India's Second National Communication to the United Nations Framework Convention on Climate Change

– Work Programme

August 2008

UNITED NATIONS DEVELOPMENT PROGRAMME

MINISTRY OF ENVIRONMENT AND FORESTS

GLOBAL ENVIRONMENT FACILITY

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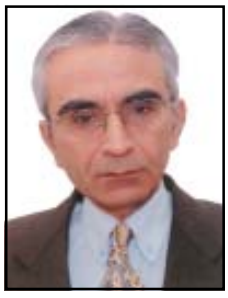
विजय शर्मा
Vijai Sharma



सचिव
भारत सरकार
पर्यावरण एवं वन मंत्रालय

Secretary
Government of India
Ministry of Environment and Forest

Foreword

India is a Party to the United Nations Framework Convention on Climate Change. The Convention enjoins Parties to communicate information about the implementation of the Convention, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances. Article 12 of the Convention relates to the communication of information pertaining to implementation in accordance with Article 4 (1) of the Convention, whereby each Party is required to communicate to the Conference of the Parties the following:-

- A national inventory of anthropogenic emissions by sources and removals 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;
- A general description of steps taken or envisaged by the Party to implement the Convention; and
- Any other information that the 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.

Towards fulfillment of obligations under the Convention, India furnished its Initial National Communication (INC) on June 22, 2004 within the stipulated time. The INC provided information on emission of greenhouse gases of anthropogenic origin by sources and removals by sinks at 1994 level. Besides, the INC contained information on impacts and the vulnerability of key economic sectors in India and related activities. India's INC is well recognized for its scientific rigour and content. While preparing the INC, concerted efforts were made to develop country specific emission factors. About 7% of the emissions were prepared using tier 3 methodology, 23% using tier 2 and 70% of the emission categories were still at the tier 1 level. The tiers indicate the level of refinement in the estimation.

Soon after the submission of India's INC, the Ministry of Environment & Forests launched the preparatory activities for the preparation of India's Second National Communication (SNC or NATCOM II). In accordance with the provisions of the Convention, the necessary agreed full costs for preparation of the SNC were obtained. The SNC is being prepared in accordance with the guidelines adopted by the Eighth Conference of the Parties in 2002. The SNC is required to be furnished in four years after receipt of the agreed full costs, i.e., June, 2011.

The SNC attempts to build on its institutional network created under the INC. The Work Programme has been developed most comprehensively involving R&D institutions, Government Ministries/Departments, autonomous institutions and non-governmental organizations. The component on estimation of inventories entails the participation of 61 institutes and aims to enhance the quality of estimation of emissions from key source categories with respect to INC.

The significant feature of the SNC lies in its innovative approach in devising the programme on Vulnerability Assessment and Adaptation wherein as many as 75 institutions are being involved in its implementation. The work programme includes preparation of the national level impact assessment of sectors such as Water, Agriculture, Natural Ecosystems and Forestry, Coastal Zones, Health and Energy. Simultaneously, an attempt has been made to undertake an integrated assessment of Impacts, Vulnerability and Adaptation frameworks in the relevant thematic areas.

It is hoped that the participating institutions will not only contribute to the development of information but also generate awareness, while enhancing the capacity of the stakeholders to respond to climate change.

Vijai Sharma

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Background

India is a Party to the United Nations Framework Convention on Climate Change (UNFCCC). The objective of this Convention is to achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level needs to be achieved within a timeframe sufficient to allow ecosystems to adapt naturally to climate change, ensure food security, and enable economic development in a sustainable manner.

According to the Article 4.1 of the UNFCCC, all Parties to the Convention, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, need to periodically report to the Convention a National Communication, the elements of which are described in the Article 12 of the Convention.

Towards fulfillment of obligation under the UNFCCC, India submitted its Initial National Communication (NATCOM I) to the UNFCCC Secretariat in June 2004, within three years of receipt of financial support from the Global Environment Facility (GEF). The information furnished in the NATCOM I was in accordance with the guidelines provided in decision 10 of the 2nd Conference of Parties (COP) and developed through a broadbased participatory approach involving 16 ministries / departments and 131 research teams drawn from Research & Development institutions, universities, non-governmental organisations (NGOs), and industry associations. India is currently engaged in the process of the preparation of its Second National Communication (NATCOM II). The following sections briefly describe the outputs of NATCOM I, implementation arrangement for the NATCOM II, the guidelines and the work programme, and activities initiated towards preparation of Second National Communication.

