NATIONAL MISSION ON STRATEGIC KNOWLEDGE FOR CLIMATE CHANGE

Under
National Action Plan on Climate Change

Mission Document

GOVERNMENT OF INDIA
DEPARTMENT OF SCIENCE & TECHNOLOGY
MINISTRY OF SCIENCE & TECHNOLOGY

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Mission Document of National Mission on Strategic Knowledge for Climate Change

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EXECUTIVE SUMMARY

India is a country which is and will be severely impacted by climate change at a time when she is confronted with huge development imperatives. India has already declared that even as she pursues her social and economic development objectives, she will not allow her per capita emissions of the developed countries. With an economy closely tied to its natural resource base and high dependence on climate-sensitive sectors such as agriculture and forestry, India may face a major threat because of the projected changes in climate. In response, the Government of India has formulated a National Action Plan on Climate Change, which outlines India's domestic plan for sustainable development with specific proposals under each mission representing what India believes she needs to do in terms of ecologically sustainable development and serving the objectives of adaptation and mitigation. As one of the eight National Missions which form the core of the National Action Plan, the National Mission on Strategic Knowledge for Climate Change (NMSKCC) seeks to build a vibrant and dynamic knowledge system that would inform and support national action for responding effectively to the objective of ecologically sustainable development.

A strong and strategic knowledge system is essential for identifying, formulating, planning and implementing policy driven actions while maintaining the necessary economic growth rate. Such a strategic knowledge system for informing and supporting climate sensitive actions will need to address a number of objectives. The mission should address climate science with region specific modeling; an assessment of various technology scenarios and alternatives for complying with national objectives; leveraging international cooperation and strengthening our initiatives for selection and development of new technologies for adaptation and mitigation; and ensuring that knowledge gaps are bridged. It is essential that the vitality of the knowledge enterprise addressing the climate change issues is maintained through human and

institutional capacity-building. Such measures are necessary for designing policy responses and implementation approaches at the national level and for inputs to negotiations at the international fora by designated departments.

The National Mission on Strategic Knowledge for Climate Change should ideally serve as service mission to National Action Plan for Climate Change with in built capacities for continuous and mid course changes in trajectories to take into account of international developments in climate change related issues.

The strategic knowledge system should be able to access as well as integrate data, information and assessments originating from a large number of inter-connected sources. The current modes of data generation and information and knowledge sharing in India do not enable the required integrated approach. Data sharing among various data sources is necessary for building strategic actions based on knowledge-led paths. Therefore, the mission recognizes that a) there are considerable knowledge resources available with various Ministries, Government agencies and R&D institutions which should be made available for sharing even within Government for building strategic knowledge and b) there must be certain benchmarks for the collection, collation and interpretation of data. The norms must be set by the NMSKCC for data gathering and knowledge sharing. Without a credible data sharing mechanism, building strategic knowledge on climate change is virtually impossible. A necessary pre-condition for NMSKCC is a bench marked data collection and sharing system aided by appropriate high bandwidth hard ware infrastructure to network knowledge bodies in the strategic knowledge framework. Alignment of National data sharing policy to facilitate data sharing among knowledge partners is crucial.

Knowledge networks which would inform and support strategic actions and policies among the stakeholders are necessary. Such knowledge networks will be required to identify, guide and develop suitable technology centered adaptation actions on the one hand and provide informed inputs to the policy process and international negotiations.

Many Ministries and Departments of the Government of India have been supporting research related to climate change and response options through intra- and extra-mural research and knowledge support systems. These include the Ministry of Science & Technology [Department of Science & Technology (DST), Department of Biotechnology (DBT), Council of Scientific & Industrial Research (CSIR)], Ministry of Earth Sciences (MoES), Ministry of Environment & Forests (MoEF), Ministry of Agriculture [Department of Agriculture and Cooperation (DAC), Indian Council of Agricultural Research (ICAR)], Department of Space (DOS), Ministry of Water Resources (MoWR), Department of Atomic Energy (DAE), among others. These wide-ranging R&D efforts need to be further strengthened. The National Mission on Strategic Knowledge for Climate Change would build on this existing base to launch new initiatives as appropriate in a mission-mode manner. The National Mission on Strategic Knowledge for Climate Change would give a fillip and further enhance the effectiveness and impact of the various existing intra and extra-mural support systems.

As a part of its role as the nodal ministry for coordinating India's participation in the global negotiations on climate change, the Ministry of Environment & Forests undertakes a major, periodic inventory & assessment exercise through which the country's National Communication (NATCOM) is prepared and reported to the UN Framework Convention on Climate Change (UNFCCC). The NATCOM process, which is important as a stock-taking exercise and for meeting our obligations under the UNFCCC, draws from, and depends on, the wide base of knowledge institutions and networks. By strengthening these networks; building institutional capacity; and by addressing the knowledge gaps; the actions under the Mission will contribute to, and support the NATCOM process, and increase the effectiveness and quantum of our national responses to climate change.

Thus, mission mode actions are required for -

a) Formation of well designed knowledge networks with a well structured framework for harmonization, interoperability, sharing and exchange of data of relevance to climate change and responses
b) Enhancing the research capability in climate science,
c) Positioning a technology watch system for key sectors related to economic development, likely to be affected by climate change,
d) Leveraging development of suitable technologies for adaptation and mitigation of climate change under various missions,
e) Assisting other agencies engaged in the implementation of the National Action Plan for Climate Change and supporting the actions under the other Missions, as and if necessary.

At the present time, several knowledge groups are engaged in research and development on science relating to climate change but are either weakly coupled or non-networked. The NATCOM process has been performing a valuable task in bringing about interconnections among some knowledge institutions from various departments/ ministries. Therefore, formation of knowledge networks among all the knowledge institutions and select specialist groups engaged in climate change research supported by an enabling data sharing policy is integral part of the National Mission on Strategic Knowledge for Climate Change. Enhancement of National capability on climate modeling involves both strengthening of observational networks and networking capacity for data gathering, assimilation and sharing, inclusive of measures to enhance the access to and availability of relevant data. The National Mission on Strategic Knowledge will leverage the next generation high bandwidth data networks being created through the National Knowledge Network (NKN) to enable scientists to collaborate, access and share computational and data resources. Creation and strengthening of research infrastructure, such as high performance computing is also essential. These actions have to be accompanied by long-term strengthening of the knowledge system by building human and institutional capacity. At the same time, creation of awareness and

suitable capacity at different levels of government is also important to facilitate implementation of appropriate measures.

The National Mission on Strategic Knowledge for Climate Change focus on

a) Mapping of the knowledge and data resources relevant to climate change and positioning of a data sharing policy framework for building strategic knowledge among the various arms of the Government,

b) Identification of knowledge gaps, and Formation of global technology watch groups to help accomplish the task of technology selection and prioritization,

c) Networking of knowledge institutions after investing critical mass of physical, intellectual and policy infrastructure resources,

d) Creation of new (about five) dedicated centres within the existing institutional framework for building of human capacities by insitutiing 50 Chair professorships on climate change and about 200 trained professionals (mostly PhDs) in various areas of knowledge domain relevant to climate change policy and actions.

e) Promotion of research and development and innovation on climate science, technologies and applications through nationally coordinated Extra Mural Research, Development and Delivery programmes but consistent with the mission mode actions defined above

f) Building international cooperation on S&T for climate change agenda through strategic alliances and

g) Assistance to the formulation of policies for a sustained developmental agenda within a responsive climate change framework and inputs to the Ministry of Environment and Forests and Ministry of External Affairs.

CHAPTER-1

Introduction

The Fourth Assessment Report of Inter Governmental Panel on Climate Change (IPCC) provides an unequivocal message regarding the significance of the problem of climate Change and the urgency of response. At the same time, significant uncertainties still remain in the computation of effects of Green House Gases on regional climates. As a result, it is often the case that future climate change projections based on global models without local considerations offer insufficient basis for the formulation of effective response measures by the National Governments. Global climate change projections do not always lend themselves with certainty and detail to tailor National response strategies. Science, therefore, has to play an important role for improving the understanding of the problems specific to regions as well as in contributing towards the possible solutions and responses.

The National Action Plan on Climate Change (NAPCC) incorporates the India's vision of sustainable development and the steps India must take to realize it while avoiding Greenhouse Gas emissions. The NAPCC has enunciated actions through eight national missions, of which the National Mission on Strategic Knowledge for Climate Change is one. It is recognized that the knowledge component of this mission may focus on knowledge systems and their elements (e.g., people, scientific understanding, research infrastructure, etc) whereas the strategic component is for supporting long-term goals of the country with regard to sustainable development in this context.

The National Mission on Strategic Knowledge for Climate Change recognizes

a) The importance of measurements and quantification,

b) The dynamic and changing nature of knowledge and technology, and

c) The importance of the ability to seize new and emerging technology opportunities.

It will identify the challenges of and the responses to climate change and assessment of risk based on available knowledge. It will augment the knowledge-base in areas such as region specific climate modeling, India-specific emission factors, adaptation or vulnerability indicators and metrics, ecosystem service indicators, energy-economic models, carbon footprints and impact assessment in specific sectors. The mission would ensure core funding for high quality and focused research on various aspects of climate change in India.

The Ministry of Science & Technology (MoST) and the Ministry of Earth Sciences (MoES) have been supporting and carrying out research & development in many areas of significance to climate change and responses, including through intra- and extra-mural research and knowledge support systems. For example, the Indian Climate Research Programme (ICRP) was a decade-long effort to improve understanding of monsoon and climate-related issues. The first ever national level methane campaign was sponsored and implemented by the Ministry of Environment & Forests and coordinated at the National Physical Laboratory. in the 90's to improve scientific understanding of methane emissions and atmospheric chemistry, which led to important scientific findings with high policy significance. Laboratories/Institutions under the Ministries of Science & Technology and Earth Sciences such as the Indian Institute of Tropical Meteorology (IITM), the National Physical Laboratory (NPL), the India Meteorological Department (IMD), the Central Leather Research Institute (CLRI), the National Institute of Oceanography (NIO), the National Environmental Engineering Research Institute (NEERI), among others, have made significant contributions to climate change research. They have supported important assessment activities like India's National Communication (NATCOM) to the United Nation Framework Convention on Climate Change (UNFCCC).

CHAPTER-2

Main Objectives of the Mission

Anthropogenic climate change has been studied world wide based on global general circulation models (GCM) under various greenhouse gas emission scenarios. Whereas GCMs are employed with some success in assessing likely global consequences of climate change, it is essential that efforts are made to enhance spatial resolution of such consequent analysis.

The consequences of climate change on the social systems are expected to vary in different regions of the world on account of several regional and other local factors. Therefore different modeling studies, adaptation strategies and technology systems would be required in differing geographical and social contexts. Further, there are many uncertainties in disaggregating the effects of global warming on different agro climatic regions due to still inadequate scientific understanding of the processes involved in the climate change. This would require developing a strong capability in basic and applied research in climate science by strengthening observational and modeling tools and systems. India is too large a country to adopt strategies based on global averages of climate change. The current levels of uncertainties associated with likely consequences of climate change in various regions of the country are significant and do not enable the development of strategic action plans for different regions within the country.

