**EFC/SFC memorandum for appraisal of " Ocean Advisory & Information Services, Computational Infrastructure & Communication Systems (OASIS)"**

**1. Scheme Outline**

**1.1 Title of the scheme: Ocean Advisory& information Services, computational Infrastructure and communication Systems (OASIS)**

**1.2 Sponsoring Agency (Ministry/Department/ Autonomous Body or undertaking): Ministry of Earth Sciences (MoES)**

**1.3 Total Cost of the proposed scheme:** 184.685 Crores.

**1.4 Proposed duration of the scheme:** Three years (2017 - 2020).

**1.5 Nature of the scheme: Central Sector scheme/ Centrally Sponsored Scheme:** Central Sector Scheme

**1.6 For central schemes, sub-schemes/components, if any, may be mentioned. For centrally sponsored schemes, central and state components, if any, may be mentioned**

**1.7 Whether a new/a continuing scheme? In case of continuing scheme, whether old scheme was evaluated and what were main findings:**
**It is a continuous Scheme.** Old scheme was evaluated thoroughly and recommended for continuation of Independent Review Committee (IRC) constituted by Ministry of Earth Sciences (MoES). The major findings/outcome/deliverables of this project is given in Annexure -4.

**1.8 Whether in principle approval is required? If yes has been obtained:** Required

**1.9 Whether a Concept paper or a detailed paper has been prepared and stake holders consulted? In case of new centrally Sponsored scheme, whether the state governments have been consulted?**
Not applicable as this is continuing program and accordingly a SFC is prepared and submitted.

**1.10 Which existing schemes/ sub-schemes are being dropped, merged or rationalized?**
None are dropped, merged or rationalized.

**1.11 Is there an overlap with an existing scheme/sub-scheme? If so, how duplication of effort and wastage of resources are being availed:** No

**1.12 In case of an umbrella scheme (program) give the details of scheme and sub-schemes under along with the proposed outlay component-wise.** No
Note: It may kindly be noted that the word scheme here is used in a generic sense. It includes

programs, schemes and sub-schemes, which depend on need can be appraised and approved as stand-alone coast centres.

## 2 Outcomes and Deliverables

### 2.1 Stated aims and objectives of the schemes

2.1a. INCOIS is mandated to provide the best possible ocean information and advisory services to society, industry, government agencies and the scientific community through sustained ocean observations and constant improvements through systematic and focussed research. Currently the following services are being provided to the users and the supporting facilities for these services are being maintained. This proposal intended to sustain and improve the following services.

I. Tsunami Early Warning System
II. Storm Surge Early Warning System
III. Ocean State Forecast Services
IV. Marine Fisheries Advisory Services
V. Multi Hazard Vulnerability Mapping Services
VI. Coral Bleaching Alert System
VII. Data Services
VIII. Computational Facilities, Web Based Services and Communication Facility
IX. Establishing Field Stations/Regional Centres for operational ease

**2.1b. Detailed objectives and activities proposed under each service has been provided in the following section.**

**i) Tsunami Early Warning System**

The Indian Tsunami Early Warning System (ITEWS)has the responsibility to provide tsunami advisories to Indian Mainland and the Island regions. Acting as one of the Regional Tsunami Advisory service Providers (RTSPs) for the Indian Ocean Region, ITEWS also provide tsunami advisories to the Indian Ocean rim countries.

- Sustain and improvement of National Tsunami warning System.
- Sustain and improvement of Regional Tsunami Service for the Indian Ocean region.
- Sustain and maintain the existing core tsunami observation network.
- Enhance DSS application, sea-level data inversion, modelling and other associated elements for provision of services for Indian Domain and Global Domains.
- Utilization of real-time GNSS and SMA data for operational tsunami warning.
- Real-time tsunami modelling and inundation mapping for vulnerable Indian coasts.
- Capacity building, Education & Training.
- Conduct regular communication tests and mock drills.
- Operationalization of tsunami services for South China Sea through RIMES framework.
- Tsunami risk assessment for high vulnerable coasts.

**ii) Storm Surge Early Warning System**

- Development and implementation of storm surge forecasting service to provide early warning advisory on storm surge heights and associated inland inundation extents along the Indian coasts.

**iii) Ocean State Forecast Services**

- To forecast the state of the ocean in a daily operational manner, and to disseminate the forecasts and ocean information to a wide range of user categories through different modes of dissemination.
- To sustain and improve the high resolution coastal and open ocean (regional-basis) daily operational forecasts, advisories and products.
- To deliver user-specific, impact-based and user-demanded forecasts and analysis products to the users.
- To obtain the validation of the forecasts and maintenance of the OSF-related real-time observational networks through decentralized funded projects.
- To deliver customized forecast products to industries and maritime users
- Spearhead in Ocean forecast services in the Indian ocean region

**iv) Marine Fisheries Advisory Services**

- Sustain and Improve PFZ and Tuna Fishery Advisories.
- Development of Species Specific fishery advisories for other species like Hilsa, Oil Sardine, etc.
- Improved dissemination mechanisms.
- New Initiatives towards Ecosystem based long-term Fishery Advisory Services (EFAS).

**v) Multi Hazard Vulnerability Mapping Services**

- Improvements/up gradation of the MHVM.
- Improvement and maintenance of 3D VAS application.
- Coastal risk assessment.

**vi) Coral Bleaching Alert System**

Objective of the service is to provide the satellite based coral bleaching alert, Geospatial services. The following activities are being proposed

- Sustain the service of Coral Bleaching Alert System.
- Improvement of the service by adding the feasible additional parameter.
- Up gradation of coastal geospatial database.
- Development of digital classification scheme for the coral reefs.
- Assessment of the extent of the bleaching impact using high resolution satellite data.

**vii) Data Services**

The aim of data services component of OASIS is to provide research quality data and derived products for performing high quality research on some of the active areas of research pertaining to Indian Ocean. Major objectives of the project are:

- Sustain the acquisition and distribution of data.
- Sustain the reception, processing and quality control of data from existing in-situ observing systems viz., Argo Floats, Moored Buoys, Drifting Buoys, XBT/XCTD, Current Meter Moorings, AWS, Wave Rider Buoys, Wave Height Meters etc.
- Add data from new observations like Gliders, Bay of Bengal Observatories, Project Specific data sets, OMM cruises to the processing chain.

- Set up Integrated Metadata portal for all the parameters and data generated through MoES institutes.
- Sustain the existing ground stations and generate remote sensing products for all operational services.
- Enhance the quality control methods for correcting the data and making them of research quality.
- Digital Ocean visualization Lab for on the fly visualization of data and products.
- Efficient tracking of data users by adopting Digital Object Identifier (DOI) methods.
- Up-gradation of existing ground stations for future missions viz. Oceansat-3, NPP, JPSS etc.
- Use Big data concepts to handle huge data from remote sensing and ocean models.
- Implementing data analytics, e and m-commerce while catering data to users.
- Setting up of private cloud to host and manage data.
- Generate long term remote sensing products for climate studies from NOAA & OCM series.
- Develop user preference time interval composite, high resolution (750m) operational physical and biological data products from JPSS series of satellites.
- Development of value added products from all the data obtained from search and rescue operations.
- Inject the data for generation of re-analysis products. Reach out to universities to bring about data awareness and effective utilization of data archived at INCOIS.
- Reach out to users through ITCOO training programs.
- Conduct theme based workshops targeting researchers and students from various organizations and universities. Fund data utilization projects for identified themes of use to INCOIS data management activities.
- Carry out digitization activities of hand written old ship cruise records.

**viii) Computational Facilities, Web Based Services and Communication Facility:**

- Designing, Planning & Implementation and Maintenance of IT Projects for various Operational and R&D Projects.
- Finalization of suitable specs, preparation of RFPs towards procurement of High end parallel computing cluster systems, Procurement and installation of other IT Infrastructure to support operational and R&D activities of INCOIS.
- System administration and application porting/installations so as to ensure smooth functioning of various operational and R&D projects.
- Network Planning, Procurement & installation of network components.
- Design, Implementation and operations & maintenance of Networking including Wi-Fi, Internet Bandwidth.
- Development, Hosting and Maintenance of INCOIS Website, Tsunami Website, ISGN Website etc.
- Development and maintenance of application software and other web applications.

**Communication Facilities:**

- Designing, planning, implementation and maintenance of communication facilities required for various projects at INCOIS.

- Augmentation &Upgradation of INSAT Terminals & Associated equipment, VSAT terminals &associated equipment, Seaspace (SDAPS) Radome antenna & associated equipment including hardware & software, VPN-DMS terminal & associated video conferencing equipment, Oceansat-II terminal & associated ground station equipment etc.
- Procurement of new antenna terminals, electronics & communication components, related communication / control systems, INSAT based communication system for PFZ data, etc including establishment of electronics lab for attending first level trouble shooting activities of various communication systems

**ix) Field Stations / Regional Centres**

- Generate the regional specific customized ocean information and advisories including future forecasts.
- To carry out validation of the models / services / forecasts in the coastal regions.
- Establish the necessary lab facilities (infrastructure and technology platforms) to support the coastal and open-ocean observation platforms and to sustain and maintain the platforms.
- Enhance the coastal observation platforms, sustain of existing and new observation platforms and maintenance.
- Extend the laboratory facilities for all operational oceanography courses conducted under the ITCOOcean and produce strong and sustainable human resources in practical knowledge.
- Serve as the laboratory facility for academia and collaborative institutes for data analysis.
- To provide Capacity Building and awareness on Ocean services.