A Summary of Outputs of Initial National Communication

Output 1: An inventory of greenhouse gas emission of anthropogenic origin by sources and removals by sinks for the base year 1994

The estimates included greenhouse gas (GHG) emissions of anthropogenic origin and removal by sinks from (i) fuel combustion and fugitive emissions from the energy sector, (ii) industrial processes and product use, (iii) agriculture sector, (iv) land use, land use change, and forestry, and (v) waste management practices (see Box 1).

The total GHG emissions in 1994 were 1228 Mt of CO_2, equivalent

Box1: Summary of Greenhouse gas emissions of anthropogenic origin by sources and removals by sinks for the base year 1994

GHG source and sink categories (Gg per year)	CO_2 emissions	CO_2 removals	CH_4	N_2O	CO_2 eq. emissions*
Total (Net) National Emission	817023	23533	18083	178	1228540
All energy	679470		2896	11.4	743810
Industrial processes	99878		2	9	102710
Agriculture			14175	151	344485
Land use, land-use change and forestry*	37675	23533	6.5	0.04	14292
Waste			1003	7	23233
Emissions from Bunker fuels#	3373				3373

Table 1: Country specific Emission Factors Developed in India's Initial National Communication

Activity	Unit	EF
Coal		
Coking coal	CO_2 (tC/TJ)	25.53
non Coking coal	CO_2 (tC/TJ)	26.13
Lignite	CO_2 (tC/TJ)	28.95
Transport		
Passenger Cars (Gasoline)	g CO_2/kg of Fuel	2752.98+179.35
	g CH_4/Kg of Fuel	17.83
two wheelers (Gasoline)	g CO_2/kg of Fuel	1957.89+321.82
	g CH_4/Kg of Fuel	86.45
Coal Mining		
during mining		
degree 1	m3 CH_4/t coal mined	2.9
degree 2	m3 CH_4/t coal mined	13.1
degree 3	m3 CH_4/t coal mined	23.6
post Mining		
degree 1	m3 CH_4/t coal mined	0.98
degree 2	m3 CH_4/t coal mined	2.2
degree 3	m3 CH_4/t coal mined	3.1
Surface Mining		
during mining	m3 CH_4/t coal mined	1.8
post mining	m3 CH_4/t coal mined	0.2
Industrial Processes		
Cement production	tCO_2/ton of klinker	0.54+0.01
Lime production	tCO_2/ton quicklime	0.72
Lime stone and dolomite use	t CO_2/t ammonia	0.49+0.01
Ammonia Prod.	tCO_2/t ammonia	1.55
Nitric acid prod.		
Medium pressure plant	kg N_2O/ton of HNO3	10.1+3.8
High pressure plant	kg N_2O/ton of HNO3	2.8+1.3
high pressure /NSCR	kg N_2O/ton of HNO3	0.41+0.17
Enteric Fermentation		
Indigenous		
Dairy	kg CH_4/yr/animal	28+5
Non Dairy < 1yr	kg CH_4/yr/animal	9+3
Non Dairy 1-3 yrs	kg CH_4/yr/animal	23+8
Non Dairy (others)	kg CH_4/yr/animal	32+6
Cross bred		
Dairy	kg CH_4/yr/animal	43+5
Non-Dairy < 1 yr	kg CH_4/yr/animal	8+3
Non Dairy 1-3 yrs	kg CH_4/yr/animal	22+6
Others	kg CH_4/yr/animal	44+11
Rice Cultivation		
Rain fed - flood prone	ton CH_4/km2	19+6.0
Rainfed - drought prone	ton CH_4/km3	6.95+1.86
Irrigated (Continuously Flooded)	ton CH_4/km4	17.48+4.00
Intermittently Flooded - Single aeration	ton CH_4/km5	6.62+1.89
Intermittently Flooded - Multiple Aeration	ton CH_4/km6	2.01+1.49
Deep water	ton CH_4/km7	19+6.0

of which Carbon dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O) emissions were 65%, 31% and 4% of the total respectively. The energy sector, the largest source of GHG emissions, constitutes 61% of the total GHGs, followed by agriculture (28%), industrial processes and product use (8%), waste (2%), and land use, land use change and forestry (1%).