There are a number of constraints that limit at present the ability of the national knowledge system to deliver the required and expected outcomes for effective response. These may be summarized as follows:

- Knowledge gaps in key underlying scientific areas
- Insufficient observational and scientific information data base
- Fragmented knowledge base in terms of people, institutions and capabilities

- Poor connectivity between and within knowledge generating communities and user communities at various levels

- Lack of a systemic institutional mechanism for collating, synthesizing and delivering knowledge products for decision-making

- Absence of a strong and vibrant global technology watch system

- A knowledge system to relate technology choices with time evolved climate responses

- Absence of a knowledge system to develop various scenario for disaggregated impact assessment and

- Absence of a knowledge system to make risk-minimized selection of technology choices for meeting the developmental goals

Addressing these constraints through strategic actions that include the development of appropriate institutional and human resource capacity for this purpose will form the main goal of the National Mission on Strategic Knowledge for Climate Change. Accordingly, the following objectives have been identified for the Mission:

I. Formation of knowledge networks among the existing knowledge institutions engaged in research and development relating to climate science and facilitate data sharing and exchange through a suitable policy framework and institutional support

II. Establishment of global technology watch groups with institutional capacities to carry out research on risk minimized technology selection for developmental choices

III. Development of national capacity for modeling the regional impact of climate change on different ecological zones within the country for different seasons and living standards

IV. Generation and development of the conceptual and knowledge basis for defining sustainability of development pathways in the light of responsible climate change related actions

V. Providing an improved understanding and awareness of the key climate processes and the resultant climate risks and associated consequences

VI. Complementing the efforts under the other national missions, strengthen indigenous capacity for the development of appropriate technologies for responding to climate change through adaptation and mitigation and promote their utilization by the Government and societies for sustainable growth of economies

VII. Creating institutional capacity for research infrastructure including access to relevant data sets, computing and communication facilities and awareness to improve the quality and sector specific scenarios of climate change over the Indian subcontinent.

VIII. Ensuring the flow and generation of human resources through a variety of measures including incentives to attract young scientists to climate science

IX. Building alliances and partnerships through global collaboration in research & technology development on climate change under International and bilateral S&T cooperation arrangements

CHAPTER-3

Approach and Strategies to Address Gap Areas

The Mission adopts an approach which is consistent with that adopted in the development of National Action Plan on Climate Change (NAPCC). That is, the Mission recognizes that the directional change required is not so much about 'what' we might do, but rather about 'how' we might do what is right to do. Thus, while there is no change in the fundamental developmental goals, there is an attempt to re-prioritize, re-design and re-emphasize interventions to have a greater and more effective outcome. A rational and scientific assessment and basis for the region specific national actions is conceived.

Strategic knowledge systems should draw inputs from various stakeholders inclusive of representatives of civil society to assimilate the traditional knowledge systems and referencing of technologies to the social contexts of the country

The proposed approach under the Mission therefore has the following features:

- Strengthen and prioritize ongoing and planned programmes

- Increase the spatial and temporal resolution of regional impact of climate change as referenced to ecosystem scale foot prints of GHGs variations within India

- Develop national capacity to undertake studies for assessment of different technology scenarios for select key sectors

- Prioritize actions around key thematic areas such as climate modeling and climate projections, assessment of impacts, vulnerability & adaptation and identifying, assessing, selecting and developing adaptation and mitigation technologies, complementing the effects under other national missions as appropriate

- Use existing delivery structures empowered as necessary

- Create knowledge networks through a hub-and-spoke model, with core institutions linked to a wider range of knowledge partners linking both Intra-mural and Extra Mural Research support systems

- Create new knowledge institutions leveraging existing strengths as and when appropriate

- Develop and provide knowledge and information products for use at specific and different levels and serve as an internal knowledge alert system while assisting the relevant groups with inputs for international negotiations. Such information and knowledge products may include options, scenarios, indicators, risk assessments, etc.

The Mission will further address two important cross-cutting issues as an integral part of the Mission design and implementation:

  - Building human and institutional capacity at various levels, and

  - Engaging and benefiting from global collaboration in scientific research & technology development

An integral part of the approach is the creation of an empowered and effective Mission office. The Mission office would not only help in managing the flow of resources, but would also perform important functions of knowledge assimilation, synthesis, communication and outreach.

A strategic framework for the research agenda to be supported under the Mission will be developed. This framework will reflect the knowledge and science-related priorities of key sectors such as agriculture, water resources, energy, environment, habitat, transportation, health and biodiversity (ecosystems) for enabling comprehensive research and technology initiatives to underpin the plan of action. Such a strategic framework will be useful for the

S&T funding agencies and their sectoral partners dealing with other national missions on climate change; will ensure consistency, avoid duplication and focus new funding on priority areas. For example, the Department of Biotechnology's (DBT) initiative on agrobiotechnology and climate change has received several proposals. Similarly the Indian Council of Agricultural Research (ICAR) has a network program for climate change research and responses in the agriculture sector.

Many institutions and programmes in the Ministry of Science & Technology and Ministry of Earth Sciences are engaged in identifying, assessing, developing and working towards the dissemination of solutions for adaptation and mitigation to climate change. They are thus well-placed to provide knowledge and technology support to the national actions on climate change, including the other missions under the NAPCC.

These main actions proposed under the Mission are described in greater detail in the following section.

CHAPTER-4

Proposed Actions to Address Objectives and Goals of the Mission

4.1 Establishing Networks of Knowledge Institutions

Although there are number of institutions engaged already in research and development with a bearing on climate change and responses, there is no effective mechanism to network these knowledge institutions. Data sharing among these institutions is also not well facilitated. Data sharing policy for climate change modeling and simulation of responses is critical. Already, the Ministry of Science and Technology has been directed by the Government to suggest suitable policy changes. Some preliminary effort in building network of knowledge institutions has already commenced under the direction of Principal Scientific Advisor. The National Knowledge Network (NKN) will serve as the underlying common infrastructure to support data sharing and collaboration. Research relevant for Climate change is being undertaken through both Intra Mural and Extra Mural Research support systems. A coordinating mechanism is required for networking the research outputs of all the knowledge institutions. Establishment of an updatable and interactive knowledge portal on climate change research in the country is an identified action. The already existing expert committee under the Chairmanship of Principal Scientific Advisor will be further strengthened to serve the needs of National Mission on Strategic Knowledge for Climate Change.

4.2 Quantum increases in research on climate science

Advancing the base of knowledge in climate science will require an integrated set of interventions that include improvements in the observations of key climate and biogeochemical variables; studies of basic phenomena and dynamical behavior, and a significantly scaled-up effort towards improving climate modeling.

Climate modeling is being undertaken in some knowledge institutions within the computational and intellectual infrastructure available to these entities. The Ministry of Earth Sciences has established a Centre for Climate Change Research (CCCR) with Indian Institute of Tropical Meteorology as the nodal centre. The National Centre for Medium Range Weather Forecasting (NCMRWF) has been a lead organization for global data assimilation and weather modeling in the country for generating medium, extended range, monthly and seasonal predictions over India. IMD has been collecting meteorological data for over 100 years and taken action to measure GHG concentrations and fluxes as well. There are other knowledge institutions including some laboratories of CSIR, Indian Institute of Science and Indian Institutes of Technology which are engaged in climate modeling currently. The Strategic Knowledge Mission on Climate Change would seek to develop spatially as well as temporally resolved climate models with revalidation arrangements inclusive paleobotanical evidence for covering the needs of a large country like India. Effects of climate change on varying ecosystems of the country could be expected. Considering the importance of international collaboration and to take the benefits from the science developed elsewhere around the world, Ministry of Earth Sciences has initiated large number of international collaboration programmes to enhance understanding of climate variability and change.. Several other ongoing and planned international collaborative research projects are going to strengthen the climate research in the country.

Integrated climate and Earth observing systems are key elements for further progress in understanding of climate change. The current and future space-based observational platforms of the Department of Space would play an important role. Such platforms and networks would be helpful for monitoring and measurements of key climate and biogeochemical variables including greenhouse gases. In addition, remote sensing will also play an important role for measuring and characterizing changes in ecosystems and land use & land cover change; and the feedbacks with climate change.

In view of the importance of improving scientific understanding of the processes and future impacts of climate change, a quantum increase in climate modeling research and climate science overall; with suitable division of focus is envisaged under the National Mission on Strategic Knowledge for Climate Change. This overall increase in the climate science & modeling effort will be accompanied by targeted efforts to address specific knowledge gaps, which are elaborated in a subsequent section (4.5).

4.3 Setting up an effective mechanism for data sharing and access

There are several data bases that are relevant for climate research, along with the respective agencies that are responsible for collecting and supplying that data. Through National Mission on Strategic Knowledge for Climate Change, efforts will be made to establish an effective mechanism for sharing and access of data both within Government and also with public. To begin with, a two-tier system is proposed in which there will be free circulation, on demand, within Government and a more limited, but free access, with non-governmental and academic and research institutions. It is also proposed that the data access to non-governmental and academic institutions may be effected through the concept of 'registered users' who will have easier access to climate related data held by the various scientific Ministries and Departments of the Government. There is a separate initiative being taken up by the government relating to a national policy on data sharing and access which will be adopted as and when the policy is approved. The Ministries and their agencies are also expected to initiate action to digitize the data, maintain meta-databases of global quality, and streamline the procedures governing access. Following are the existing databases maintained by various Ministries/departments:

Sl.No.	Database	Data Collecting and supplying Agency
1.	**Oceans** Sea surface temperature, salinity, sea level rise	Ministry of Earth Sciences
2.	**Cryosphere** Snow Cover Glacial data	a) National Remote Sensing Agency (NRSA) b) Geological Survey of India c) Snow and Avalanche Studies Establishment (SASE), Defence

		Research and Development Organisation
3.	**Meteorology** Precipitation Humidity Surface temperature Air temperature Evaporation data	India Meteorological Department, Ministry of Earth Sciences.
4.	**Land Surface** Topography Erosion Imagery (vegetation map) Forest cover	a) Survey of India b) National Remote Sensing Agency (NRSA)
5.	**Hydrological** Ground water Water quality River water Water utilization	a) Central Water Commission b) State Water Resource Organization
6.	**Agriculture** Soil profile Area under cultivation Production and Yield Cost of Cultivation	Ministry of Agriculture
7.	**Socio-Economic** Demography Economic status	Census of India
8.	**Forests** Forest resources Plant and animal Species distribution	a) Forest Survey of India b) State Forest Department c) Botanical Survey of India d) Zoological Survey of India e) Department of Space
9.	**Health Related Data**	Department of Health Research

4.4 Building foresight for climate change response

A strategic prioritization of knowledge gaps in key climate sensitive sectors through an approach of global benchmarking and assessment will be undertaken. Approaches and strategy for empowering decision-making for bridging the gaps will be identified through mission mode actions. An assessment of current state of climate change related research and developmental activities at state and national level is a primary requirement for better planning of interventions.