**2.2 Indicate year-wise deliverable in tabular formation**

Details are provided under **Annexure-1**

**2.3 Indicate outcomes of the schemes in the form of measurable indices which can be used to evaluate the proposal periodically. Baseline data or survey against which such outcome bench marked also should be mentioned.**

Outcomes of the scheme can be measured based on the no of advisories given to the end users, number of products, reports, publications generated for the services and increasing user base for the services provided. Further the economic benefits of the services provided by INCOIS under this project/scheme is clearly evaluated and summarized in a independent report brought out by NCEAR.

**2.4 Indicate other schemes/sub- schemes being undertaken by the Ministries/Departments which has significant outcome overlap with the proposed scheme. What converges framework have been evolved to consolidate out comes and save public resources**

No overlap of schemes.

**3. Target Beneficiaries**

**3.1 If the scheme is specific to any location, area and segment of population, please give the details and basis for selection**

One component of this project is intended to assess the coastal vulnerability and risk along the selected

vulnerable coasts.

**3.2 Please bring out specific interventions directed in favour of social groups, namely SC, ST, differently abled, minorities and other vulnerable groups.**

Not applicable, as the ocean information and advisory services are aimed to cover all the coastal population irrespective of gender, caste and creed.

**3.3 Please bring out special interventions if any, in northeast, Himalayan, LWE, Island territories and other backward areas**

Not applicable

**3.4 In case of beneficiary oriented schemes, indicate the mechanism for identification of target beneficiaries and the linkage with Addhaar/ UID numbers**

Not applicable as the ocean information and advisory services are aimed to cover all the coastal population irrespective of gender, caste, creed and whether they dwell along the coast or in islands.

**3.5 Whether possible, the mode of delivery should involve the Panchayat Raj institutions and Urban local bodies. Whether this is indented, the preparedness and ability of the local bodies for executing the proposal may also be examined**

Not applicable.

**4. Cost Analysis**

**4.1 Cost estimate for the Scheme duration: both year-wise, scheme wise and item wise separately, segregated into non-recurring and recurring expenses are given below. Further details are provided in Annexure-2.**

| **Budget for the period 2017 - 2020** | **Outlay (Rs. In Crores)** | | | |
|---|---|---|---|---|
| **Service** | **2017-18** | **2018-19** | **2019-20** | **Total** |
| Tsunami Early Warning System | 14.25 | 12.95 | 8.31 | **35.51** |
| Storm Surge Early Warning System | 0.735 | 0.26 | 0.23 | **1.225** |
| Ocean State Forecast Services | 3.11 | 9.16 | 9.08 | **21.35** |
| Marine Fisheries Advisory Services | 9.83 | 10.34 | 9.06 | **29.23** |
| Multi Hazard Vulnerability Mapping Services | 16.58* | 6.5 | 6.55 | **13.05** |
| Coral Bleaching Alert System | 0.49 | 0.49 | 0.49 | **1.47** |
| Data Services | 7.76 | 4.66 | 2.7 | **15.12** |
| Computational Facilities, Web Based Services and Communication Facility | 37.65 | 14.15 | 13.2 | **65.00** |
| Field Stations | 0.78 | 1.01 | 0.94 | **2.73** |

| | | | | |
|---|---|---|---|---|
| **Total** | 74.605 | 59.52 | 50.56 | **184.685** |

*Approved budget available from initial sanction (during previous FYPs - DOD/4/6/2005 - TC (part II) dated 3rd march, 2011 and corrigendum dated17th April, 2014 and corrigendum dated September, 2016 ) and work will spill over to 2017-18 this is excluded in the current proposal for arriving at the total budget.

**4.2 The basis of these cost estimates along with the reference dates for normative coasting**

As per current market prices and current salaries of temporary scientific staff

**4.3 In case of land is to be acquired, the details of coast of land coast of rehabilitation/Resettlement, if any**

Land acquisition of one acre on east coast and one acre on the west coast is required for the establishment of two field stations/ regional centres as per prevailing market rate fixed by government.

**4.4 In case of pre-investment activities or pilot studies are being carried out, how much has been spent on this.**

Not applicable

**4.5 In the case of the scheme involves payout subsidy, the year wise and component wise expected out go may be indicated**

Not applicable

**4.6 In case committed liabilities are created, who will or has agreed to bear the legacy burden? In case assets are created, arrangements for their maintenance and upkeep?**

Not created.

**5 Scheme Financing**

**5.1 Indicate the source of finance for the scheme: budget support, extra-budgetary sources, external aid, state share etc.**

It is central budget support scheme

**5.2 If external sources are intended, the sponsoring agency may indicate, as also whether such funds have been tied up?**

Not applicable

**5.3 Indicate the components of the coast that will be shared by the state governments, local bodies, user beneficiaries or private parties?**

Not applicable

**6 Approvals and Clearances**

Requirement of mandatory approvals and clearances from various local, state and national bodies and their availability may be indicated in a tabular form (land acquisition, environment, forestry, wildlife

etc.)
No approvals required

**7 Human Resources**

**7.1 Indicate the administrative structure for implementing the scheme. Usually creation of new structures, entities etc should be avoided.**

The present administrative structure in INCOIS/MoES will be utilized.

**7.2 Manpower requirement, if any. In the case posts, permanent or temporary, are intended to be created, a separate proposal may be sent on file to personal division of department of expenditure (such proposals may be sent only after the main proposal is recommended by the appraisal body)**

Total manpower requirement is provided here under. Service wise manpower break up is given under **Annexure-3**

| Year | Requirement in each year | | | Cumulative strength | | |
|---|---|---|---|---|---|---|
| | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants | **Office Assistants/Lab Attendants/ Drivers** | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants * | **Office Assistants/ Lab Attendants /Drivers** |
| 2017-18 | 35 | 29 | 10 | 35 | 29 | 10 |
| 2018-19 | 9 | 12 | 0 | 44 | 41 | 10 |
| 2019-20 | 2 | 2 | 0 | 46 | 43 | 10 |

The recruitment of project scientists and research fellows/Project Assistants will be done every six months whenever vacancy arises during the project period.

**7.3 In case outsourcing of services on hiring of consultants is intended, brief details of the same may be provided.**

Professional services and CAMC/AMC work components mentioned under various services are being out sourced.

**8. Monitoring and Evaluation**

**8.1 Please indicate the monitoring framework for the scheme and the arrangements for statutory and social audit (if any)**

There will be valuating committees such as Research Advisory committee (RAC), Governing council (GC), SRMC, SSC. Apart from this, a high level project monitoring committees(PMCs), TFE, etc are in place to guide/monitor/evaluate these projects.

**8.2 Please indicate the arrangements of third party/independent evaluation? Please note that**

**evaluation is necessary for extension of schemes from one period to another**
IRCs will be formed for evaluation of projects also.

**9. Comments** of Finance advisor, Niti Aayog, department of expenditure and other ministries/Department may be summarized in tabular form along with how they are being internalized and used to improve this proposal

**10 Approval sought**
Please attach an executive summary along with the concept/detailed paper outlining the main elements and overallarchitecture of proposed scheme. The executive summary of the scheme is provided as **Annexure-4.**

**Annexure-1**

2.2 Indicate year-wise deliverable in tabular formation

The year wise deliverables of the different services proposed are provided in the following tables

**i) Tsunami Early Warning System**

Year wise deliverables for the period 2017 - 2020.

