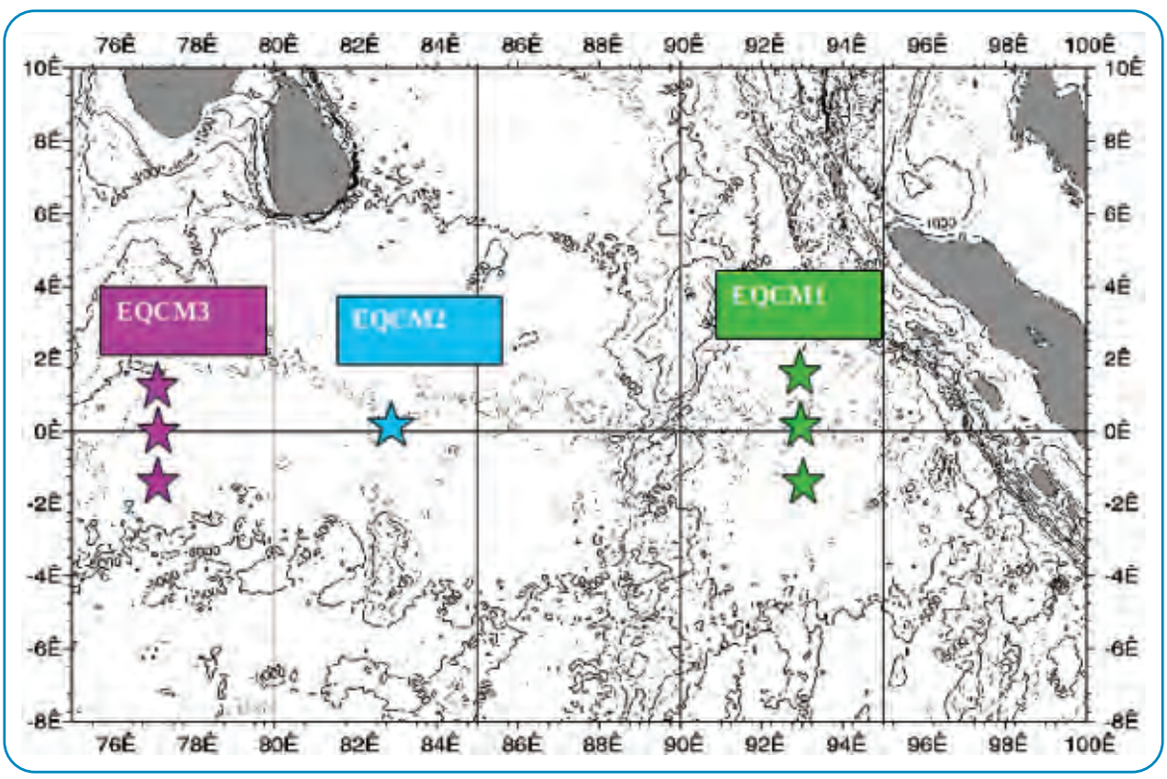


Figure 8.18. Equatorial Indian Ocean Observational Array since 2000.

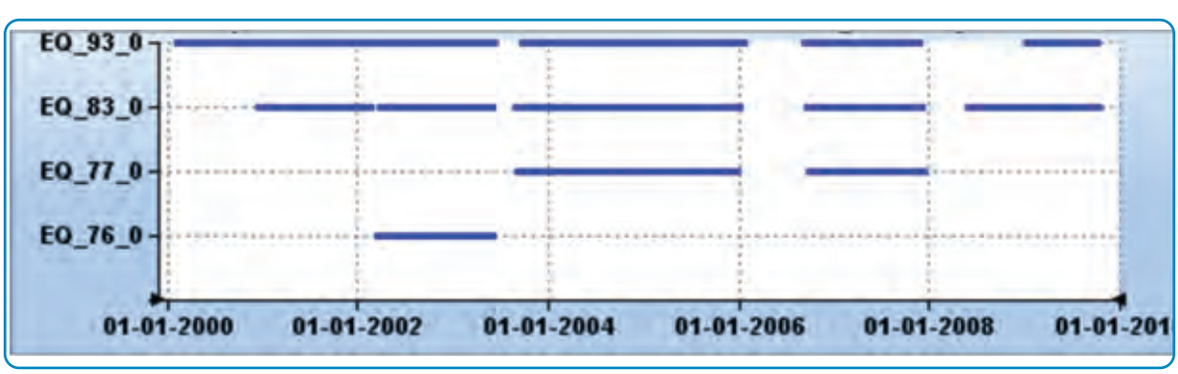


Figure 8.19. Availability of current data from the Equatorial current mooring system.

8.10. XBT transects

To understand the evolving state of the upper ocean thermal structure in the Northern Indian Ocean, ESSO-INCOIS supports the XBT transects program continuously. XBT provides upper ocean temperature profiles up to 760 m along selected shipping lanes in the seas around India at bimonthly intervals. The major XBT transects are Mumbai – Mauritius, Chennai – Port Blair, Port Blair – Kolkata, Chennai – Singapore, and Kochi – Lakshadweep. The data from this system is transferred to ESSO-INCOIS and made available to the public in a user friendly data format. Totally 257 XBT profiles and 92 XCTD profiles pertaining to the Indian Ocean were archived at ESSO-INCOIS in the past one year.

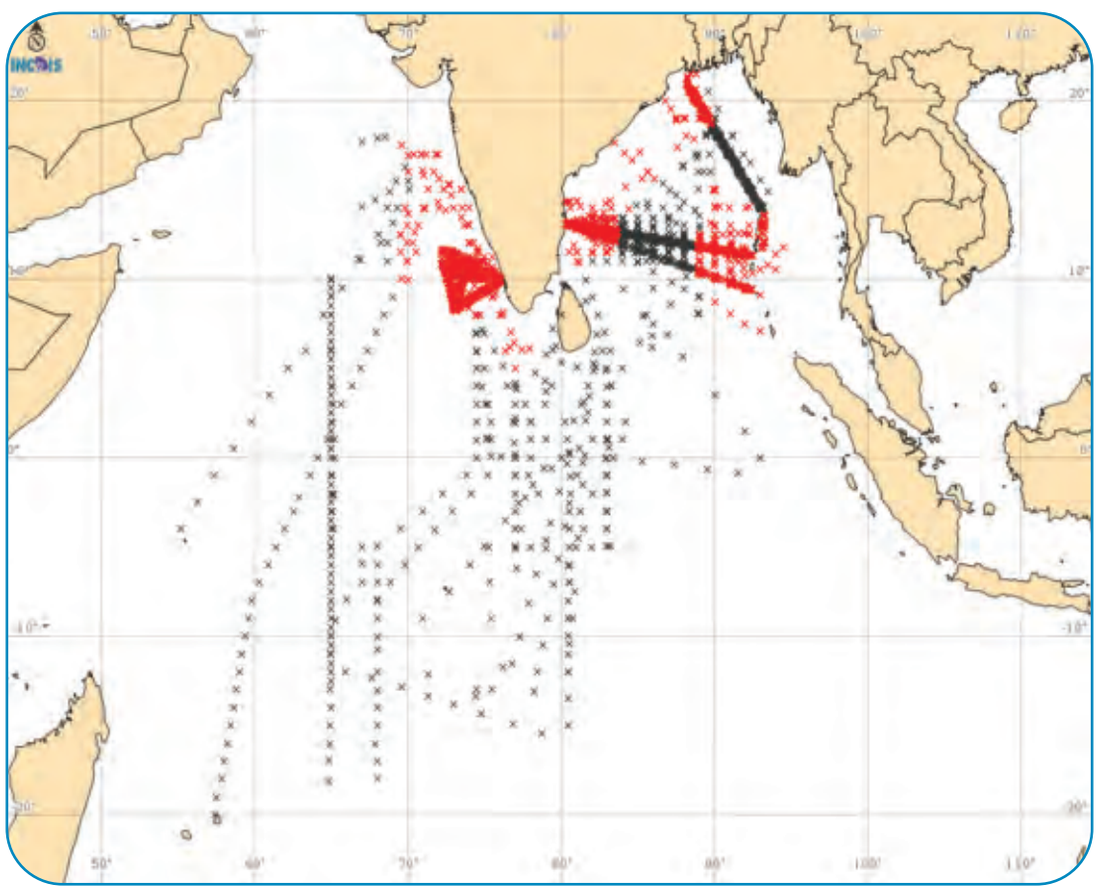


Figure 8.20. XBT tracks since 1991. Black and red color indicates coastal and open ocean observation.

8.11. Surface Drifting Buoys

The surface drifting buoy program was initiated with an aim to estimate the surface current, atmospheric pressure and sea surface temperature. 22 surface drifters (19 by NIO Goa and 3 by ESSO-INCOIS) were deployed during the past one year. The drifting buoys use the ARGOS satellite system for transmitting data.

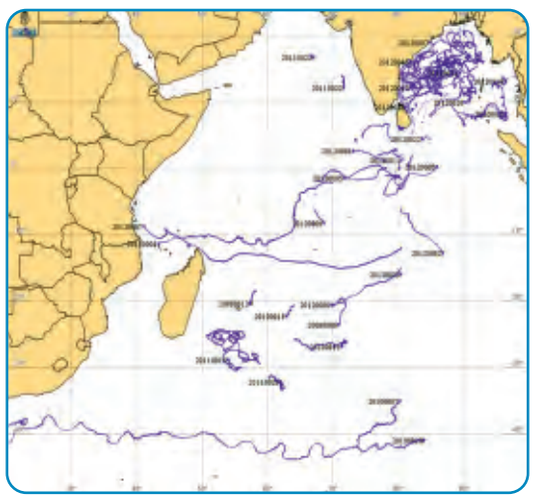


Figure 8.21: Data density map of surface drifter as on March, 2013.

8.12. HF Radar data

In order to provide a synoptic view of coastal currents and waves along the coastal waters upto 200km offshore, a network of HF Radar comprising 5 pairs of Radar at Andhra Pradesh Coast, Tamil Nadu Coast, Gujarat Coast, Orissa Coast and Andaman island has been established. Current meter moorings are deployed in each of the Radar locations to validate the current data. Data from HF Radar, which are received in real time at ESSO-INCOIS, are converted into user friendly formats such as NetCDF and archived.

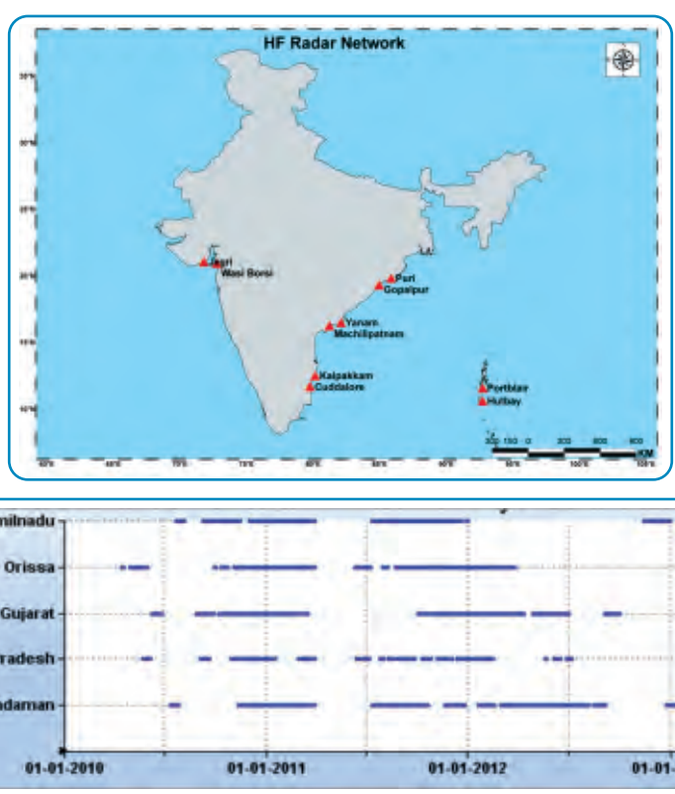


Figure 8.22: HF Radar network in the Indian coast and Availability of data from HF Radar as on 31st March, 2013.

9. Capacity Building, Outreach and Training

Continuous interaction with the user community is one of the most important processes through which we receive valuable feedbacks and suggestion which improve our services. ESSO-INCOIS conducted several User Interaction Meetings/Workshops for targeted users. In addition, Joint User Interaction Meetings are conducted every year at ESSO-INCOIS.

9.1. 2nd ESSO-INCOIS User Interaction Workshop

The 2nd ESSO-INCOIS User Interaction Workshop was conducted at ESSO-INCOIS during 10th-11th May 2012. Participants included 150 users/delegates from agencies like ONGC, Navy, Coast guard and from various fishing communities. The workshop was inaugurated by Shri M. Shashidhar Reddy, Hon'ble Vice Chairman, National Disaster Management Authority (NDMA) in the presence of Dr. B. Battacharjee and Dr. Harsh K. Gupta Hon'ble Members of NDMA, Dr. V.K. Dadhwal, Director, NRSC and Dr. M. Vijayakumaran, DG, FSI. Dr. S.S.C. Shenoi, Director, ESSO-INCOIS welcomed the Hon'ble Guests, distinguished invitees and users. A new service for disseminating the Ocean State Forecast along the ship routes, an Atlas containing the maps of the Coastal Vulnerability Index (CVI) and a CD on Argo data products-Ver 2.1 were launched/ released on the occasion. Following the inaugural function, sessions were conducted to interact with the users in detail. During interaction with the stakeholders, there were requests from fishermen to give Species Specific Forecast specially for Mackerels, Carangids, Seer fish and Ribbonfish. Fishermen also showed interest to receive oceanographic parameters such as Sea Currents and Swell. There was also a request to continue the service on a daily basis.

Figure 9.1: Dr. M. Shashidhar Reddy, Hon'ble Vice Chairman, National Disaster Management Authority (NDMA) inaugurating the 2nd User Interaction Workshop on 10th May, 2012 held at ESSO-INCOIS.

9.2. 3rd ESSO-INCOIS User Interaction Workshop

The 3rd ESSO-INCOIS User Interaction workshop was held on March 8th, 2013 at ESSO-INCOIS, Hyderabad. Around 170 delegates, including about 25 fishermen representing the fishing communities in Tamil Nadu, Andhra Pradesh and Kerala, the officials of ONGC, Indian Navy, Coast guard, Port and Harbours, Shipping companies, Coastal Police and researchers from different Universities and Scientific organizations participated in the workshop. Vice Admiral Bimal Kumar Verma, AVSM, Chief of Staff, HQ, Eastern Naval Command, Indian Navy was the Chief Guest of the function. Director of National Remote Sensing Centre (NRSC), Hyderabad, Dr. V.K. Dhadwal and Director of Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES), Bangkok, Dr. A.R. Subbiah graced the occasion as Guest of Honours. New ESSO-INCOIS products, such as "Ocean State Forecast for Maldives", "Global ocean analysis product", "Web map services of Ocean State Forecast" and "Content Management System (CMS) for Ocean Data and Information System (ODIS)" were launched during the event. A DVD on Argo Data and Products for Indian Ocean was also released during the workshop. Three books about awareness of the ESSO-INCOIS services and on the success cases of ESSO-INCOIS, also were released during the workshop. Implementation Agreement between ESSO-INCOIS and RIMES for collaborative efforts for ocean research and services was signed by the Directors of ESSO-INCOIS and RIMES.

Figure 9.2: Vice Admiral Bimal Kumar Verma, AVSM, Chief of Staff, HQ, Eastern Naval Command, Indian Navy) inaugurates the 3rd User Interaction Workshop on 8th March, 2013 held at ESSO-INCOIS.

Fig. 9.3 A user poses questions during the 3rd User Interaction Workshop at ESSO-INCOIS.

9.3. Capacity Building on Tsunami Early Warning Services

A one-day Tsunami Awareness Workshop was conducted at Reliance Industries Ltd (RIL), Mumbai on 24th May 2012. During the workshop, training was given on how to interpret tsunami bulletins issued by ITEWC.

Several Tsunami Awareness leaflets titled 'Early Warning System', 'Sensing a Tsunami', ''Tsunami on move', 'Tsunami Preparedness', 'What is Tsunami', 'Tsunami Safety for Boaters' and 'Tsunami Safety Rules' in English and Telugu languages were prepared and distributed.

A film on the IOwave-11 mock drill was played in "Pride of India ISC Expo-2013" of 100th Indian Science Congress, Kolkata during 3rd-7th January 2013.

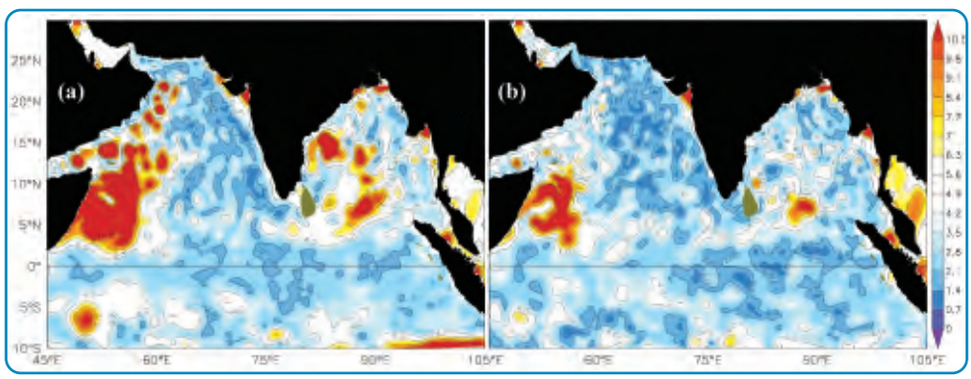


Figure 10.2: Root mean square difference (cm) between sea level anomaly derived from HYCOM simulation and gridded altimeter product before (a) and after (b) assimilation during the period 22nd August, 2012 - 20th September 2012.

10.2. Modular Ocean Model (MOM4p1)

A high vertical resolution regional Indian Ocean model with open boundary conditions has been set up in collaboration with the Geophysical Fluid Dynamics Laboratory (GFDL), USA and the Indian Institute of Science (IISc), Bangalore using Modular Ocean Model (MOM4p1). The regional model with a uniform 25 km horizontal resolution and less than 1.0 meter vertical resolution near the surface extracts boundary conditions from the global runs of MoM4p1 at GFDL. The model simulated the seasonal variation of upper ocean fresh water content (FWC) and sea surface salinity overall. The most exciting result is that model could simulate the spatial and temporal distribution of the sea surface salinity pattern along the east and west coast of India and in the southeastern Arabian Sea. The inter-annual upper ocean salinity analysis showed that the bias over the northern Bay of Bengal is ~ 0.2 psu except during winter time when it reaches ~ 0.8 psu when compared to Argo observations.

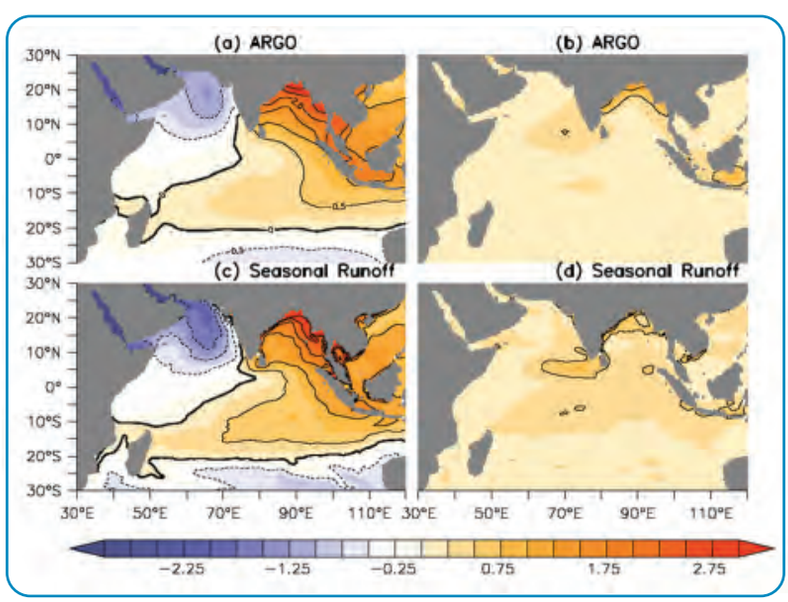


Figure 10.3. Mean upper ocean (0-30 m) fresh water content (m) and its standard deviation (STD) from (a) and (b) Argo observations and (c) and (d) model simulations.