Several existing organizations such as Technology Information, Forecasting and Assessment Council (TIFAC) and the National Resources Data Management System (NRDMS) within the DST, National Environmental Engineering Research Institute (NEERI), National Institute of Science, Technology and Development Studies (NISTADS) etc within CSIR, National Institute of Ocean Technology (NIOT) within MoES, the new Science and Engineering Research Board (SERB), National Science and Engineering Academies, and NATCOM process of the Ministry of Environment and Forests could play a role in serving as a global technology and policy watch system. Since technology is dynamic and evolves continuously, Global Technology Watch system should be institutionalized within some well identified institutions. Under a separate time bound Extra Mural Research project under Strategic Knowledge Mission technology capabilities within the country will be mapped in a time bound manner. Some of the existing knowledge institutions should be tasked to undertake research on prioritization, as well as the assessment of hazard risk, exposure and vulnerability. Expert networks that tap into the global pool of scientific expertise available in the open scientific community will also be important in this process. A standing and independent think tank on technology assessment and prioritization is envisaged.

4.4.1 Decision support tools and methods

A wide range of knowledge-based decision support tools and analytical environments would be required to support policy bodies on responses through adaptation and mitigation actions. Such technology tools include, inventory / source estimation models for greenhouse gases, climate models and modeling capability to provide high quality and region specific climate change projections over the Indian subcontinent with adequate spatial resolution and time evolution. The assessments of impacts and vulnerability will take into consideration also the local and regional environmental conditions and social practices. Adaptation strategies will be developed based on scenario analysis after making allowances for various socio–economic and developmental priorities in the general frame work of the National Action Plan on Climate Change. A significant level of disaggregation of data as well as integration of

different scenario for national policies would be required for planning the response strategies for the country. Therefore the tools and methodologies available for planning adaptation interventions and integrated assessment from the global models would need to be retrofitted to suit the Indian conditions and requirements. In other words, a country specific modeling capability is envisaged as a part of the Nation Mission on Strategic Knowledge for Climate Change.

Reliable and detailed regional information, including current and future assessments of climate variability and change, is essential in the design of effective strategies for adaptation to climate change. Priorities of the Mission are a) good-quality climate observations with sufficient spatial coverage over a long period of time, b) suitable of models to depict current and future regional climate and c) a thorough understanding and appreciation of the uncertainties and constraints associated with the use of both data and regional and global models. Analyses of economic implications, life cycle, farm as well as catchment systems and the societal impact of climate change are prioritized Planning, operational and investment decisions will need to be supported.

Targeted research programmes will be created for modification and customization of existing tools and models to match the specific regional and national context. Considering the need to accelerate the learning process for tool development, international S&T collaboration will be developed. Existing linkages with international institutions, such as the programme with the IIASA (International Institute for Applied Systems Analysis) may need to be tapped.

4.5 Filling knowledge gaps

Basic bottom-up individual-PI driven disciplinary research is already supported through existing programmes, for example: Indian Climate Research Programme (ICRP) of Science and Engineering Research Council (SERC) within DST, Centre for Climate Change Research (CCCR) of MoES. Short-term assessment and synthesis activity is supported by MoEF's NATCOM. While

such interventions are useful, a much more proactive and scaled-up approach will be required for filling the gaps in key knowledge and science domains.

The issue of filling gaps will be addressed by the National Mission on Strategic Knowledge for Climate Change (NMSKCC) through the creation of *knowledge networks to permit most effective and sustained utilization of S&T resources* and to accelerate the knowledge generation process. Given that an interdisciplinary / multi-disciplinary approach will be required for most of the knowledge gaps, such an approach will help leverage the existing, but largely dispersed and fragmented scientific strength.

These networks will be anchored around specific lead institutions / organizations for particular knowledge domains. In cases, where there are no clear existing institutions, large network research programmes with specific responsibilities, deliverables and accountability provisions will be created. In domains of long-term, strategic importance, creation of new institutions is also envisaged. These will serve as the anchors / core of the knowledge networks. In all cases, these knowledge networks will be guided by advisory bodies with key stakeholder representation. A combination of both bottom up and top down approaches to planning and implementation of research for filling gaps in the knowledge areas is planned. Top down R&D initiatives will have to be implemented through an inter ministerial mission mode programme for avoiding duplication and speedy completion of mission tasks. For early filling of the knowledge gaps under mission mode programmes, the Strategic Knowledge Mission could create a fund with an empowered inter ministerial council in the form of Committee of Secretaries for decision making on research funding and implementation.

Some of the key knowledge domains are identified below, together with a possible lead institution or the modality of creating a knowledge network:

- Monsoon dynamics – seasonal to inter-annual prediction and linkages with long-term climate change (IITM, Pune lead)

- Aerosols and cloud & radiative feedback (Network research programme; MoES lead)

- Ocean and coastal biogeochemistry and influence on GHG sources and sinks (NIO/INCOIS/CMLRE lead)

- Coastal geomorphology change and mapping / modeling of coastal hazards including cyclone hazards (Network research programme; MoES lead – Indian National Centre for Ocean Information Services (INCOIS), NIOT, Integrated Coastal and Marine Area Management (ICMAM), National Centre for Antarctic and Ocean Research (NCAOR) along with other institutions in the country)

- Long-term change in key ecosystems (measurement, process understanding & modeling of biogeochemistry and climate coupling) (MoES lead; Network research programme)

- Integrative studies of vulnerability, adaptation and climate risk management in key sectors such as infrastructure, human health and water resources (New institution)

- Studies of Himalayan glaciers and assessment of glacial changes and glacier dynamics including possible responses (initially led by Wadia Institute of Himalayan Geology (WIHG), new institution proposed on Himalayan glaciology. Ice Core studies led by NCAOR)

- Regional climate projections and development of regional climate models. Global modeling, quantification and representation of uncertainties in the model simulations (IITM lead)

- Other knowledge domains may be identified during the course of the NMSKCC implementation.

Although the IPCC-AR4 has addressed the general global trends on climate change, spatially resolved assessments are necessary for India. There is a need to develop high resolution Atmosphere Ocean General Circulation Models (AOGCM) and nested Regional Climate Models (RCM) that simulate regional climate change inclusive of monsoon behavior. The mission will accomplish this objective by pooling institutional capabilities and computational resources.

Several unique features of climate and weather science would require to be employed for multi-ensemble and multi-year simulations of the present and future climate. Indigenous Regional Climate Models (RCM) are necessary to generate accurate future climate projections up to (at least) district level. Regional data re-analysis projects should be encouraged. A Regional Model Inter-comparison Project (RMIP) for climate is required to minimize uncertainty in future climate projections.

The developmental plans of the country require an increased supply of energy and materials. Atom and Energy efficiencies of most technologies deployed in processes for manufacturing need to be revisited. This is currently an area of knowledge gap. A technology assessment group with climate change focus for key sectors will be necessary.. Adaptation and adoption of technologies without suitable ranking for climate change sensitivity could cause serious challenges in later years. The establishment of a well developed knowledge system for technology audit for climate change potentials based on research and development is a mission goal and planned output.

4.6 S&T Innovations for Climate Change Responses

Given the importance of science, technology and innovation to advance the process of solution development; this Mission element will be operationalized through two sub-elements or sub-Missions.

4.6.1 Mitigation technologies sub-Mission

The Council of Scientific and Industrial Research (CSIR), has already initiated an ambitious effort to look at technology and energy security, with almost 17% of its 11th Plan budget relevant for climate change related actions. The CSIR would take the lead for anchoring the Mitigation technologies sub-Mission. CSIR's existing modalities for technology development and public-private partnerships for technology transfer and diffusion would be leveraged to accelerate development of climate-friendly technologies. Examples include the solar PV and its applications, technology appraisal of coal-to-liquid approaches, R&D in carbon capture & storage and synthetic biology approaches for biofuels and bioproducts production.

In addition, there are a number of other ongoing initiatives and initiatives under development that would be of relevance with regard to technologies and solutions for mitigation. These include:

- Utilization of bamboo for distributed energy generation, under the NMBA
- Development of materials for next-generation solar cells, under the Nano-Mission
- Development of instrumentation and sensors that may be useful for energy efficiency applications, under DST's Technology Development Board (TDB)
- A coordinated pan-IIT research programme on solar energy technology development, supported through DST's TDB
- Public-private consortia projects for automotive propulsion technologies, under the Core Advisory Group on Automotive R&D (CAR) [PSA's office]
- Fuel-cell technology development under Centre for Fuel Cell Technology (CFCT) in the International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), Hyderabad.

- Desalination of coastal water and wave energy technology under NIOT,Chennai

In addition, the Technology Development Board provides a unique funding window for technology development & up-scaling support.

The technologies outlined above exclude those related to nuclear energy which comes under the Department of Atomic Energy. The issue is also being addressed separately by other national missions viz., Mission on Energy Efficiency and also to some extent in National Solar Mission.

4.6.2 Adaptation technologies sub-Mission

Climate risk management includes the understanding and characterization of risk, followed by the formulation and implementation of risk management technologies and strategies. New technologies and innovation are also important in moving towards climate-resilient development through the better management of climate-related risks Some current examples of adaptation-related technology development efforts include:

- Remote sensing applications for agricultural vulnerability assessment

- Water technology Mission being implemented under the directive of the Supreme Court through Ministry of Science and Technology

- NIOT's freshwater production technology for coastal areas

- DBT (and DST) initiatives on agrobiotechnology and food security, including the work of the Agharkar Research Institute.

There are wide-ranging technologies for adaptation outlined under several other national missions on climate change. The efforts here will complement and enrich those programmes.

4.7 Strengthening Institutional and Knowledge Capacity

Strengthening knowledge and institutional capacity in key scientific areas follows directly from the main mandate of the Ministry of Science and Technology. In view of the long-term nature of the climate change issue and the very broad scope and dimensions of the problem, it will be important to develop a diverse portfolio of capacity-building interventions in a targeted and strategic manner.

These interventions would include capacity-building at various levels, including strengthening the base of curiosity-driven scientific research; creating centers of excellence in priority areas in existing institutions; and setting up new institutions in gap areas that allows for leveraging the global and national knowledge-base.

Strengthening knowledge capacity also requires an adequate level of human resources of high quality and with requisite skills, and the research infrastructure that would enable these individuals and institutions to function effectively and productively.

4.7.1 Human Capacity Building

Human resources development is at the core to sustain climate research in India. At the present stage of our development, the scientific base engaged in climate change response is dispersed and needs a planned expansion and strengthening. Enhancement of capacity within the next five years is a priority action identified under the mission.

A "Climate Change Research and Fellowship Programme" will be initiated to create special research fellowships at the pre-doctoral and post-doctoral level for climate research (starting at about 50 per year, and increasing to about 200 per year over the next 10 years). This will be accompanied by the creation of about 50 "Professor Chairs" in Universities and IITs for climate research. A variant of this would be National Research Chairs that would have a built-in

flexibility that would make it possible to get academic leaders from overseas, even for short durations.

The Training School model of the Department of Atomic Energy with training linked to a guaranteed employment may be explored for creating and sustaining the demand for quality manpower in climate change related areas.