| Year | Deliverables |
|---|---|
| 2017-18 | • Detect, locate and determine the magnitude of potentially tsunamigenic earthquakes occurring in the Indian Ocean and provide timely advisories on 24 X 7 basis to India & Indian Ocean rim countries.<br>• Sustain and maintain the existing core tsunami observation network.<br>• Setting up of unit source parameters for global subduction zones based on subduction zone geometry and generate coastal forecast points & Zones for global domain.<br>• Generation of open ocean propagation data base (OOPSDB) master simulation of for global domain<br>• Maintenance and enhancements of the existing DSS application<br>• Validation studies of sea level inversion mechanism.<br>• Operationalization of sea level inversion using open ocean observations.<br>• Enhanced Tsunami operational services using GNSS & SMA data<br>• Setting up of models for Stand by Inundation modelling (SIM) & Real Time Inundation Modelling(RIMS) activities<br>• Parallelization of Tunami N3 code using state of the art technology to achieve minimal and rapid computations<br>• Tsunami Workshops for National/ International stakeholders<br>• Conduct two Communication tests for validating the communication links/modes.<br>• Tsunami awareness material in coastal languages |
| 2018-19 | • Detect, locate and determine the magnitude of potentially tsunamigenic earthquakes occurring in the Indian Ocean and provide timely advisories on 24 X 7 basis to India & Indian Ocean rim countries.<br>• Operationalization of tsunami services for south China Sea through RIMES framework<br>• Sustain and maintain the existing core tsunami observation network.<br>• Utilization of coastal tide gauge GNSS data in tsunami operations.<br>• Validation of Master simulations of global domains<br>• Mount efforts for Parallelization of Tunami F2<br>• Continue to generate the OOPSDB<br>• Modular decision support system Development to use in mobile workstations<br>• Green functions for coastal SIMs<br>• Sea level inversion using Coastal tide gauges data.<br>• Real time inundation modelling (RIM) for Selected Indian vulnerable coastal regions<br>• Website for tsunami awareness and preparedness<br>• Tsunami Workshops, Sensitization workshops on tsunami preparedness for National/ |

| | |
|---|---|
| | International stakeholders<br>• Conduct two Communication tests for validating the communication links/modes.<br>• Tsunami Mock drills<br>• Tsunami awareness material in coastal languages |
| 2019-20 | • Detect, locate and determine the magnitude of potentially tsunamigenic earthquakes occurring in the Indian Ocean and provide timely advisories on 24 X 7 basis to India & Indian Ocean rim countries& South China sea countries.<br>• Sustained maintain the existing core tsunami observation network.<br>• DSS application maintenance and optimization for cloud environment<br>• Sea level inversion using Coastal tide gauges data.<br>• Operationalization of service level -III by including the inundation information in the bulletins<br>• Enhancement of the tsunami website to serve for service level -III with inundation maps facility , loss estimate system, etc<br>• Tsunami Workshops, Sensitization workshops on tsunami preparedness for National/ International stakeholders<br>• Conduct two Communication tests for validating the communication links/modes.<br>• Tsunami Mock drills<br>• Tsunami awareness material in coastal languages |

**ii) Storm Surge Early Warning System**

Year wise deliverables for the period 2017 - 2020.

| Year | Deliverables |
|---|---|
| 2017-18 | • Formulation of methodology for Probabilistic Storm Surge guidance system (P-Surge) will be completed.<br>• Automated P-Surge guidance system is planned to complete here. |
| 2018-19 | • Automation of P-surge guidance will be done here if this part is pending.<br>• Setting up of ADCIRC + SWAN Coupled model as part of the enhancement of the current storm surge early warning system. |
| 2019-20 | • Enhance the capabilities of current Decision Support System (DSS) with open source software's and platform. Inclusion of Population index and strategic coastal infrastructure impact information due to coastal inundation in surge bulletins. |

**iii) Ocean State Forecast Services**

Year wise deliverables for the period 2017 - 2020.

| Year | Deliverables |
|---|---|
| 2017-18 | • Maintained and improved (accuracy, spatio-temporal resolution and reliability) Ocean State Forecast Services.<br>• User-demanded new products and Services (**wave surge advisories, Port Information System, Offshore wind farm advisory GUI and Mobile App etc.**) and any product based on time-to-time user requirement/demand.<br>• Customized forecast services to offshore and costal industries. |

| | |
|---|---|
| 2018-19 | • Maintained and improved (accuracy, spatio-temporal resolution and reliability) Ocean State Forecast Services.<br>• User-demanded new products and Services (like **small craft advisories**) and any product based on time-to-time user requirement.<br>• Integrated ocean forecast services to Indian Ocean countries in collaboration with RIMES.<br>• More validation programs to improve Services. |
| 2019-20 | • Maintained and improved (accuracy, spatio-temporal resolution and reliability) Ocean State Forecast Services.<br>• User-demanded new products and Services (**Interactive navigation tools, Navy-specific encrypted forecast system etc.**) and any product based on time-to-time user requirement.<br>• Improved dissemination chain especially direct dissemination to Sea.<br>• Customized forecast services to coastal tourism.<br>• More User interaction meetings and awareness programs to strengthen the customer base. |

**iv) Marine Fisheries Advisory Services**

Year wise deliverables for the period 2017 - 2020.

| Year | Deliverables |
|---|---|
| 2017-18 | • Daily Fishery advisories<br>• Capacity Building and awareness workshops – 5 Nos.<br>• Enhancement in the user base.<br>• Experimental species specific advisories on Hilsa<br>• Validation of experimental advisory services<br>• R &D on fishery and primary productivity modelling. |
| 2018-19 | • Daily Fishery advisories<br>• Capacity Building and awareness workshops – 5 Nos.<br>• Enhancement in the user base<br>• First out come on spawning/breeding ground (Hilsa) monitoring system, to define contribution on stock.<br>• Validation of experimental advisory services.<br>• R &D on fishery and primary productivity modelling. |
| 2019-20 | • Daily Fishery advisories<br>• Capacity Building and awareness workshops – 5 Nos.<br>• Enhancement in the user base<br>• Validation of experimental advisory services.<br>• R &D on fishery and primary productivity modelling. |

**v) Multi Hazard Vulnerability Mapping Services**

Year wise deliverables for the period 2017 - 2020.

| **Year** | **Deliverables** |
|---|---|
| 2017-18 | • Completion of the 3D GIS mapping for the remaining 3300 sq km |

| | |
|---|---|
| | • Fair weather condition and timely permissions are constraint for the survey |
| 2018-19 | • Improvements/ugradation of the MHVM along the west coast using the ALTM data from NRSC Phase-II project<br>• Availability of input data is constraint. |
| 2019-20 | • Coastal risk assessment<br>• Initiate the ALTM survey for Islands<br>• MHVM Atlas for Indian Mainland with updated maps |

**vi) Coral Bleaching Alert System**

Year wise deliverables for the period 2017 - 2020.

| Year | Deliverables |
|---|---|
| 2017-18 | • Coral Bleaching Alerts<br>• Collection of data from field and other collateral; sources, satellite data processing |
| 2018-19 | • Coral Bleaching Alerts<br>• Collection of data from field and other collateral sources, satellite data processing<br>• Improvements of coral bleaching alerts<br>• Availability of the data in near-real time is the constraint |
| 2019-20 | • Improved Coral Bleaching Alerts<br>• Processing of satellite data, field data and other secondary data<br>• Improvements of coral bleaching alerts<br>• Coral reef classification scheme for the assessment of the changes |

**vii) Data Services**

Year wise deliverables for the period 2017 - 2020.

| Year | Deliverables |
|---|---|
| 2017-20 | • High quality data sets for operational and research use.<br>• Value added products from in situ and remote sensing for operational and research purpose.<br>• New ground station for OCM-3 and other future remote sensing missions like JPSS, NPP etc.<br>• Awareness about data holdings and increase in usage of data and data products leading to increased publications and thesis.<br>• State of art data and related services with the use of Digital Ocean and research coming out of funded projects.<br>• Enhance the reach ability by using LAS, ERDAP and web based services.<br>• Rescue and archiving of legacy data added to Indian Ocean Hydrobase.<br>• Digitized records of old cruises data leading to enhancement data for climate studies. |
| 2018 - 19 | • High quality data sets for operational and research use.<br>• Value added products from in situ and remote sensing for operational and research purpose.<br>• New ground station for OCM-3 and other future remote sensing missions like JPSS, |

| | |
|---|---|
| | NPP etc.<br>• Awareness about data holdings and increase in usage of data and data products leading to increased publications and thesis.<br>• State of art data and related services with the use of Digital Ocean and research coming out of funded projects.<br>• Rescue and archiving of legacy data added to Indian Ocean Hydrobase.<br>• Digitized records of old cruises data leading to enhancement data for climate studies. |
| 2019 - 20 | • High quality data sets for operational and research use.<br>• Value added products from in situ and remote sensing for operational and research purpose.<br>• Awareness about data holdings and increase in usage of data and data products leading to increased publications and thesis.<br>• State of art data and related services with the use of Digital Ocean and research coming out of funded projects.<br>• Enhance the reach ability by using LAS, ERDAP and web based services.<br>• Rescue and archiving of legacy data added to Indian Ocean Hydrobase. |

**viii) Computational Facilities, Web Based Services and Communication Facility**

Year wise deliverables for the period 2017 - 2020.

