GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
LOK SABHA
UNSTARRED QUESTION No. 151
TO BE ANSWERED ON WEDNESDAY, FEBRUARY 24, 2016

RESEARCH WORK

151.   DR. MANOJ RAJORIA:

Will the Minister of EARTH SCIENCES be pleased to state:

(a)   the names of countries with which agreements have been signed to promote scientific cooperation in the field of Earth Sciences; and

(b)   the details of the work conducted under the said agreement during the last three years and the current year?

ANSWER
MINISTER OF STATE FOR MINISTRY OF SCIENCE AND TECHNOLOGY
AND MINISTRY OF EARTH SCIENCES
(SHRI Y. S. CHOWDARY)

(a)   The countries with which agreements have been signed to promote scientific cooperation in the field of Earth Sciences are:

- United State of America (USA), Indonesia, Mauritius, United Kingdom, Belmont Forum Countries (Australia, Austria, Brazil, Canada, China), European Commission, France, Germany, Japan, Norway, South Africa.
- United Nations Educational, Scientific and Cultural Organization/ Intergovernmental Oceanographic Commission (UNESCO/IOC).
- BIMSTEC (Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation) Member countries namely Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka and Thailand.

(b)   The details of the work conducted under the said agreement during the last years and current year is in Annexure-1.

The details of the work conducted under the agreement with various countries during the last years and current year

Sl. No.	Name of the country with whom MoU/Agreement/ signed	Year in which signed	Broad objectives	Details of the work undertaken so far
1	National Oceanic and Atmospheric Administration(NOAA), USA	16.4.2008	Technical Cooperation in Earth Observations and Earth Sciences.	MoU for Technical Cooperation in Earth Observations and Earth Sciences between National Oceanic and Atmospheric Administration (NOAA), USA and Ministry of Earth Sciences (MoES) was signed on 16 April 2008. Under this MoU, ten joint research and development activities have been undertaken with identified Principal Investigator (PIs) from India and US with well defined objectives and deliverables in the field of monsoon, ocean observations, tropical cyclone, Tsunami, INSAT 3D, Predictive Capabilities on Marine Fisheries and Harmful Algal blooms, development of an ocean wave modeling and assimilation system for the Indian Ocean Region to enhance the capability to generate a skillful global wave model systems especially for monsoon conditions. (a) The collaboration has resulted in fundamental understanding of Indian Ocean dynamics and ocean-atmosphere interactions that affect the weather and climate through ocean observations from RAMA

| | | | | moorings. 129 RAMA deployments were under taken during the period 2008 to present. Till date, the data from RAMA moorings have been used in 78 articles published in international journals. India is also using RAMA data to generate ocean analysis products through the assimilation. Global ocean analysis using GODAS (Global Ocean Data Assimilation System) by assimilating all available in-situ data forms an important initial condition for seasonal monsoon prediction by coupled model. Considering the mutual benefits and also the importance of RAMA moorings in generating useful data, this activity is continued for additional five years with effect from 16 April 2013.

(b) Under the Implementing Agreement (IA) on Technical Cooperation for the study of Dynamical Seasonal Prediction of Indian Summer Monsoon Rainfall, a "Monsoon desk" was established at National Centers for Environmental Prediction (NCEP). Main objective of the IA was to develop dynamical weather prediction models for understanding of the Indian monsoon onset, break and retreat phases and associated rainfall characteristics. The work under taken under this IA has contributed to the "Monsoon Mission" program of the MoES to coordinate numerical model simulations and diagnostics, between NCEP, Earth System Science Organisation- Indian Institute of Tropical Meteorology |
|---|---|---|---|---|

| | | | | (ESSO- IITM) and ESSO -India Meteorological Department (IMD). This has been useful to provide improved weather/climate forecast guidance during the monsoon rainy season to various Indian economic and agriculture sectors.