The activities undertaken for estimating the emission inventories included development of country specific emission factors for some of the categories, namely, net calorific values (NCVs) of Indian coal types; CH_4 from surface coal mining and deep mining; CO_2 and CH_4 from gasoline-driven passenger cars and two-wheelers; CO_2 from cement production, lime production, lime stone and dolomite use, and ammonia production; N_2O from nitric acid production; and CH_4 from enteric fermentation and rice cultivation. Table 1 gives the various country specific emission factors developed and used in the NATCOM I.

The Inter Governmental Panel on Climate Change (IPCC) guidelines (1996) were used for estimating national greenhouse gas emission inventories by sources and removals by sinks. Of the total categories estimated, emissions from 70% of the source categories were made using the IPCC tier-1 methodology, 23% were estimated using tier-2 methodology, and the rest were done with tier-3.

Output 2: Climate change projection scenarios

The climate change scenarios have been developed using the second generation Hadley Centre Regional Model (HadRM2) and the IS92a future scenarios of increased GHG concentrations. (Figure 1a and b). The projections indicate that above 25°N latitude, the maximum temperature may rise by 2-4°C during the 2050s and in the northern region the increase in maximum temperature may exceed 4°C. The minimum temperature in the 2050s is expected to rise by 4°C all over India, with a further rise in temperature in the southern peninsula. At an all-India level, little change in monsoon rainfall is projected up to the 2050s. There is an overall decrease in the number of rainy days over a major part of the country. This decrease is greater in the western and central parts (by more than 15 days), while near the Himalayan foothills (Uttaranchal) and in the Northeast the number of rainy days may increase by 5-10 days. Increase in rainy day intensity by 1-4 mm/day is expected all over India, except for small areas in the northwest where rainfall intensities are expected to decrease by 1 mm/day.

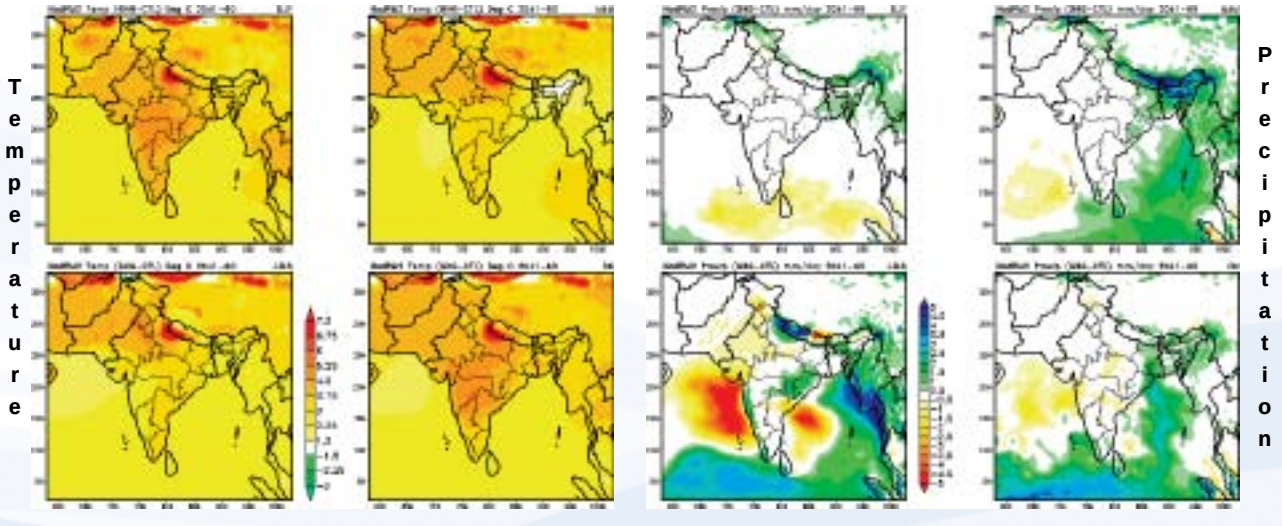


Figure1: Seasonal (a) temperature and (b) precipitation projections for the 2050s