| Year | Deliverables |
|---|---|
| 2017-18<br>2018-19<br>2019-20 | **Computing:**<br>• Planning, Implementation, operations and maintenance of computing infrastructure (hardware, software, networking, application software etc) for various Operational and R&D projects of INCOIS.<br>• Setting up of data centre for Installation and maintenance of new HPC (700-800TF with 4PB storage).<br>• Procurement, Installation and maintenance of about 50TF with 500TB storage HPC.<br>• Augmentation and up-gradation of hardware, software, networking etc.<br>• Technology refreshment of Tsunami Data Centre.<br>• Changing IP v4 based network to IP v6 network.<br>• Establishment of DR Site for INCOIS data and services.<br>• ISO Certification for CWG activities.<br>• Central computing facility.<br>• Implementation and maintenance of 3D VAS, Digital Ocean, Integrated Dissemination System etc.<br>**Web Based Services:**<br>• Continue to maintain INCOIS Website, ISGN Website, Tsunami Website, and IIOE-2 Website including various other web applications.<br>• SSL Certification for INCOIS Website & Ocean Data Portal<br>• Development of 2D and 3D Visualization, Analysis and Inundation Modeling Software Application (3DVAS).<br>• Streamlining of Web application for Ocean Data Information System (ODIS) |

| | |
|---|---|
| | • Development of WebGIS Application to display the Cruise Information and IIOE-2 Metadata Portal.<br>• Development of the Online Discussion Forums for IIOE-2 and INCOIS Intranet websites.<br>• Mobile Applications for INCOIS Services<br>• Restructuring the design for MoES Metadata Portal, Tsunami Website, Argo Floats Web Application and web mapping applications.<br>• Login Based Online Recruitment Portal with various reports generation, screening of the applications facility.<br>**Communication Facilities:**<br>• Installation of 5 no's of new Radar based Tide Gauge systems for reception of real time tide gauge data.<br>• Up gradation of INSAT MSS and DRT hub systems at INCOIS.<br>• Up gradation of existing 21 Tide gauge systems (Data loggers & sensors).<br>• Up gradation of 21 No's of INSAT MSS and UHF transmitters at Tide gauge locations.<br>• Up gradation of INSAT Data processing systems at INCOIS.<br>• Prototype demonstration of IRNSS/GAGAN based data dissemination system for INCOIS.<br>• Prototype demonstration of INSAT based two ways Terminal for Ocean observation platforms.<br>• Permanent communication lab setup at INCOIS for communication related activities. |

**ix) Field Stations / Regional Centres**

Year wise deliverables for the period 2017 - 2020.

| Year | Deliverables |
|---|---|
| 2017-18 | • Establishment of Field stations<br>• Development of Sampling Protocols and manuals on operation of equipments<br>• Community Awareness on the existence, facilities and benefits<br>• Extending the existing ocean services.<br>• Training programmes<br>• Field support to the observation programmes of INCOIS |
| 2018-19 | • Establishment of laboratory facilities for sample analysis<br>• Development of Sampling Protocols and manuals on operation of equipments<br>• Community Awareness on the existence, facilities and benefits<br>• Extending the existing ocean services.<br>• Field support to the observation programmes of INCOIS. |
| 2019-20 | • Training Manuals, Reports and Scientific Papers<br>• Field support to the observation programmes of INCOIS. |

Annedxure-2

**4.1 Cost estimate for the Scheme duration: both year-wise, component-wise, segregated into non-recurring and recurring expenses.**

i) **Tsunami Early Warning System**

Budget proposed for the period 2017-2020 (in Crores)

| S No. | Item | 2017-18 | 2018-19 | 2019-20 | Total |
|---|---|---|---|---|---|
| 1 | Salaries | 0.9 | 1.95 | 2.15 | 5 |
| 2 | Domestic Travel Expenses | 0.1 | 0.15 | 0.15 | 0.4 |
| 3 | Foreign Travel Expenses | 0.25 | 0.5 | 0.5 | 1.25 |
| 4 | Office Expenses | 0.05 | 0.05 | 0.05 | 0.15 |
| 5 | Publications | 0.05 | 0.1 | 0.1 | 0.25 |
| 6 | Other Administrative Expenses | 0.5 | 0.1 | 0.1 | 0.7 |
| 7 | Supplies & Materials | 4.14 | 3.12 | 3.68 | 10.94 |
| 8 | Advertising & Publicity | 0.1 | 0.24 | 0.29 | 0.63 |
| 9 | Minor Works | 0 | 0 | 0 | 0 |
| 10 | Professional Services | 0.5 | 1.24 | 1.29 | 3.03 |
| | **Total (Revenue)** | **6.59** | **7.45** | **8.31** | **22.35** |
| 11 | Machinery & Equipment | 7.66 | 5.5 | 0 | 13.16 |
| 12 | Major Works | 0 | 0 | 0 | 0 |
| 13 | **Total (Capital)** | **7.66** | **5.5** | **0** | **13.16** |
| 14 | **Total (Revenue + capital)** | **14.25** | **12.95** | **8.31** | **35.51** |

ii) **Storm Surge Early Warning System**

Budget proposed for the period 2017-2020 (in Crores)

| Sl No. | | 2017-18 | 2018-19 | 2019-20 | Total |
|---|---|---|---|---|---|
| 1 | Salaries | 0 | 0 | 0 | **0** |
| 2 | Domestic Travel Expenses | 0.02 | 0.03 | 0.04 | **0.09** |
| 3 | Foreign Travel Expenses | 0.1 | 0.12 | 0.14 | **0.36** |
| 4 | Office Expenses | 0 | 0 | 0 | **0** |
| 5 | Publications | 0.02 | 0.02 | 0.02 | **0.06** |
| 6 | Other Administrative Expenses | 0.00 | 0.06 | 0.00 | **0.06** |
| 7 | Supplies & Materials | 0.5 | 0 | 0 | **0.5** |
| 8 | Advertising & Publicity | 0.01 | 0.01 | 0.01 | **0.03** |
| 9 | Minor Works | 0 | 0 | 0 | **0** |
| 10 | Professional Services | 0 | 0 | 0 | **0** |
| | **Total (Revenue)** | **0.65** | **0.24** | **0.21** | **1.1** |
| 11 | Machinery & Equipment | 0.085 | 0.02 | 0.02 | **0.125** |
| 12 | Major Works | 0 | 0 | 0 | **0** |
| 13 | **Total (Capital)** | **0.085** | **0.02** | **0.02** | **0.125** |
| 14 | **Total (Revenue + capital)** | **0.735** | **0.26** | **0.23** | **1.225** |

iii) **Ocean State Forecast Services**

Budget proposed for the period 2017-2020 (in Crores)

| Sl No. | | 2017-18 | 2018-19 | 2019-20 | Total |
|---|---|---|---|---|---|
| 1 | Salaries | 0.7 | 1.3 | 1.3 | **3.3** |
| 2 | Domestic Travel Expenses | 0.1 | 0.2 | 0.2 | **0.5** |
| 3 | Foreign Travel Expenses (For training & instrument establishment plus DA etc.) | 0.1 | 0.4 | 0.2 | **0.7** |
| 4 | Office Expenses | 0.03 | 0.03 | 0.03 | **0.09** |
| 5 | Publications | 0.05 | 0.05 | 0.05 | **0.15** |
| 6 | Other Administrative Expenses (Dissemination charges, boat hiring charges etc.) | 0.15 | 0.35 | 0.35 | **0.85** |
| 7 | Supplies & Materials (Data & software purchase, AMC of hardware/software etc.) | 0.3 | 1.3 | 1.4 | **3** |
| 8 | Advertising & Publicity (User interaction, awareness & training workshop, outreach programme, publicity materials expense etc.) | 0.2 | 0.2 | 0.2 | **0.6** |
| 9 | Minor Works (Civil & electrical works) | 0.03 | 0.03 | 0.03 | **0.09** |
| 10 | Professional Services (Outsourced validation projects, training to in-house forecasting personnel etc.) | 1 | 3.8 | 3.8 | **8.6** |
| 11 | Integrated Ocean Information Services (OSF and Tsunami) to IO countries through RIMES | 0.15 | 0.8 | 0.8 | **1.75** |
| | **Total (Revenue)** | **2.81** | **8.46** | **8.36** | **19.63** |
| 12 | Machinery & Equipment (Hardware, Desktops, Laptop, storage, instrument/equipment, peripherals etc.) | 0.3 | 0.7 | 0.72 | **1.72** |
| 13 | Major Works | 0 | 0 | 0 | **0** |
| 14 | **Total (Capital)** | **0.3** | **0.7** | **0.72** | **1.72** |
| 15 | **Total (Revenue + capital)** | **3.11** | **9.16** | **9.08** | **21.35** |

iv) **Marine Fisheries Advisory Services**

Budget proposed for the period 2017-2020 (in Crores)

| Sl No | Budget Item | 2017-18 | 2018-19 | 2019-20 | Total |
|---|---|---|---|---|---|
| 1 | Salaries (Existing: 2 Scientists, 4 Sci Assts. + 2 new Scientists & 3 new Sci Asst + 1 Lab Attendent as per 7th CPC) | 0.48 | 1.08 | 1.25 | **2.81** |
| 2 | Domestic Travel Expenses (Including DA, TA) | 0.10 | 0.25 | 0.25 | **0.60** |
| 3 | Foreign Travel Expenses (Including DA, TA) | 0.10 | 0.10 | 0.10 | **0.30** |