10. Ocean Modelling

10.1. HYCOM

A 1/12th degree eddy resolving Hycom has been set up for the Indian Ocean domain and inter-annual simulations were carried out for the period May 2009 to December 2012. The validation of simulated oceanic parameters shows better representation of oceanic features compared to the previous 1/4th degree setup of Hycom and the results of this validation are made available on the ESSO-INCOIS website.

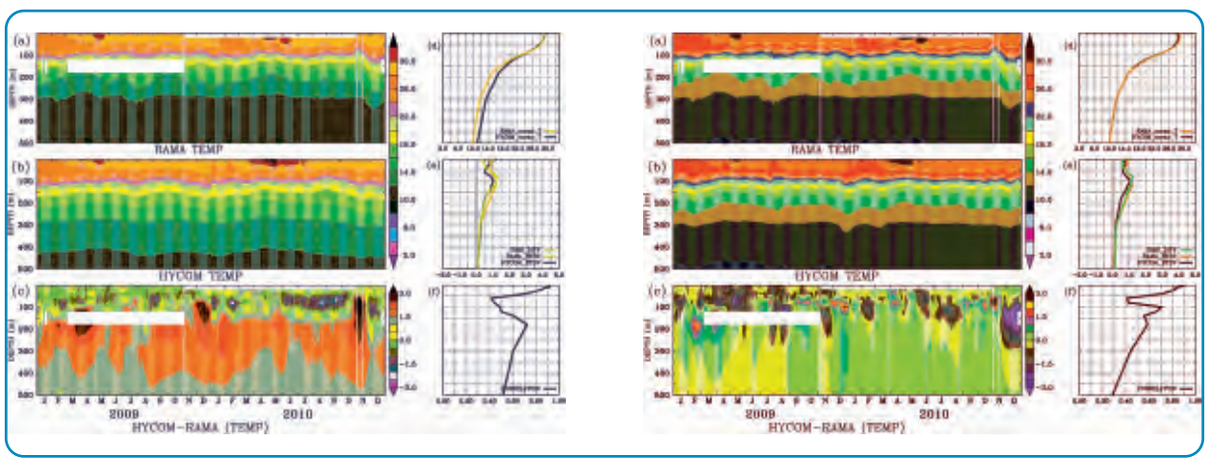


Figure 10.1: Time-Depth section of temperature from (a) RAMA, (b) 1/12th HYCOM, (c) the difference between Hycom and RAMA at 12°N, 90°E. The left side of plot shows the statistical parameters such as (d) mean (e) RMSD between model and observations (green) and standard deviation of model (black) and observation (red) and (f) correlation between model and observation. (In the figure left (right) panel shows 1/4th degree (1/12th degree) Hycom simulation.

Further, satellite measured sea level anomalies and sea surface temperature data are being assimilated to this model using the multi-scale sequential assimilation scheme based on the reduced order Kalman Filter. Currently, this system is producing daily ocean analysis as well as 180 hours forecast on experimental basis using forcing fields obtained from the Global Forecasting System (GFS), NCEP, USA. The assimilation system is being further improved based on inferences from the comparison of model analyses/forecasts and observations.

10.3. Global biogeochemistry model

The recent version of modular ocean model (MOM5) coupled with the biological-chemical model - Tracers Of Phytoplankton with Allometric Zooplankton (TOPAZ) is used to simulate the seasonal climatology of chlorophyll, nitrate and dissolved oxygen in the Global Ocean. This coupled model has a uniform zonal resolution of 1.0 degree and variable meridional resolution of 1.0 to 0.33 degree with maximum resolution over the equatorial region. Vertically, the model has 50 levels. The climatological simulations with Coordinated Ocean Reference Experiments (CORE-II) forcing shows that the model setup needs further refinement to reproduce the observed spatial patterns of chlorophyll, nitrate and dissolved oxygen in the Indian Ocean.

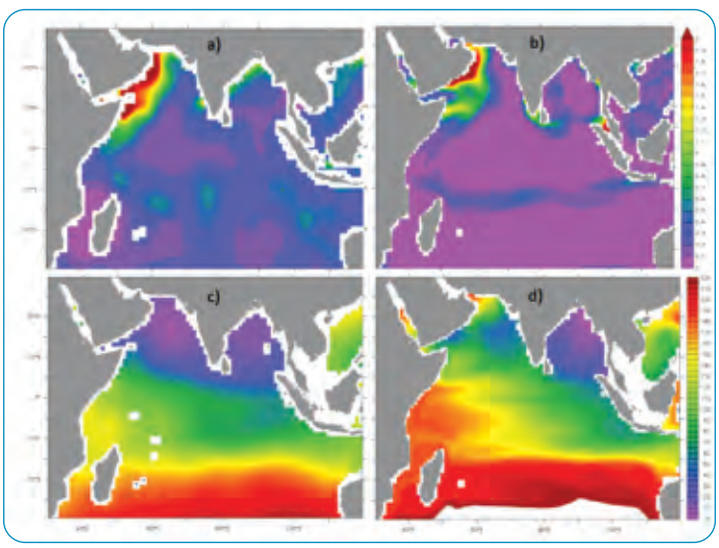


Figure 10.4: 100th year model simulation (a, c) and WOA09 (b, d) observation of (a, b) Nitrate (µM) and (c, d) Dissolved Oxygen (µmole/Kg).

10.4. High-resolution Operational Ocean Forecast and reanalysis System (HOOFS)

After setting up the Indian Ocean Forecast System (INDOFOS) at a horizontal resolution of approximately 12.5 km, ESSO-INCOIS is now developing a very high resolution operational ocean forecast system for the coastal waters of India. The proposed system will comprise a series of Regional Ocean Modelling System (ROMS) setups at horizontal resolution of approximately 1.5 km. These high resolution coastal setups of ROMS will take boundary conditions from a basin-scale ocean analysis system. As a pilot project, a high resolution coastal ROMS is set up for the north-eastern Arabian Sea, which extends from 67.0° E to 74.0° E in the east-west direction and 15.0° E to 25.0° E in the north-south direction. At present this model setup takes boundary condition from the basin-scale set up of ROMS with a horizontal resolution of 12.5 km.

Comparison of the along-shore component of currents as well as the SST simulated by the HOOFS model with satellite and mooring observations suggests that there is considerable improvement in the simulations using HOOFS compared to the earlier lower resolution ROMS model setup.

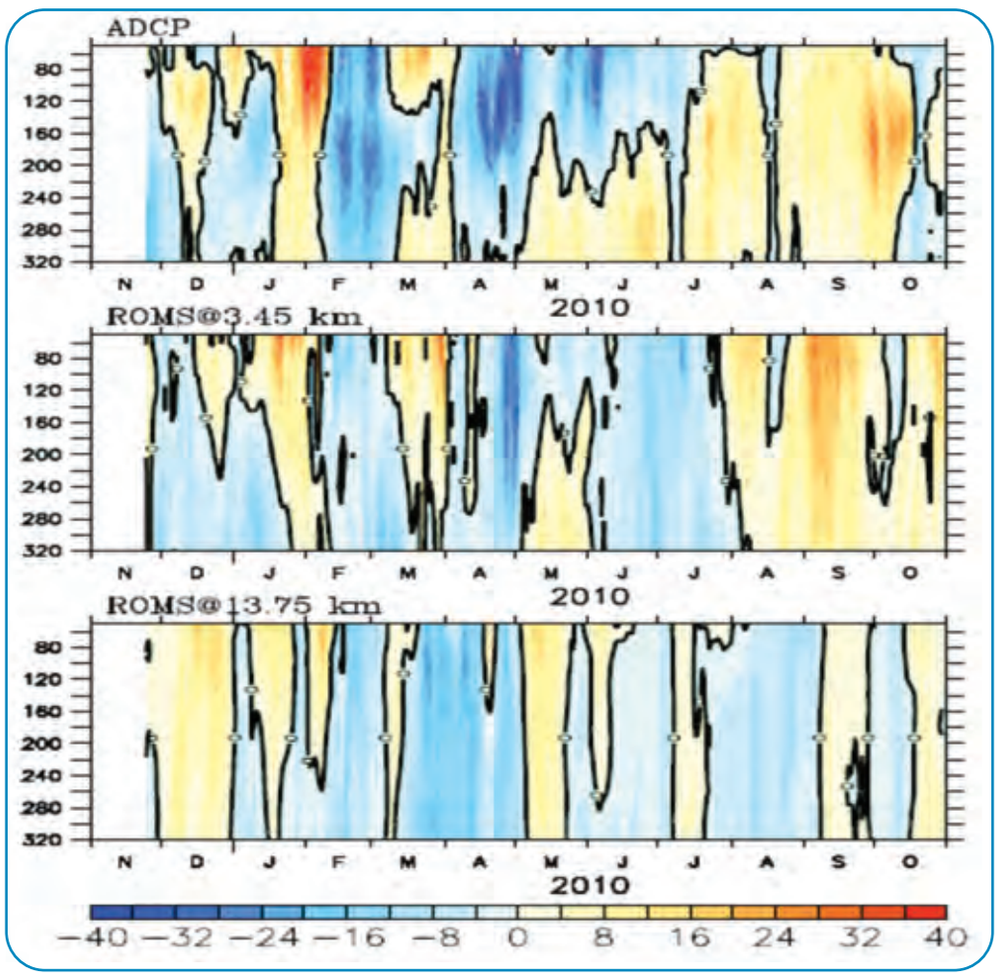


Figure 10.5: A comparison of along-shore component (cm s^{-1}) of simulated currents at 69.2 °E, 20 °N with ADCP measurement for the period 1st December 2009 to 31st October 2010.

10.5. Early Warning for Storm Surges

A storm surge model based on ADCIRC is successfully installed on HPC and configured for the east coast of India. Triangular gridded meshes were developed for the entire east coast of India to compute the cyclone induced surges and associated inland inundations. The model was tested with some past cyclonic data and the model simulated results are in agreement with the available observations. This storm surge model was run in real time for the Neelam cyclone and the results were in good agreement with the observations reported by the India Meteorological Department. The model will be operationalised soon in collaboration with IMD who will provide the forecasts on cyclone intensity and track.

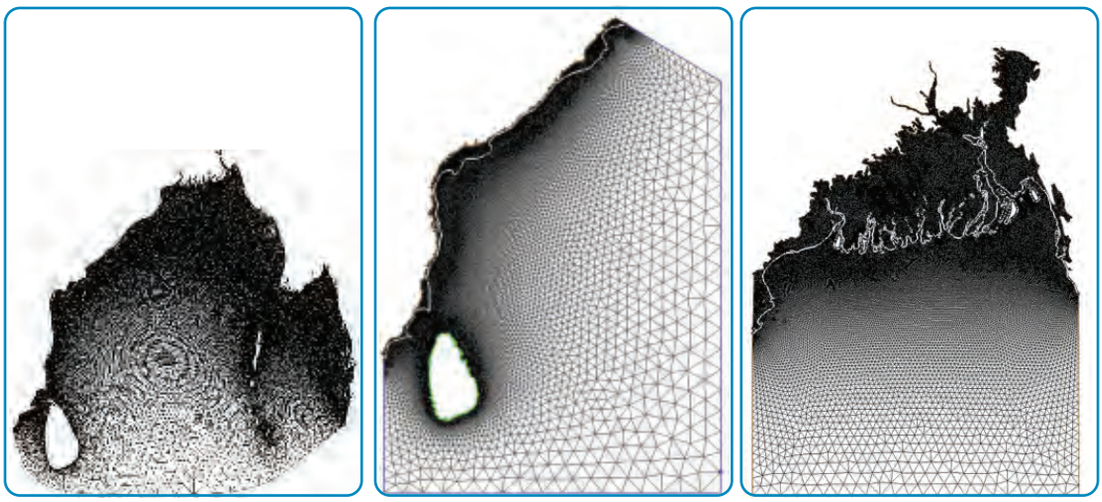


Figure 10.6: (Left) Model domain and grid for the simulation of surges alone. The east coast is divided into two domains (Middle & Right) for the simulation of inundation due to storm surge

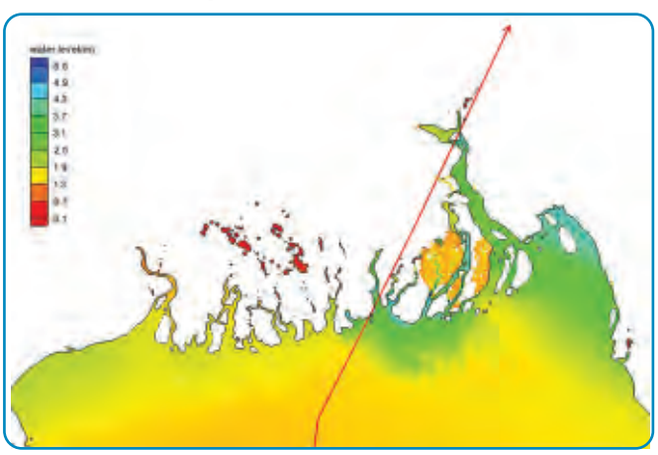


Figure 10.7: Model simulated surge is about 5.5 m at the time of landfall during Sidr cyclone, 2007. Computed horizontal extent of inundation is about 20 km inland through river. SAARC Disaster Management Centre (SDMC) reported value of inundation is 15 km. (Source: saarc-sdmc.nic.in/pdf/publications/sdr/chapter-2.pdf). Red colored line shows the track of the Sidr cyclone

10.6. Simulating WAves Nearshore (SWAN)

The SWAN model is being set up at ESSO-INCOIS for the prediction of wind-wave characteristics in the coastal waters of India. As a pilot experiment, SWAN (version 40.85) was set up off the coast of Pudducherry. The model was forced with ECMWF blended winds and integrated by taking the boundary conditions from WAVEWATCH III. The model setup has a resolution of 250 m and an extent of around 1.3 deg x 1.3 deg. The wave spectrum simulated by the model shows that the total wave energy simulated by the model matched well with the observations while the distribution of wave energy in different frequency bands showed differences. Further the model could simulate bimodal as well as multimodal spectra. The daily variations in significant wave height were also simulated by the model to a good extent.

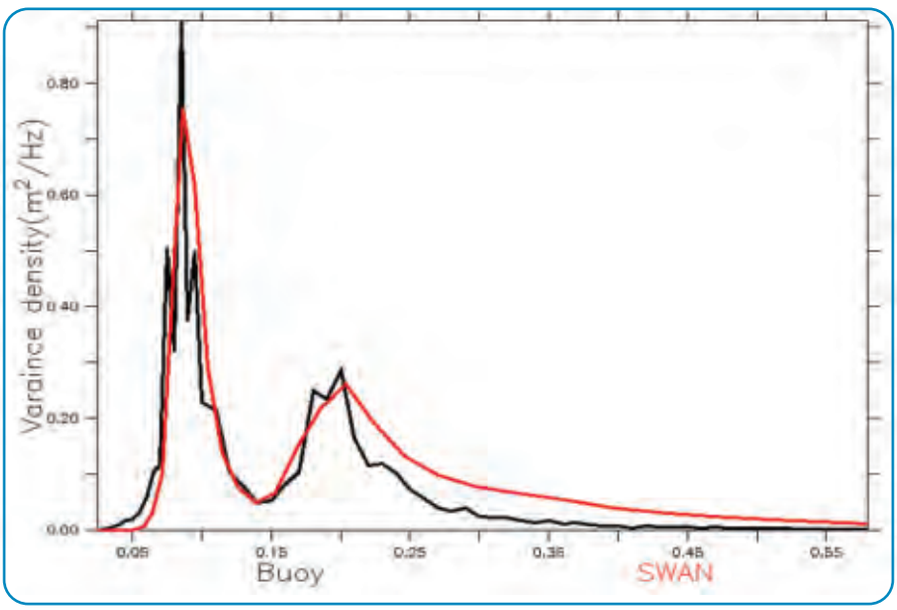


Figure 10.8: Comparison of a one dimensional wave spectrum (m^2/Hz) at coastal Pondicherry between the nested SWAN model and buoy observations for July.

11. Satellite Oceanography Research Programme (SATCORE)

11.1. Time Series Stations

As a part of the SATCORE programme, time-series stations were established in Indian coastal waters for measurement of optical and bio-geo-chemical parameters. The measurements at time-series stations were sustained in collaboration with NIO-Goa, Goa University (Goa), Mangalore University (Mangalore), CIFT-Kochi (Kochi), IIT-Madras (Gulf of Mannar), Annamalai University (Parangipettai, Pondichery and Nagapatinam), Andhra University (Visakhapatnam) and Berhampur University (South Odisha). The data acquired from these stations are being utilised for the optical characterisation of Indian coastal waters as well for the validation, improvement and development of bio-optical algorithms in Case-II waters.

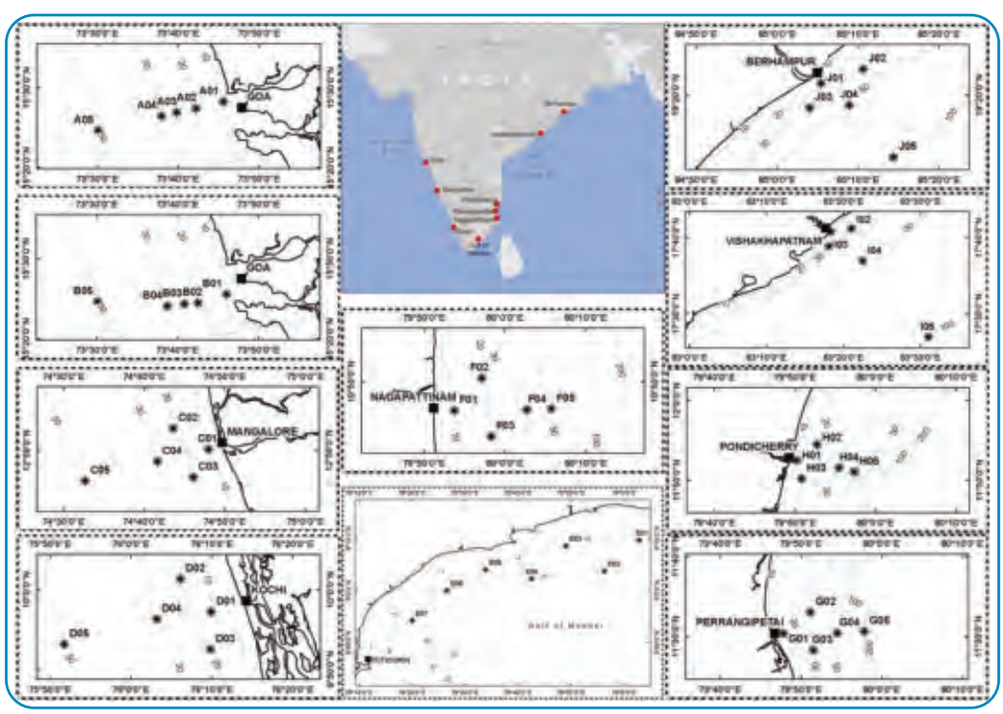


Figure 11.1: Schematic showing the location of time-series stations established as a part of the SATCORE programme.

11.2. Evaluation of empirical algorithms in different water types at a coastal site off Kochi

The variability in spectral remote sensing reflectance (Rrs) was analyzed in view of optically active substances (OAS) such as chlorophyll_a (Chl-a), Chromophoric Dissolved Organic Matter (CDOM) and Volume Scattering Function at 650 nm (β650). Based on the variability in spectral Rrs three water types were identified. The type-1 waters showed peak Rrs in the blue band having low concentration of OAS. In type-2 and type-3 waters, peak Rrs was shifted to the longer wavelengths (560 and 570 nm for type-2 and 3 waters respectively) due to increase in concentration of OAS.