4.7.2 Strengthening institutional capacity

The Ministry is already in the process of developing a national initiative on Himalayan glaciology, initially anchored at WIHG. This national institution on glaciology will provide important knowledge support for National Mission for Sustaining Himalayan Ecosystem.

In a similar manner, institutional capacity will be created and strengthened in other areas of long-term, strategic importance, through 'Centers of excellence'. These Centers of excellence will be initiated by leveraging the infrastructure and capabilities of existing institutions at the outset, with the possibility of evolving into independent institutions over a period of time. They could be collectively designated as the "national climate change knowledge centers", and operated through a common apex management structure to allow mobility of people and cross-fertilization and synergies in the work. These Centers would be linked to the knowledge gap areas identified earlier, but their role would include not only research and knowledge generation, but also human resource development, training, outreach and dissemination of knowledge and knowledge products.

Some possible Centres of excellence (including virtual/network centres) may be:

a) Centre for Climate Change Research (CCCR) (IITM, Pune) will focus on climate modeling and regional / global projections, Data assimilation, regional reanalysis, global modeling, physical processes, quantification and representation of uncertainties in model simulations.

b) Regional Climate Centre (IMD, Pune) for building climate related service to provide climate services as a WMO Regional Centre

c) National Institute for Himalayan Glaciology (WIHG, Dehradun)

d) Centre for S&T Capacity Building in Climate Change

e) Centre for climate risk management (issues of vulnerability & adaptation)

f) Centre for development of technologies for enhancing energy efficiency in synergy with the National Mission for Enhanced Energy Efficiency being taken up separately.

g) Centre for materials for energy conversion and energy storage

h) Institutions that could serve as 'homes' for some of these centers include: NEERI, Nagpur; Indian Institute of Science (IISc), Bangalore; Jawaharlal Nehru University (JNU), Delhi; National Physical Laboratory (NPL), Delhi; Jadavpur University, Kolkata, Indian Institute of Technology (IIT), Bombay and Indian Institute of Technology, Delhi.

The activities of these Centres should be transparent and accessible to the stakeholders and policy makers through dedicated web-based services being created for the National Mission on Strategic Knowledge for Climate Change. The mission will seek to link and network knowledge institutions through open platforms of data availability, scientific information and knowledge sharing. Such open platforms might offer a good opportunity to enlist the global research community in the response to climate change.

4.7.3 Creating and strengthening essential knowledge infrastructure

Climate change data emanate from many specialized disciplines within the domains of earth, physical, biological, environmental and engineering sciences. These data are often available in disparate forms, such as data output from models forecasting climate conditions, satellite images of ocean and land

masses, and proxy samples from different regions. The widespread availability of such data is important to developing a comprehensive understanding of climate change and its potential impacts.

In addition to existing operational observational networks, it may be necessary to set up long-term research observational networks to address specific knowledge gaps. Notable among the ongoing efforts include observational networks for long-term ecological and ecosystem research, and networks for observations for fluxes of greenhouse gases – INDO FLUX NET is launched by the Ministry of Earth Sciences during the XI Plan in view of their importance in helping to understand and address climate change. DOS through their National Carbon Project has started establishing such networks in selected ecosystems of India. An added impetus to these efforts to build additional observational capacities as may be required from time to time would happen through the Mission.

The provision and utilization of data and information is a key aspect of strengthening capacity. The National Spatial Data Infrastructure (NSDI) will be used to deliver single window access to climate and related data, under the aegis of a national data access & sharing policy, which is currently under consideration by the government.

Access to, and utilization of data and computational resources, will be achieved through the National Knowledge Network, which will provide multi-gigabit data connectivity to key knowledge institutions.

4.8 Outreach and Internal stakeholder linkages

National Mission on Strategic Knowledge for Climate Change (NMSKCC) is expected to develop two kinds of knowledge products, one suited for wider audiences and other specially needed for internal stake holders. Hence the mission should adopt dual strategies for knowledge exchange. Some general information on climate change for mobilization of youth for research and awareness would be disseminated through normal channels. Development and

dissemination of information and knowledge products ideally required for policy building would be limited to internal stake holders within the decision bodies.

Some proposed interventions for wider audience under the NMSKCC include:

Open platforms for information and knowledge sharing and collaboration, building linkages for outreach and dissemination. NGO's could host and manage these platforms, which would largely be web-based, but which would include possibilities of doing capacity-building.

The Ministry of Science & Technology, Ministry of Environment & Forests and the Ministry of Earth Sciences have a number of existing platforms and mechanisms for outreach and information dissemination to a wide range of communities and audiences. The environmental education and awareness programmes of the Ministry of Environment & Forests, such as National Environment Awareness Campaign, (NEAC), Environmental Appreciation Forces, publications and Global Learning and Observations to Benefit the Environment (GLOBE) are relevant in outreach and internal stakeholder linkages. The programmes of the DST in partnership with the Honkong and Shanghai Banking Corporation Ltd (HSBC); dedicated science and weather channels to be launched by MoST/MoES; activities of the National Council for Science & Technology Communication (NCSTC) and Vigyan Prasar, including the rather successful Science Express (train) by DST. These will be leveraged. The climate change area is a source of many exciting and challenging scientific problems, and the creation of awareness and understanding regarding these science issues, particularly amongst the students and youth would be important for stimulating further entry of talented young scholars into this field.

Specific knowledge products for internal stake holders will be made available only to the registered users associated with the National Action Plan on Climate Change. It is believed that some of the knowledge products developed under NMSKCC will be required for international negotiations by the Ministry of Environment and Forests. Therefore, an empowered committee would be formed to decide about the data for exclusive use of internal stake holders.

CHAPTER-5

Work Elements and Functional Arrangements

Several actions have been identified as a part of the National Mission on Strategic Knowledge for Climate Change under NAPCC. The actions identified form a combination of both centralized and distributed functions among all the partners engaged in the mission. The various activities selected for distributed functions are listed along with the possible agency responsible for implementation as given in the table and indicated in the Fig-1 below.

Elements of distributed functions of the Mission	**Nodal Ministries/ Departments responsible for implementation**
Climate observations, monitoring, modeling and climate Science; Ecosystem Modelling	Ministry of Earth Sciences (MoES)
Development of Technologies for adaptation& mitigation in CSIR laboratories	Council for Scientific and Industrial Research (CSIR), Ministry of Science & Technology
Agro biotechnological Initiatives for adaptation to climate change	Department of Biotechnology (DBT), Ministry of Science & Technology
Technology Watch, Technology foresight, Extra Mural Research, S&T International Cooperation and linkages	Department of Science & Technology (DST), Ministry of Science & Technology
Space based environmental data base	Department of Space (DOS)
International Negotiation and Policy development and dialogue	Ministry of Environment and Forests (MoEF)
International negotiation and cooperation	Ministry of External Affairs (MEA)

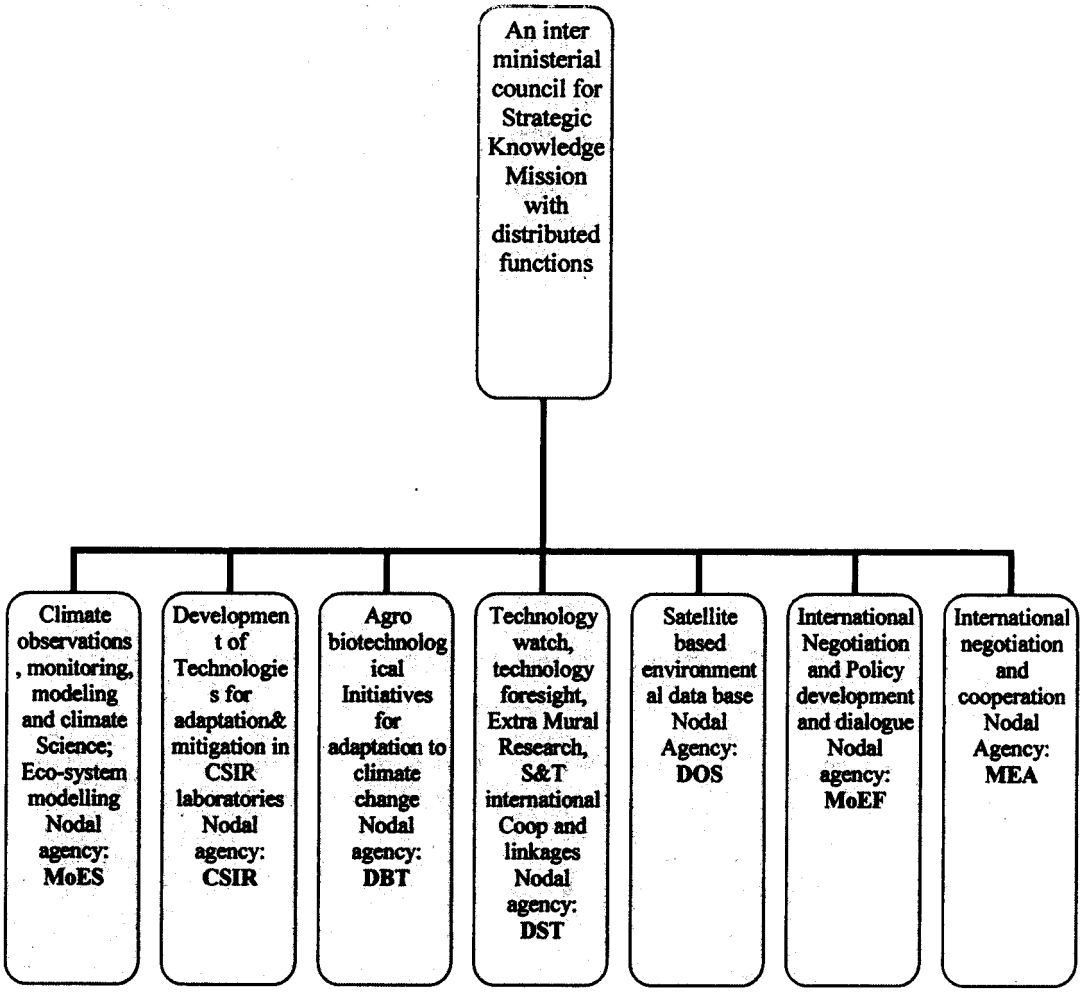


Fig 1: Inter-ministerial Council and distributed functions of its partnering ministries/departments

CHAPTER-6

Timelines for Actions Proposed for Implementation of the Mission

SNo	Action item	Proposed schedule of action
1	Formation of Networks of Knowledge Institutions	September, 2009
2	Nomination of Nodal officers for each partnering agency/department	September,2009
3	Establishment of an interactive Knowledge portal	November, 2009
4	Creation of knowledge centers in climate modeling	To start in October, 2009
5	Enhancement of high band width computational infrastructure (super grid)	To start in November, 2009
6	Establishment of a global Technology watch cell	November, 2009
7	Commissioning of technology assessment studies for climate change ranking potentials	To start in December, 2009
8	Fine tuning of implementation arrangements based on the finalized mission document	November,2009
9	Establishment of a fund for Strategic Knowledge Mission within the budget lines of partnering departments for distributed functions	December,2009
10	Creation of a common fund for centralized actions	January,2010
11	More precise definitions of knowledge gaps for actions	December,2009
12	Constitution of a National Think tank for Strategic Knowledge Mission	December, 2009

