Ocean Society of India

NATIONAL SEMINAR ONCLIMATE CHANGE

AND COASTAL OCEAN PROCESSES (CCCOP-2019)

held at IIT Delhi during 4-5 July 2019

(Co-sponsor: India Meteorological Department)

REPORT AND RECOMMENDATIONS

The Ocean Society of India (OSI) organized a National Seminar on "Climate Change and Coastal Ocean Processes" (CCCOP-2019) at Centre for Atmospherics Sciences, Indian Institute of Technology Delhi during 4-5 July 2019. The Seminar was co-sponsored by India Meteorological Department, Government of India. It was a great success in fulfilling its aims with the contributions from eminent scientists, researchers and students from a wide range of institutes across the country. There were a total of 13 lead talks and 30 presentations in the seminar. There were a total of 6 sessions in the seminar covering (i) Climate change and coastal hazards, (ii) Coastal currents, waves and tides, (iii) Coastal erosion/accretion processes and their modeling, (iv) Coastal ecosystems and their modelling, (v) Climate change impacts on coastal ocean processes, (vi) Adaptation to coastal hazards and climate change impacts. The major highlights of the seminar are listed below.

SCIENTIFIC OUTCOMES

Observational studies

- Analysis of monthly composite altimeter tracks to indicate an increased wave activity in the Southern Ocean that rapidly progresses towards the tropical belt.
- The frequency of fast-moving synoptic storms have also increased in the Southern Ocean belt (high intense storms and their frequency are increased in the past two decades). Climate change has a profound impact on the wind and wind waves.
- XBT records spanning two decades for the central Bay of Bengal reveal an increasing warming trend in the surface and sub-surface waters. Interestingly, the sub-surface waters at a depth of 600 m exhibit anomalous warming compared with that at 100 m depth.
- A substantial rise in PDI (Potential Density Index) and ACE (Accumulated Cyclone Energy) in the present decade compared with the period of 1980s are observed. The decadal variability in PDI has increased almost by a factor of six in the past four decades.
- A 3/5-power law fitted to the original wind formulae, which provides a reasonably good estimate for the surface wind field.
- NIOT's OOS team supported INCOIS for the deployment of Flux Buoy developed by Woods Hole Oceanographic Institution (WHOI) under scientific project "Coupled

physical processes in the Bay of Bengal and monsoon air-sea interaction" as part of MoES National Monsoon Mission programme.

- NIOT' OOS in collaboration with SAC established twin buoy systems at CALVAL site off Kavaratti in Arabian Sea during Dec 2011. The buoy is capable of measuring in-water optical and biological parameters in an unattended manner for long-term time series with less vertical tilt.
- The changes observed in micro plankton and meso plankton community in the EAS (Eastern Arabian Sea), Arctic Fjords and SIO (Southern Indian Ocean) which is a link between primary and tertiary trophic levels could bring alteration in the food web dynamics of the region.
- Study based on the high-frequency tidal currents suggests that the bathymetry plays a significant role in the intensification of tides in the near-shore regions and stratification is responsible for tidal amplification during the post monsoon season.
- The long term average of global mean sea level rise (SLR) is currently about 1.7mm/year. However, in the past two decades the global average is observed to be 3.4mm/year. In the Indian Ocean also an increase of about 3.0mm/year, consistent with global mean SLR during this period is found.
- A reduction of about 25% rainfall in the northeast region during the recent years is observed. Though it is not an issue locally as it is still in excess for this region, it reduces the amount of freshwater outflow into the Bay of Bengal and hence changes its stratification.

Modeling studies

- The projections on SLR, waves, storm surges and other climate parameters for different scenarios of climate change downscaled from global models for the Indian coast is now available in the CWC's India-WRIS portal under 'Coastal Climate Data' for use and further improvement.
- N216 GC2 system along with NEMOVar ODA has been configured and are being run in real-time for medium range forecast (15 days daily) and, Extended Range Prediction (ERP, Multi-week up to 4 weeks once a week). As well as a standalone NEMO global model is also being run for 10 days (daily).
- Stand-alone and coupled NEMO (at 15 days scale) verification for Indian Ocean are being carried out. As well as hindcast for the ERP (multi-week) system is also being carried out for summer monsoon and winter seasons.
- Sea-Ice verification for Polar Regions are also being carried out in days-to-season scale from these runs.
- WRF model with better initial conditions and best cumulative parameterization of 24 h forecast performs well that brings out the importance of parallel tight coupled SWAN–ADCIRC model for forecast of extreme wave events in the North Indian Ocean which has practical implications for operational needs.

- The mechanisms behind the discontinuity of western boundary current in the Bay of Bengal (East India Coastal Current) during the southwest monsoon season is investigated using numerical model. The discontinuity is governed by westward and southwestward propagating eddies between two opposite facing flows along the boundary.
- The statistical comparisons show that the present MOM configuration used in GODAS system needs to be improved for the better representation of upper ocean stratification in BoB.
- Numerical study suggested that the cyclone can enhance the inertial mixing under the influence of strong upper ocean stratification.
- There is an increasing trend in frequency noticed for post-monsoon cyclones in the past three decades, whereas for pre-monsoon season, the trend is still unclear.
- The ocean environment simulated using the coupled model can be used to calculate transmission losses in sound propagation on the spatial domain and on the diurnal scale.
- HWRF-HYCOM coupled simulations are used to analyze the oceanic and atmospheric factors contributing for the rate of intensification of Ockhi. High ocean heat content, thick barrier layer and favorable atmospheric circulation helped Ockhi to intensify rapidly.
- While the climate change projections of SLR for 2100 for RCP 8.5 globally is less than 1m, the downscaling along Indian cost for the same RCP show a higher SLR at 1.1m.