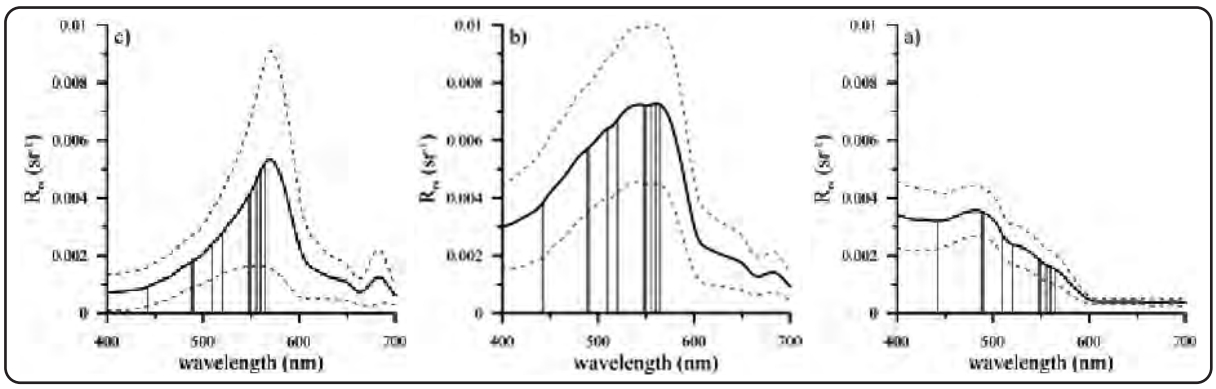


Figure 11.2: Spectral remote sensing reflectance (Rrs) in the waters off Kochi. Similar spectra were clubbed together as a) Type 1, b) Type-2 and c) Type-3. The solid line represents mean and the dotted line represents the standard deviation. The vertical bars indicate the wavelengths used in the empirical algorithms.

The assessment of six empirical algorithms for Chl-a (OC3C, OC4O, OC4, OC4E, OC3M and OCMO2) showed that OC3M and OC4 performed better. Further, in the case wherein the Chl-a concentration was more than 1.0 mg-m^{-3}, it was found that the ratio of 488/510/520 nm to 547/550/555/560/565 nm dominates. The assessment of algorithms in different water types indicated better performance of all the algorithms in type-1 waters. However the performance was poor in type-2 and 3 waters which could be attributed to the significant covariance of Chl-a with CDOM.

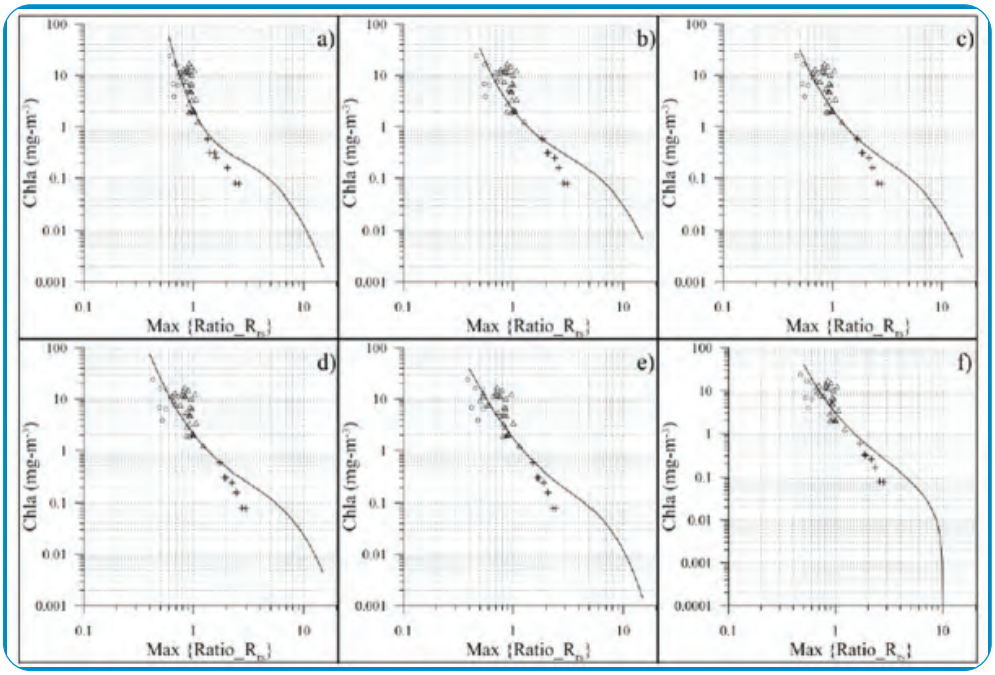


Figure 11.3: Plot showing the function (solid line) for the algorithms a) OC3C, b) OC4O, c) OC4, d) OC4E, e) OC3M and f) OC4O2 algorithms. The in situ measured Chl-a corresponding to the maximum ratio of Rrs has been overlaid for different water types. The plus (+) sign corresponds to Type-1, open triangle (Δ) corresponds to Type-2 and open circles (○) corresponds to Type-3 waters.

11.3. Evaluation of chlorophyll derived from MODIS using empirical (OC3M) and semi-analytical (GSM & GIOP) algorithms

The eastern Arabian Sea coastal shelf is influenced by river run-off and winter convection in the north and the monsoonal upwelling in the south. Bio-optical parameters were measured along this coastal area from March 2009 to June 2011 to characterise the optical water type and to validate three chlorophyll_a (Chl-a) algorithms as applied to Moderate Resolution Imaging Spectro radiometer on Aqua (MODIS-Aqua) data. The north and south sections of the coast were dominated by Total Suspended Matter (TSM), Coloured Dissolved Organic Matter (CDOM) and Chl-a for most of the year. The central section, that represents a transition between winter convection and coastal upwelling, was dominated by TSM and CDOM.

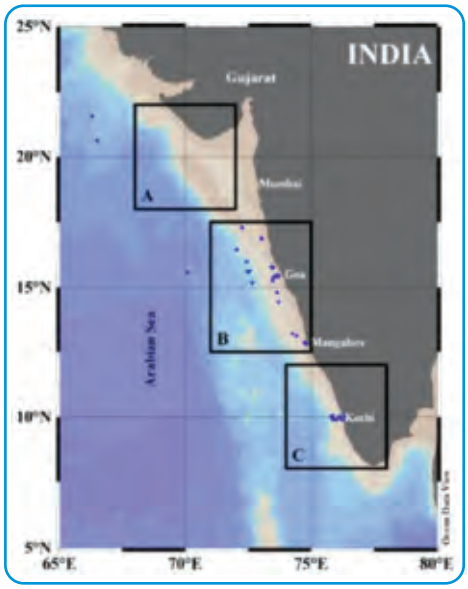


Figure 11.4: Maps of study area; left hand map gives all in situ stations and right hand map shows satellite match-up sampling stations. The boxes show the region for time-series analysis.

Ocean Colour 3 band ratio (OC3M), Garver-Siegel-Maritorena Model (GSM) and Generalized Inherent Optical Property (GIOP) Chl-a algorithms were evaluated against in situ measurements. The errors in the estimation of Chl-a using OC3M, GSM and GIOP in all regions were 11%, 24% and 55% respectively. OC3M was less affected by errors in remote sensing reflectance Rrs and by spectral variations in absorption by CDOM and TSM compared to the other algorithms. OC3M currently provides the most accurate Chl-a estimates for the eastern Arabian Sea coastal waters.

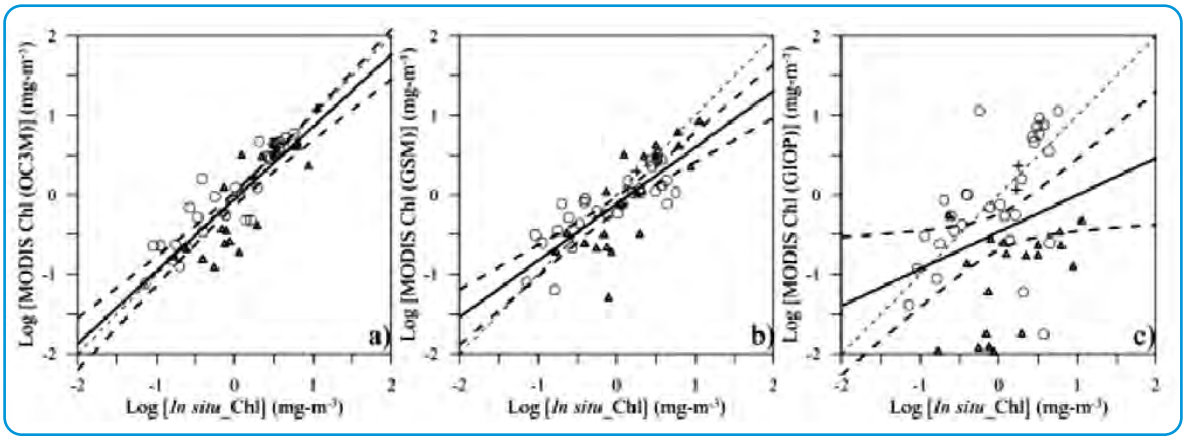


Figure 11.5: Scatter plot showing the relation between logarithm of in situ measured and MODIS Aqua derived Chl-a using a) OC3M, b) GSM and c) GIOP algorithm. Crosses are for North eastern coastal Region ('A'), closed circles are Central coastal Region ('B') and open triangles are South eastern coastal Region ('C'). The dotted line is the 1:1, solid line is regression line and dashed lines are 95% confidence limits.

11.4. Time-series analysis of chlorophyll-a derived from MODIS-aqua using OC3M and GSM algorithm

A nine year Chl-a time series from 2002 to 2011 was generated to assess the regional differences between OC3M and GSM in relation to the effects of CDOM, TSM and atmospheric correction errors on the algorithms. In the north-eastern coastal area (Region A) the maximum concentration of Chl-a occurred during December to February and lower concentrations occurred during the monsoon months in July and August. In this region, GSM consistently gave a higher Chl-a (0.14-12.75 mg m^{-3}) compared to OC3M (0.24-4.60 mg m^{-3}), especially during the winter in all years except 2008 and 2010. OC3M Chl-a however, was closest to the in situ data. In Region 'B', both algorithms indicated the maximum Chl-a in June, with the highest in 2005. OC3M yielded slightly higher Chl-a (0.18-2.76 mg m^{-3}) compared to GSM (0.08-1.98 mg m^{-3}), but in January 2007 and July 2010 GSM yielded higher values than OC3M. Again OC3M estimates were closest to the in situ Chl-a values though they were consistently under-estimated. In Region C in the south-east, both algorithms showed the same temporal pattern, with lower estimates of Chl-a during the winter months and high estimates during the monsoon months.

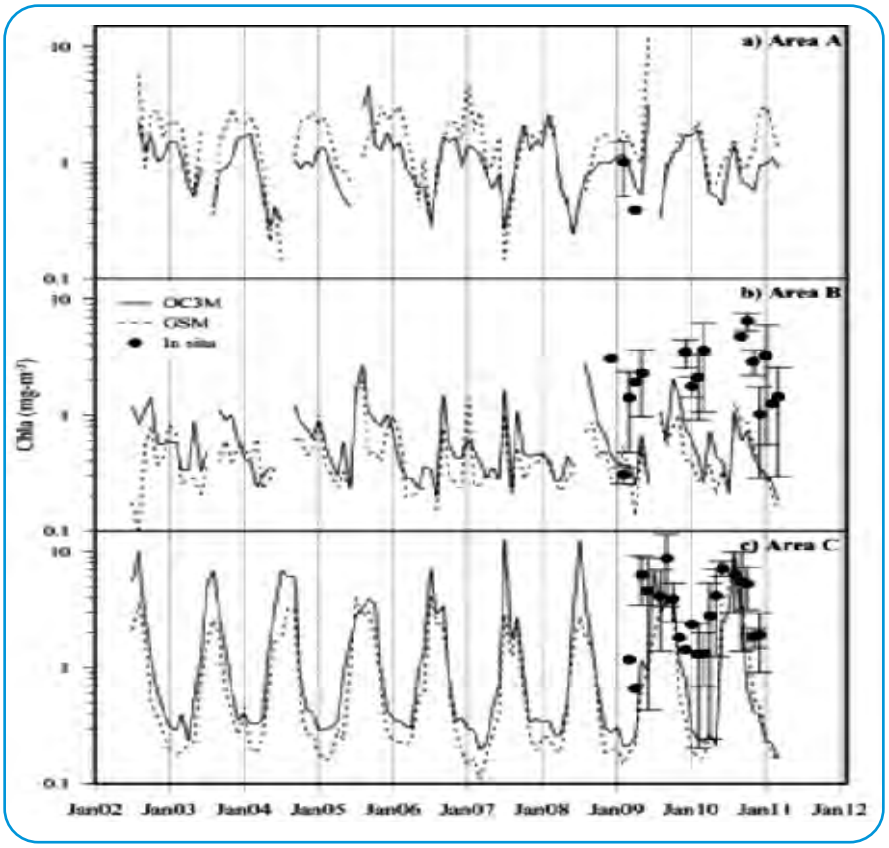


Figure 11.6: Monthly mean Chl-a time series generated from MODIS-Aqua from coastal region a) 18-22 °N and 68-72 °E, b) 12.5-17.5 °N and 71-75 °E and c) 8-12 °N and 74-78 °E. The solid line is for Chl-a generated using OC3M algorithm and the dotted line is for Chl-a generated using GSM algorithm. The filled circles are monthly mean in situ Chl-a and the vertical bars indicate the standard deviation.

11.5. Data availability from SATCORE program

A valuable data set of physical, optical and bio-geo-chemical was generated from the SATCORE programme for the period from 2008 - 2013. The measured parameters include: Chlorophyll_a (Chl-a), Coloured Dissolved Organic Matter (CDOM), Total Suspended Matter (TSM), Inherent Optical Properties (IOP) including absorption and scattering coefficients, Apparent Optical Properties (AOP) measured using a hyperspectral radiometer, measurement using the Conductivity-Temperature-Depth (CTD) instrument, Nutrients, Aerosol Optical Thickness (AOT) and Meteorological parameters (Met) measured using Autonomous Weather Station (AWS). The data was contributed by T. Suresh, NIO-Goa (TSU), H. B. Menon, Goa University (HBM), B. R. Raghavan (BRR), Mangalore University, P. Muhamed Ashraf, CIFT-Kochi (PMA), S. T. Balasubramanian, Annamalai University (STB), Nittla Sarma, Andhra University (NSS), K. Gopala Reddy(KGR)and K. C. Sahu, Berhampur University (KCS).

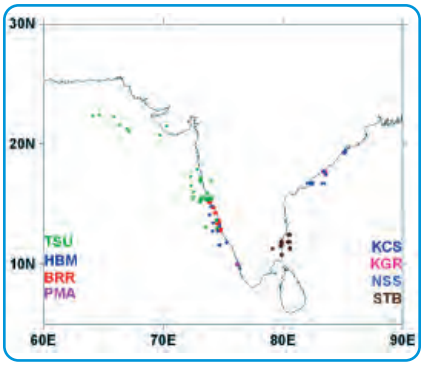


Figure 11.7: Schematic showing the sampling locations at which the data was generated as a part of SATCORE programme by project associates: T. Suresh, NIO-Goa (TSU), H. B. Menon, Goa University (HBM), B. R. Raghavan (BRR),Mangalore University P. Muhamed Ashraf, CIFT-Kochi (PMA), S. T. Balasubramanian, Annamalai University (STB), Nittla Sarma, Andhra University (NSS), K. Gopala Reddy (KGR) and K. C. Sahu, Berhampur University (KCS).

Table 11.1: Count of the stations sampled at SATCORE time-series stations. The measurement includes: Chlorophyll_a (Chl-a), Coloured Dissolved Organic Matter (CDOM), Total Suspended Matter (TSM), Inherent Optical Properties (IOP) including absorption and scattering coefficients, Apparent Optical Properties (AOP) measured using hyperspectral radiometer, measurement using Conductivity-Temperature-Depth (CTD) instrument, Nutrients, Aerosol Optical Thickness (AOT) and Meteorological parameters (Met) measured using Autonomous Weather Station (AWS).

	HBM	TSU	BRR	PMA	STB	KGR	NSS	KCS
Chl	78	205	872	387	1451	230	1331	378
CDOM	78	163	153	205	0	130	1255	412
TSM	78	95	872	273	611	241	407	44
IOP	0	75	0	71	0	163	0	0
AOP	63	85	44	59	30	70	0	0
CTD	68	140	868	293	598	0	1073	0
DO	0	156	0	281	598	0	1391	409
Nutrient	0	0	233	367	590	0	1499	409
AOT	35	0	0	0	0	87	0	0
Met	0	0	532	0	0	0	0	0
Total Station	**78**	**123**	**543**	**293**	**671**	**119**	**394**	**79**

12. Research Highlights and Publications

One of the most important factors that contributes to the sustained growth of ESSO-INCOIS in the field of Operational Oceanography is the focused research and development activity which in turn translates to services. In addition to the in-house R&D programmes, ESSO-INCOIS also funds projects to the scientists at other institutions and universities.

Outcomes of the R & D activities are published in peer-reviewed journals. Scientists from ESSO-INCOIS published more than 40 research articles in the past one year period. Some of the published research is highlighted here.

12.1. Validation of model forcings using a ship-mounted AWS

A network of ship mounted Automatic Weather Stations (AWS) integrated with INSAT 3A and 3C were established on board the research vessels belonging to MoES, GSI and FSI for the continuous measurement of surface Met-ocean parameters. The data were used for the validation of the forcing parameters used to force the ocean models in Indian Ocean Forecasting System (INDOFOS). Preliminary validation and inter comparison of the analyzed products obtained from National Centre for Medium Range Weather Forecast (NCMRWF) and European Centre for Medium Range Weather Forecast (ECMWF) were carried out using an AWS mounted on board Oceanographic Research Vessel Sagar Nidhi when she made a cruise across three oceanic regimes viz. Tropical Indian Ocean (TIO), Extra Tropical Indian Ocean (ETIO) and Southern Ocean (SO). It was noticed that though the performance of the analyzed products from both atmospheric models are similar, the air temperature in Extra Tropical Indian Ocean and wind speed in the Southern Ocean from ECMWF are marginally better estimated.

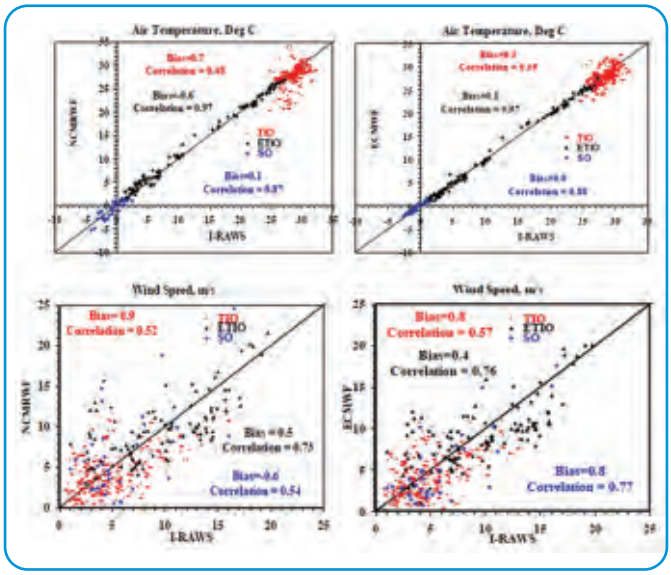


Figure 12.1: Scatter plots (NCMRWF vs. AWS; left panel ECMWF vs. AWS; right panel) of Air temperature and wind speed separately for each oceanic regime. The bias and correlation derived from 6 hourly collocated data are also shown. The black line shown diagonally across the figures indicates a perfect matching.

12.2. A comparison of Argo-derived sea surface temperature with satellite microwave sensor derived sea surface temperature in tropical Indian Ocean

The in situ and satellite based microwave sensor derived sea surface temperatures (SST) were compared in the Tropical Indian Ocean (TIO) for the period January 2009 – December 2010. The temperature measured by the Argo profiling floats at ~ 5 m was considered as the in-situ SST. The in situ data was used to produce the weekly gridded maps at 0.25° × 0.25° spatial resolution using Data-Interpolating Variational Analysis (DIVA) method. The weekly Argo Sea Surface Temperature (ASST) was then compared with Tropical Rainfall Measuring Mission Microwave Imager (TMI) satellite-derived SST (TMISST) and also with the blended Optimum Interpolation Sea Surface Temperature (OISST) product. It is observed that the RMSDs (the Root Mean Square Differences) and bias between the products were less than 0.5 °C and 0.2 °C respectively.