Some of the major works undertaken under the IA include (i) Establishment of a dynamical extended range forecast system at the IITM for monsoon prediction (ii) Establishment of a Global Forecast System and Global Ensemble Forecast System (GEFS) at ESSO-National Centre of Medium Range Weather Forecasting (NCMRWF) (iii) Development of an Earth System Model at ESSO- IITM (iv) Transfer of modelling infrastructure between NCEP and MoES institutes (v) Satellite data assimilation etc.

(c) Under the IA on Predictive Capabilities on Marine Fisheries and Harmful Algal blooms, two main studies envisaged are:

i) Develop HAB monitoring and prediction System (HAMPS) for the Indian EEZ.
ii) Short-term prediction of Sardine, Mackerel and anchovies of the south east Arabian sea (STEP-SAM).
The work done under this scientific collaboration so far are:

HAB group: A species specific algorithm was developed in house at ESSO- Centre for Marine Living Resources & |

				Ecology (*CMLRE*), Kochi using satellite and in situ data. Hands-on training on phytoplankton toxin analysis was given to toxin group (CIFT). The algorithm to distinguish Noctiluca bloom from other diatom bloom has been developed and has been implemented on operational mode at ESSO-INCOIS. Workshops: 4 workshops were conducted so far on "Development of Predictive Capabilities on Marine Fisheries and Harmful Algal Blooms in Indian Seas" at Hyderabad, India on February 11-14, 2013; "Development of Predictive Capabilities on Marine Fisheries and Harmful Algal Blooms in Indian Seas" at Kochi on September 23-27 2013; "Development of Predictive Capabilities on Marine Fisheries and Harmful Algal Blooms in Indian Seas" at Kochi on September 22-26, 2014; "Development of Predictive Capabilities on Marine Fisheries and Harmful Algal Blooms in Indian Seas" at Hyderabad on September 16-26, 2015. NOAA experts visited India and provided training to Indian scientists in various aspects of prediction modeling. Training: Training on stock assessment and prediction modeling was conducted. On capacity building aspect, a training programme on "Fishery Stock Assessment and Ecosystem Modeling" organized at INCOIS in Sep 2015 in collaboration with NFSC (NOAA), USA. This was attended by

				participants from 18 National Institutes and academia. d) Under the agreement signed on 14 Nov 2014 on Ocean wave modelling and data assimilation, Wave forecasting model (WW3) is made operational and a modelling study on the flash flooding events along Indian coastline caused by southern ocean swells (Kallakkadal events) is completed & communicated to journal.
2	Met. Office, United Kingdom	28.8.2008	Collaboration Agreement Met. Office's Unified Earth System Modelling Software.	Under this agreement, ESSO-NCMRWF has implemented the advanced seamless unified Modelling (UM) system of Met Office, UK. A comprehensive evaluation has demonstrated improved performance of the unified model against the performance of the existing model used by the National Weather Service of the country. In order to have a more robust collaborative partnership on joint developmental programs among all the international partners of the UM system (UK, Korea, Australia, India) under a common governance structure, a Consortium Agreement for Core partnership at an Annual Contribution of £ 100,000 is being undertaken. Following the approval of Cabinet, the Earth System Science Organization-Ministry of Earth Sciences (ESSO-MoES) has joined the consortium with the U. K. Met Office (UKMO), Korea Meteorological Administration (KMA) and the Commonwealth of Australia through its Bureau of Meteorology and the Commonwealth Scientific

| | | | | Industrial and Research Organization (CSIRO) for a coordinated effort in the development of a state-of-art Unified Model (UM) Earth System Model for the seamless prediction of weather and climate from days to season.