| | | | | | |
|---|---|---|---|---|---|
| 4 | Office Expenses (Stationery, Furniture, Meeting expenses etc) | 0.10 | 0.20 | 0.20 | **0.50** |
| 5 | Publications (Cost towards publications publication in peer review journals) | 0.00 | 0.01 | 0.01 | **0.02** |
| 6 | Other Administrative Expenses (Overhead charges, , Boat hiring, warphase fee, cruise related expenses, port handling charges, dissemination charges, etc) | 1.00 | 2.50 | 2.50 | **6.00** |
| 7 | Supplies & Materials (Communication, calibration, data purchase, data maps and manuals, AMC (for Integrated Dissemination System (IDS)), maintenance of equipment, labware, chemicals, tags and its accessories, etc) | 0.75 | 2.00 | 2.00 | **4.75** |
| 8 | Advertising & Publicity (User interaction and awareness, market survey, outreach programs, publicity materials (brochures, palm plates, short films etc)) | 0.10 | 0.15 | 0.20 | **0.45** |
| 9 | Minor Works | 0.00 | 0.00 | 0.00 | **0.00** |
| 10 | Professional Services (Consultancy projects, out sourced projects, training expenses, Integrated Dissemination System (IDS)) | 1.00 | 2.50 | 1.50 | **5.00** |
| | **Total (Recurring)** | 3.63 | 8.79 | 8.01 | **20.43** |
| 11 | Machinery & Equipment: Hardware, Desktops, instruments, equipments, laptops, storage, peripherals, software, Hardware for IDS, servers, etc. | 6.20 | 1.55 | 1.05 | **8.80** |
| 12 | Major Works (land acquisition, building | 0.00 | 0.00 | 0.00 | **0.00** |
| 13 | **Total (Non-Recurring)** | **6.20** | **1.55** | **1.05** | **8.80** |
| 14 | **Total (Revenue + capital)** | **9.83** | **10.34** | **9.06** | **29.23** |

**v) Multi Hazard Vulnerability Mapping Services**

Budget proposed for the period 2017-2020 (in Crores)

| **Sl No.** | | **2017-18*** | **2018-19** | **2019-20** | **Total** |
|---|---|---|---|---|---|
| 1 | Salaries (2 sciC, 2 Ass.) | 0.08* | 0.36 | 0.36 | **0.72** |
| 2 | Domestic Travel Expenses | 0 | 0.1 | 0.1 | **0.2** |
| 3 | Foreign Travel Expenses | 0 | 0 | 0 | **0** |
| 4 | Office Expenses | 0.00 | 0.02 | 0.02 | **0.04** |

| | | | | | |
|---|---|---|---|---|---|
| 5 | Publications | | 0.02 | 0.02 | **0.04** |
| 6 | Other Administrative Expenses | 0.5* | 0.3 | 0.3 | **0.6** |
| 7 | Supplies & Materials (Topographic /Satellite Data, 3DVAS | 8* | 5.5 | 5.55 | **11.05** |
| 8 | Advertising & Publicity | 0 | 0 | 0 | **0** |
| 9 | Minor Works | 0 | 0 | 0 | **0** |
| 10 | Professional Services (3D GIS Mapping) | 7* | 0 | 0 | **7** |
| | **Total (Revenue)** | **16.08** | **6.3** | **6.35** | **12.65** |
| 11 | Machinery & Equipment (Hardware/Software) | 0.5* | 0.2 | 0.2 | **0.9** |
| 12 | Major Works | 0 | 0 | 0 | **0** |
| 13 | **Total (Capital)** | **0** | **0.2** | **0.2** | **0.4** |
| 14 | **Total (Revenue + capital)** | **16.58*** | **6.5** | **6.55** | **13.05** |

*Approved budget available from initial sanction (during previous FYPs - DOD/4/6/2005 - TC (part II) dated 3rd march, 2011 and corrigendum dated17th April, 2014 and corrigendum dated September, 2016 ) and work will spill over to 2017-18 this is excluded in the current proposal for arriving at the total budget.

**vi) Coral Bleaching Alert System**

Budget proposed for the period 2017-2020 (in Crores)

| Sl No. | | 2017-18 | 2018-19 | 2019-20 | Total |
|---|---|---|---|---|---|
| 1 | Salaries (One SciC.) | 0.12 | 0.12 | 0.12 | **0.3** |
| 2 | Domestic Travel Expenses | 0.05 | 0.05 | 0.05 | **0.15** |
| 3 | Foreign Travel Expenses | 0.02 | 0.02 | 0.02 | **0.06** |
| 4 | Office Expenses | 0.02 | 0.02 | 0.02 | **0.06** |
| 5 | Publications | 0.01 | 0.01 | 0.01 | **0.03** |
| 6 | Other Administrative Expenses | 0.05 | 0.05 | 0.05 | **0.15** |
| 7 | Supplies & Materials (RS Data) | 0.1 | 0.1 | 0.1 | **0.30** |
| 8 | Advertising & Publicity | 0.00 | 0.00 | 0.00 | **0.00** |
| 9 | Minor Works | 0.00 | 0.00 | 0.00 | **0.00** |
| 10 | Professional Services (validation) | 0.1 | 0.1 | 0.1 | **0.30** |
| | **Total (Revenue)** | **0.47** | **0.47** | **0.47** | **1.41** |
| 11 | Machinery & Equipment (SW/HW) | 0.02 | 0.02 | 0.02 | **0.06** |
| 12 | Major Works | 0.00 | 0.00 | 0.00 | **0.00** |
| 13 | **Total (Capital)** | **0.02** | **0.02** | **0.02** | **0.06** |
| 14 | **Total (Revenue + capital)** | **0.49** | **0.49** | **0.49** | **1.47** |

vii) **Data Services**

Budget proposed for the period 2017-2020 (in Crores)

| SNo. | | **2017-18** | **2018-19** | **2019-20** | **Total** |
|---|---|---|---|---|---|
| 1 | Salaries (Existing 4 Scientist, 2 Sci Asst + 4 new Scientists & 2 new Sci Asst as per the 7th CPC.) | 0.75 | 0.8 | 0.85 | 2.4 |
| 2 | Domestic Travel Expenses (Including DA, TA) | 0.05 | 0.05 | 0.05 | 0.15 |
| 3 | Foreign Travel Expenses (Including DA, TA) | 0.1 | 0.1 | 0.1 | 0.3 |
| 4 | Office Expenses (Stationery, Furniture, Meeting expenses etc) | 0.02 | 0.02 | 0.01 | 0.05 |
| 5 | Publications (Cost towards publications publication in peer review journals) | 0.01 | 0.01 | 0.01 | 0.03 |
| 6 | Other Administrative Expenses (Overhead charges, Seamen charges, Exercise duty, Boat hiring, warphase fee, cruise related expenses, port handling charges, dissemination charges etc) | 0 | 0 | 0 | 0 |
| 7 | Supplies & Materials (Communication (OCM-3 ground station, JPSS), calibration, data purchase, data maps and manuals, AMC (Digital Ocean annual maintenance), maintenance of equipment etc) | 1.27 | 3.27 | 1.27 | 5.81 |
| 8 | Advertising & Publicity (User interaction and awareness, market survey, outreach programs, publicity materials (brochures, palm plates, short films etc)) | 0.02 | 0.02 | 0.02 | 0.06 |
| 9 | Minor Works | 0.04 | 0.04 | 0.04 | 0.12 |
| 10 | Professional Services (Consultancy projects, out sourced projects (Digital Ocean Development), training expenses) | 4.5 | 0.25 | 0.25 | 5 |
| | **Total (Revenue)** | **6.76** | **4.56** | **2.6** | **13.92** |
| 11 | Machinery & Equipment (Servers for Digital Ocean) | 1 | 0.1 | 0.1 | 1.2 |
| 12 | Major Works | 0 | 0 | 0 | 0 |
| 13 | **Total (Capital)** | 1 | 0.1 | 0.1 | 1.2 |
| 14 | **Total (Revenue + capital)** | **7.76** | **4.66** | **2.7** | **15.12** |

viii) **Computational Facilities, Web Based Services and Communication Facility**

Budget proposed for the period 2017-2020 (in Crores)

| **Sl** | | **2017-** | **2018-** | **2019-** | **Total** |
|---|---|---|---|---|---|
| 1 | Salaries | 1.40 | 1.60 | 1.80 | **4.80** |
| 2 | Domestic Travel Expenses | 0.10 | 0.10 | 0.10 | **0.30** |
| 3 | Foreign Travel Expenses | 0.10 | 0.10 | 0.10 | **0.30** |
| 4 | Office Expenses | -- | -- | -- | **--** |
| 5 | Publications | -- | -- | -- | **--** |
| 6 | Other Administrative Expenses | -- | -- | -- | **--** |
| 7 | Supplies & Materials **(CAMC)** | 6.50 | 7.00 | 7.10 | **20.60** |
| 8 | Advertising & Publicity | -- | -- | -- | **--** |
| 9 | Minor Works | -- | -- | -- | **--** |

| | | | | | |
|---|---|---|---|---|---|
| 10 | Professional Services **(Training)** | 0.10 | 0.10 | 0.10 | **0.30** |
| 11 | **Total (Revenue)** | **8.20** | **8.90** | **9.20** | **26.30** |
| 12 | Machinery & Equipment **(Augmentation, Procurement and other new initiatives)** | 29.45 | 5.25 | 4.00 | **38.70** |
| 13 | Major Works | -- | -- | -- | -- |
| 14 | **Total (Capital)** | **29.45** | **5.25** | **4.00** | **38.70** |
| 15 | **Total (Revenue + capital)** | **37.65** | **14.15** | **13.20** | **65.00** |