Output 3: An assessment of impacts of climate change on various sectors

Water

Hydrological modelling (using the SWAT model) of 12 river basins in India in combination with the outputs of the HadRM2 run on the IS92a scenario indicate that in the 2050s there is likely to be a general reduction in the quantity of available runoff with extreme water stress conditions in the western and south western river basins and rare water stress conditions in the river basins in central and eastern regions (Figure 2). The severity of droughts and intensity of floods in various parts of India are likely to increase by the 2050s.

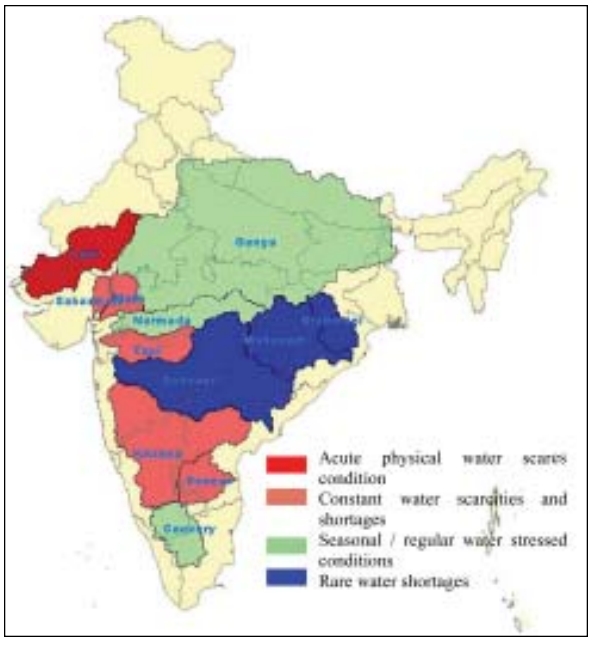


Figure 2: Projections of river run off in the 2050s for the major river basins in India

Agriculture

Simulations using dynamic crop models indicate a decrease in duration of cropping season and their yields, as temperatures increase in different parts of India between 2010 and the 2070s. These reductions will be, however, generally offset by the increase in CO_2 levels, the magnitude of this response will vary with crop, season, region, and climate change scenarios. Scenarios linked to (i) highest increase in temperature and lowest increase in CO_2 detrimental to crop growth i.e a pessimistic scenario, and (ii) large increase in CO_2 and a small change in temperature promoting crop growth i.e. an optimistic scenario, show that irrigated rice yields will have a small gain in production, irrespective of the scenario anywhere in the country. However, wheat yields in central India are likely to suffer by up to 2% under the pessimistic scenario but likely to improve by 6% in the optimistic scenario. Sorghum, being a C4 plant, does not show any significant response to increase in CO_2, and hence different scenarios do not affect its yield. Figure 3 shows the indicative changes in percentage yield of irrigated wheat due to climate change.

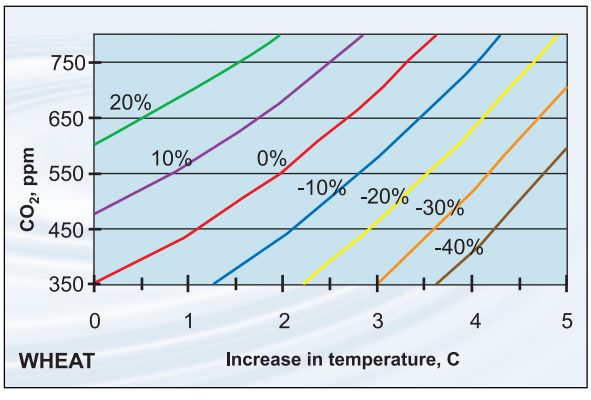


Figure 3: Percentage change in irrigated wheat yields between the period 2010-2070 when temperature is projected to rise upto 5°C

Forest ecosystems

Assessments using BIOME-3 vegetation response model indicate shifts in forest boundary, changes in species-assemblage or forest types, changes in net primary productivity, possible forest die-back in the transient phase, and potential loss or change in biodiversity. Even in a relatively short span of 50 years, most forest biomes in India seem highly vulnerable to the projected change in climate. About 70% of the vegetation is likely to find itself less optimally adapted to its existing location, making it more vulnerable to adverse climatic conditions as well as biotic stresses (Figure 4).