RECOMMENDATIONS

Observational studies

- Though there is a good network of tide gauges existing for Indian coasts, it is desirable to have network of tide gauges covering all the gap regions along the coast.
- Measurement of land movement is important for accurate assessment of regional sea level rise. Towards this GNSS measurements are available for Indian Ocean, but not for the coast. Hence, the tide-gauge locations shall have simultaneous GNSS measurements.
- In the context of SLR, it was reported that ground water depletion causes changes in local sea level, which needs to be studied in detail. It is also pointed out that subsidence of coastal city areas was also a factor and needs monitoring.
- Salt water intrusion in coastal region is a major problem faced in several coastal locations of the country and more investigations are required.
- It is important to note that the climate change impacts are clearly visible on wind and wave climate of the Indian Ocean. Downscaling technique of global models and their validation before use is required. Identify the best quality wind data and then study wave characteristics.
- Increased ocean observation systems covering deep as well as coastal oceans of our seas are required. Dense network of observation systems near the coastal region is required.

- Impact of climate change in the frequent severe cyclonic storms along the Indian coast (e.g. Fani cyclone off Odisha coast) needs detailed study. Ocean heat content is pointed out to be a major contributor in the recent Ockhi cyclone; more studies are required on this, particularly in the Sri Lankan region.
- The pelagic ecosystems and their food chain components are being affected by climate change and needs deeper investigations.
- Detailed assessment of long-term interaction and changes between Arabian Sea oxygen minimum zone and upwelling along west coast of India is necessary to predict the future changes in the extent of coastal deoxygenation and associated biogeochemical and fishery responses. Upwelling and oxygen minimum zones need to be monitored.
- During pre- and post- summer monsoon period the western boundary currents in the Bay of Bengal (East India Coastal Current) is conspicuous in its presence but during the summer monsoon season this current is having discontinuities with several eddies and these need more studies.
- To capture vital signatures of the earth system response to climate variability and change, multi-scale and multi sensor network need to be built for long-term measurements of various environmental, terrestrial, marine and bio-geochemical variables at large, regional and local scales.
- Monitoring of bathymetry at those locations, where significant changes are observed at regular intervals, at least once in 5 years, is required.
- There is a need to commission studies to assess potential outcomes of climate change in maritime geography and critical infrastructure over the coming decades.

Modeling studies

- The need of the hour is to use coupled ocean-atmospheric models for the prediction of coastal ocean parameters.
- Build Earth System Model (ESM) to treat comprehensively the coupling of various sub-systems to improve our predictions of weather, climate and hazards and to locate new living as well as non-living resources.
- Impact based weather forecasting, extended range and seasonal forecasting need further follow up.
- Also, the numerical modeling efforts have to be strengthened to understand the impact of ocean environment, particularly in the global warming scenario, on the biological productivity. Not enough modeling studies are undertaken across the country in this regard. Hence, use of the coupled models of physics based geo-chemical-biological models are the need of the hour for the Indian seas.
- Reduction in the northeast rainfall by about 25% over the last few years is observed. This reduction in the rainfall reduces the freshwater out flow into the Bay of Bengal and alters

its stratification. The impact of ocean stratification on the physical and biological processes are to be studied by both field scientists and numerical modelers.

- Time series observations on bio-geo-chemical parameters along the Indian coasts along with physical parameters are important to understand ecosystem over the coastal ocean. This would help the ecosystem modeling efforts.

Planning and adaptation to climate change

- Comprehensive Shoreline Management Plan (SMP) with proper identification of sediment cells for different segments along our coastline is necessary in order to prepare ourselves to the consequences of coastal erosion and hazards in the light of climate change.
- Preservation of natural sand dunes and rebuilding of the sand dunes for coastal protection needs to be encouraged. Sand based solutions and growing native plants to be done for sustainability of beaches and sand dunes.
- The Reference Manual on Climate Change Adaptation Guidelines for Coastal Protection of the Central Water Commission provides an easy-to-use method to develop responses to climate change impacts.
- The concept of Minimum Beach Level (MBL) introduced in the Reference Manual on Climate Change Adaptation Guidelines needs to be practiced for preventing flooding of hinterland during storms.
- There is need to strengthen the adaptation measures to coastal infrastructure in the light of climate change.
- Scientific investigation, computer modeling and sound environmental impact assessment over and above the standard engineering criteria need to be strengthened before decision making in coastal protection and management.
- For sea level rise and coastal zone impacts comprehensive multi-institutional programs should be organized along with engineering and technical solutions structural safety of coastal investments.
- Expanding services are needed in four key climate-sensitive sectors, such as agriculture, water, health and climate and disaster risk management for rendering customized services for societal, environmental or economic benefits.
- Due to the fact of impact of climate change on shoreline changes, denudation and accretion phenomena are taking place at varying rates. Consequently saline water incursion and resultant mangrove establishment and its successions are taking place. Further investigations in this regard are required.