**ix) Field Stations / Regional Centres**

Budget proposed for the period 2017-2020 (in Crores)

| Sl | Budget Item | 2017-18 | 2018-19 | 2019-20 | Total |
|---|---|---|---|---|---|
| 1 | Salaries (Scientists – 2 Nos) | 0.10 | 0.22 | 0.25 | **0.57** |
| 2 | Domestic Travel Expenses | 0.05 | 0.10 | 0.10 | **0.25** |
| 3 | Foreign Travel Expenses | 0.00 | 0.00 | 0.00 | **0.00** |
| 4 | Office Expenses (Stationery, Furniture, Meeting expenses, security, electricity, water and other operational maintenance costs, etc) | 0.20 | 0.05 | 0.05 | **0.30** |
| 5 | Publications | 0.01 | 0.01 | 0.01 | **0.03** |
| 6 | Other Administrative Expenses (Overhead charges, , Boat hiring, warphase fee, cruise related expenses, port handling charges, dissemination charges, etc) | 0.05 | 0.20 | 0.20 | **0.45** |
| 7 | Supplies & Materials (Communication, calibration, data purchase, data maps and manuals, AMC (for Integrated Dissemination System (IDS)), maintenance of equipment, labware, chemicals, tag accessories, etc) | 0.04 | 0.10 | 0.10 | **0.24** |
| 8 | Advertising & Publicity (User interaction and awareness, market survey, outreach programs, publicity materials (brochures, palm plates, short films etc)) | 0.05 | 0.10 | 0.10 | **0.25** |
| 9 | Minor Works | 0.03 | 0.03 | 0.03 | **0.09** |
| 10 | Professional Services | 0.05 | 0.10 | 0.10 | **0.25** |
| | **Total (Recurring)** | 0.58 | 0.91 | 0.94 | **2.43** |
| 11 | Machinery & Equipment | 0.20 | 0.10 | 0.00 | **0.30** |
| 12 | Major Works | 0.00 | 0.00 | 0.00 | **0.00** |
| 13 | **Total (Non-Recurring)** | 0.20 | 0.10 | 0.00 | **0.30** |
| 14 | **Total (Revenue + capital)** | 0.78 | 1.01 | 0.94 | **2.73** |

**Annexure-3**

**7.2 Manpower requirement, if any. In the case posts, permanent or temporary, are intended to be created, a separate proposal may be sent on file to personal division of department of expenditure (such proposals may be sent only after the main proposal is recommended by the appraisal body)**

i) Tsunami Early Warning System

| Year | Requirement in each year | | | Cumulative strength | | |
|---|---|---|---|---|---|---|
| | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants | **Office Assistants/Lab Attendants/Drivers** | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants | **Office Assistants/Lab Attendants/Drivers** |
| 2017-18 | 9 | 8 | 9 | 9 | 8 | 9 |
| 2018-19 | 2 | 4 | --- | 11 | 12 | 9 |
| 2019-20 | --- | --- | --- | 11 | 12 | 9 |

ii) Storm Surge Early Warning System

| Year | Requirement in each year | | Cumulative strength | |
|---|---|---|---|---|
| | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants |
| 2017-18 | -- | -- | -- | -- |
| 2018-19 | -- | -- | -- | -- |
| 2019-20 | -- | -- | -- | -- |

iii) Ocean State Forecast Services

| Year | Requirement in each year | | Cumulative strength | |
|---|---|---|---|---|
| | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants |
| 2017-18 | 7 | 3 | 7 | 3 |
| 2018-19 | 2 | 4 | 9 | 7 |
| 2019-20 | -- | -- | 9 | 7 |

iv) Marine Fisheries Advisory Services

| Year | Requirement in each year | | | Cumulative strength | | |
|---|---|---|---|---|---|---|
| | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants | **Office Assistants/Lab Attendants/Drivers** | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants* | **Office Assistants/Lab Attendants/Drivers** |
| 2017-18 | 4 | 7 | 1 | 4 | 7 | 1 |
| 2018-19 | 0 | 0 | 0 | 4 | 7 | 1 |
| 2019-20 | -- | -- | --- | 4 | 7 | 1 |

v) Multi Hazard Vulnerability Mapping Services

| Year | Requirement in each year | | Cumulative strength | |
|---|---|---|---|---|
| | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants |
| 2017-18 | 2 | 2 | 2 | 2 |
| 2018-19 | -- | -- | 2 | 2 |
| 2019-20 | -- | -- | 2 | 2 |

vi) Coral Bleaching Alert System

| Year | Requirement in each year | | Cumulative strength | |
|---|---|---|---|---|
| | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants |
| 2017-18 | 1 | 0 | 1 | 0 |
| 2018-19 | -- | -- | 1 | 0 |
| 2019-20 | -- | -- | 1 | 0 |

vii) Data Services

| Year | Requirement in each year | | Cumulative strength | |
|---|---|---|---|---|
| | **Scientists/ Project scientists** | **Research Fellows/** Project | **Scientists/ Project scientists** | **Research Fellows/** Project |

| | | | | |
|---|---|---|---|---|
| | | Assistants | | Assistants |
| 2017-18 | 4 | 4 | 4 | 4 |
| 2018-19 | 2 | 2 | 6 | 6 |
| 2019-20 | -- | -- | 6 | 6 |

viii) Computational Facilities, Web Based Services and Communication Facility

| **Year** | **Requirement in each year** | | **Cumulative strength** | |
|---|---|---|---|---|
| | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants |
| 2017-18 | 6 | 5 | 6 | 5 |
| 2018-19 | 3 | 2 | 9 | 7 |
| 2019-20 | 2 | 2 | 11 | 9 |

ix) Field Stations / Regional Centres

| **Year** | **Requirement in each year** | | | **Cumulative strength** | | |
|---|---|---|---|---|---|---|
| | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants | **Office Assistants/Lab Attendants/Drivers** | **Scientists/ Project scientists** | **Research Fellows/** Project Assistants* | **Office Assistants/Lab Attendants/Drivers** |
| 2017-18 | 2 | 0 | 0 | 2 | 0 | 0 |
| 2018-19 | 0 | 0 | --- | 2 | 0 | 0 |
| 2019-20 | -- | -- | --- | 2 | 0 | 0 |

**Annexure-4**

**Executive summary and benefits of the scheme**

**Brief details about the scheme:**

INCOIS is mandated to provide the best possible ocean information and advisory services to society, industry, government agencies and the scientific community through sustained ocean observations and constant improvements through systematic and focussed research. Currently the following services are being provided to the users and the supporting facilities for these services are being maintained. This proposal intended to sustain and improve the existing services pertaining to Fishery and Ecosystem (PFZ, Tuna, Coral Reef, HAB) services, daily forecast products for operational and Navigation safety (OSF) and Hazard related (Tsunami, Storm Surge, High Wave, Oil Spill, MHVM) services. Besides, INCOIS also engaged in providing the value added services to boost blue economy. All the above services are being supported by the allied services such as Web, Computational and Communication facilities. These allied services support in generation of the services and effective dissemination to the users. Further, INCOIS is proposing to set up two field stations one on east coast and another on west coast for the operational convenience and maintaining the observatories. Suite of products pertaining to Ocean and coastal zone are combined into following main services of INCOIS.

- Tsunami Early Warning System
- Storm Surge Early Warning System
- Ocean State Forecast Services
- Marine Fisheries Advisory Services
- Multi Hazard Vulnerability Mapping Services
- Coral Bleaching Alert System
- Data Services
- Computational Facilities, Web Based Services and Communication Facility

**Performance of these ongoing services during 12th plan:**

**i) Tsunami Early Warning System (an ISO Certified service)**

Sustained and continued 24 X 7 service of ITEWS and during the reporting period XII FYP, ITEWC has monitored 230 earthquakes of magnitude ≥ 6.5. Four tsunami events recorded magnitude more than 7.5 with minor tsunami were efficiently detected and provided timely warning. A state-of-the-art Indian Seismic and GNSS Network (ISGN) comprising 135 stations, which is the first of its kind to be implemented in the country to handle both seismic and GNSS stations and provide high quality data for multi-use scientific research and operational monitoring. Fine tuning of methodology to estimate source parameters from real-time GPS displacements is completed. GUI development to deploy at warning centre is in progress.