During the year 2015, state-of-art global, regional and convective scale model with horizontal resolutions of 17, 4 and 1.5 km respectively have been implemented. A global data assimilation system using observations from Indian/International Satellites has been implemented. An ensemble prediction system with 44 members has also been implemented to generate probabilistic forecasts. |
|---|---|---|---|---|
| 3 | Belmont Forum Countries namely Australia, Austria, Brazil, Canada, China, European Commission, France, Germany, Japan, Norway, South Africa, UK and USA | 10.01.2013 | To carry out international collaborative research through joint calls for funding, with an aim to deliver knowledge to enable societies to meet sustainable developmental goals in the coming decades. | An MoU was signed between MoES and the Belmont forum Countries, which is a group of the world's major and emerging funders of global environmental change research and international science councils, to support Indian Scientists for international collaborative research through joint calls in societal relevant global environmental change challenges. Presently India is participating in 4 Collaborative Research Action (CRA) areas namely Coastal Vulnerability, Food Security, Biodiversity and Climate Services and Inter-regional linkages. |
| 4 | The Nature Environment Research Council (NERC), United | 1.3.2013 | Cooperation in the field of Earth Sciences | (a) MoES and the Nature Environmental Research Council (NERC) of UK, entered into an MoU with the objective of articulating a set of high priority research initiatives towards |

| | Kingdom | | | addressing the seminal issues raised by the changing Hydrological Cycle with special emphasis on south Asia. Five joint projects awarded are showing good progress.

(b) Under the MoU, NERC and ESSO-MoES have signed an Implementation Agreement on "South Asian Monsoon Collaboration" on 11th November 2013 to collaborate in monsoon research.

Subsequently, joint call was made inviting Indian and UK scientists for proposals in monsoon research. Three collaborative research projects between India and UK scientists have been funded as follows:

(i) Interaction of Convective Organization and Monsoon Precipitation, Atmosphere, Surface and Sea (INCOMPASS) (ii) Bay of Bengal Boundary Layer Experiment (BoBBLE) and (iii) South West Asian Aerosol - Monsoon Interactions (SWAAMI).

The INCOMPASS project deals with understanding the interactions between the land-surface, boundary layer, convection, the large-scale environment and the monsoon variability. IISc. Bangalore is the lead institute and many other Indian and UK institutes are joining this research work through field campaigns and modeling.

The BoBBLE project deals with the impact of ocean-atmosphere processes in the Bay of Bengal |
|---|---|---|---|---|

				on the South Asian Monsoon. In this project IISc. Bangalore is the lead investigator with many Indian and UK institutes working together to understand the air-sea interaction in monsoon. (b) As part of the existing umbrella agreement between ESSO-MoES, India and NERC, UK on Technical Cooperation Earth Sciences signed in March 2013, a Scoping Workshop on Atmospheric Pollution and its Impact was organized during 11-13 May 2015 in New Delhi to facilitate networking, discussion and enable researchers to share ideas on key research questions in the area of atmospheric pollution and human health which will contribute in improving air quality in Delhi. Following this, an Implementation Agreement (IA) on Atmospheric Pollution and Human Health in an Indian Megacity was signed between ESSO-MoES and DBT from India and NERC and Medical Research Council (MRC) from UK. An Announcement of Opportunity for inviting initial proposals from Indian and UK scientists was published in September 2015. Around 15 proposals have been received which are being peer-reviewed.
5	United Nations Educational, Scientific and Cultural Organization/ Intergovernm ental Oceanograph ic	04.07.2013	Setting up of International Training Centre to enable support for capacity building activities in the field of operational	Following the agreement signed in 2013, conducted 17 training programmes aiming at capacity development in the areas of operational oceanography to about 490 trainees from India and 73 from 23 countries mainly from the Indian Ocean rim countries and Africa.

				Between August 2015 - February 2016, 2 National and 2 International training courses were conducted and 131 trainees including 13 foreign participants were trained.
6	BIMSTEC (Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation) Member countries namely Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka and Thailand.	04.03.2014	Establishment of a BIMSTEC Centre for weather & climate	Following the signing of MoU in March 2014, the BIMSTEC Centre for Weather and Climate (BCWC) was established at ESSO-NCMRWF, in March 2014.

A Training Workshop on "Improved Weather and Climate Predictions" during 26 Aug-01 Sept 2014 was conducted at ESSO-NCMRWF, Noida with participants from Bangladesh, Myanmar, and Sri Lanka.