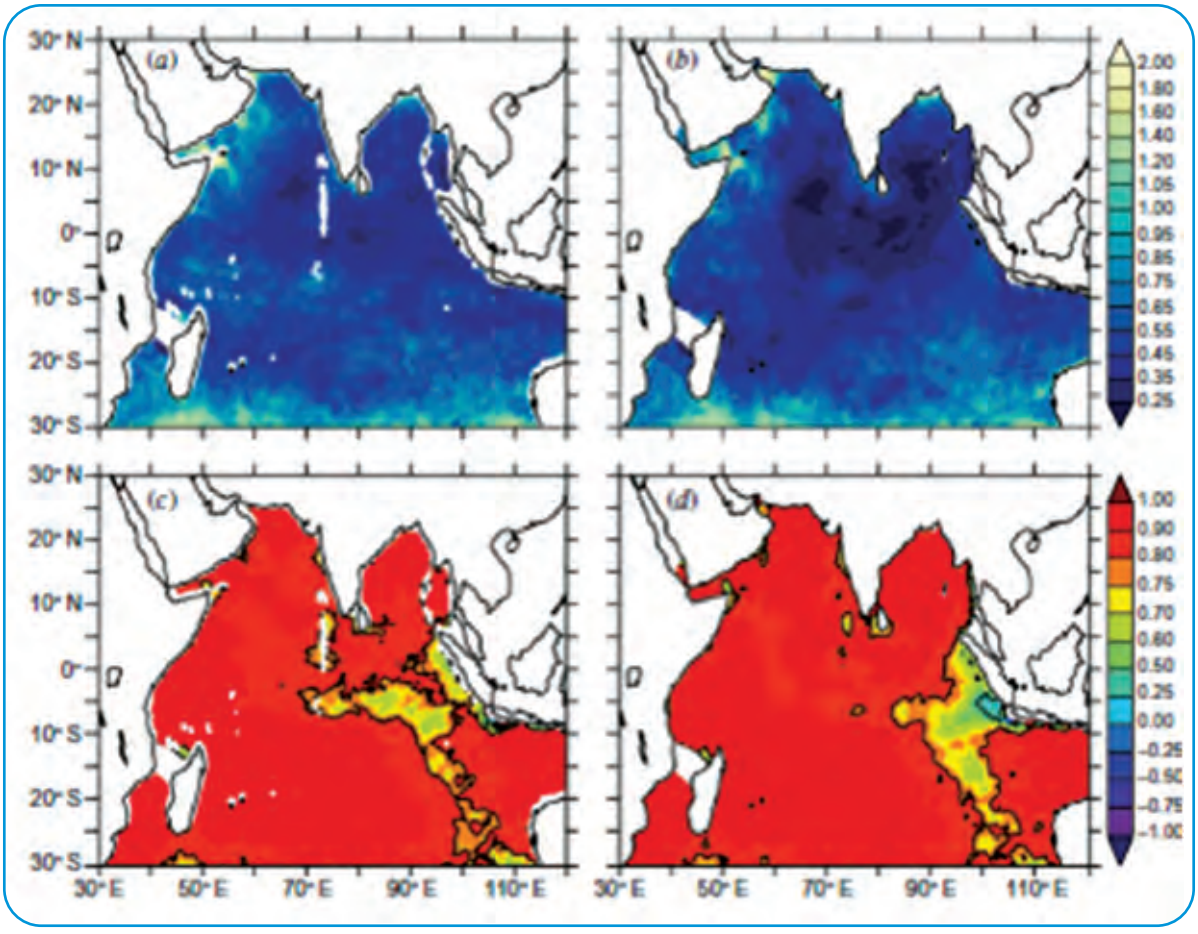


Figure 12.2: Spatial distribution of RMSE (Root Mean Square Error) between (a) ASST and TMISST (◦C) and (b) ASST and OISST (◦C). Correlation coefficient between (c) ASST and TMISST and (d) ASST and OISST. Area outside the line contours (thick black) in (c, d) indicates 95% confidence.

12.3. What could be the trends in chlorophyll-a concentration in the Arabian Sea?

One of the recent studies on satellite-derived Chlorophyll concentrations (Chl-a) in the western Arabian Sea (AS) has suggested an increasing trend [Goes et al., Science, 2005]. However, the only record that was used in that study to draw this conclusion is too short in length to resolve longer-term trends. Analysis of a long term record of satellite derived ocean colour data showed changing trends in the summer Chlorophyll in the western AS before and after 2003.

Chl-a concentration increased till 2003 but declined since then. This indicates a secular multi-year trend in Chl-a variability. However, this trend is not uniform over the entire region. Analysis of wind, Sea Surface Temperature (SST), Sea Level Anomaly (SLA) and thermocline depth, suggests that the declining summer monsoon chlorophyll-a (Chl-a) concentration may be due to the increasing SLA in this region.

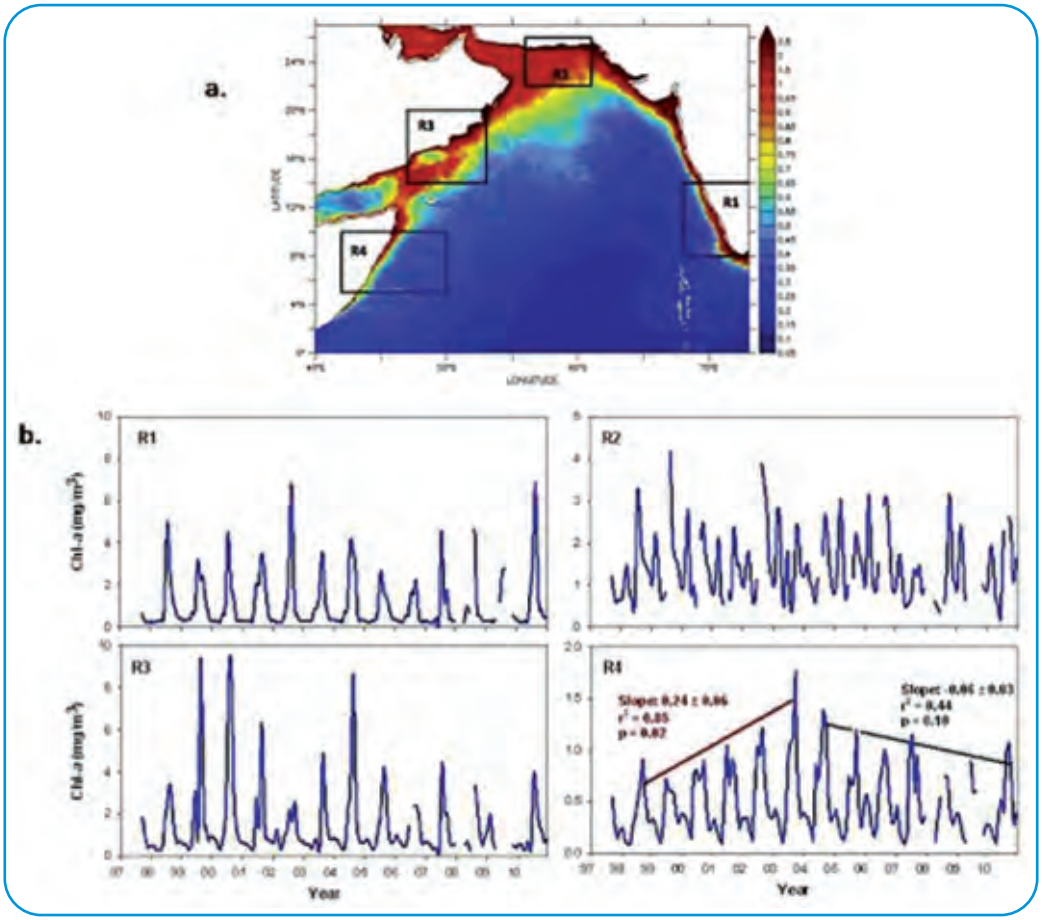


Figure 12.3 (a): Box shows the areal limit for regions R1 (73–78°E & 8–14°N), R2 (61–66°E & 22–26°N), R3 (52–58°E & 14–20°N) and R4 (47–55°E & 5–10°N). The base image shows composite (1998–2010) surface chlorophyll for the Arabian Sea basin. (b) Area averaged monthly time series of Chl-a for the region R1, R2, R3 and R4. The trend lines shown in R4 depict the increasing and decreasing trends during 1998–2003 and 2004–2010, respectively.

12.4. Feasibility of utilizing GHRSST product for operational generation of Potential Fishing Zone (PFZ) advisories.

The operational generation of Potential Fishing Zone (PFZ) advisories in India is limited by the availability of the satellite data during the cloudy days due to the inability of the passive sensors to see through the clouds. Microwave sensors cannot be used for the delineation of the Potential Fishing Zones due to their coarser resolution. Hence the possibility of utilising GHRSST, which is available on daily basis at 5 km spatial resolution was explored. The GHRSST product was examined to find out how many PFZ features are identifiable in that product and whether they match with features identified with the currently used high resolution SST products derived from NOAA-AVHRR / MODIS Aqua. Similarly, false features, if any identified, are also examined. It appeared that the OSTIA product is suitable for operational generation of PFZ advisories with certain limitations. While delineating the fishing zones, care must be taken to identify only the large sized features.

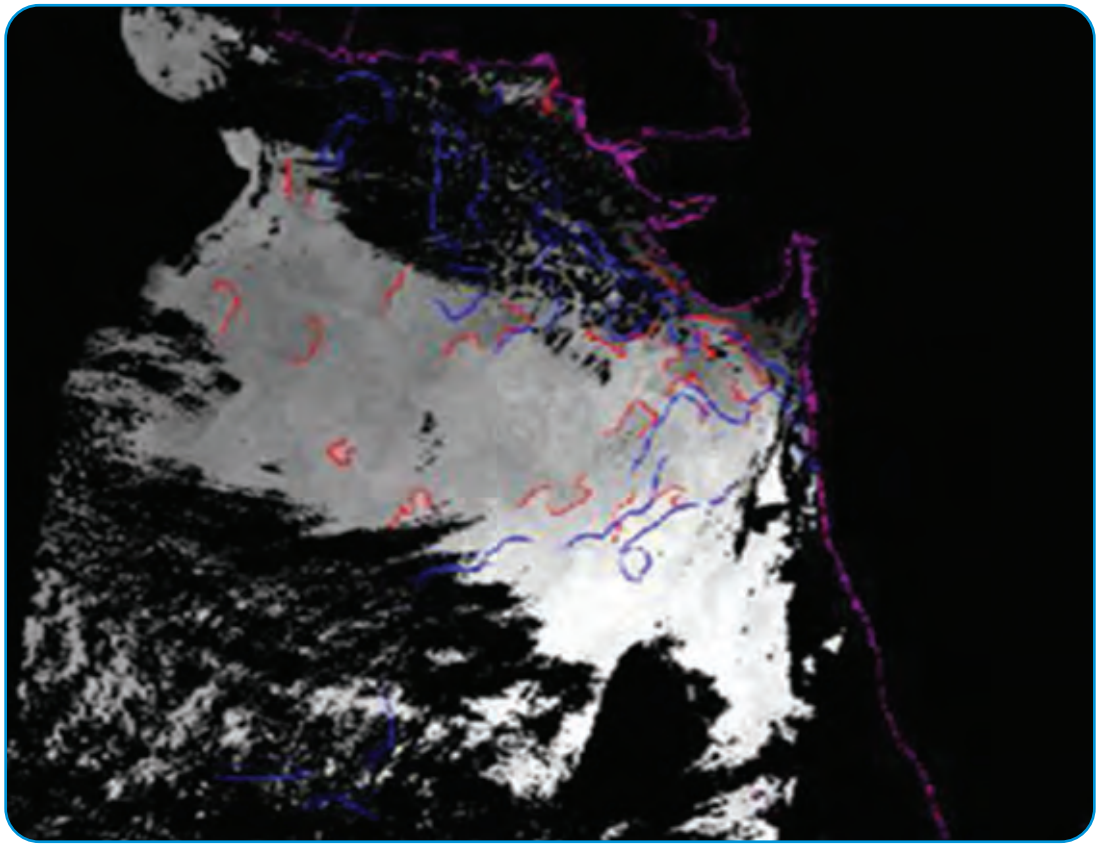


Figure 12.4: PFZ lines delineated from SST Images of NOAA-AVHRR and GHRSST; NOAA-AVHRR derived SST (Background) of Jun 3rd, 2008.
[**Thick Navy Blue lines:** PFZ lines drawn using GHRSST
Thin Red lines: PFZ lines drawn using NOAA AVHRR SST
Thin Purple Marking: Indian Coastline
Matched GHRSST Features: 08 (38%)
Non-existing GHRSST in NOAA: 02 (20%)]

12.5. Research Publishing Performance

There was a growth in Publications as seen graphically :

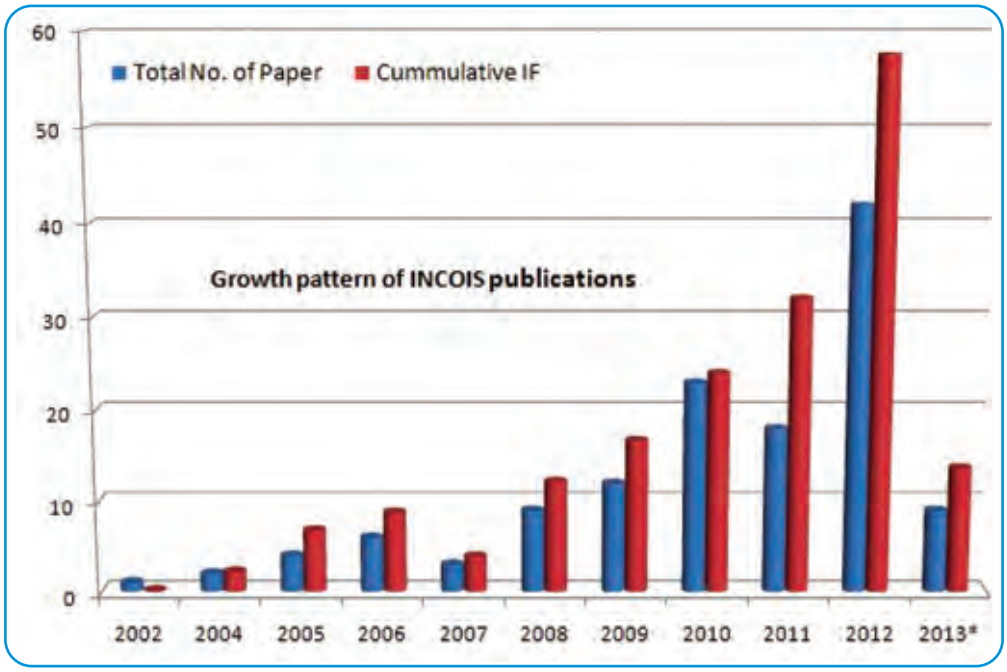


Figure 12.5: Variation of number of publication and cumulative impact factor of INCOIS publications.

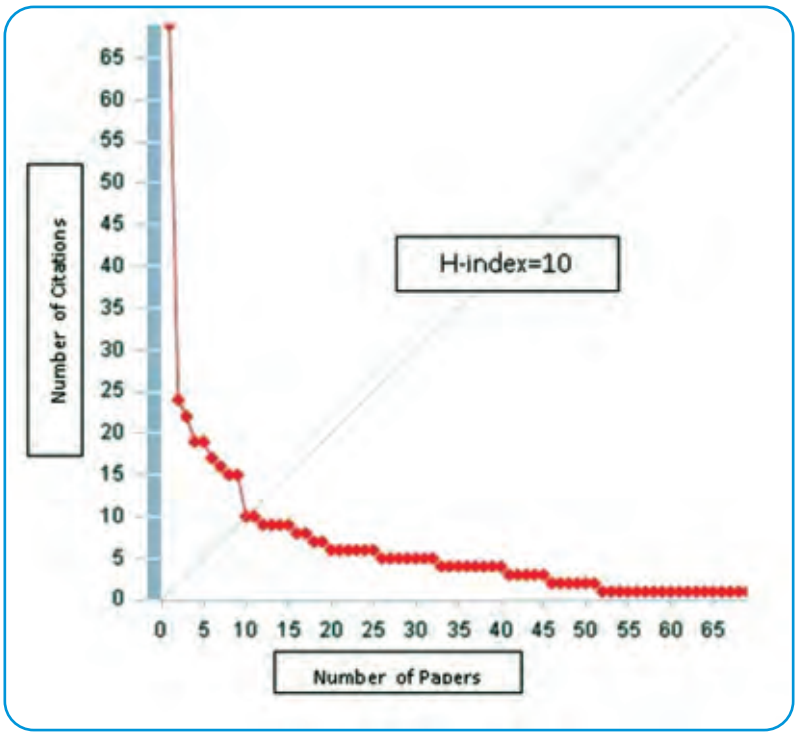


Figure 12.6: Distribution of number of citations vs. number of publications.

12.6. List of Publications during (April 2012-March 2013)

1. Amol, P., D. Shankar, S. G. Aparna, S. S. C. Shenoi, V. Fernando, S. R. Shetye, a. Mukherjee, Y. Agarvadekar, S. Khalap, and N. P. Satelkar (2012), Observational evidence from direct current measurements for propagation of remotely forced waves on the shelf off the west coast of India, Journal of Geophysical Research, 117 (C5), C05017.

2. Chacko, N., M. Ravichandran, R. R. Rao, and S. S. C. Shenoi (2012), An anomalous cooling event observed in the Bay of Bengal during June 2009, Ocean Dynamics, 62 (5), pp.671-681.
Chakraborty, K., S.Haldar, and T.K. Kar (2013), Global stability and bifurcation analysis of a delay induced prey-predator system with stage structure, Nonlinear Dynamics, pp. 1-19.

3. Chakraborty, K., K. Das, and T. K. Kar (2013), Combined harvesting of a stage structured prey-predator model incorporating cannibalism in competitive environment, Comptes Rendus Biologies, 336 (1), pp.34-45.

4. Chakraborty, K., and T.K. Kar (2012), Economic perspective of marine reserves in fisheries: A bioeconomic model, Mathematical Biosciences, 240 (2), pp.212-222.

5. Chakraborty, K., S. Jana, and T.K. Kar, (2012), Global dynamics and bifurcation in a stage structured prey-predator fishery model with harvesting, Applied Mathematics and Computation, 218 (18), pp. 9271-9290.

6. Chatterjee, A., D. Shankar, S. S. C. Shenoi, G. V Reddy, and G. S. Michael (2012), A new atlas of temperature and salinity for the North Indian Ocean, Journal of Earth System Science, 121 (3), pp.559-593.

7. Chiranjivi, J., T.V.S. Udaya Bhaskar, K.A.Joseph, and A.N. Balchand (2012), Application of satellite products to study upwelling, chlorophyll and mixed layer depth of southeastern of Arabian sea, International Journal of Ocean and Climate Systems, 3 (2), pp.97-108.

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9. Chopra, S., D. Kumar, B. K. Rastogi, P. Choudhury, and R. B. S. Yadav (2012), Estimation of seismic hazard in Gujarat region, India, Natural Hazards, 65 (2), pp. 1157-1178.

10. Chopra, S., D. Kumar, P. Choudhury, and R. B. S. Yadav (2012), Stochastic finite fault modelling of M w 4.8 earthquake in Kachchh, Gujarat, India, Journal of Seismology, 16 (3).

11. Devi, E.U., and S.S.C. Shenoi, (2012), Tsunami and the effects on coastal morphology and ecosystems: A report, Proceedings of the Indian National Science Academy, 78 (3), pp. 513-521.

12. Girishkumar, M. S., M. Ravichandran, and V.Pant (2012), Observed chlorophyll-a bloom in the southern Bay of Bengal during winter 2006–2007, International Journal of Remote Sensing, 33 (4), 1264-1275.

13. Glejin, J., V. S. Kumar, T. M. B. Nair, J. Singh, and P. Mehra (2013), Observational Evidence of Summer Shamal Swells along the West Coast of India, Journal of Atmospheric and Oceanic Technology, 30 (2), pp. 379-388.