Continuous effort and focussed research enabled improvements in the tsunami modeling. Tunami-N2 configured for extended new Indian ocean domain covering South China Sea for 25 hours simulation. Open ocean propagation scenario database using Tunami-N2 for Indian ocean and south china sea generated and optimized for regional tsunami service for the Indian ocean and south china sea. Real-time tsunami model launch for OOPS configured for eq. Magnitude greater than 8.0 in the global ocean using tunami-n2. The Configuration TUNAMI F2 for operational Indian ocean domain is completed and the NETCDF routines are incorporated in F2 during the reporting period. As start off, parallelisation TUNAMI F2 routines done using Open-MP for open ocean propagation scenario grid

outputs

These models were extensively validated with observations. For the operational purpose, an enhanced Open Ocean Propagation Scenario Database (OOPS DB) generated using Tunami N2 was optimized and validated against the tsunami deep ocean observations (Tsunami Buoys) for all major events (M>6.5) in reporting period including 11 April 2012 events. Tsunami model Tunami N2 was setup for generation of scenario using high Resolution data (with 2.5 km spatial resolution). Each model scenario in OOPSDB was generated by constructing unit sources of 100 km X 50 km boxes (slip equivalent to EQ magnitude 7.5) with a total simulation time of 25 hours. "on-fly" magnitude/depth scaling approach taken to generate required simulation results for any higher magnitude earthquake from the basic unit source results by Application Basic fundamental geophysical equations for Calculations and generation of Open Ocean Propagation Scenario Database (ABC of OOPSDB).

Total six R&D projects pertaining to the paleo tsunami and tectonic studies along the Andaman-Sumatra and Makaran sources have been carried out by the PIs from NGRI, IISc, JNCSAR. M.S. University, Anna University and IIT Kanpur. The results of these studies are enlightening the phenomenon of plate tectonics and helps in reconstructing the paleo tsunami stratigraphy in the region.

Total nine communication tests and six national level mock drills have been conducted in addition to IOWAVE exercise in the Indian Ocean region. Total 205 institutions were visited the tsunami warning centre including 1,43 officials and 10,047 students. Several SOP workshops were conducted for the national stake holders such as state disaster management authorities.

Considering the vulnerability of the Andaman & Nicobar (A&N) Islands due to their closeness to a subduction zone, ESSO-INCOIS has implemented a fail-safe satellite-based communication system connecting 7 Emergency Operation Centres (EOCs) of A&N with ESSOINCOIS. A new Decision support tool version 2015 and dissemination tool were developed in-house and tested in IOWave16 exercise

**ii) Storm Surge Early Warning System**

Setting up of numerical model for Storm surge services is completed. A decision support tool for storm surge forecast was developed in-house and tested by providing the experimental storm surge forecast during various cyclones and made operational. Experimental storm surge forecast was given to disaster management offices during 'Phailin' October, 2013. Experimental forecast was continued for Helen, Lehar and Madi cyclones in the year 2013. Storm Surge advisories made operational since 'HudHud' cyclone and provided information well in advance to safe guard the lives of coastal population. Real time surge forecasts were successfully issued for recent cyclone Roanu. As per the IMD reports, INCOIS forecasted surge heights are most accurate. Importance of wave set-up inclusion in surge modelling was noticed through series of experiments using coupled ADCIRC + SWAN model. Implementation this coupled model results in the storm surge advisories is in progress.

**iii) Ocean State Forecast Services**

Ocean State Forecast and Information services is one of the major services rendered from ESSO-INCOIS having huge user base, which is to be continued along with its further developments/refinement/progress. Ocean State Forecast Services are available for Arabian Sea, Bay of Bengal, Northern Indian Ocean, Southern Indian Ocean, Red Sea, Persian Gulf and South China Sea for parameters such as wave height and direction (both wind waves and swell waves), wave and swell periods, sea surface currents, Sea Surface Temperature, Mixed Layer Depth, Depth of the 20 degree

isotherm, astronomical tides, wind speed and direction and oil-spill trajectory. Further, it provides more detailed forecast information for specific locations like fish landing centers, small fishing harbors, major and minor ports, etc. as well as for the coastal waters of the maritime states, union territories and island regions (Andaman & Nicobar and Lakshadweep) of India under its coastal forecasting component.

User-required customized/tailor-made products, to be named a few recent ones here, the 'Ocean state forecast along ship routes', 'Sea state forecast for port and harbors, 'OSF-Web map services' and other highly-demanded and impact-based services were developed and made operational based on the huge demand from the user community; and this is reflected in the drastic increase in the user statistics. High wave bulletins with alerts or warning were found to be so helpful to the users, especially during the extreme weather conditions like cyclones. The joint INCOIS-IMD bulletins during cyclones and depressions were started from February 2014 onwards, with the incorporation of meteorological parameters as well as warnings from IMD as well. Oil spill events are increasing in the Indian waters, taking this into consideration, INCOIS has developed a system namely Online Oil Spill Advisory (OOSA) for forecasting the oil spill trajectories which will help in mitigating the hazards and cautioning the local population. Indian Coast Guard has collaborated for an extensive usage of the above system, which is developed in-house indigenously. Networks of Automatic Weather Stations (AWS) onboard ships (a network of 34 AWSs by 2016), Wave Rider Buoys (WRB; a net work of 14 WRBs by 2016) and Wave Height Meter maintained by ESSO-INCOIS have been used for getting real-time sea and weather related information for the general public (available in the INCOIS website in real time mode) as well as for better ocean state forecasting by fine-tuning the models and assimilating them in to the forecast models.

ESSO-INCOIS continue providing the ocean state forecasts not only to all the sea faring communities like the fishermen, Indian Navy, Indian Coast Guard, merchant and passenger shipping agencies, offshore oil & gas exploration industries, research organisations but also to other coastal communities. These forecasts are generated operationally on High Performance Computers and disseminated in vernacular languages by different modes-using the latest Information and Computational Technology tools-like Mobile phones (SMS & voice message), Radio (AIR & FM), TV, Electronic Display Boards, E-mails, Website and Fax. ESSO-INCOIS is also having close collaborations with various NGOs like M. S. Swaminathan Research Foundation (MSSRF), Reliance Foundation, Pondicherry Multipurpose Social Service Society (PMSSS) etc., and other private and societies (like Indian Farmers Fertiliser Cooperative Limited (IFFCO) Kisan Sanchar Limited (IKSL), etc.) who are working with the fishing communities to disseminate the advisories on a daily operational basis. The Ocean State Forecasting operations and services's Quality Management System was conferred with ISO 9001:2008 certification in 2014. User feedbacks suggest not only that the forecasts are > 80% accurate, but also that the forecasts/information/advisories reach the maximum end users and disaster management authorities on time, which is also equally crucial for saving life and property. The feedbacks from users of different category mentioned above reach ESSO-INCOIS through different mechanisms like postal tappal, mobile phones, fax, e-mails, website, and also being collected by periodic user interaction meetings at ESSO-INCOIS as well as at different parts of the coastal locations.

**iv) Marine Fisheries Advisory Services**

Numbers of PFZ and Tuna advisories are being increased by providing forecast for every day except ban periods and unfavourable weather conditions (earlier PFZ was 6 days/week and Tuna 3days/week). This led to 60% increase in number of advisories when compared to the advisories issued during Apr 2012 – Mar 2013. Total fish landing centres used to generate the PFZ information were increased from 257 to 1280 stations. Maps used in the advisories are being improved by creating smart maps overlaid with surface current vectors.

Large improvements in the advisory mechanism has been achieved by developing the user friendly applications such as: Android mobile application; multi-lingual SMS messages; 24x7 Helpline services were launched for Kerala fishermen in partnership with MSSRF; Fisher Friend Mobile Application (FFMA) launched in Andhra Pradesh where INCOIS is the content partner. MoUs signed with TCS, IKSL, Reliance Foundation, Tamil Nadu and Karnataka State Fishery Departments for dissemination of the advisories. The total user base has increased from 97,000 in 2011-12 to 2.5 lakhs in 2015-16 through adoption of various dissemination modes. Procured 100 Nos. of new Digital Display Systems (DDS) with Solar Power, VSAT communication, siren system. Establishing an Integrated Dissemination System (IDS), a software platform is being developed to disseminate the ocean information services of INCOIS through Multi Lingual SMS, Voice Call / Audio Advisory, Mobile Apps (User / Admin modules), Social Media (Facebook, Twitter, etc.), Email, GTS, Fax, Digital Display Boards, Radio / Television broadcast units, IVRS, Cloud Channels, etc

59,590 users have participated in 1392 awareness / capacity building programmes during April 2013-March 2016. Several feedbacks were received from the users and made improvements in the advisories based on these users' requirements. Besides, several other user awareness campaigns / user interaction workshops in collaboration with partners such as MSSRF, Reliance Foundation, etc are being organised regularly

Total 198 concurrent PFZ Validation Experiments were conducted by sub-projects during the first year of XII Plan were boost the confidence on the advisories and helped in the improvement. Later focussed on physicochemical and fishery data collection and R & D aspects towards improvement of the advisories

A sustained R7D efforts in-house at INCOIS to incorporate additional data from Altimetry / SSH to generate PFZ/ Tuna fishery Advisories to overcome the Cloud limitation and based on the results SSH is now incorporated in the PFZ / Tuna advisories. The Oxycline data is also calculated and the same is being provided as the Maximum Fishing Depth in the Tuna fishery advisories to make it 3D advisory. Conducted Satellite Telemetry studies on Yellowfin Tunas with Pop-up Satellite Archival Tags (PSAT). The new type of PSATs have Magnetic Sensor, accelerometer, and Solar Panels. 07 Yellowfin Tunas were tagged with PSAT (X-Tag) during April 2013- March 2014 and 10 Yellowfin Tunas during April 2015-March 2016 with Sea Tags.