13	Formation of Thematic working groups for each knowledge gap area	January,2010
14	Mounting of Sub missions on climate modeling, S&T innovations for climate change, technologies for adaptation, technologies for mitigation, scenario analysis for responses and consequence assessment and technology foresight appraisal	To start in January,2010 (generally a three year sub-mission)
15	Strengthening of Human capacities	An ongoing activities
16	Strengthening of institutional capacities	An ongoing activities
17	Establishment of S&T cooperation with select countries on climate change	An ongoing activity, but strategic partners will be selected and partnerships developed based on the identified priorities
18	Mid term review (Third party for internal audit)	January,2011
19	Mid course correction arrangements if any	February 2011
20	Periodic submission of reports	Quarterly starting September, 2009
21	Submission of final reports	Mid 2012

CHAPTER-7

Implementation Arrangements, Coordination Mechanism and Organizational Structure for the Mission

National Mission on Strategic Knowledge for Climate Change (NMSKCC) envisages an organizational structure based on nodal centers coordinated effectively through appropriate leadership models. A matrix structure of management is planned. In order to implement the Mission elements and activities indicated in the project proposal, a dedicated programme office with adequate supporting and supervising scientific and technical staff is essential for coordination with nodal officers of various partnering agencies and departments. The mission recognizes the roles of Scientific and Technological elements, Technology-policy interfaces and S&T inputs for International negotiations. A Programme office with mirror sites in both the Ministry of Science and Technology and Ministry of Environment and Forests is envisaged. Strategic Knowledge systems being unique, the organizational structure designed for implementation is also special. Implementation efforts in this regard will have to adopt proactive and targeted approaches that utilize mechanisms such as public-private partnerships and leverage international cooperation.

Broad mission directions and the interface with the policy community and internal stakeholders will be managed at the centralized level. Centralized functions would also include the planning and allocation of resources.

The actual delivery of resources and the design, implementation and monitoring of specific actions will be carried out through empowered, distributed structures corresponding to the different mission elements. Distributed functions will be directly enacted by the respective partner within their allocations for climate research funding. The central arrangements would consist of an Oversight mechanism comprises of three functions addressing science & technology elements, technology-policy interfaces and inputs for International negotiations.

The S&T Oversight function is proposed to be steered by Principal Scientific Adviser (PSA) to Government of India. The present expert committee under the Chairmanship of PSA may be enlarged and developed to serve the Oversight function. The Technology-Policy Oversight function is proposed to be led by Hon'ble Minister for Science & Technology and Earth Sciences. The International Negotiation Input Oversight function may be led by Hon'ble Minister for Environment & Forests. A schematic view of above structure is presented in Fig.2 below:

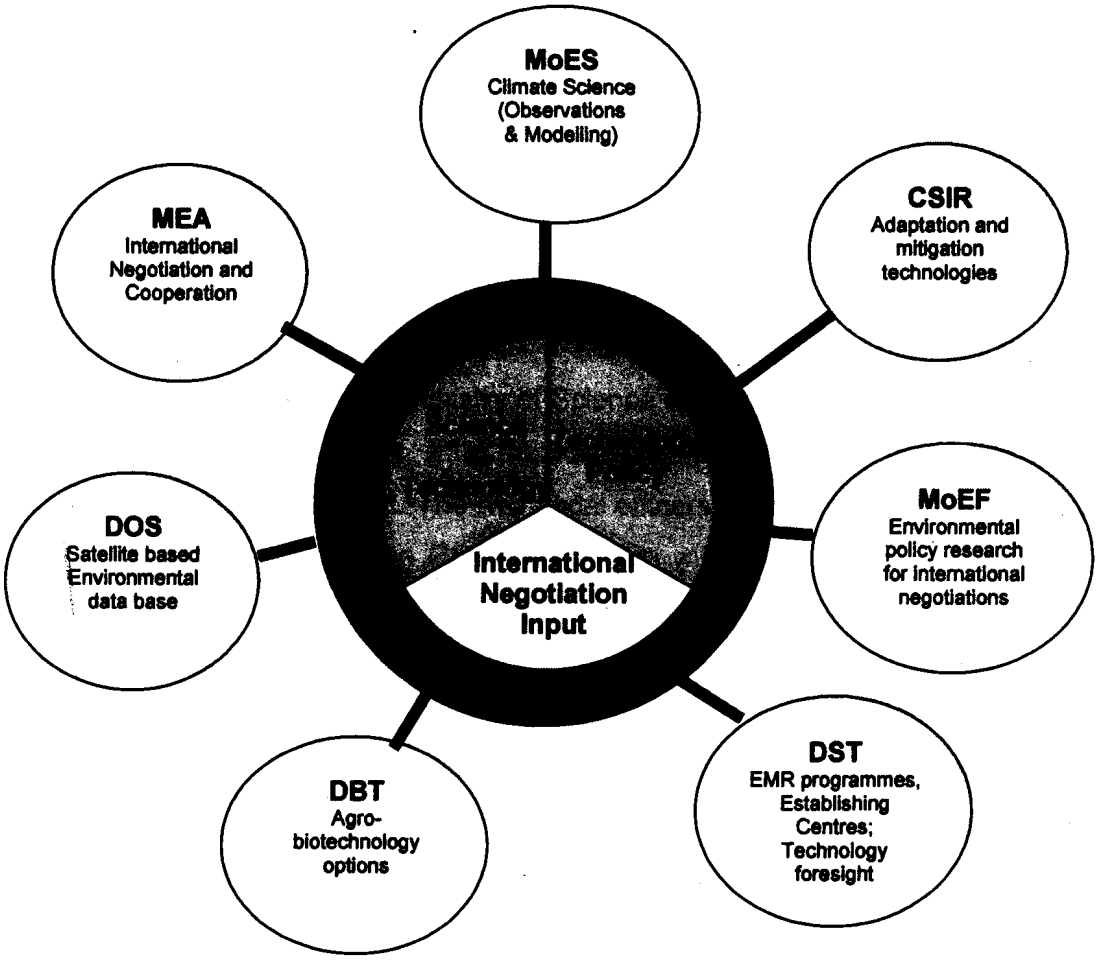


Fig 2: Structural arrangements for Oversight mechanisms

A mechanism for the PM's council for periodical and scheduled reporting of progress to the PMO would be developed and implemented.

Distributed work functions are best carried out within the administrative and resource allocations of each individual partner agency or the department. However, an effective coordination function is required for steering, consultations and informing of each other various developments within the Strategic Knowledge Mission arrangement. For this an Inter-Ministerial council in the form a Committee of Secretaries (CoS) is proposed. A Committee of Secretaries of MoES, DST, DBT, DSIR, DOS, MoEF and MEA will steer the mission. The Committee will not have a nominated chair, but depending on the subject of discussion, the CoS will elect a chair for each meeting. The CoS will be serviced by a Coordination Cell with mirror sites in MoST and MoEF. An effective and empowered Mission office will need to be created and staffed by the administrative ministry or an outsourced unit.

In view of the importance of science – policy interface associated with the Strategic Knowledge Mission, a special coordinating mechanism has been proposed. A Coordination Cell with a nodal officer each in the Ministry of Environment & Forests and Ministry of Science & Technology, along with mirror sites in the two ministries with duplicates of all relevant information and documentation, is proposed. The two nodal officers will serve as Co-Conveners for the decision-making. The Coordination Cell will work in close collaboration with the nodal unit of Ministry of Earth Sciences in the Strategic Knowledge Mission. This Coordination Cell will be responsible for coordination with nodal institutions and thematic working groups and report to the Oversight committees and Committee of Secretaries as well as submit periodic reports to the PMO.

Under this Mission, total of 5 or 6 professional expert groups (to be known as Thematic Working Groups) will be identified in various scientific institutions for commissioning thematic and policy research programmes and activities.

Considering the significant role likely to be played by the State Governments, their active participation in the Mission activities and goals needs to be ensured.

Fig 3 is a schematic diagram depicting interactive mechanism of various Central government agencies with State governments and also their linkages with Thematic Working groups.

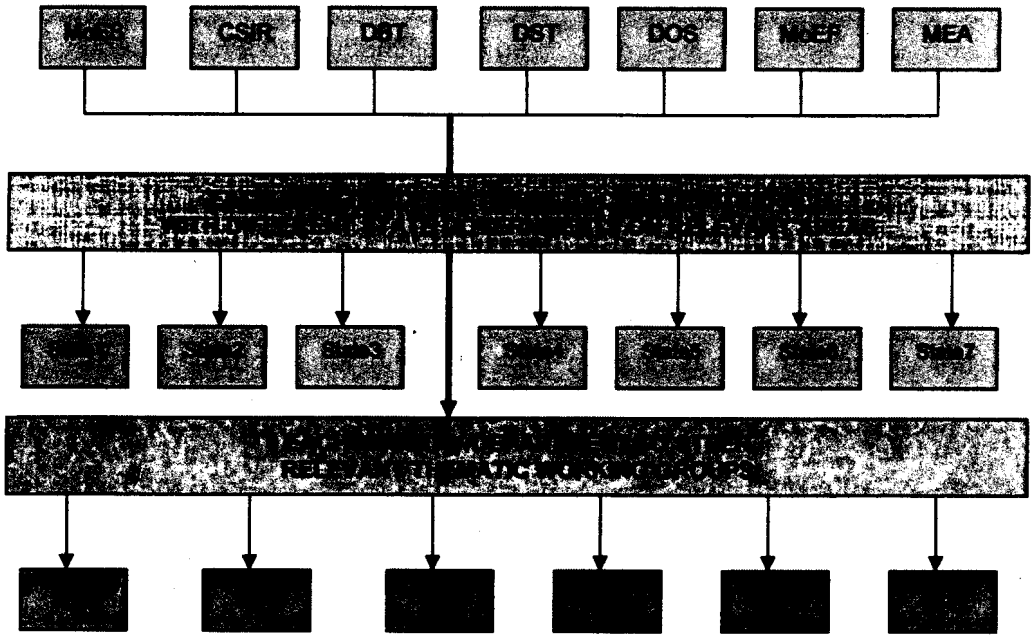


Fig 3: Interactive mechanism of various central and state government agencies and their linkages with Thematic Working groups

Given the need for an expedited and efficient resource delivery system, the Mission will adopt a process that combines extra-mural and intra-mural research funding. The core nodes for the knowledge networks would serve as the channel for resource delivery and would deliver resources not only within the network (intra-mural), but would also perform an extra-mural function, by delivering resources to the broader scientific community that may be entrained into the network over a period of time.

CHAPTER-8

Mission Deliverables

Deliverables from the National Mission on Strategic Knowledge for Climate Change have been identified to be

I. At least 10 thematic knowledge networks with critical mass and strength in the areas of climate science, Regional-climate modeling, global technology watch systems, global technology foresight and regional emission inventories, optimal mix of energy related technologies, agro biotechnologies for different agro climatic zones relevant to Indian sub continent

II. Total number of 10 technical reports on the subject of ranking climate change sensitivity indices of technologies for select sectors of economic importance including agriculture including live stock, water, housing and construction, human health care, energy, environment and transport.