14. Harikumar, R., S. Sampath, and V. Sasi Kumar (2012), Altitudinal and temporal evolution of raindrop size distribution observed over a tropical station using a K-band radar, International Journal of Remote Sensing, 33 (10), pp. 3286-3300.

15. Harikumar, R., T. M. Balakrishnan Nair, G. S. Bhat, S. Nayak, V. S. Reddem, and S. S. C. Shenoi (2013), Ship-Mounted Real-Time Surface Observational System on board Indian Vessels for Validation and Refinement of Model Forcing Fields, Journal of Atmospheric and Oceanic Technology, 30 (3), pp. 626-637.

16. Jana, S., M. Chakraborty, K. Chakraborty, and T.K. Kar, (2012), Global stability and bifurcation of time delayed prey-predator system incorporating prey refuge, Mathematics and Computers in Simulation, 85, pp. 57-77.

17. Joseph, A., P. Rivankar, and T.M. Balakrishnan Nair, (2012), Study of wind speed attenuation at Kavaratti Island using land-based, offshore, and satellite measurements Proceedings of SPIE - The International Society for Optical Engineering, 8372, 837217.

18. Joseph, S., A. J. Wallcraft, T. G. Jensen, M. Ravichandran, S. S. C. Shenoi, and S. Nayak (2012), Weakening of spring Wyrtki jets in the Indian Ocean during 2006–2011, Journal of Geophysical Research, 117 (C4), C04012.

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20. Kumar, T. S., S. Nayak, C. P. Kumar, R. B. S. Yadav, B. A. Kumar, M. V Sunanda, E. U. Devi, N. K. Kumar, S. A. Kishore, and S. S. C. Shenoi (2012), Successful monitoring of the 11 April 2012 tsunami off the coast of Sumatra by Indian Tsunami Early Warning Centre, Current Science, 102 (11), p.1519.

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23. Nagamani, P. V, M. M. Ali, G. J. Goni, D. N. Pedro, J. C. Pezzullo, and T. V. S. U. Bhaskar (2012), Validation of satellite-derived tropical cyclone heat potential with in situ observations in the North Indian Ocean, Remote Sensing Letters, 3 (7), pp. 615-620.

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26. Pokhrel, S., H. Rahaman, A. Parekh, S. K. Saha, A. Dhakate, H. S. Chaudhari, and R. M. Gairola (2012), Evaporation-precipitation variability over Indian Ocean and its assessment in NCEP Climate Forecast System (CFSv2), Climate Dynamics, 39 (9-10), pp.2585-2608.

27. Prakash, S., T. M. B. Nair, T. V. S. U. Bhaskar, P. Prakash, and D. Gilbert (2012), Oxycline variability in the central Arabian Sea: An Argo-oxygen study, Journal of Sea Research, 71, pp. 1-8.

28. Prakash, P., S. Prakash, H. Rahaman, M. Ravichandran, and S. Nayak (2012), Is the trend in chlorophyll- a in the Arabian Sea decreasing◦, Geophysical Research Letters, 39 (23), L23605.

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39. Udaya Bhaskar, T. V. S., E. P. Rama Rao, R. Venkat Seshu, R. Devender (2012), A Note on Three Way Quality Control of Argo Temperature and Salinity Profiles - A Semi-Automated Approach at INCOIS, International Journal of Earth Sciences and Engineering, 05 (06), pp.1510-1514.

40. Yadav, R. B. S., T. M. Tsapanos, Y. Bayrak, and G. C. Koravos (2012), Probabilistic Appraisal of Earthquake Hazard Parameters Deduced from a Bayesian Approach in the Northwest Frontier of the Himalayas, Pure and Applied Geophysics, 170 (3), pp. 283-297.

41. Yadav, R. B. S., J. N. Tripathi, and T. S. Kumar (2012), Probabilistic Assessment of Tsunami Recurrence in the Indian Ocean, Pure and Applied Geophysics, 170 (3), pp. 373-389.

42. Yadav, R. B. S., Y. Bayrak, J. N. Tripathi, S. Chopra, A. P. Singh, and E. Bayrak (2012), A Probabilistic Assessment of Earthquake Hazard Parameters in NW Himalaya and the Adjoining Regions, Pure and Applied Geophysics, 169 (9), pp. 1619-1639.

43. Yadav, R. B. S., Y. Bayrak, J. N. Tripathi, S. Chopra, and E. Bayrak (2012), Regional variation of the ω upper bound magnitude of GIII distribution in Hindukush-Pamir Himalaya and the adjacent regions: A perspective on earthquake hazard, Tectonophysics, 544-545, pp. 1-12.

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12.7. Technical Reports /Atlas

* "Identification of wind potential zones in western offshore field of ONGC" by R. Harikumar, T.M. Balakrishnan Nair and S.S.C. Shenoi, Report No. INCOIS-ISG-TR-2012-08, September, 2012.

* "A three way semi-automated approach for quality control of Argo temperature and salinity profiles" T.V.S Udaya Bhaskar, E Pattabhi Rama Rao, Venkat Seshu R and R. Devender, Report No. INCOIS-DMG-TR-2012-07, August, 2012.

* Study of waters of the Goa coast on significant wave heights up to a distance of 12 Nautical miles to enable extension/fixation of I V Limits. Report No. INCOIS-ISG-TR-2012-05.

* "Mock Tsunami drill (IOWave11)" Sunanda M.V, T. Srinivasa Kumar, Ch. Patanjali Kumar, B. Ajay Kumar, E. Uma Devi, J. Padmanabham, N. Kiran Kumar, Pradeep Kumar M, INCOIS Technical reports, INCOIS-ASG-TR-2012-04 , April, 2012.

* "Validation of 0.25 x 0.25 Indian Ocean HYCOM" Sudheer Joseph and M. Ravichandran, Report No. INCOIS-DMG-TR-2012-03, May, 2012.

* Atlas of Mixed Layer and Sonic Layer Depth of Indian Ocean (July, 2012) T.V.S Udaya Bhaskar, E Pattabhi Rama Rao, Geetha G, M Ravichandran Atlas No. INCOIS-DMG-ATLAS-2012-06.

13. Information Technology Capability and Building Infrastructure:

13.1. Computing Infrastructure

ESSO-INCOIS continued to maintain a computing and network infrastructure with an up-time of 99% to support the operational and R&D projects. The computer infrastructure includes Link Load balancers, Application load balancers, firewalls, core switches, edge switches, 30 km long campus-wide networking, a high performance computer facility and its allied infrastructure which includes a processor cooling system, precision air conditioning units, uninterrupted power supply units,a redundant computer facility, a 300 TB storage facility, Enterprise Resource Planning servers, a File Transfer Protocol server, web & application servers, Live Access Server, workstations, desktops and laptops. The network and the infrastructure is set up in such a manner so that no single point of failure can affect the operational services at ESSO-INCOIS. Office automation was achieved using SAP (Systems, Application and Products). Some of the modules like Purchase and Stores, Finance and Accounts etc. are already made operational. The Human Resources module and Employ Self Service module also will be made operational soon.

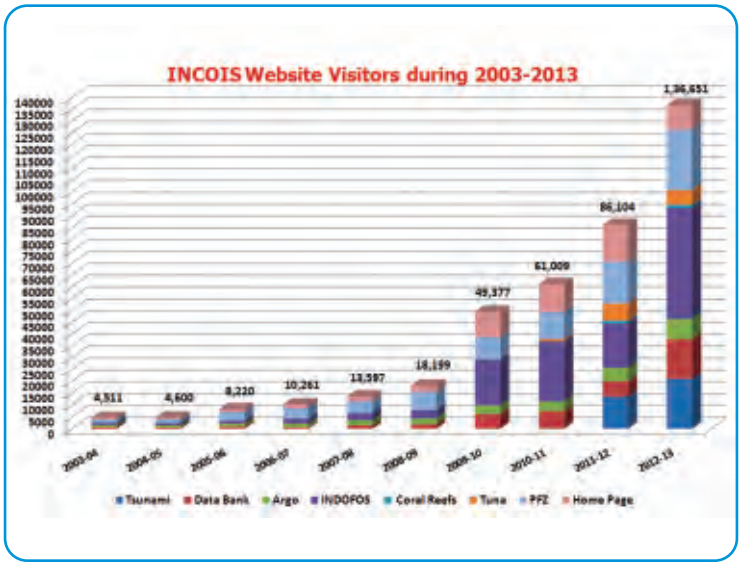

Figure 13.1: Statistics of INCOIS website visitors for the period 2003-2013.

13.2. Web based services

The Web Team of ESSO-INCOIS designs, develops and implements web applications for the dissemination of various the services and products. The following new applications were developed and implemented during the year.

1. Displaying Ocean State Forecasts for Maldives, Kerala (in Malayalam), Tamil Nadu (in Tamil), and Maharashtra (in Marathi).
2. Web application for displaying Argo floats in the Exclusive Economic Zone.
3. Uploading INDOFOS-High Wave Alerts Information from the OSF Lab and publishing through the ESSO-INCOIS web-site operationally.

4. Automated comparison of data from Wave Rider Buoys and Moored Buoys with Ocean State forecasts in real time.
5. Display of HYCOM products and their validation.
6. Display of news clippings. Coastal Vulnerability Atlas of India on web
7. Design and development of PORSEC web page.

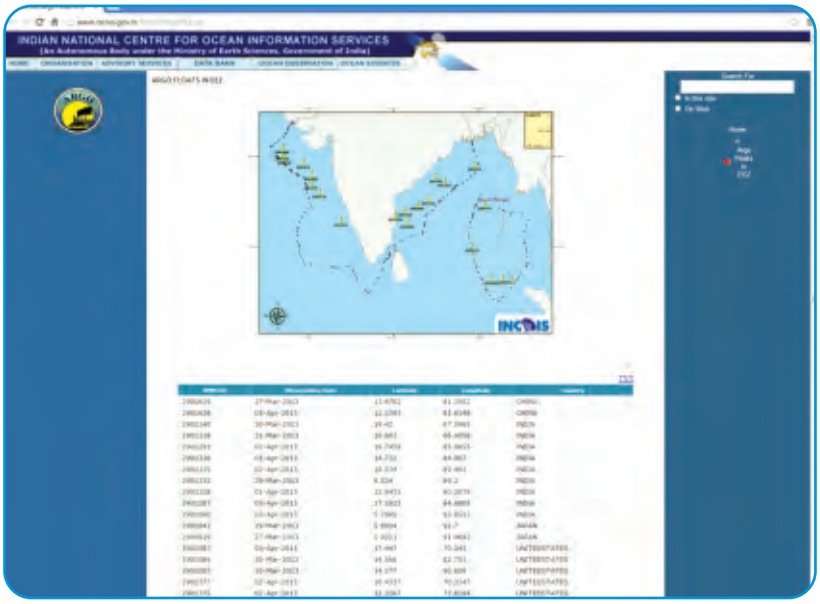

Figure 13.2: Web application for the display of Argo floats in EEZ.

13.3. Building Infrastructure

ESSO-INCOIS is in the process of expanding its building infrastructure. The new construction work that includes 5500 m^2 of the vertical extension of main building, construction of amenities building of 665 m^2, Guest house 3200 m^2, a multipurpose hall (650 m^2) and staff quarters of 4500 m^2 is progressing well.

Figure 13.3: Expansion of ESSO-INCOIS building infrastructure in progress.

14. Seminar/Symposia/Meetings/Conference/ Workshops

14.1. The Pan Ocean Remote Sensing Conference (PORSEC) 2012

ESSO-INCOIS hosted the biennial Pan Ocean Remote Sensing Conference (PORSEC) - 2012 held in Kochi, India, during 5th-9th November 2012. The event was rich and diverse with the attendance of 544 participants, including 200 students, from 19 countries. 275 research papers and 78 posters spread over 25 technical sessions were presented during the conference. Dr. K. Radhakrishnan, Secretary Department of Space and Chairman, Indian Space Research Organisation inaugurated the conference in the presence of Dr. Shailesh Nayak, Secretary, Ministry of Earth Sciences, and Chairman, Earth System Science Organisation. The dignitaries highlighted the plans of Government of India in ensuring the continuity of remote sensing data through the launch of remote sensing satellites dedicated to ocean research and monitoring. They also highlighted the need for international collaboration in utilizing the remote sensing data for the benefit of society. Dr. Jim Gower, President of the PORSEC association reminded the delegates about the dangers of global warming and necessity of utilizing remote sensing technology to understand the warming trends and possible mitigation. The plenary talks delivered by Dr. R. Navalgund, Dr. Shuba Satyendranath, Dr. S.R. Shetye, Dr. Timothy Liu, Dr. Toshio Yamagata and Dr. R. Krishnan attracted much attention and interest. The Ministry of Earth Science (MoES), Indian Space Research Organization (ISRO), Department of Science and Technology (DST), Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR), Indian Institute of Tropical Meteorology, National Institute of Ocean Technology, National Centre for Antarctic and Ocean Research, State Bank of India, Andhra Bank, IBM, Sea Space, ONGC, Office of Naval Research (USA), and ESRI, India sponsored the conference at various levels.

A pre-conference tutorial was also organised prior to the conference at CIFT, Kochi. The major focus of the tutorial was on Ocean Colour Remote Sensing and Active Microwave Remote Sensing. The tutorial included classroom sessions, laboratory sessions, field trips and hands on data processing of Ocean Colour, Scatterometer, Altimeter and Synthetic Aperture Radar (SAR). The pre-conference training was attended by 31 participants selected from 8 countries. The trainees also carried out mini projects focusing on the topics covered during the tutorial.

Figure 7.1: Inauguration of PORSEC-2012 by Dr. K. Radhakrishnan, Chairman, ISRO and Dr. Sailesh Nayak, Secretery MoES.

Figure 7.2: From the pre-conference tutorial.

14.2. NOAA-MoES workshop on "Development of Predictive Capabilities on Marine Fisheries and Harmful Algal Blooms in Indian Seas"

The Ministry of Earth Sciences (MOES), India and the National Oceanic and Atmospheric Administration (NOAA), USA has an active Memorandum of Understanding (MOU) for bilateral cooperation in the areas of atmospheric and ocean science. Under this MoU, a workshop was conducted involving scientists from India (ESSO-INCOIS, CMLRE, CMFRI, ICMAM, NIO) and USA(NWFSC, University of Maine, SWFSC, University of Washington) to expand the cooperation on marine living resource science; particularly, the science of predicting fluctuations in the abundance and distribution of small pelagic fishes in upwelling systems and forecasting of HABs. ESSO-INCOIS hosted this workshop in Hyderabad during 11th-14th February 2013. The workshop explored the types of research needed for the implementation of short-term prediction of pelagic fish namely, Sardines, Mackerel and Anchovies in the southern Arabian Sea and to develop a HAB monitoring and forecasting system for the Indian EEZ. The workshop formulated future plans and suggested to sign an IA between MoES and NOAA to facilitate the cooperative work in these areas.

Figure 7.3: Participants of NOAA-MoES workshop on "Development of Predictive Capabilities on Marine Fisheries and Harmful Algal Blooms in Indian Seas".

14.3. 13th Argo Data Management Team (ADMT) meeting

13th Argo Data Management Team (ADMT) meeting was hosted by ESSO Indian National Centre for Ocean Information Services (ESSO-INCOIS), Hyderabad, during November 12th – 16th November 2012. As many as 50 participants from 12 different countries representing their DAC and Global Data Assembly Centres (GDAC) participated in the meeting. The first two days of the meeting were devoted for the bio-Argo related issues and the rest of the three days were devoted to discuss the data management related issues.

14.4. 14th Foundation day of ESSO-INCOIS

ESSO-INCOIS celebrated the 14th Foundation Day on 3rd February 2013. Dr Ch. Mohan Rao, Director, CCMB-CSIR, Hyderabad delivered the Foundation Lecture on the topic "Current excitement in modern biology and medicine". In connection with the foundation day celebrations, an open-house was arranged. Nearly 300 students from different schools in Hyderabad visited ESSO-INCOIS on this occasion. Students were given a tour of ESSO-INCOIS labs where PFZ and OSF services are being generated. They also visited the HPC facility, Tsunami Warning Centre and Satellite Data Reception Station. A short film on ESSO-INCOIS was also screened at Auditorium to provide information on ESSO-INCOIS services.

Figure 7.4: Photographs from the ESSO-INCOIS Foundation day activities.

14.5. Symposia and Lectures at ESSO- INCOIS:

1. Prof. Eric D' Asaro and Dr. Craig Lee from Applied Physics Laboratory, University of Washington, USA delivered a talk on "Autonomous Physical, Chemical and Biological Measurements in the North Atlantic Bloom" on 27th February 2013.

2. Dr. Ch. Mohan Rao, Director, CCMB-CSIR, Hyderabad delivered the Foundation day Lecture on "Current excitement in modern biology and medicine" on 3rd February 2013 on the eve of 14th ESSO-INCOIS foundation day.

3. Prof. Toshio Yamagata, Director, Application Laboratory, JAMSTEC, Japan delivered a talk on "An Oceanographic History leading to JCOPE" on 14th November 2012.

4. Prof. Julian P. McCreary, Jr. Professor of Oceanography, IPRC, Hawaii, USA delivered a talk on "Dynamics of the oxygen minimum zones in the North Indian Ocean" on 12th October 2012.

5. Dr. Venu Ittekkot, Goethe-Institute, Germany delivered a talk on "Capacity Building and Higher Education related to Global Change Issues" on 9th July 2012.

6. Prof. Raghu Murtugudde, University of Maryland, USA, delivered series of a lectures on physical, dynamic and biological oceanography during 4th - 15th June 2012.

7. Dr. StephaneSaux-Picart, Plymouth Marine Laboratory, UK has delivered a talk on "Primary Production & Model Validation" on 16th November 2012.

Figure 7.5: Lectures/Seminars given by distinguished visitors at ESSO-INCOIS: (clockwise from left, Prof. Raghu Murtugudde, Dr. Venu Ittekkot , Prof. Eric D' Asaro, Dr. Ch. Mohan Rao, Prof. Toshio Yamagata, Prof. Julian McCreary).

15. International Interface

15.1. SIBER (Sustained Indian Ocean Biogeochemistry and Ecosystem Research) International Programme Office

Since its inception in 2010 the SIBER International Programme Office (IPO) functioning at ESSO-INCOIS made significant contributions to the SIBER community which includes logistical arrangements for holding annual Science Steering Committee (SSC) meetings, information sharing and maintenance of SIBER website hosted by ESSO-INCOIS. SIBER IPO also organizes the Executive Committee (group of selected SSC members) Meetings online wherein progress of SIBER is reviewed. During the year 2012-2013 IPO organized 4 SIBER executive committee meetings. This year the 3rd SSC meeting was held in Cape Town during 15th-17th October 2012.

15.2. IOGOOS (Indian Ocean-Global Ocean Observation System) Secretariat.

IOGOOS Secretariat, located at ESSO-INCOIS has been successfully coordinating IOGOOS activities including annual meetings and capacity building initiatives. The IOGOOS Ninth annual meeting was organized at Cape Town, South Africa during October 19th – 20th, 2012. At this meeting, major decisions were made in regard of restructuring the governance of IOGOOS. IOGOOS will now have three officers representing the Western Indian Ocean, the Northern Indian Ocean and the Eastern Indian Ocean. Two Additional Officer/Associate Officers will be nominated to represent the projects/sub-groups of IOGOOS. India continued to have an IOGOOS Officer representing the Northern Indian Ocean. Institute of Marine Science and Fisheries of Chittagong University, Bangladesh joined IOGOOS as a member.

IOGOOS Secretariat has the responsibility for (i) Maintenance of IOGOOS Membership details and their focal contacts (ii) Coordination and organisation of Annual meetings and General Body meetings that includes preparation of agenda in consultation with officers, mobilizing funds for organisation of meetings, preparation of annual meeting reports, notification of vacancies, maintenance of financial accounts of IOGOOS secretariat, etc. (iii) circulating the rules of procedures, etc. amended by the annual general body meetings, (iv) coordination with the subsidiary bodies under IOGOOS.