R & D on Automatic Frontal detection system for both SST and Chlorophyll and implemented the same in the operational process chain. Taken up 13 sub-projects to collect the physico-chemical-biological and fishery data from various locations and to focus on R & D to improve the advisories. R&D towards Species specific advisories on Hilsa Fishery is carried out. Historical data analysis, standardization of sampling methodology, cruises for data collection and correlation analysis is being done in collaboration with Jadavpur University. A preliminary study on occurrence and migration of Sardine in Indian Ocean using satellite data (SST, CHL), upwelling Index and other climatic indicators

under is being carried out under NOAA-MoES collaboration. Working on Mariculture site suitability along the coastal states of India. Efforts are in place towards Habitat Suitability prediction maps

**v) Multi Hazard Vulnerability Mapping Services**

The Multi-hazard Vulnerability Mapping is completed for entire Indian Mainland using topographic data from ALTM and Cartosat-1 data. Areas for setting up 3D GIS maps were identified from the MHVM. MHVM atlas comprising 929 maps on 1:25000 scales has been prepared. The high vulnerable coasts to tune of ~3800 sq km between Kochi to Paradeep have been identified based on the availability of ALTM data and the 3D GIS mapping in these areas is in progress. Currently, work completed for Cuddalore, Pondicherry and parts of Machilipatnam covering 500 sq km. The work is in progress and expected cot be completed by the end of 2017. An integrated software application to visualize and analyze the 3D GIS data was developed. This application can able to integrate all the 2D and 3D data. Modeling of tsunami and storm surge including the data preparation also integrated in this model. When the event of tsunami/storm surge take place the application will trigger the modeling and uses these model output and generate the building level risk

Besides, Real-time tsunami inundation modeling methodology has been finalized and modeling grids were set up. Standby Inundation Models (SIMs) are high resolution grids that were set up on parallel mode for various vulnerable coastal domains and inundation modeling executed in the High Performance Computing (HPC) system. The test cases were run and methodology is finalized. However the optimization of the code is under progress to improve the computation time.

**vi) Coral Bleaching Alert System**

The coral bleaching Alert System (CBAS), a service initiated from INCOIS since February 2011. This model uses the satellite derived Sea Surface Temperature (SST) in order to assess the thermal stress accumulated in the coral environs. This information yields in drawing the early signs of the intensity and spatial extents of coral bleaching. This methodology adopted from NOAA reef and tested for the earlier bleaching events of Indian coral environs occurred during 2005 and 2010. The service CBAS disseminated once in three days comprising the HotSpot, Degree of Heating Weeks and time series products. The bleaching event recorded during summer months of 2016 was well in advance and the products were used for the ground observations. Total 680 advisories were generated from the inception of the service till end of August 2016.

**vii) Data Services**

INCOIS, being the central repository for marine data in the country, receives voluminous oceanographic data in real time, from a variety of in-situ and remote sensing observing systems. The Ocean Information Bank provides information on physical, chemical, biological and geological parameters of ocean and coasts on spatial and temporal domains that is vital for both research and operational oceanography. The Ocean Information Bank is supported by the data received from Ocean Observing Systems in the Indian Ocean (both the in-situ platforms and satellites) as well as by a chain of Marine Data Centres. INCOIS has been designated as the National Oceanographic Data Centre by the International Oceanographic Data Exchange Programme (IODE) of International Oceanographic Commission (IOC). Further, INCOIS serves as the National Argo Data Centre, Regional Argo Data Centre, and also the regional data centre and clearing house for the Indian Ocean region for the IOGOOS Programme.

During XII plan INCOIS established Ocean Data and Information System (ODIS) to serve heterogeneous data sets from multitude of in situ platforms. Further the state of the art technology was utilized to serve the research community. All possible means of dissemination like Live Access Server, Web services, FTP and off line DVDs were are all employed to serve the user community. Also Digital Ocean project to integrate all the data viz., in situ, model outputs and remote sensing data along with on the fly visualization, querying and dissemination was taken up and successfully implemented. Specialized services were extended to Indian Navy. Many Atlases were developed utilizing all the available data from the ministry funded projects. Data search and archival was taken up in a big way and many of the data from cruises funded by ministry were unearthed and archived at INCOIS.

**viii) Computational Facilities, Web Based Services and Communication Facility**

As an operational centre, INCOIS is involved in projects of national and international importance and requires usage of latest technological ICT infrastructure. The prime objective of INCOIS is to provide ocean information and advisory services. The products generated at INCOIS are disseminated to various user communities on a daily basis through web and other modes of dissemination. At INCOIS, ocean products are generated from the data obtained from various observational platforms and from numerical models. The data thus generated is translated into useful advisories and services. The huge volume of data pumped in from various observational platforms, the data generated out of the numerical models and running of numerical models well with-in the stipulated time lines is possible with the availability of computing and communication infrastructure in place. In this regard infrastructure required for web services, computational facility and communication facilities were established as per the requirements of the services. These facilities are having necessary redundant and failsafe facility with periodical backup and storage. The robust communication facility was established and HUB stations are maintained to ensure the continuous supply of the data for routine operational use.

**Project's significance and socio-economic benefits**

The services of INCOIS has demand by users (fishery, navigation, shipping, offshore industry, coastal populace, disaster management authority, etc) and provides vital information on the resources, safety and routine operational services. This is reported in the independent studies carried out by MSSRF include (i) Improving Livelihoods of Fishermen- case Studies from Andhra Pradesh and Union Territory of Pondicherry, (ii) Role of ESSO-INCOIS-MSSRF Helpline services in the Lives of Fishermen: Case studies from Tamilnadu and Andhra Pradesh, (iii) The Fisher Friend Mobile Application: Case Studies on Effective Use of Ocean State forecast and Potential Fishing Zone for a Better Livelihood, etc. The complete reports are available at the website of MSSRF. (http://mssrf.org/information_education_and_communication_case_studies).

The economic benefits due to the usage of OSF services has been studied by National Council for Applied Economic Research (NCAER) recently. One of the examples is "Since 'no go ahead mission' advisories given, the net benefit by Indian Navy during 2013-2015 works out to be Rs. 4161.9 crore" the report says. Report continues - another impact-based service is Oil-spill advisory services, and the coast guard takes the advisory from the ESSO-INCOIS about the oil-spill trajectory, and the amount of spill, and hence the polluters were charged prices for 15,211 tonne, and has been computed to be Rs. 89.43 crore only during the year 2015. The estimated value addition for ONGC because of the OSF and information services is 3.74 trillion at 12% social discount rate. The authors conclude the report saying

"The overall economic benefits to all industries, due to OSF service, per our computations exceed Rs 3.7 trillion".

Identifications of PFZs as well as Ocean State forecast by INCOIS are found to be both timely, accurate and of significant value to the fishing community. Total Annual net economic benefit due to PFZ:Rs. 34,000 to Rs. 50,000 Crore. The economic benefits resulting from identification of PFZs to estimate the GDP. Only mechanized crafts adopt PFZ: Can go upto from 0.81 % to 1.47 to 1.65 % of national GDP. Both mechanized and motorized crafts adopt PFZ: Can go upto 1.58 to 2 % of national GDP. All mechanized crafts, motorised crafts and traditional crafts adopt PFZ: Around 2.04 % of National GDP. Catalytic roles by MS Swaminathan Research Foundation (MSSRF), Village Resource Centres (VRC) and Village Knowledge Centre (VKC) in raising awareness and facilitating the knowledge transfer. The Key take-aways from the proactive role of INCOIS with the catalytic role of the partnering agency MSSRF could be major milestones in the road map for the progress. Further details, and economic benefits for Port &Harbours, shipping community etc., are given in the full report, which is available at http://www.ncaer.org/downloads/Reports/ImpactAssessment-MOES.pdf.

The disaster related services are providing warning to nation in order to save lives and minimize losses. These services equipped with robust monitoring mechanism and world class practices to cater the advisories during the event. The Indian Tsunami System has been recognized as world class warning centre with best SOP. This centre is recognized as regional tsunami service provider and playing major international role in the Indian Ocean by providing tsunami advisories to Indian Ocean rim countries. Storm surge warning service is also providing the very accurate information on the storm surge well in advance. This helps the disaster management authorities take appropriate measure to manage disaster. This is evident by the reduction of the lives lost during the recent storm surge events. Further the coastal vulnerability and risk assessment due to inundation hazards has been assessed and 3D GIS mapping comprising 3D buildings associated with socio-economic data has been set up for the high vulnerable coasts. These information has been integrated on the cutting edge technology 3D visualization application with 3D analytics generate the building level risk assessment. This will significantly support the disaster management authority to take decisions.

Services and products of INCOIS have potential to generate tangible benefits (direct and indirect) to users especially offshore industries and coastal establishments, which can boost the **blue economy** significantly.

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