III. Regional and disaggregated climate models taking into account of tropical physics and Indian monsoon-Himalayas interactions

IV. 50 Chair professorships in climate change science and technology

V. About 200 specially trained climate change research professionals with specialization in different areas of knowledge domain and expertise

VI. At least three viable Public-Private Partnerships in the areas on adaptation and mitigation technologies

VII. Technology watch groups in the areas of climate change science, renewable energy, clean coal technology, carbon sequestration and storage, water shed management, precision agriculture, convergent technology options for housing and construction, transport, solar energy materials and devices, waste management and S&T policy for climate

change research will be developed and positioned with a critical mass of expertise base.

VIII. Mission deliverables would include enunciated technical goals of the NAPCC document enshrined within the strategic knowledge mission objectives

IX. Thematic report on Technology-policy interfaces in the areas of energy, per-capita emissions at various GDP growth rates, agro biotechnology directives

X. Development of S&T collaborations with countries like USA, China, Japan and multilateral groups like EU on specific areas identified through internal prioritization

CHAPTER-9

Financial Resources Required

Fund requirements for the National Mission on Strategic Knowledge for Climate Change would be met through two streams. Some of the ongoing activities of various knowledge institutions may be supported through internal resources. Various arms of the Government have already earmarked large resources for climate change related actions leading to the development of strategic knowledge. Within the Ministry of Science and Technology and Earth Sciences such allocations are estimated over Rs 2500 crores. Mission on Strategic knowledge for Climate Change proposes to leverage those investments earmarked and promote coordination and deepening of those activities for assimilation and accumulation of Strategic Knowledge through deployment of a special and catalytic fund.

The Mission plans to support a number of research and analysis on strategic knowledge areas associated with technology related activities being undertaken in the R&D sector. It is estimated that a total fund of Rs 75 Crore will be required for the implementation of the Mission for the reminder part of the XIth Plan period. Special provision will be made for additional fund of Rs 75 crores within the already allocated fund of Rs 11028 crores for the Department of Science and Technology for the XI th plan period. Special allocations of Rs 2500 crores are planned for the XIIth plan period to develop the objectives of the National Mission on Strategic Knowledge for Climate Change.

ANNEX-I

Brief Activity Reports of Ministries/Departments partnering in the National Mission on Strategic Knowledge for Climate Change

Annex-I

Brief Activity Reports of Ministries/Departments partnering in the National Mission on Strategic Knowledge for Climate Change

MINISTRY OF SCIENCE & TECHNOLOGY

A. Department of Science & Technology

The Department of Science and Technology, Government of India has enrolled into a role of strengthening the Foundation and the Research and Development base of the country. It is the main public policy support body for science and technology. The Department is also the major agency in the country for promotion of basic sciences with a share of nearly 50% of Extra Mural funding of research projects. The Department plays a critical role in the technology development programmes relating to key sectors and in the development of International Cooperation in Science and Technology. Popularization of science, relating science to society, promotion of entrepreneurship, National Resources data management and generation of data bases and initiatives targeting empowerment of women through applications of science and technology form important areas of focus for planned interventions by the Department. The Department has been collaborating with many other socio-economic ministries in the Government and Science and Technology councils of various State Governments. The Department has been supporting an array of autonomous institutions engaged in basic research, technology forecasting, laboratory accreditation and science popularization. Output indicators of these institutions reveal a strong correlation between inputs and outputs. There is now a case for models based on evidence based budgeting as a part of research support systems. The department oversees two sub departments namely Survey of India and National Atlas and Thematic Mapping Organization (NATMO).

Followings are the autonomous/ aided institutions/professional bodies/subordinate departments under DST

a. Autonomous/ aided institutions

- Agharkar Research Institute, Pune
- Aryabhatta Research Institute of Observational-Sciences, Nainital
- Birbal Sahni Institute of Palaeobotany, Lucknow
- Bose Institute, Kolkata
- Centre for Liquid Crystal Research, Jalahalli, Bangalore
- Indian Association for the Cultivation of Science, Kolkata
- Indian Institute of Astrophysics, Bangalore
- Indian Institute of Geomagnetism, Mumbai
- International Advanced Research Centre for Powder Metallurgy and New Materials, Hyderabad
- The Institute of Advanced Study in Science & Technology
- Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore
- National Accreditation Board for Testing & Calibration Laboratories, New Delhi
- Raman Research Institute, Bangalore
- S.N. Bose National Centre for Basic Sciences, Kolkata
- Sreechitra Tirunal Institute for Medical Sciences & Technology, Thiruvananthapuram
- Technology Information, Forecasting & Assessment Council (TIFAC), New Delhi
- Vigyan Prasar, New Delhi
- Wadia Institute of Himalayan Geology, Dehradun

b. Professional Bodies

- Indian National Science Academy, New Delhi
- Indian Academy Of Sciences, Bangalore
- Indian National Academy Of Engineering, New Delhi
- The National Academy Of Sciences, Allahabad
- The Indian Science Congress Association, Kolkata

c. Subordinate departments/institutions

- Survey of India (SOI)
- National Atlas and Thematic Mapping Organization (NATMO)

The Department of Science and Technology (DST), has embarked upon three pronged approach to further strengthen its service to the Science & Technology sector. This includes a) launching of a number of new initiatives during the eleventh plan period b) consolidation of continuing programmes for larger outreach and c) strengthening the ongoing flagship programmes & initiatives through enhanced efficiencies. Several landmark developments with potentials for directional changes within the department and across entire S&T sector of the country have been accomplished during last few years. Following are some highlights of the major developments emanating from the programmatic activities.

(i) <u>New Major Initiatives</u>

- Formation of Science and Engineering Research Board:
- Launch of Innovation in Science Pursuit for Inspired Research (INSPIRE).
- Promotion of University Research and Scientific Excellence (PURSE):
- Launch of Cognition Science Initiative and Innovation Clusters: .
- Security Technology Initiative: .
- Water Technology Initiative.
- Establishment of Indian Beam line in the Synchrotron in KEK, Japan:.
- Joining International Consortia on Facility for Anti Proton and Ion Research (FAIR):
- Establishment of New Institutes and Centers under Nano mission:.
- Establishment of Science Bridges and Support of Next Generation Telecom NetWork:
- Research Project support under strategic partnerships under EU-India, Indo-UK, Indo-Australia, Indo-Israel, Indo-Canada programmes :

(ii) Consolidation of Ongoing programmes for larger Reach

- Special Package for North East Region for Science Education and Research under FIST
- Educational Initiatives on Nano science and Technology
- Science Express
- S&T inputs to Agriculture
- National Mission on Bamboo Applications
- Enlargement of Drug and Pharma Research Programme
- Changing the mode of funding of National Innovation Foundation (NIF)
- Taking over of Institute for Advanced Studies and Science and Technology, Guwahati
- National Centre for Himalayan Glaciology in the Wadia Institute of Himalayan Geology
- Enlargement of Patent Facilitation Centers
- Activities under Gender Budgeting

(iii)Strengthening of ongoing Flagship Programmes

- Science and Engineering Research Council (SERC).
- Technology Development
- International S&T Cooperation
- State Science & Technology Councils
- Science Society Programmes
- Science Popularization
- National Database
- Natural Resources Data Management System (NRDMS)
- Survey of India and NATMO
- National Training Programme
- Science & Technology Advisory Committee (STAC)

B. Council of Scientific & Industrial Research (CSIR)

The Council of Scientific & Industrial Research (CSIR) -- an autonomous body under Department of Scientific and Industrial Research (DSIR), Ministry of Science & Technology, aims to provide industrial competitiveness, social welfare, strong S&T base for strategic sectors and advancement of fundamental knowledge.

The Strategic Road Map designed for CSIR as it stepped into the new Millennium envisaged:

- Re-engineering the organisational structure;
- Linking research to marketspace;
- Mobilising and Optimising the resource base;
- Creating an enabling infrastructure; and
- Investing in high quality science that will be the harbinger of future technologies.

CSIR is one of the world's largest publicly funded R&D organisations having linkages to academia, R&D organisations and industry. CSIR with its 38 laboratories forms a giant S&T network of scientists in the country. CSIR is also part of a global S&T research alliance having the objective of applying global knowledge pool for global good through global funding.

Following institutions of CSIR are engaged in R&D on environmental, climate change and energy related aspects:

Labs	Environmental, climate change and energy related aspects currently undertaken
National Institute of Environmental Engineering Research Institute (NEERI, Nagpur)	Environmental Monitoring-- Physical, chemical and biological monitoring of air, water and land, Environmental Biotechnology-- treatment systems for domestic and industry-specific waste waters, restoration/reclamation of degraded/spoiled land environment; hazardous waste management-- wastes characterization, treatment and disposal facilities, impact assessment; environmental systems design, modelling & optimization – modelling air quality, river and estuarine water quality, ground water system, non-linear ecosystem, effluent treatment packages ; environmental impact and risk assessment and audit ; environmental policy analysis; societal missions (including advice to the Judiciary)
National Geophysical Research Institute (NGRI, Hyderabad)	Exploration of hydrocarbons and gas hydrates, mineral exploration and engineering geophysics, exploration, assessment and management of groundwater resources, Lithosphere, Earth's interior and Palaeo-environment, geo-environment studies and geophysical instrumentation.
National Institute of Oceanography (NIO, Goa)	Coastal and oceanic resources' exploration and exploitation; Resource mapping of polymetallic nodules, gas hydrate deposits, beach placer deposits, Marine bioresources exploration and utilization; environmental impact assessment, pollution control and waste disposal in the sea; coastal zone development; impact predictions of coastal activity on marine ecology; environmental management
CSIR Centre for Mathematical Modelling & Computer Simulation (C-CMMACS, Bangalore)	Oceanic modelling, modelling of water table, Climate and environmental modelling
Central Fuel Research Institute (CFRI, Dhanbad)	Coal gasification characteristics of Indian coals; catalytic hydrogenation of coal to oil, development of device for oxythermal treatment of raw briquettes, process development for dry-quenching of coke, de-sulphurization of coal
Central Mining Research Institute (CMRI, Dhanbad)	Exploitation of coal deposits and other minerals in different geo-mining conditions, environmental management, reclamation and development of innovative eco-friendly mining practices