During the period April 2012 – June 2013, IOGOOS Secretariat has carried out the following:

1. IOGOOS Workshop and Ninth Annual meeting was organized at Cape Town, South Africa during October 19th – 20th, 2012. The IOGOOS Secretariat prepared the meeting agenda in consultation with the IOGOOS Chair and Officers, secured funds from UNESCO-IOC Perth Regional Programme Office (PRPO) for sponsoring the participation of 6 delegates at the meeting, coordinated the logistics with the sponsored delegates, coordinated with the local hosts for organization of the meeting, maintained the IOGOOS Statement of Expenditures, etc. The meeting report is under preparation.

2. Facilitated the nomination of Prof. Nic Bax, Stream Leader, Understanding Ocean Ecosystems, CSIRO, Australia as representative of IOGOOS to the Southern Indian Ocean Regional Workshop to facilitate the description of ecologically or biologically significant marine areas (EBSAs) held during July 30th – August 30th, 2012 at Mauritius.
3. Facilitated the approval of the New IOGOOS Membership by Institute of Marine Science and Fisheries of Chittagong University, Bangladesh during IOGOOS IX annual meeting.
4. Facilitated the election of New IOGOOS Officers against the vacant positions during IOGOOS IX annual meeting.
5. Put efforts in re-engaging several IOGOOS Members who were inactive for a long time and in updating their respective focal representatives to IOGOOS.
6. Coordinated with the Project Leaders of IOGOOS Coastal Projects on Project activities
7. Facilitated the nomination of Dr. Rezah Badal, IOGOOS Officer in the GOOS Africa Coordinating Committee Meeting held at Cape Town, South Africa during January 21st – 23rd, 2013.
8. Coordinated the tele-conferences of the IOGOOS Officers and IOGOOS Secretariat.
9. Participated in the IOC GOOS Office "Assessment Tool for GRAs". Completed the survey form "Outline of GRA Info" along with the Success Story of IOGOOS to IOC GOOS office/US IOOS Program Office.
10. Provided inputs on IOGOOS activities to GOOS Africa Coordinating Committee Meeting and to GOOS 6th Regional Forum meeting.
11. Provided a letter of support to Dr. Nick Hardman-Mountford who is making a proposal, in collaboration with Drs. M. Ravichandran and Wajih Naqvi, India, to the Australia-India Strategic Research Fund (Round 7) focusing on coordinated protocol development and deployment of bio-Argo floats in the Eastern Indian Ocean.
12. Coordinating with Head, Ocean Matter's Unit of Prime Minister's Office, Mauritius for organization of the IOGOOS X Annual meeting scheduled to be held at Port Louis, Mauritius during October 21st – 24th, 2013.
13. Coordinating with IOC PRPO and UNESCO Jakarta Office for mobilization of funds to the extent of USD 20000 for organization of the IOGOOS X Annual meeting.

15.3. International Society for Photogrammetry and Remote Sensing (ISPRS)

The International Society for Photogrammetry and Remote Sensing is a non-governmental organization devoted to the development of international co-operation for the advancement of photogrammetry and remote sensing and their applications.

E. Pattabhi Rama Rao, Head-DMG, ESSO-INCOIS has been selected as the Chair of the Working Group - IV/4 on Geospatial Data Infrastructure under the Technical Commission IV (Geospatial Databases and Location Based Services) for the inter-sessional period 2012-16.

T. Srinivasa Kumar, Head-ISG, ESSO-INCOIS has been selected as the Chair of the Working Group-VIII/1 on Disaster and Risk Reduction under the Technical Commission VIII (Remote Sensing Applications and Policies) for the inter-sessional period 2012-16.

15.4. Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)

RIMES operates from the regional early warning center located at the campus of the Asian Institute of Technology in Pathumthani, Thailand and is an international, intergovernmental and non-profit-making entity established on 30th April 2009, registered with the United Nations since 1st July 2009, aiming to provide regional early warning services and build the capacity of its Member States in the end-to-end early warning of tsunami and hydro-meteorological hazards.

As per MOU between MoES, Govt. of India and RIMES for provision of forecast services to the RIMES member countries, Ocean State Forecast services of ESSO-INCOIS, Hyderabad, has now been extended to the Maldives Islands in the Indian Ocean from March 8th, 2013 on a daily operational mode.

Additionally in the international RIMES project, "Strengthening real-time ocean observation systems in Indian Ocean countries for ocean forecast services-Phase 1 Maldives" in which ESSO-INCIS will be a participant, commencing in June 2013, it is proposed to setup an observational system to validate the forecast and monitor the seas around this Island nation. Setting up this ocean forecasting and observation system along the coasts of Indian Ocean countries, our capabilities to forecast offshore events around us also will be strengthened as many ocean hazards are remotely forced and cross these countries before hitting Indian coast.

15.5. Ocean SITES

Ocean SITES is a worldwide system of long-term, deepwater reference stations monitoring the full depth of the ocean, from air-sea interactions down to 5,000 meters.

It is an integral part of the Global Ocean Observing System. The network complements satellite imagery and other in-situ observation data (like Argo floats) by extending the dimensions of time and depth.

The observational systems viz. Argo profile floats, Drifters, Equatorial and Coastal Current Meter Moorings , ADCP moorings, HF Radar, Tsunami buoys, Wave Rider Buoys, Ship Board AWS etc. implemented and monitored by ESSO-INCOIS are part of this worldwide system as per the XII Plan Proposal 2012-17.

15.6. Partnership for Observation of the Global Oceans (POGO)

The Partnership for Observation of the Global Oceans, POGO, is a forum created in 1999 by directors and leaders of major oceanographic institutions around the world to promote global oceanography, particularly the implementation of an international and integrated global ocean observing system.

As a member of this partnership ESSO-INCOIS organized a training programme "The Application of Ocean Colour Remote Sensing in Primary Productivity and Ecosystem Modelling" from February 5th – February 26th, 2012.

15.7. Argo Data Management Team

The Argo float array of 3,000 free-drifting profiling floats that measures the temperature and salinity of the upper 2000 m of the ocean. This allows continuous monitoring of the climate state of the ocean, with all data being relayed and made publicly available within hours after collection.

ESSO-INCOIS is a contributor deploying and maintaining a number of floats in the Indian Ocean. On 25th October 2012, ESSO-INCOIS hosted the Argo Executive Meeting, followed by the Bio-Argo Workshop and the 13th Argo Data Management Meeting.

16. General Information

16.1. B.Tech/M.Tech/MSc. Dissertations

ESSO-INCOIS continued to be the favourite destination of students from different universities and institutes to carry out the Project/Dissertation works as part of B. Tech./ M. Tech./ M. Sc. course work. 33 students carried out the project work at ESSO-INCOIS during 2012-13 under the supervision of scientists from ESSO-INCOIS.

Table 8.1 List Of Students who Completed Project Work at ESSO-INCOIS

S. No.	Name of Student	Name of the Institute	Project Guide from ESSO-INCOIS
1.	V. Sunil	Jawaharlal Nehru Technological University, Hyderabad	H. Rahaman
2.	G. Sidhartha	Geethanjali Collage of Engineering & Technology	B.V. Satyanarayana
3.	S. Shyam Kumar	MG University, Kerala	T. Srinivas Kumar
4.	Syed Mohamed Yasin	VCET, Madurai	B.V. Satyanarayana
5.	V.K. Vishakh	Mangalore University	Aneesh A Lotlikar
6.	P.R Deepak	Mangalore University	Aneesh A Lotlikar
7.	D. Roopa	Jawaharlal Nehru Technological University, Hyderabad	R. Venkat Shesu
8.	K. Harika	Elenki Institute of Technology, Hyderabad	K. Muralikrishna
9.	N. LaxmiPriya	Elenki Institute of Technology, Hyderabad	K. Muralikrishna
10.	M.J. Riyas	CUSAT, Cochin	R. S. Mahendra
11.	P. Vandana	VNR-VJIT, Hyderabad	T.M. Balakrishna Nair
12.	G. Swetha	VNR-VJIT, Hyderabad	T.M. Balakrishna Nair
13.	K. Ramana Kumar	VNR-VJIT, Hyderabad	T.M. Balakrishna Nair
14.	P. Swetha	Indian Institute of Surveying & Mapping, Hyderabad	N Kiran Kumar
15.	M. Krishnapriya.	CUSAT, Cochin	T.Srinivas kumar
16.	Effy John	CUSAT, Cochin	Balakrishna Nair TM
17.	Srividya	CUSAT, Cochin	Balakrishna Nair TM
18.	G. Mahendar	Jawaharlal Nehru Technological University, Hyderabad	R.S.Mahendra
19.	K. Sampath Kumar	Jawaharlal Nehru Technological University, Hyderabad	C. H. Patanjali

S. No.	Name of Student	Name of the Institute	Project Guide from ESSO-INCOIS
20.	P. Anil Kumar	VNR-VJIT, Hyderabad	R. Venkat Shesu
21.	B.V.V. Uday Naresh	Jawaharlal Nehru Technological University, Hyderabad	N. Kiran Kumar
22.	B. Veerabrahma Chari	Jawaharlal Nehru Technological University, Hyderabad	R. Venkat Shesu
23.	T. Ravisha	BV Raju Inst. of Technology, Hyderabad	N. Kiran Kumar
24.	D. Adithya	BV Raju Inst. of Technology, Hyderabad	N. Kiran Kumar
25.	S. Kavya	BV Raju Inst. of Technology, Hyderabad	N. Kiran Kumar
26.	Y. Naveen Kumar	Jawaharlal Nehru Technological University-Hyderabad	T. Srinivas Kumar
27.	S. Nagaharika	Jawaharlal Nehru Technological University-Hyderabad	T. Srinivas Kumar
28.	P. Bhavani	Jawaharlal Nehru Technological University-Hyderabad	Srinivas Rao
29.	K. Divya	Jawaharlal Nehru Technological University-Hyderabad	Srinivas Rao
30.	Srikanth	Jawaharlal Nehru Technological University-Hyderabad	T. Srinivas Kumar
31.	Rakeshkumar Raptan	GIET, Orissa	K. Muralikrishna
32.	Ashok kumar Polai	GIET, Orissa	K. Muralikrishna
33.	S. Jagannatha Swamy	GIET, Orissa	K. Muralikrishna

16.2. Honors/Awards:

1. Dr. Srinivas Kumar T, Head (ASG), INCOIS was elected as fellow of Andhra Pradesh Akademi of Sciences (APAS) considering his outstanding contributions to the research in Tsunami and Ocean Sciences.

2. Mr. R. Venkat Shesu, Scientist, ESSO-INCOIS was awarded with the "Certificate of Merit" in the category of ocean sciences on the occasion of foundation day of Ministry of Earth Sciences (MoES) held on 27th July, 2012.

3. Shri Suresh Ganti, Scientfic Assistant, ESSO-INCOIS received the "Best Employee" award on the occasion of foundation day of Ministry of Earth Sciences (MoES) held on 27th July, 2012.

16.3. Promotion of Hindi:

ESSO-INCOIS continued to promote and propagate the use of the Official Language, Hindi. During 2012-2013, various efforts were made to promote the use of Hindi in the institute. The Potential Fishing Zone Advisories are now being issued in Hindi along with local Languages.

Hindi Pakhwara celebrations were organized at ESSO-INCOIS during September 2012. Dr D D Ozha, Sr. Scientist, Member, Joint Hindi Advisory Committee, MoES & DST and Dr. Ravi Ranjan, Head of the Department (Hindi), University of Hyderabad, delivered lectures on "Importance of useful chemicals in the life" and "Hindi ki Bhavbhumi & Vicharbhumi" respectively during the seminar on official language held at ESSO-INCOIS on 24th September 2012. Competitions in essay writing, power point presentations, quiz and poem recital in Hindi were also conducted for the staff of ESSO-INCOIS and their children.

Dr Satya Prakash, Scientist 'C' participated in the 20th Annual Scientific Hindi Seminar on "Jalvayu ke sambandh main smudhra ki bhumika" (The role of the oceans in relation to climate) held on 22nd March 2013 at MoES, New Delhi.

Figure 8.2: From Hindi day celebrations.

16.4. Vigilance Activities:

Dr. M. Ravichandran, Scientist 'G' & Head - MOG continued to function as the vigilance officer at ESSO-INCOIS. The vigilance awareness week was observed from 29th October 2012 to 3rd November 2012. The pledge on vigilance awareness was taken by the officers and staff of ESSO-INCOIS on 29th October 2012 at 11:00 AM. During the period April 2012 to March 2013 no complaints related to vigilance were received.

16.5. ESSO-INCOIS Human Capital

Scientific Staff

Table 8.2

Group	Scientist ' B' & above	Scientific Assistant – B	Project Scientist	Project Assistant	JRF/ SRF/ Ph.D. Program	Research Assistant	Scientist Fellow	Total
Director	1	-	-	-	-	-	-	1
MOG	10	2	1	2	1	-	-	15
ASG	9	5	8	7	1	-	-	30
CWG	7	5	3	3	-	-	-	18
ISG	10	3	3	2	3	1	1	24
DMG	5	2	1	4	-	-	-	12
ESSG	-	1	-	-	-	-	-	1
Grand Total :	**42**	**18**	**16**	**18**	**5**	**1**	**1**	**101**

Administrative Staff

Table 8.3

Group	Group A officials (Regular)	Group B Officials (Regular)	Group B officials (contract mode)	Group C (contract mode)	Total
ESG	3	8	4	7	22
Grand Total:	**3**	**8**	**4**	**7**	**22**

16.6. Right to Information Act:

Right to Information Act, 2005, is being executed at ESSO-INCOIS. Information related to the institute is uploaded regularly on the website in the prescribed format under Right to Information Act. Shri E.Pattabhi Rama Rao, Scientist 'E' & Head - DMG functioned as Public Information Officer and Dr. S.S.C.Shenoi, Director, ESSO-INCOIS acted as First Appellate Authority. During April 2012 to March 2013, 5 requests were received under the right to information act. Requested information was provided as per RTI act. No appeals were received during the period.

16.7. Deputations Abroad :

Table 8.4

S. No.	Name of the Official	Meeting/Conference/Training
1.	S. S. C. Shenoi, Director, ESSO-INCOIS.	To attend the 45th session of IOC Executive Council and meetings of the Inter-Sessional Working Group at UNESCO HQ, Paris, France during 25th-28th June 2012. To attend the Indian Ocean Global Ocean Observing System (IOGOOS) workshop and 9th annual meeting preceded by 9th meeting of the Indian Ocean Panel (IOP), 3rd meeting of Sustained Indian Ocean Bio-geochemical and Ecological Research (SIBER) and 3rd meeting of IndOOS Resource Forum (IRF) in Cape Town, South Africa during 15th-20th October 2012. To attend meeting of the 9th Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS-IX) and Preparatory Meetings at Jakarta, Indonesia during 26th-30th November 2012
2.	M. Ravichandran Scientist 'G'	To attend Indian Ocean Global Ocean Observing System (IOGOOS) workshop and 9th annual meeting preceded by 9th meeting Indian Ocean Panel (IOP), 3rd meeting of Sustained Indian Ocean Bio-geochemical and Ecological Research (SIBER) and 3rd meeting of IndOOS Resource Forum (IRF) in Cape Town, South Africa during October 15th-20th, 2012. To participate in 14th Argo Steering Team (AST-14) meeting held at Wellington, New Zealand during March 18th-22nd, 2013.
3.	T. Srinivas Kumar, Scientist 'E' .	To participate in the International Society for Photogrammetry and Remote Sensing (ISPRS) Technical Commission – VIII symposium at Melbourne, Australia during August 25th, 2012 to September 1st, 2012. To attend Indian Ocean Global Ocean Observing System (IOGOOS) workshop and 9th annual meeting preceded by 9th meeting Indian Ocean panel (IOP), 3th meeting of Sustained Indian Ocean Bio-geochemical and Ecological Research (SIBER) and 3th meeting of IndOOS Resource Forum (IRF) in Cape Town, South Africa during October 15th- 20th, 2012. To attend meeting of the 'Nineth Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS-IX) and Preparatory Meetings at Jakarta, Indonesia during November 26th-30th, 2012. To attend meeting of the TOWS Task Team 3 on Tsunami Watch Operations and Sixth meeting of the Working Group on Tsunamis and other Hazards related to Sea Level Warning and Mitagation Systems (TOWS-WG-VI) in Paris, France during February 18th-21st, 2013.

S. No.	Name of the Official	Meeting/Conference/Training
4.	E. Pattabhi Rama Rao, Scientist 'E' .	To participate in the XXI Congress of ISPRS at Melbourne, Australia during August 25th, 2012 to September 1st, 2012. To participate in the 22nd Session of the IOC Committee on International Oceanographic Data and Information Exchange (IODE-XXII) held at Ensenada, Mexico during March 11th-15th, 2013.
5.	Sudheer Joseph, Scientist 'E' .	To participate in Expert Team on Operational Ocean Forecasting Systems (ETOOFS-4) (Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) meeting held at Washington, DC, USA during March 25th-29th, 2013.
6.	Francis P. A., Scientist-D.	To attend the 5th Symposium of Group of Earth Observation System of Systems held in Tokyo, Japan, during April 2nd-4th, 2012.
7.	M. Nagaraja Kumar Scientist 'D'	To attend Indian Ocean Global Ocean Observing System (IOGOOS) workshop and 9th annual meeting preceded by 9th meeting Indian Ocean panel (IOP), 3rd meeting of Sustained Indian Ocean Bio-geochemical and Ecological Research (SIBER) and 3rd meeting of IndOOS Resource Forum (IRF) in Cape Town, South Africa during October 15th-20th, 2012.
8.	Satya Prakash, Scientist 'C' .	To attend Indian Ocean Global Ocean Observing System (IOGOOS) workshop and 9th annual meeting preceded by 9th meeting Indian Ocean panel (IOP), 3rd meeting of Sustained Indian Ocean Bio-geochemical and Ecological Research (SIBER) and 3rd meeting of IndOOS Resource Forum (IRF) in Cape Town, South Africa during October 15th-20th, 2012.
9.	Girishkumar M.S., Scientist' C' .	To participate in the training programme 'Targeted Training Activity: Oscillation Monsoon in the Current and Future Climate' at ICTP, Italy during July 30th, 2012 to August 10th, 2012.
10.	M. Vijaya Sunanda, Scientist 'C' .	To attend International Training Course on Earthquake Monitoring,Tectonic Deformation, Seismic Zoning Methods and Tsunami Early Warning System by Meteorologicial, Climatological and Geophysical Agency (BMKG) at Jakarta, INDONESIA during November 19th, 2012 to December 1st, 2012.
11.	Kunal Chakraborty, Scientist 'C' .	To participate in the quarterly thematic program on Mathematics of Bio-Economics (MABIES) under the Mathematics of the Planet Earth (MPE), at Insitut Henri Poincare (IHP), Paris 2013 during February 4th-15th, 2013.

S. No.	Name of the Official	Meeting/Conference/Training
12.	Nimit Kumar Joshi, Project Scientist-B.	To participate in MOMSEI – III (Monsoon Onset Monitoring and its Social & Ecosystem Impacts) organized by IOC/WESTPAC as summer school of SEAGOOS Pilot Project at Qingdao, China during August 6th-10th, 2012.
13.	N. Suresh Kumar, Project Scientist-B.	To attend training on Calibration and testing (Ballasting) of Argo floats at the School of Oceanography, University of Washington, Seattle, USA during April 30th, 2012 to May 4th, 2012.
14.	T V Rajesh, Scientific Asst-B.	To participate in "The Living Ocean and Coast" of Indian Section for YEOSU EXPO 2012 at Seoul, Republic of Korea during July 6th-24th, 2012.

17. Consultancy Projects

The following consultancy projects were taken up by ESSO - INCOIS during 2012-2013:

Table 17.1

Name of the Customer	Scientific Consultancy Services provided during 2012-13
Captain of Ports, Govt. Of Goa	Study of waters in the Goa coast on significant wave heights up to a distance of 12 nautical miles to enable/fixation of GOA IV limits.
Director General - Project Varsha, Indian Navy	Preparation of Coastal wave modelling data
Institute of Oil and Gas Production Technology, ONGC, Mumbai	Consultancy services for identification of wind potential zones in western offshore field of ONGC.