Two scientists from Nepal (Tribhuban University, Kathmandu) visited for training on weather modeling and data assimilation in May-June 2014. The forecast products from theESSO- NCMRWF global models for the BIMSTEC region are disseminated through the ESSO-NCMRWF website.

Research work to further improve the forecast products are being carried out. Prediction skill of the NCMRWF Unified model (NCUM) for extreme rainfall events was evaluated. It was found out that the model was able to predict extreme rainfall events 3 to 4 days in advance. A procedure was developed to identify extreme events from real-time rainfall |

The first row continues from the previous page, with column 3 (objective/description) showing "oceanography for the Indian Ocean Rim (IOR) and islands region as well as Africa" and column 1 label "Commission (UNESCO/IOC)".

				forecasts for the BIMSTEC region.
7	University Corporation for Atmospheric Research (UCAR), USA	24.09.2014	It will result in improved forecasting skill for benefit of society at large. This will bring academia and scientists together to transform knowledge into service	Under this MoU, enhanced cooperation involving various academic institutes in both countries for capacity building in the field of Earth System Science are being taken up. Few areas of cooperation include: Wind Profiler System Development; Radar Meteorology; Airborne platforms and Aircraft facilities; nowcasting of severe weather events; Hydrometeorology; Satellite /Remote Sensing data related research and development; Oceanographic and climate research; Capacity Building through scientific lectures and distance learning etc.; Urban Flooding. Some preliminary work under the said MoU has been initiated.
8	Research Council of Norway, (RCN) Norway	14.10.2014	Exchange of scientific resources, personnel and technical knowledge to support the improvement or development of programs in Earth Sciences and Services for both parties.	A joint call for undertaking collaborative work between India and Norway was launched in Feb 2015 under the two themes viz: Geo Hazards and Climate Systems in Polar Regions. A total of 19 proposals were received under these two themes.

All the proposals went through a joint review mechanism and during the joint meeting held on 11th Sept., 2015, three proposals under the Geohazards theme and five proposals under Climate Systems in Polar Regions were selected for funding. The selected proposals are being processed for funding.

The selected proposals under Climate Systems in Polar regions, will carry out the |

				studies to understand the following:
				i. Ocean - sea-ice - atmosphere teleconnections between the Southern Ocean and North Atlantic during the Holocene; ii. Mass balance, dynamics, and climate of the central Dronning Maud Land coast, East Antarctica; iii. Impacts of South Asian Aerosols on Regional and Arctic Climate; iv. Effect of future Antarctic sea-ice loss on Indian summer Monsoon rainfall and v. Pliocene Arctic Climate Tele-connections Whereas under Geohazards theme, studies will be undertaken on the following topics: i. Intraplate Seismicity in India and Norway, ii. Landslide hazard assessment in NE India and iii. Delineation of the target fault-zone for Koyna scientific deep drilling by accurate location of micro-earthquakes.
9	the Helmholtz Association, Germany	7.4.2015	Cooperation in the field of earth system sciences	Under this MoU, an Implementation Agreement has been signed between ESSO-IITM, Pune and Forschungszentrum Jülich GmbH, Germany in Dec., 2015 to work on a project entitled, "Effect of Asian Summer Monsoon (ASM) on the Upper Troposphere-Lower Stratosphere (UTLS): Feedback on monsoon circulation".
10	World Climate Research Program	09.02.2015	Hosting International CLIVAR Monsoon	The International CLIVER Monsoon Project Office (ICMPO) at ESSO-IITM Pune is responsible to (i) implement

	(WCRP), Geneva		Project office (ICMPO) at ESSO-IITM, Pune.	CLIVAR Research Opportunities such as intra-seasonal, seasonal and inter-annual variability and predictability of Monsoon systems, in close cooperation with relevant WCRP activities (ii) development of a CLIVAR "Research Opportunity" on links between the monsoons and the cryosphere and (iii) Support to the Climate panels such as Monsoons Panel and Indian Ocean Region Panel. ICMPO/IITM has brought out three issues of CLIVAR Exchanges which include a special issue on monsoon, entitled "Advancing understanding of monsoon variability and improving prediction".