Central Building Research Institute (CBRI, Roorkee)	Disaster mitigation and process development, precast cyclone resistant houses; shelter planning; Surface and ground water quality monitoring for organic/inorganic pollutants; environmental impact assessment, environmental audit & environmental management plan; devices for abatement of pollution in lime kilns, etc; Development of construction techniques and planning guidelines for buildings in disaster prone areas-flood/cyclone,
Central Mechanical Engineering Research Institute (CMERI, Durgapur)	Pollution-free power generation. Modelling of India's Energy Economic System and computer simulation & analysis-based methods for enhancement of power plant operation and performance, fuel cells, biogas from municipal works.
Central Salt & Marine Chemicals Research Institute (CSMCRI, Bhavnagar)	Water purification technologies, Wasteland development; Monitoring of environmental quality of coastal region; Environment impact assessment studies; Environment audit for industries; Identification and performance evaluation of wastewater outfalls; Ecological survey and other oceanographic studies
Regional Research Laboratory, Bhopal	Water resources management and watershed development, monitoring and auditing of industries, environmental monitoring, water treatment
Regional Research Laboratory, Jorhat	Disaster mitigation and process development, precast cyclone resistant houses; Biogas, oil wells, chemicals, etc.
Regional Research Laboratory, Thiruvananthapuram	Development of organo-based materials for applications in solar energy harvesting.
Industrial Toxicology Research Centre (ITRC, Lucknow)	Evaluation of eco-friendliness of chemicals and products; identification and disposal of hazardous wastes; impact of hazardous industrial chemicals on the health of workers, chemical disaster monitoring; environmental audit; preparation of plans for chemicals disaster management; analysis and measurement of pollutants using specially designed protocols; potable and waste water quality analysis; analysis of polycyclic aromatic hydrocarbons and pesticide residues; development of mathematical models for environmental risk assessment
Central Road Research Institute (CRRI, New Delhi)	Landslide correction, environmental impacts, highway planning and management, instrumentation for highways and bridges.
National Metallurgical Laboratory (NML, Jamshedpur)	Development of cleaner processes/technologies for metallurgical industries – both ferrous/non-ferrous sectors; investigations on nature of pollution caused by metallurgical sector; prevention and control of pollution through process integration; recycling of

	metallurgical wastes; comprehensive assessment of water quality; development of processes and technologies for purification of process and ground water; reduction in green house gas emission in metallurgical sector with special focus on small and medium enterprises; development of emission norms and standards
National Physical Laboratory (NPL, New Delhi)	Studies pertaining to atmospheric physics, measurements and modeling of greenhouse gases, standards and calibrations, Solar energy/cells.
Indian Institute of Petroleum (IIP, DehraDun)	Fuels obtained from non-conventional energy sources. Biodiesel, industrial/domestic stoves, pollution control.
Indian Institute of Chemical Technology (IICT, Hyderabad)	Use of biomass-derived gas for power generation and heating. Fuel cells.
National Aerospace Laboratories (NAL, Bangalore)	Wind energy, Fuel cells.
Regional Research Laboratory (RRL, Bhubaneswar)	Gasification system for biomass and solar thermal systems. Coal beneficiation, multi fuel biomass stoves, biogas.
Regional Research Laboratory (RRL, Jammu)	Geothermal energy, Solar dryers.
National Botanical Research Institute (NBRI), Lucknow	Bio-fuel
Central Leather Research Institute (CLRI), Chennai	Control of Total Dissolved Solids at the Common Effluent Treatment Plant (CETP), technology solutions for resolving the issue of TDS, integrated environmental management plan, application of Upflow Anaerobic Sludge Blanket (UASB) reactor based technology for exclusive treatment of tannery waste waters;

C. Department of Biotechnology

Established in 1986, Department of Biotechnology (DBT), under the Ministry of Science and Technology focuses on the development of the field of modern biology and biotechnology in India. In more than a decade of its existence, the department has promoted and accelerated the pace of development of biotechnology in the country. Through several R&D projects, demonstrations and creation of infrastructural facilities a clear visible impact of this field has been seen. The department has made significant achievements in the growth and application of biotechnology in the broad areas of agriculture, health care, animal sciences, environment, and industry.

The impact of the biotechnology related developments in agriculture, health care, environment and industry, has already been visible and the efforts are now culminating into products and processes. More than 5000 research publications, 4000 post-doctoral students, several technologies transferred to industries and patents filed including US patents, can be considered as a modest beginning. Department of Biotechnology (DBT) has been interacting with more than 5,000 scientists per year in order to utilise the existing expertise of the universities and other national laboratories. A very strong peer reviewing and monitoring mechanism has been developed. There has been close interaction with the State Governments particularly through State S & T Councils for developing biotechnology application projects, demonstration of proven technologies, and training of human resource in States and Union Territories. Programmes with the states of Gujarat, Rajasthan, Madhya Pradesh, Orissa, West Bengal, Haryana, Punjab, Jammu & Kashmir, Mizoram, Andhra Pradesh and Uttar Pradesh have been evolved. Biotechnology Application Centres in Madhya Pradesh and West Bengal have already been started.

A unique feature of the department has been the deep involvement of the scientific community of the country through a number of technical task forces, advisory committees and individual experts in identification, formulation, implementation and monitoring of various programmes and activities.

In India, more than a decade of concerted effort in research and development in identified areas of modern biology and biotechnology have given rich dividends. The proven technologies at the laboratory level have been scaled up and demonstrated in field. Patenting of innovations, technology transfer to industries and close interaction with them have given a new direction to biotechnology research. Initiatives have been taken to promote transgenic research in plants with emphasis on pest and disease resistance, nutritional quality, silk-worm genome analysis, molecular biology of human genetic disorders, brain research, plant genome research, development, validation and commercialisation of diagnostic kits and vaccines for communicable diseases, food biotechnology, biodiversity conservation and bioprospecting, setting up of micropropagation parks and biotechnology based development for SC/ST, rural areas, women and for different States.

Necessary guidelines for transgenic plants, recombinant vaccines and drugs have also been evolved. A strong base of indigenous capabilities has been created. The field of biotechnology both for new innovations and applications would form a major research and commercial endeavor for socio-economic development in the next millennium.

Following is the mandate of the department:

- Promote large scale use of Biotechnology
- Support R&D and manufacturing in Biology
- Responsibility for Autonomous Institutions
- Promote University and Industry Interaction
- Identify and Set up Centres of Excellence for R&D
- Integrated Programme for Human Resource Development
- To serve as Nodal Point for specific International Collaborations
- Establishment of Infrastructure Facilities to support R&D and production
- Evolve Bio Safety Guidelines, manufacture and application of cell based vaccines

- Serve as nodal point for the collection and dissemination of information relating to biotechnology

Following is the list of autonomous institutions working with DBT:

- Centre for DNA Fingerprinting and Diagnostics (CDFD), Hyderabad
- Institute of Bioresources and Sustainable Development (IBSD), Imphal
- The Institute of Life Sciences, Bhubaneshwar
- National Institute of Immunology, New Delhi
- National Institute Of Plant Genome Research, New Delhi
- National Brain Research Centre, Manesar (Deemed University)
- National Centre For Cell Sciences, Pune
- Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram

Although the Department has been embarking on several areas of bio-technology, a few programmes relating to environmental and climate change issues are given below:

a. Crop Biotechnology

Agriculture is the mainstay of the Indian Economy. Agriculture and Allied sectors contribute nearly 25 per cent of Gross Domestic Production (GDP), while about 65-70 per cent of the population is dependent on agriculture for their livelihood. India has achieved a major breakthrough in agricultural production as a result of technology evolved by Indian scientists and its wide adoption by the farmers. However, India would need to increase the food production to 250 millions tonnes by the 2020. Therefore, there is a need for critical appraisal of the post-green revolution technology to draw up a balance sheet so that strategies are evolved for achieving sustainable agriculture. The intensive agriculture in India has caused widespread changes in the agro-ecosystem. The insect pest, disease and weed complex has undergone a tremendous change. There is an overall depletion in soil fertility as a result of intensive cultivation of crops.

Poor productivity levels and inadequate investments in infrastructure in the last two decades were masked by the huge surpluses, caused partly by low food grain buying capacity and change in lifestyle patterns shifting food patterns. Presently Indian agriculture appears to have reached a plateau and policymakers have been emphasizing the need for new initiatives to boost agricultural outputs. This would not only be essential for ensuring healthy economic growth in the country but also for improving the livelihoods of the poor in rural India.

The department is supporting three main types of research activities under the scheme; R&D projects in priority crops, multi-institutional projects and Plant Molecular programmes in certain institutions/universities. The multi-institutional project involves interaction amongst a number of institutions with well defined objectives. The project on (a) the development of transgenics crops – cotton, rice, mungbean and tomato resistance to biotic stresses deal with cotton bollworm, CLCV, in rice – RTSV and RTVV, in mungbean MYMV and in tomato TLCV (b) the project on molecular characterization and field trials of mustard transgenics for hybrid seed production and low – till cultivation is being pursued by three institutions. The project involves studies on characterization of male sterility/restoration lines and improvement of technology, testing of male sterile lines and the identify homozygous barstar the storer liens (c) development of varieties with durable resistance to leaf and stripe rust using molecular marker technology in wheat. This project deals with validation of genetic stocks for documented genes conferring seed and adult plant resistant to leaf rust and stripe rust, identification of molecular markers for important gene and pyramiding important APR and seed resistance genes in common cultivars and (d) Salinity and dehydration stress tolerance in rice: cloning of responsive genes, their promoters and development of transgenics. In this project vectors with proper promoters and genes of interest will be constructed for rice transformation. Finally, to utilize the known genes isolated by the participating groups and develop protocols for transformation of rice cultivars. The Plant Molecular Biology programmes are ongoing at MKU, Madurai ; TNAU, Coimbatore ; Bose institute, Kolkata and UDSC, New Delhi.

b. Environmental Biotechnology

Realising the tremendous potential of biotechnology to offer unique, efficient, ecofriendly and economically viable options for waste treatment in situ and degradation of hazardous toxic waste into relatively less harmful or harmless byproducts, the Department of Biotechnology has given a major thrust to programmes for ecorestoration of degraded ecosystems, mining spoil dumps, development of biosensors for detection of pollutants , treatment of industrial effluents, use of molecular markers for characterisation of biodiversity. The programme has been conceived and steered by distinguished scientists who chaired the task force on Environmental Biotechnology and Biodiversity Conservation. In addition to the distinguished members of the task force, inputs from a large number of scientists and experts from user industry are also obtained.

C. Biofuel and Bioenergy

An end-to-end mission programme has been initiated by the Department which aims at (i) perfecting technologies for establishing bioenergy plantations for different agro-climatic zones with the involvement of local people, (ii) economically viable production of ethanol using different raw material and efficient, high yielding strains of microorganisms, (iii) biodiesel production for oil(s) and hydrocarbon using alternate feed stock especially lignocellulosics wastes and improved transesterification process (iv) production of hydrogen from algae and bacteria.

MINISTRY OF EARTH SCIENCES

The Ministry of Earth Sciences (MoES) is mandated to provide the nation with best possible services in forecasting the monsoons and other weather/climate parameters, ocean state, earthquakes, tsunamis and other phenomena related to earth systems through well integrated programmes. The Ministry also deals with science and technology for exploration and exploitation of ocean resources (living and non-living), and play nodal role for Antarctic/Arctic and Southern Ocean research. The Ministry's mandate is to look after Atmospheric Sciences, Ocean Science & Technology and Seismology in an integrated manner.

The Earth Commission, under which the Ministry of Earth Sciences works in Mission Mode based on Commission structure, is responsible for formulating policies, oversee implementation of policies and programs in mission mode, and ensure the necessary interdisciplinary integration.