18. List of Acronyms

ADCP	:	Acoustic Doppler Current Profiler
AOT	:	Aerosol Optical Thickness
ASCAT	:	The Advanced Scatterometer
ASG	:	Advisory services and Satellite oceanography Group.
AWS	:	Automated Weather Station
BoB	:	Bay of Bengal
CBAS	:	Coral Bleaching Alert System
CDOM	:	Chromophoric Dissolved Organic Matter
CFS	:	Climate Forecast System
CMS	:	Content Management System
CORE-II	:	Coordinated Ocean Reference Experiments
CTD	:	Conductivity, Temperature, and Depth
CVI	:	Coastal Vulnerability Index
CWG	:	Computational facilities and Web based services Group.
DIVA	:	Data-Interpolating Variation Analysis
DMG	:	Data Management and information Group.
ESG	:	Executive Support service Group.
ESSO	:	Earth System Science Organization
FSI	:	Fisheries Survey of India
GSI	:	Geological Survey of India
GFS	:	Global Forecasting System
GODAS	:	Global Ocean Data Assimilation System
GTS	:	Global Telecommunication System
HOOFS	:	High-resolution Operational Ocean Forecast and reanalysis System
ICG	:	Intergovernmental Coordination Group
IIOE	:	International Indian Ocean Expedition
IITM	:	Indian Institute of Tropical Meteorology
INCOIS	:	Indian National Centre for Ocean Information Services

INDOFOS	:	Indian Ocean Forecasting System
IOC	:	Intergovernmental Oceanographic Commission
IODE	:	International Oceanographic Data and Information Exchange
IOGOOS	:	Indian Ocean Global Ocean Observing System
IOTWS	:	Indian Ocean Tsunami and other hazards Warning System
ISG	:	Information Services and ocean sciences Group
ISR	:	Institute of Seismological Research (ISR)
ITCOOcean	:	International Training Centre for Operational Oceanography
ITEWC	:	Indian Tsunami Early Warning Centre
JMA	:	Japan Meteorological Agency
LAS	:	Live Access Server
MoES	:	Ministry of Earth Sciences
MOG	:	Modeling and ocean Observation Group.
MOM	:	Modular Ocean Model
NCEP	:	National Center for Environment Prediction
NCMRWF	:	The National Centre for Medium Range Weather Forecasting
NEIST	:	North East Institute of Science and Technology, Jorhat
NIO	:	National Institute of Oceanography
NIOD	:	Negative Indian Ocean Dipole
NIOT	:	National Institute of Ocean Technology
NOAA	:	National Oceanic and Atmospheric Administration
NODPAC	:	Naval Operations Data Processing and Analysis Centre
OAFlux	:	Objectively Analyzed air-sea Fluxes
OAS	:	Optically Active Substances
OBIS	:	Ocean Bio-Informatics System
ODIS	:	Ocean Data and Information System
OSTIA	:	Optimal Sea surface Temperature and sea-Ice Analysis
PDNOM	:	Project Directorate of Naval Oceanology and Meteorology
PFZ	:	Potential Fishing Zone
PIOD	:	Positive Indian Ocean Dipole
POGO	:	Partnership for Observation of Global Oceans

PORSEC	:	Pan Ocean Remote Sensing Conference
PTWC	:	Pacific Tsunami Warning Center
RIMES	:	Regional Integrated Multi-Hazard Early Warning System
ROMS	:	Regional Ocean Modelling System
RTSP	:	Regional Tsunami Advisory Service Provider
SATTUNA	:	Satellite Telemetry studies on migration patterns of Tunas in Indian Seas
SeaWiFS	:	Sea viewing Wide Field-of-view Sensor
SIBER	:	Sustained Indian Ocean Biogeochemistry and Ecosystem Research
SoI	:	Survey of India
SST	:	Sea Surface Temperature
SWAN	:	Simulating Waves Nearshore
TOPAZ	:	Tracers Of Phytoplankton with Allometric Zooplankton
TSM	:	Total Suspended Matter
VRC	:	Village Resource Centres
WIHG	:	Wadia Institute of Himalayan Geology

12. Finance

The report of the auditors and audited accounts of INCOIS for the year 2012-2013 are placed in Appendix-1 to this report.

Appendix-1

B. SRINIVASA RAO & CO.,
CHARTERED ACCOUNTANTS

Head Office:
Ameer Estate, Flat No. 103,
S. R. Nagar, Hyderabad - 500 038.
✆ : 040-23757406, Fax : 66737406
E-mail: bsrandco@gmail.com

AUDITORS' REPORT

To

The Chairman and Members,
Governing Council,
INDIAN NATIONAL CENTRE FOR
OCEAN INFORMATION SERVICES,
Ocean Valley, Pragathinagar (BO), Nizampet (SO)
Hyderabad – 500 090

We have audited the attached Balance Sheet of the INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES as at 31st March 2013, and also the Income & Expenditure Account and Receipts & Payments Account for the year ending on that date annexed thereto. These financial statements are the responsibility of the Society's management. Our responsibility is to express an opinion on the financial statements based on our Audit.

We conducted our audit in accordance with auditing standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material mis-statements. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion and report that:

1. We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purposes of our Audit.
2. In our opinion, proper books of accounts as required by the Society, have been kept by the Society so far as appears from our examination of such books.
3. The Balance Sheet, Income and Expenditure Account and Receipts and Payments Account are in agreement with the Books of Account.
4. In our opinion and to the best of our information and according to the explanations given to us and subject to the notes forming part of accounts, the Balance Sheet as at 31st March 2013, Income and Expenditure Account and Receipts and Payments Account for the year ending on that date together with the Schedules and Notes on Accounts Annexed therewith give a true and fair view of the state of affairs of the Society.

Place: Hyderabad
Date : 08-07-2013

For **B.SRINIVASA RAO & CO.,**
Chartered Accountants

(Ch. Anand)
Partner
M.No. : 222732
FRN No.: 008763S

INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

(Ministry of Earth Sciences, Govt. of India)
'Ocean Valley', Pragathinagar (BO), Nizampet (SO), Hyderabad - 500 090

BALANCE SHEET AS AT 31ST MARCH 2013

Particulars	Schedules	Current Year (2012 - 13) Rs.	Previous Year (2011 - 12) Rs.
LIABILITIES			
Corpus fund	1	11,85,48,960	9,65,51,897
Earmarked funds	2	40,16,06,499	37,55,32,547
Current liabilities and Provisions	3	5,16,05,867	3,26,88,071
Total		**57,17,61,326**	**50,47,72,515**
ASSETS			
Fixed Assets	4	1,64,53,218	3,65,74,981
Current Assets, Loans & Advances	5	55,53,08,108	46,81,97,534
Total		**57,17,61,326**	**50,47,72,515**
Notes forming part of Accounts	11		

As per our report of even date
For **B.SRINIVASA RAO & CO.,**
Chartered Accountants

(Ch Anand)
Partner
M.No. 222732
FRN No: 008763S

Place: Hyderabad
Date: 08-07-2013

For and on behalf of **INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES**

(S. Nageswara Rao)
Accounts Officer

(K.K.V. Chary)
Sr. Administrative Officer

(S.S.C. Shenoi)
Director

INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

(Ministry of Earth Sciences, Govt. of India)
'Ocean Valley', Pragathinagar (BO), Nizampet (SO), Hyderabad - 500 090

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2013

Particulars	Schedules	Current Year (2012 - 13) Rs.	Previous Year (2011 - 12) Rs.
INCOME			
Income from sales / Other Income	6	25,22,193	41,05,459
Interest Earned on Investments	7	78,72,721	71,14,156
Recurring Grants	8	22,11,68,246	8,17,00,000
Increase / Decrease in Inventories		-	1,15,891
TOTAL - A		**23,15,63,160**	**9,30,35,506**
EXPENDITURE			
Establishment Expenditure	9	5,11,56,443	4,78,53,055
Other Administrative Expenses	10	13,19,36,067	3,80,80,218
Depreciation		2,64,73,587	56,68,673
TOTAL - B		**20,95,66,097**	**9,16,01,946**
Excess of Income over expenditure (A-B)		**2,19,97,063**	14,33,560
Add / Less: Prior Period Expenditure		-	1,01,400
Balance being net income / deficit transferred to Corpus Fund		**2,19,97,063**	**15,34,960**
Notes forming part of Accounts	11		

As per our report of even date
For **B.SRINIVASA RAO & CO.,**
Chartered Accountants

(Ch Anand)
Partner
M.No. 222732
FRN No: 008763S

Place: Hyderabad
Date: 08-07-2013

For and on behalf of **INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES**

(S. Nageswara Rao)
Accounts Officer

(K.K.V. Chary)
Sr. Administrative Officer

(S.S.C. Shenoi)
Director

INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

(Ministry of Earth Sciences, Govt. of India)
'Ocean Valley', Pragathinagar (BO), Nizampet (SO), Hyderabad - 500 090

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2013

RECEIPTS	CURRENT YEAR 2012 - 13		PAYMENTS	CURRENT YEAR 2012 - 13	
Opening Balance	**Rs.**	**Rs.**	**Establishment Expenses**	**Rs.**	**Rs.**
State Bank of India, HAL Campus Br.	3,05,63,724		Pay Leave Salary Allowace	4,23,07,890	
Andhra Bank, Pragathi Nagar Br.	11,31,819		NPS, CPF, IDBPS	29,73,813	
INCOIS-Consultancy Services - Pragathi Nagar Br.	2,64,147		Staff Welfare	16,50,380	
Short Term Deposits with Bank	27,30,00,000	30,49,59,690	Leave Travel Concession	20,04,244	4,89,36,327
			Administrative Expenses		
Earmarked Funds			Maintenance & Repairs	3,63,12,418	
			Travel Expenses - Inland	20,18,762	
"Ocean Information and Advisory Services (O-IAS)	26,25,00,000		- Foreign	7,23,898	
			- Others	19,46,644	
Ocean Observation Systems (OOS)	23,00,00,000		Membership Fee	6,12,500	
			Vehicle Hiring	18,48,722	
Satellite Coastal and Oceanographic Research (SATCORE)	4,76,00,000		Garden Expenses	9,69,727	
			House Keeping Expenses	36,83,912	
International Training Centre for Operational Oceanography	1,50,00,000		Security Expenses	51,54,890	
			Electricity Expenditure	2,62,09,032	
V Sat Terrestrial Link	2,00,000		Water Expenses	9,20,328	
Construction of New Building (Phase II)	8,00,00,000	63,53,00,000	Postage & Telegraphs	2,44,066	
			Telephone & Fax Expenditure	5,63,564	
Recurring Grants	**19,21,00,000**	**19,21,00,000**	Legal Expenses	1,23,622	

Other Receipts			Honorarium to External Exports	1,00,500	
Consultancy Projects - Sundry Debtors	22,07,763		Conveyance Expenses	1,87,410	
Earnest Money Deposits	4,17,000		Bank Charges	276	
Security Deposits	41,06,251		Printing & Stationery	6,75,318	
Interest on Short term deposits	3,71,03,334		Advertisement & Publicity	18,16,485	
Interest on Bank Account	5,60,523		Papers and Periodicals	53,303	
Interest on Vehicle Advance to Employees	1,05,144		General Expenses	2,48,622	
Interest on Marginal amount	38,14,054		Audit Fee	44,944	
NF POGO	9,67,699		Seminar, Conference & Workshop Expenses	2,14,84,779	
Phanikar ship	7,411		International Interface	1,16,67,699	
PORSEC 2012	58,67,838		Material Consumable	34,66,409	12,10,77,830
Vehicle advance to employees	11,59,123		**Payments Against Earmarked Funds**		
TDS Account	33,00,585		**a) Ocean Information and Advisory Services (OIAS)**		
Other Receipts	6,430		Equipment	1,00,50,598	
Air India Coupons	3,81,034		Consumables	6,34,541	
Mobilisation advance received	78,36,125		Advance to Sub Projects	2,95,88,385	
Sale of Tender Forms	21,300	6,78,61,614	Advance to Purchase	3,01,80,574	
			Technical Expenses	1,20,05,455	
Unspent Balances refunded from Sub Projects			Travel Expenses	51,92,021	
			Manpower	89,22,804	
IISC, Banglore	1,35,260		Margin Money	59,56,500	
IIT, Madras	10,899		Administrative Expenses	45,78,693	10,71,09,571
FSI, Mumbai	11,815		**b) Computational Facilities**		
SAC, Ahmedabad	60,00,000		Equipment	6,59,658	6,59,658
TIFR, Banglore	2,11,219		**c) Satellite Coastal and Oceanographic Research**		
CIFE,Mumbai	1,20,121		Equipment	7,960	
IITM, Pune	6,80,414		Advance to Sub Projects	1,79,04,512	
ICAR, Goa	15,866		Advance to Purchase	53,95,274	
Anna University	61		Travel Expenses	3,27,935	
LPSC/ISRO, Bangalore	52,93,350	1,24,79,005	Manpower	6,35,665	
			Administrative Expenses	2,94,411	2,45,65,757

Margin Money			**d) Observation Networks**		
Ocean Information and Advisory Services			Equipment	2,16,176	
(OIAS)	78,75,850		Software/Hardware	17,635	
Satellite Coastal and Oceanographic			Consumables	5,83,956	
Research (SATCORE)	38,60,419	1,17,36,269	Advance to Sub Projects	10,00,74,000	
			Advance to Purchase	3,51,81,294	
			Travel Expenses	21,53,661	
			Manpower	15,18,658	
			Administrative Expenses	74,58,818	
			Margin Money	3,15,80,400	
			Data Transfer Charges	48,10,524	18,35,95,122
			e) Construction of New Building (Phase II)		
			Architect Fee	24,50,751	
			Construction of Building	8,57,62,693	8,82,13,444
			f) HPC Systems-INCOIS	29,18,241	29,18,241
			g) HPC Systems-Others	41,02,484	41,02,484
			h) MH Early Waring System	67,47,626	67,47,626
			i) V Sat Terrestrial Link	11,67,53,721	11,67,53,721
			j) Multi Hazard Vulnerability	28,151	28,151
			k) International Training Centre	5,040	5,040
			Unspent balances refunded		
			i) HPC Systems-Others	51,15,729	
			ii) Ernet India	10,43,277	61,59,006
			Expenditure on Fixed Assets		
			Furniture & Fixture	53,894	
			Office Equipment	3,24,822	
			Computer/Peripherals	7,13,159	
			Electrical Installation	9,79,079	
			Library	42,80,869	63,51,823

			Other Payments		
			Service Tax payable	2,78,590	
			NF-POGO	6,574	
			PORSEC - 2012	45,41,408	
			Other Advances	20,22,478	
			Travel Adv. Foreign	38,643	
			Vehicle advance to employees	6,30,000	
			Advance to Purchase	1,29,14,431	
			Air India Coupons	3,81,034	
			Deposits	15,05,000	2,23,18,158
			Closing Balance		
			INCOIS Current A/c SBI,HAL Campus Br.	1,38,62,676	
			INCOIS Current A/c-AB, Pragathi Nagar Br.	2,99,611	
			INCOIS Consultancy SB A/c -AB , Pragathi Nagar Br.	27,32,332	
			Short term Deposits with Bank	46,80,00,000	48,48,94,619
Total	1,22,44,36,578	1,22,44,36,578	**Total**	1,22,44,36,578	1,22,44,36,578

As per our report of even date
For **B.SRINIVASA RAO & CO.,**
Chartered Accountants

(Ch Anand)
Partner
M.No. 222732
FRN No: 008763S

Place: Hyderabad
Date: 08-07-2013

(S. Nageswara Rao)
Accounts Officer

For and on behalf of **INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES**

(K.K.V. Chary)
Sr. Administrative Officer

(S.S.C. Shenoi)
Director

INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

(Ministry of Earth Sciences, Govt. of India)
'Ocean Valley' , Pragathinagar (BO), Nizampet (SO), Hyderabad - 500 090

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2013

SCHEDULE - 1 CORPUS FUND

(Amount in Rs.)

Particulars	Current Year (2012 - 13) Rs.	Previous Year (2011 - 12) Rs.
Corpus Fund at the beginning of the year	9,65,51,897	9,50,16,937
Add: Net income transferred from Income & Expenditure Account	2,19,97,063	15,34,960
BALANCE AS AT THE YEAR END	**11,85,48,960**	**9,65,51,897**

INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

SCHEDULE - 2 EARMARKED FUNDS

(Amount in Rs.)

Particulars	FUND - WISE BREAK UP															TOTALS	
	Building Fund	MDC & Equipment Fund	Ocean Information and Advisory Services(O-IAS)	Computational Facilites	SATCORE	Observation Networks	ITCOO	HPC SYSTEMS-INCOIS	IT & E Governance Fund	HPC SYSTEMS-Others	MH Early Warning System	V SAT Node	Ernet India	IOAS	MH Vulnerability	Portable EDBs	Current Year 2012 - 13	Previous Year 2011 - 12
a) Opening balance of the funds	6,23,63,470	-811	4,30,19,151	3,30,00,879	43,65,599	1,55,08,717	-	1,39,21,553	21,65,357	92,18,213	4,31,02,744	7,11,79,174	10,43,277	-4,51,954	7,47,49,579	23,47,599	37,55,32,547	43,43,83,992
b) Additions to the Funds:																		
i) Grants	8,00,00,000	-	16,25,00,000	-	4,76,00,000	23,00,00,000	1,50,00,000	-	-	-	-	2,00,000	-	-	-	-	53,53,00,000	57,89,32,977
ii) Interest if any	1,01,31,941	-	92,50,583	33,53,309	2,55,049	34,23,307	2,50,638	13,37,670	2,20,214	-	42,14,341	11,75,801	-	-	76,21,259	2,39,400	4,14,73,512	3,28,46,784
iii) Advance for Sub Projects Utilised	-	-	6,79,06,045	2,96,59,658	8,38,43,996	2,92,90,063	-	-	-	-	-	-	-	-	-	-	21,06,99,762	9,95,91,430
iv) Advance for purchase utilised	-	-	4,00,51,057	-	2,03,88,012	17,79,563	-	-	-	-	-	20,36,801	-	-	-	-	6,42,55,433	45,77,86,392
V) Margin money reversed	-	-	1,17,36,269	-	50,89,419	9,41,84,067	-	-	-	-	-	5,49,65,000	-	-	-	-	16,59,74,755	6,21,54,362
Vi) Mobilizations Advance reversed	78,36,125	-	-	-	-	-	-	-	-	-	-		-	-	-	-	78,36,125	62,32,688
TOTAL (a+b) - A	**16,03,31,536**	**-811**	**33,44,63,105**	**6,60,13,846**	**16,15,42,075**	**37,41,85,717**	**1,52,50,638**	**1,52,59,223**	**23,85,571**	**92,18,213**	**4,73,17,085**	**12,95,56,776**	**10,43,277**	**-4,51,954**	**8,23,70,838**	**25,86,999**	**1,40,10,72,134**	**1,67,19,28,625**
C) Utilisation/Expenditure																		
i) Capital Expenditure																		
W.I.P	8,57,62,693	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8,57,62,693	4,81,24,534
Architect fee	24,50,751	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24,50,751	61,41,075
Equipments	-	-	1,64,31,811	2,99,92,835	1,85,73,112	20,08,304	5,040	-	-	-	-	9,07,079	-	-	-	-	6,79,18,181	74,30,04,845
Computers / Software	-	-	47,651	-	5,800	59,583	-	-	-	-	-	-	-	-	-	-	1,13,034	87,60,036
Other Assets	-	-	5,000	-	-	-	-	-	-	-	-	-	-	-	-	-	5,000	89,78,171
Total	**8,82,13,444**	**-**	**1,64,84,462**	**2,99,92,835**	**1,85,78,912**	**20,67,887**	**5,040**	**-**	**-**	**-**	**-**	**9,07,079**	**-**	**-**	**-**	**-**	**15,62,49,659**	**81,50,08,661**
ii. Revenue Expenditure																		
Technical support	-	-	1,27,80,461	-	-	-	-	29,18,241	-	41,02,484	-	3,20,89,540	-	-	-	-	5,18,90,726	4,09,54,640
Administrative expenses	-	-	4,69,99,557	-	2,78,21,829	1,84,55,114	-	-	-	-	67,47,626	51,991	-	-	8,750	-	10,00,84,867	12,93,83,448
Travel	-	-	84,42,736	-	46,86,412	43,13,111	-	-	-	-	-	3,18,422	-	-	19,401	-	1,77,80,082	1,34,91,714
Consumable Materials / Data	-	-	2,59,58,819	-	2,74,14,082	2,16,14,326	-	-	-	-	-	3,19,114	-	-	-	-	7,53,06,341	39,34,889
Total	**-**	**-**	**9,41,81,573**	**-**	**5,99,22,323**	**4,43,82,551**	**-**	**29,18,241**	**-**	**41,02,484**	**67,47,626**	**3,27,79,067**	**-**	**-**	**28,151**	**-**	**24,50,62,016**	**18,77,64,691**
iii. Others																		
Advances against subprojects	-	-	2,95,88,385	-	1,79,04,512	10,00,74,000	-	-	-	-	-	-	-	-	-	-	14,75,66,897	16,32,01,800
Advance for Purchase	-	-	6,92,35,906	-	2,57,83,286	3,69,60,857	-	-	-	-	-	8,51,04,376	-	-	-	-	21,70,84,425	7,59,00,175
Mobilization Advance/ Security Deposit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10,000
Margin Money against LC	-	-	98,16,919	-	12,29,000	12,57,64,467	-	-	-	-	-	5,49,65,000	-	-	-	-	19,17,75,386	5,11,88,530
Total	**-**	**-**	**10,86,41,210**	**-**	**4,49,16,798**	**26,27,99,324**	**-**	**-**	**-**	**-**	**-**	**14,00,69,376**	**-**	**-**	**-**	**-**	**55,64,26,708**	**29,03,00,505**
TOTAL (i+ii+iii) - B	**8,82,13,444**	**-**	**21,93,07,245**	**2,99,92,835**	**12,34,18,033**	**30,92,49,762**	**5,040**	**29,18,241**	**-**	**41,02,484**	**67,47,626**	**17,37,55,522**	**-**	**-**	**28,151**		**95,77,38,383**	**1,29,30,73,857**
Advance Refunded -C	-	-	-	-	-	-	-	-	-	51,15,729	-	-	10,43,277	-	-	-	61,59,006	33,22,221
Fund Transferred to Schedule 8 - D	-	-811	-	3,60,21,011	-	-	-	-	-	-	-	-	-	-4,51,954	-	-	3,55,68,246	-
NET BALANCE AS AT THE PERIOD END (A-(B+C+D)	**7,21,18,092**	**0**	**11,51,55,860**	**0**	**3,81,24,042**	**6,49,35,955**	**1,52,45,598**	**1,23,40,982**	**23,85,571**	**0**	**4,05,69,459**	**-4,41,98,746**	**0**	**0**	**8,23,42,687**	**25,86,999**	**40,16,06,499**	**37,55,32,547**

INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

SCHEDULE - 3 CURRENT LIABILITIES & PROVISIONS

(Amount in Rs.)