The various Units under the Ministry of Earth Sciences are:

(a) Atmospheric Sciences and Seismology related institutions

- India Meteorological Department (IMD),
- National Centre for Medium Range Weather Forecasting (NCMRWF),
- Indian Institute of Tropical Meteorology (IITM) Pune, and
- Earthquake Risk Evaluation Centre (EREC) under the.

(b) Ocean Science & Technology related institutions

- National Institute of Ocean Technology (NIOT) Chennai,
- National Centre for Antarctic & Ocean Research (NCAOR) Goa,
- Indian National Centre for Ocean Information Services (INCOIS) Hyderabad,
- Integrated Coastal and Marine Area Management Project Directorate (ICMAM-PD) Chennai, and
- Centre for Marine Living Resources & Ecology (CMLRE) Kochi

MoES aims to create a framework for understanding the complex interactions among key elements of the Earth System, namely ocean, atmosphere and solid earth, by encompassing national programmes in Ocean science, meteorology, climate, environment and seismology.

MoES is the nodal ministry identified for the science of climate change with its various institutions/agencies currently focusing on different aspects of climate change related to atmosphere, ocean and cryosphere components. Following activities are underway in various MoES institutions:

SNo	Activities	Institution(s)
1	o Climate change monitoring- climate observations archival o Special campaigns	IMD, INCOIS, NIOT IITM
2	Climate Modelling (Atmospheric modeling, Ocean modeling, Atmospheric-Ocean coupled modeling)	IITM, NCMRWF, INCOIS
3	Global and Regional Climate Change Programme	All Institutions
4	Climate Change Modelling- Regional Climate change scenarios, Climate risk, vulnerability analysis and sectoral impacts; Research support for adaptation and mitigation planning across the sectors	CCCR/IITM, INCOIS, ICMAM
5	Ecosystem studies	ICMAM
6	Arctic and Antarctic Ice Core studies	NCAOR
7	Development of eco-friendly and mitigation technologies- desalination, OTEC, Wave energy etc.	NIOT
8	Paleo-climate studies	IITM, NCAOR
9	Ocean and coastal bio-geochemistry; CO_2 sources/sinks; Island ecosystems; Impacts on coastal resources, marine species, etc	INCOIS, CMLRE, NIOT
10	Coastal geomorphology change and mapping/modeling of coastal hazards including cyclone hazards	NIOT, ICMAM, INCOIS, IMD

DEPARTMENT OF SPACE

The Indian space programme was institutionalized in November 1969 with the formation of Indian Space Research Organization (ISRO). The Government of India constituted the Space Commission and established the Department of Space (DOS) in June 1972 and brought ISRO under DOS in September 1972. The Space Commission formulates the policies and oversees the implementation of the Indian space programme to promote the development and application of space science and technology for the socio-economic benefit of the country.

Department of Space (DOS) through its organizations Indian Space Research Organization (ISRO) and associated laboratories/agencies has the primary responsibility of development of space science, technology and applications towards achieving self reliance and assisting in all round development of the nation. DOS undertakes research and development activities related to space technology in the country and implements various space programmes meeting the societal needs. With this end in view, DOS has evolved the following programmes:

- Satellite communication programme for television broadcasting, telecommunications, meteorology, telemedicine and tele-education
- Remote Sensing programme for management of natural resources
- Launch vehicle programmes to orbit spacecraft Into near earth, geosynchronous and planetary missions
- Indigenous building capability for design and development of spacecraft and associated technologies for communications, resources survey and space sciences
- Fundamental research in space sciences and application programmes using space based systems for national development

The Department of Space (DOS) has, over the years, built up a strong research and development and technology base with necessary infrastructure and manpower for implementing the space programme. The various space centres/units of DOS are:

- Vikram Sarabhai Space Centre (VSSC), Thiruvananthapuram
- Liquid Propulsion Systems Centre (LPSC) , Thiruvananthapuram
- Satish Dhawan Space Centre, SHAR, Sriharikota, AP
- ISRO Inertial Systems Unit (IISU) , Thiruvanathapuram
- ISRO Satellite Centre (ISAC) , Bangalore
- Space Applications Centre (SAC) , Ahmedabad
- Development and Educational Communication Unit (DECU), Ahmedabad
- Physical Research Laboratory (PRL), Ahmedabad
- ISRO Telemetry, Tracking and Command Network (ISTRAC), Bangalore.
- INSAT Master Control Facility (MCF) , Hassan, Karnataka
- National Remote Sensing Agency (NRSA) , Hyderabad
- National Mesosphere/Stratosphere Troposphere Radar Facility (NMRF) , Gadanki, AP

MINISTRY OF ENVIRONMENT & FORESTS

Ministry of Environment & Forests is the nodal agency for the planning, promotion, co-ordination and overseeing the implementation of environmental and forestry programmes. The Ministry is also the Nodal agency in the country for the United Nations Environment Programme (UNEP).

The principal activities undertaken by Ministry of Environment & Forests, consist of conservation & survey of flora, fauna, forests and Wildlife, prevention & control of pollution, afforestation & regeneration of degraded areas and protection of environment, in the frame work of legislations.

The main tools utilized for this include surveys, impact assessment, control of pollution, regeneration programmes, support to organizations, research to solve solutions and training to augment the requisite manpower, collection and dissemination of environmental information and creation of environmental awareness among all sectors of the country's population.

The Ministry has following autonomous institutions:

- Gobind Ballabh Pant Institute of Himalayan Environment & Development, Almora
- Indian Council of Forestry Research and Education, Dehradun
- Indian Institute of Forest Management , Bhopal
- Indian Plywood Industries Research and Training Institute, Bangalore
- Wildlife institute of India, Dehradun

There are following four national authorities under the Ministry

- Central Zoo Authority, New Delhi
- National Biodiversity Authority, Chennai
- National Ganga River Basin Authority (newly created)
- National Tiger Conservation Authority, New Delhi

The Ministry has set up following Boards;

- Animal Welfare Board of India
- Central Pollution Control Board , New Delhi
- National Afforestation and Eco-development Board

Andaman & Nicobar Forest Plantations and Development Corporation, Port Blair is a Public Sector Undertaking under the Ministry of Environment and Forests.

India's National Communication (NATCOM) to UNFCCC

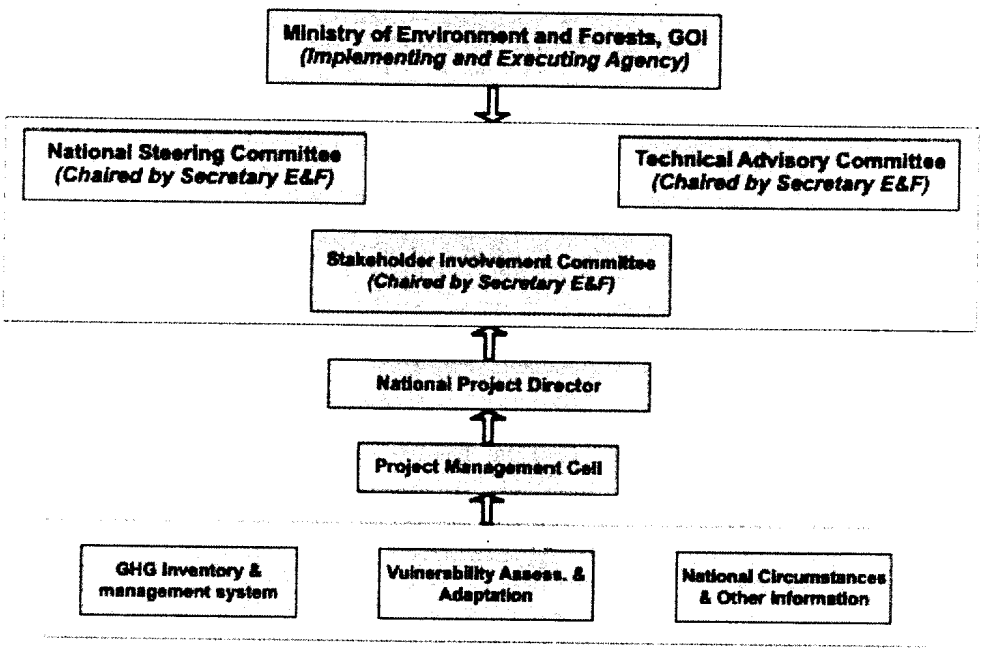
India is a Party to the United Nations Framework Convention on Climate Change (UNFCCC). All Parties taking into account their common but differentiated responsibilities and specific national regional development priorities, objectives and circumstances, are required to develop, periodically update, publish and make available to the Conference of the Parties (COP), information in accordance with the Article 12 of the Convention.

India submitted its Initial National Communication (INC) to the UNFCCC in June 2004 and is now submitting its Second National Communication (SNC).

Implementation Arrangements

The Ministry of Environment and Forests is the executing and implementing agency of India's SNC and the United Nations Development Program, India (UNDP, India) is the GEF implementing agency. A National Steering Committee comprising of members from different government ministries and departments and chaired by the Secretary, Environment and Forests (E&F) oversees the implementation of the project. A Technical Advisory Committee comprising of national experts in various areas of climate change research and chaired by Secretary E&F is advising on the technical aspects of SNC. The National Project Director, supported by a Project Management Cell coordinates and supervises the various activities of the project that have been undertaken towards the preparation of the SNC.

Implementation arrangement for SNC



Scope and guidelines for preparations of India's Second National Communication

The scope of reporting in a national communication is bound by Article 12, paragraph 1 of the Convention and includes the following elements:

a) A national inventory of anthropogenic emissions by sources and removal by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be promoted and agreed upon by the Conference of the Parties

b) A general description of steps taken or envisaged by the non-Annex I Party to implement the Convention;

c) Any other information that the non-Annex I Party considers relevant to the achievement of the objective of the Convention and suitable for inclusion in its communication, including, if feasible, material relevant for calculations of global emission trends.

MINISTRY OF EXTERNAL AFFAIRS

The Ministry of External Affairs (MEA), Government of India deals with India's foreign affairs and policies. The foreign policy of India seeks to promote an environment of peace and stability in our region and in the world to enable India's accelerated socioeconomic development and safeguard our national security. To attain these objectives, India has made vigorous efforts to develop friendly and cooperative relations with all its neighbours and to strengthen engagement with the major powers of the world. India's economic diplomacy has attached due importance to energy security that is vital for an assured high rate of growth for our economy. While pursuing the country's supreme national interests, India's foreign policy continues to be characterised by autonomy of decision-making, commitment to Panchsheel or the five principles of peaceful coexistence, and equity in the conduct of international relations. With the objective of a peaceful, stable and prosperous neighbourhood, India continues to attach the highest priority to close and good neighbourly political, economic and cultural relations with its neighbours.

MEA has been part of active negotiation on India's stand on climate change issues at various international platforms including at the Conference of Parties (CoP) of the United Nation Framework Convention on Climate Change (UNFCCC). The ministry has been actively pursuing India's climate change policies at various multi-lateral fora such as UN General Assembly, other UN bodies, other meetings of UNFCCC, G-8 Summit, meeting of ASEAN countries, SARRC Summit, Post-Forum Dialogue (PFD) Partners' Meeting with Pacific Islands Forum, etc. Climate Change issues and India's stand on these issues were also debated at various bi-lateral platforms.