Particulars	Current Year (2012 - 13) Rs.	Previous Year (2011 - 12) Rs.
A. CURRENT LIABILITIES		
Project Implementation Agency	94,875	94,875
Earnest Money Deposit	22,39,700	18,22,700
Security Deposit	77,03,667	35,97,416
Performance Deposit	45,000	45,000
Outstanding Expenses	1,92,28,726	1,11,99,240
Sundry Creditors	36,52,839	13,86,957
Retention Money	33,43,459	12,92,682
Total - A	**3,63,08,266**	**1,94,38,870**
B. PROVISIONS		
Gratuity	60,02,075	60,17,175
Accumulated Leave Encashment	92,95,526	72,32,026
Total – B	**1,52,97,601**	**1,32,49,201**
Total (A+B)	**5,16,05,867**	**3,26,88,071**

INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

SCHEDULE - 4 FIXED ASSETS

(Amount in. Rs)

DESCRIPTION	GROSS BLOCK			DEPRECIATION			NET BLOCK	
(% of Depreciation)	As at 31.03.2012	Additions during the year	As at 31.03.2013	As at 31.03.2012	For the year 2012-13	As at 31.03.2013	As at 31.03.2013	As at 31.03.2012
1. Land (0%)	1,000	-	1,000	-	-	-	1,000	1,000
2. Plant, Machinery and Equipments (15%)	4,53,57,169	-	4,53,57,169	4,33,57,964	2,99,881	4,36,57,845	16,99,324	19,99,205
3. Furniture & Fixtures (10%)	1,49,45,285	53,894	1,49,99,179	80,49,248	6,89,941	87,39,189	62,59,990	68,96,037
4. Office Equipment (15%)	28,12,709	-	28,12,709	18,17,351	1,49,304	19,66,655	8,46,054	9,95,358
5. Computer / Peripherals (60%)	88,80,761	7,13,159	95,93,920	85,78,486	2,25,058	88,03,544	7,90,376	3,02,275
6. Electric Installations (10%)	10,36,688	9,79,079	20,15,767	6,96,587	36,558	7,33,145	12,82,622	3,40,101
7. Library Books (100%)	3,87,65,446	42,80,869	4,30,46,315	1,38,90,024	2,48,92,938	3,87,82,962	42,63,353	2,48,75,421
8. Other Fixed Assets (15%)	4,07,163	3,24,822	7,31,985	2,28,918	31,806	2,60,724	4,71,261	1,78,245
9. Vehicles (15%)	18,49,835	-	18,49,835	8,62,496	1,48,101	10,10,597	8,39,238	9,87,339
Total	**11,40,56,056**	**63,51,823**	**12,04,07,879**	**7,74,81,074**	**2,64,73,587**	**10,39,54,661**	**1,64,53,218**	**3,65,74,981**
Previous year	10,94,32,612	46,23,444	11,40,56,056	7,18,12,402	56,58,673	7,74,81,075	3,64,74,981	3,76,20,210

INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

SCHEDULE - 5 CURRENT ASSETS, LOANS AND ADVANCES

(Amount in. Rs)

Particulars	Current Year (2012 - 13)		Previous Year (2011 - 12)	
A. CURRENT ASSETS				
1. Inventories (Valued at cost)	8,29,878	8,29,878	9,39,788	9,39,788
2. Cash & Bank Balance :				
a) With Scheduled Banks – Current Account				
State Bank of India HAL CAMPUS A/c	1,38,62,676		3,05,63,724	
Andhra Bank Pragathinagar A/c	2,99,611		11,31,819	
Andhra Bank Pragathinagar-Consultancy A/c	27,32,332	1,68,94,619	2,64,147	3,19,59,690
b) Short Term Deposits with SBI	46,50,00,000			27,00,00,000
c) Short Term Deposits with AB	30,00,000	46,80,00,000		30,00,000
TOTAL A:		**48,57,24,497**		**30,58,99,478**
B. LOANS, ADVANCES AND OTHER ASSETS				
1. Deposits				
a) Telephone	2,04,350		2,00,350	
b) Electricity	48,91,540		33,90,540	
c) Gas	13,100		13,100	
d) APSRTC	1,14,080		1,14,080	
e) Petrol/Diesel	1,01,400	53,24,470	1,01,400	38,19,470
2. Advances & other amounts recoverable in cash or in kind or for value to be received				
a) Vehicle Advance to Employees	12,87,423		15,64,759	
b) Advance to NRSA(Compound wall)	-		2,039	
c) Advance - NRSA (NDC)	16,79,914		38,69,949	
d) Interest Accrued	2,38,55,461		1,58,85,162	
e) Other Advances	28,93,432		53,81,819	
f) Advance for Purchase	1,29,14,431		-	
g) Sundry Debtors	19,99,662		2208272	
h) Tour Advance – Foreign	38,643		23,659	
i) LTC Advance	-		12,99,720	
j) Grants Receivable	-		10,65,00,000	
k)TDS Opening Balance	1,14,90,161		1,09,08,628	
l) TDS Accumulation during the year	41,58,347		38,82,118	
m) Secured Advances	-		28,95,819	
n) Margin Money against Bank Guarantee	39,41,667	6,42,59,141	40,56,642	15,84,78,586
TOTAL B: (1+2)		**6,95,83,611**		**16,22,98,056**
TOTAL (A+B)		**55,53,08,108**		**46,81,97,534**

INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

SCHEDULE - 6 INCOME FROM SALES / OTHER INCOME

(Amount in Rs.)

Particulars	Current Year (2012 - 13)	Previous Year (2011 - 12)
a) Sale of Tender Forms	21,300	13,000
b) Other Receipts	2,93,130	2,30,709
c) Consultancy Services	22,07,763	38,61,750
TOTAL	**25,22,193**	**41,05,459**

SCHEDULE - 7 INTEREST EARNED

a) Interest on Short Term Deposits & Others	73,07,199	65,42,701
b) Bank Accounts	93,400	1,23,066
c) Staff Advances	4,72,122	4,48,389
TOTAL	**78,72,721**	**71,14,156**

SCHEDULE - 8 IRRECOVERABLE GRANTS & SUBSIDIES RECEIVED

a) Central Government (Recurring Grant received from MoES)	18,56,00,000	8,17,00,000
b) Funds Transfer from Schedule-2	3,55,68,246	-
TOTAL	**22,11,68,246**	**8,17,00,000**

SCHEDULE - 9 ESTABLISHMENT EXPENDITURE

a) Salaries, Wages & Allowances	4,45,28,006	4,35,62,382
b) Staff Welfare Expenses	16,50,380	11,02,914
c) Contributory Provident Fund	1,39,883	1,62,585
d) New Pension Scheme	19,24,861	13,92,222
e) IDBPS Trust	9,09,069	7,82,518
f) Leave Travel Concession	20,04,244	8,50,434
TOTAL	**5,11,56,443**	**4,78,53,055**

INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

SCHEDULE - 10 OTHER ADMINISTRATION EXPENSES

(Amount in Rs.)

Sl. No.	Particulars	Current Year (2012 - 13)	Previous Year (2011 - 12)
1.	Electricity & Power Expenses	2,86,18,896	92,00,654
2.	Water Charges	9,07,547	5,77,921
3.	Operation & Maintenance expenses	4,26,58,647	92,28,446
4.	Garden Expenses	8,81,255	10,09,161
5.	Rent Expenses	-	48,180
6.	Vehicle Hiring Expenses	19,21,464	11,13,744
7.	Postage, Telephone, Fax & ISDN Charges	8,07,630	6,87,849
8.	Printing & Stationery	6,75,318	2,21,685
9.	Travelling Expenses :		
	Inland	20,18,762	17,07,116
	Foreign	7,23,898	15,12,957
	Others	19,46,644	9,17,645
10.	Seminar/Workshops Expenses	2,14,95,197	-
11.	General Expenses	2,48,621	5,09,961
12.	Audit Fee	19,999	44,944
13.	House Keeping Expenses	38,15,951	29,43,037
14.	Security Expenses	51,71,958	49,24,717
15.	Advertisement & Publicity	18,16,485	4,97,415
16.	Membership / Registration fees	6,12,500	5,07,760
17.	Internet Expenses	19,85,398	-
18.	Legal Expenses	1,23,622	25,000
19.	Papers & Periodicals	53,303	19,06,136
20.	Conveyance Expenses	1,98,131	3,53,196
21.	Material/Consumable	34,66,409	-
22.	International Interface	1,16,67,699	-
23.	Others	1,00,733	1,42,694
	TOTAL	**13,19,36,067**	**3,80,80,218**

SCHEDULE - 11

NOTES FORMING PART OF ACCOUNTS:

1. Significant Accounting Policies

a) Basis of Accounting:

The Society follows the mercantile system of Accounting and recognizes Income and Expenditure on accrual basis. The accounts were prepared on the basis as a going concern.

b) Income Recognition:

The Grant-in-aid was received by the Society from Ministry of Earth Sciences in the form of recurring grant and ear-marked funds.

The Grant-in-aid received from Ministry of Earth Sciences to the extent utilized for revenue expenditure is treated as Income to the Society and to the extent utilized for capital expenditure is added to the Corpus Fund. During the year 2012-13, the Society received Rs.18.56 Crores towards Recurring Grant as shown in the Schedule-8.

The remaining Grant-in-aid of Rs. 53.53 Crores received from Ministry of Earth Sciences is being utilized for specific purposes for which they were intended and are disclosed under the Earmarked Funds- Schedule-2.

c) Fixed Assets and Depreciation:

- Fixed Assets register was maintained by the Society.
- The management verified the assets physically by appointing a sub-committee.
- The additions to the fixed assets during the period of audit were stated at cost.
- Depreciation on Fixed Assets was provided on written down value, on pro-rata basis, as per the rates prescribed under the Income Tax Rules.

d) Inventories:

Inventory of stores, stationery items and other material of significant value are valued at cost.

Upon implementation of SAP, now the Material/Consumables will be in Stock ledgers and upon its consumption, the value will be treated as expenditure. Hence the outstanding inventory in the stock is considered as current assets shown in the Schedule-5.

e) Building:

As per the guidelines provided to the Central Autonomous Bodies, the Funds inflow and outflow relating to the building are initially to be shown under Building Fund in the Earmarked Funds under Schedule - 2 and on completion of the building, the value of building is to be transferred to the Fixed asset schedule.

During the year 2012-13, the Society received funds for the extension of the building. Since, the building work is in progress during the year 2012-13, the management had decided to continue the Building Fund in the Earmarked Fund under Schedule - 2.

f) Employee Benefits:

i) Gratuity :

The present value of the INCOIS obligations under Gratuity is recognized on the basis of an actuarial valuation made by LIC of India Ltd., as at the year end.

ii) Pension:

The IDBPS (INCOIS Defined Benefit Pension Scheme) is managed by a separate trust and employees contributions for the year 2012-13, towards pension for the employees joined prior to 01-01-2004, was transferred from INCOIS to IDBPS Trust. The present value of the INCOIS obligations under Pension as at the year end, is recognized on the basis of an actuarial valuation made by LIC of India Ltd.

iii) Leave Encashment:

The present value of the INCOIS obligations under Leave encashment is recognized on the basis of an actuarial valuation made by LIC of India Ltd., as at the year end.

iv) Periodical contributions made towards Contributory Provident Fund (CPF), New Pension Scheme (NPS) and IDBP Scheme (INCOIS Defined Benefit Pension Scheme) are charged to revenue.

g) Interest on Deposits:

The Society invested surplus funds from time to time in Short Term Deposit in Nationalized Banks. For the year 2012-13, an amount of Rs.380 lakhs was earned as interest on the Short Term Deposits in the bank. Since, the interest received on Short Term Deposits, relate to the grants accruing to the various projects and recurring grants received by INCOIS, the management decided to spread the interest on Short Term Deposits to such projects and INCOIS. Accordingly, out of total interest of Rs. 380 lakhs, the management had transferred an interest of Rs.374 lakhs to various projects classified in Earmarked Funds under Schedule – 2 and the balance interest of Rs.6 lakhs was considered as income of the Society under Schedule – 7.

h) Electricity and Water Expenses:

The management had apportioned 50% of the total electricity and water expenditure to Tsunami Project and INCOIS respectively till the end of the financial year 2011-12. In view of the allocation of budgets in the 12th Plan to the required extent, the apportioning was discontinued from the year 2012-13 and the total expenditure on this is booked to the INCOIS Society account.

2. Notes on Accounts

a) Earmarked Funds:

The Society during the year 2012-13, received Rs.53.53 Crores as Grant-in-aid towards Earmarked Funds from the Ministry of Earth Sciences (MoES) and other institutions in the form of Recurring and Non-Recurring grants as specified under Schedule -2.

Society accounted the Closing balances in Computational Facilities (high performance computing systems and ocean portal (Rs.(-) 3,60,21,101/-), MDC & Equipment Fund (Rs.(-) 811/-) and Integrated Office Automation System (Rs.(-) 4,51,954/-) which are from part of the "Schedule 2- Earmarked Funds" pertaining to the 11th five year plan period were transferred to "Schedule 8- Irrecoverable Grants & Subsidies received "as Society merged the programmes during the 12th five year plan period for operational convenience. This change in accounting policy of transfer of funds from "Schedule-2 of Earmarked funds " to "Schedule-8 of Irrecoverable Grants & Subsidies received ", has been noted.

The amounts advanced to various Earmarked Funds under Schedule-2, shall initially be shown as 'Advances to Sub Projects ' under "Others" category in the Earmarked Funds Schedule, and, on receipt of Utilisation Certificates from the respective project heads, the utilised amounts are transferred to either Capital expenditure or Revenue expenditure based on the nature of utilisation.

The INCOIS is making payments for the acquisition of equipment for the various projects classified under Earmarked Funds of Schedule-2. These payments are initially shown as 'advance for purchase' under Schedule-2, and later, on completion commissioning of the equipment, the total value of equipment is transferred to equipments under the same Schedule.

The total value of "Advance for Purchase" as on 31-03-2013 was Rs. 33.16 Crores.

The accumulated value of the capital expenditure as on 31-03-2013 (excluding advances to sub-projects and advances for purchases), incurred in each year and specified in the Earmarked Funds under Schedule - 2, are stated below:

S.No	Name of the Fund / Project	As on 01-04-2012 Rs.	Additions 2012-13 Rs.	Total Amount As on 31-03-2013 Rs.
i)	Building Fund	26,69,96,988	8,82,13,444	35,52,10,432
ii)	MDC & Equipment Fund	6,59,21,618	-	6,59,21,618
iii)	Ocean Information and Advisory Services (O-IAS)	91,19,64,679	1,64,84,462	92,84,49,141
iv)	Computational Facilities	12,28,13,632	2,99,92,835	15,28,06,467
v)	INDOMOD & SATCORE Projects	34,78,57,479	1,85,78,912	36,64,36,391
vi)	Observation Networks	25,76,48,130	20,67,887	25,97,16,017
vii)	International Training Center-ITCOO	-	5,040	5,040
viii)	HPC System-INCOIS	13,65,14,440	-	13,65,14,440
ix)	IT&E Governance Fund	5,76,21,080	-	5,76,21,080
x)	HPC Systems-Others	1,33,61,57,396	-	1,33,61,57,396
xi)	V SAT Node	6,23,90,887	9,07,079	6,32,97,966
xii)	Ernet India	72,00,000	-	72,00,000
xiii)	IOAS	51,25,986	-	51,25,986
	Total	**3,57,82,12,315**	**15,62,49,659**	**3,73,44,61,974**

b) Projects and Utilisation Certificates:

The Committees consisting the heads of respective projects and other technical persons are monitoring the status of the various projects, including the financial budgets etc., and noting the minutes of the output of such meetings.

The various assets of the projects and sub projects, purchased either by the INCOIS or respective projects and sub projects, are located at such projects and sub projects. The confirmations of the assets held by them are yet to be received.

The respective project heads send the utilization certificates for the year ending 31st March of each financial year and these certificates are received by the INCOIS during the subsequent financial year. Hence, the management had decided to pass the entries relating to the Utilisation Certificates actually received upto 31st March of each financial year.

c)

i) Contingent liabilities not provided for : NIL

ii) Estimated amount of Contracts remaining to be executed on capital account-NIL

iii) Claims against the company not acknowledged as debts-NIL

iv) The society had placed an order with M/s. Victory Genset Pvt. Ltd for purchase of two 600 KVA DG sets in the year 2009 and released 90% payment by irrecoverable LC. as per terms agreed. But, M/s. Victory Genset Pvt. Ltd had supplied only one DG set. The society claims that the documents were fabricated by supplier and hence, filed a criminal and civil suit in 2009 against the supplier. The III Additional Chief Judge of City Civil Court, Hyderabad, had passed a decree for the recovery of claim for breach of contract vide their order OS No.69 of 2010, dated 18-04-2012. Recovery is under process.

d) Figures of the previous year were regrouped wherever necessary.

e) Paise had been rounded off to the nearest rupee.

As per our report of even date
For **B.SRINIVASA RAO & CO.,**
Chartered Accountants

(Ch Anand)
Partner
M.No. 222732
FRN No: 008763S

Place: Hyderabad
Date: 08-07-2013

For and on behalf of **INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES**

(S. Nageswara Rao)
Accounts Officer

(K.K.V. Chary)
Sr. Administrative Officer

(S.S.C. Shenoi)
Director


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