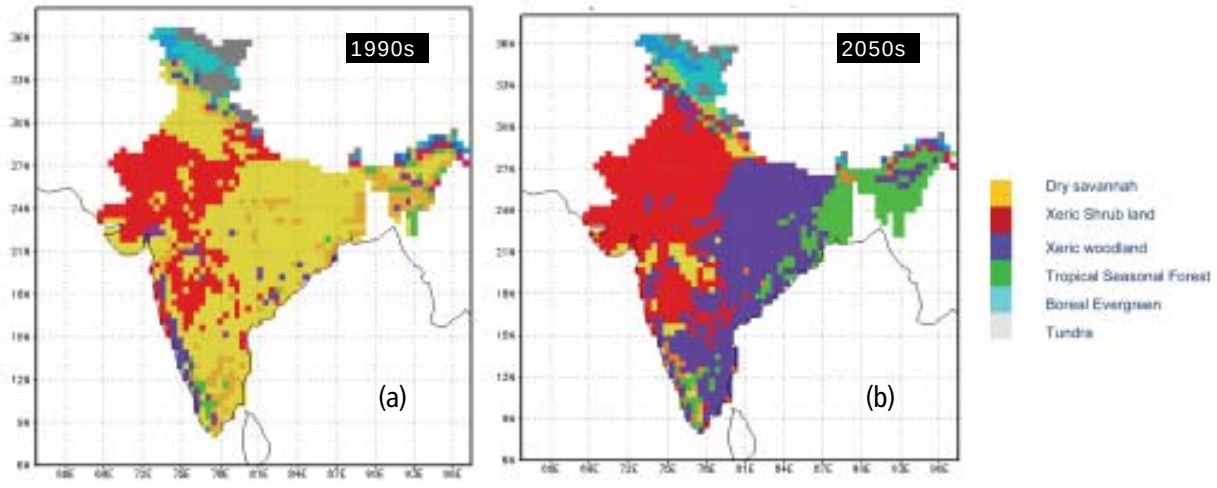


Figure 4: The control run for the base line scenario (figure 4a) and vegetation map for the year 2050s under GHG run of HadRM2 considering all grids of India and potential vegetation including grids without forests (figure 4b).

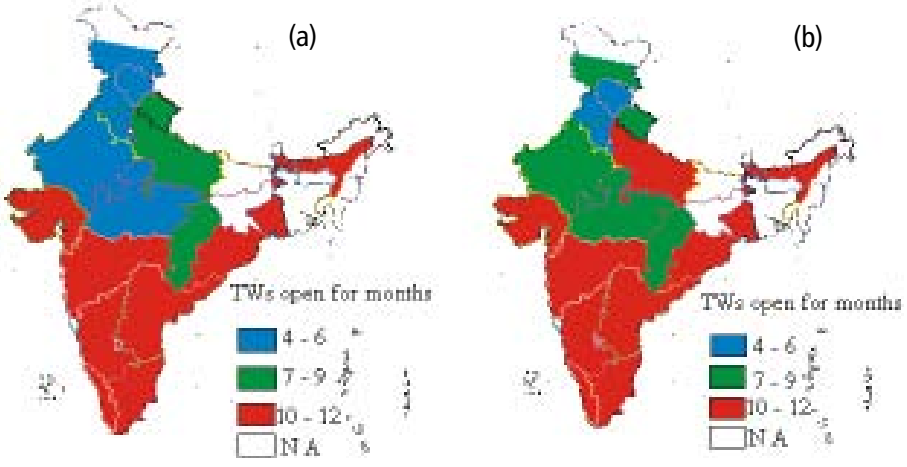


Figure 5: Transmission window (TW) of malaria in different states of India (a) for 2000 and (b) under projected climate change scenario during the 2080s

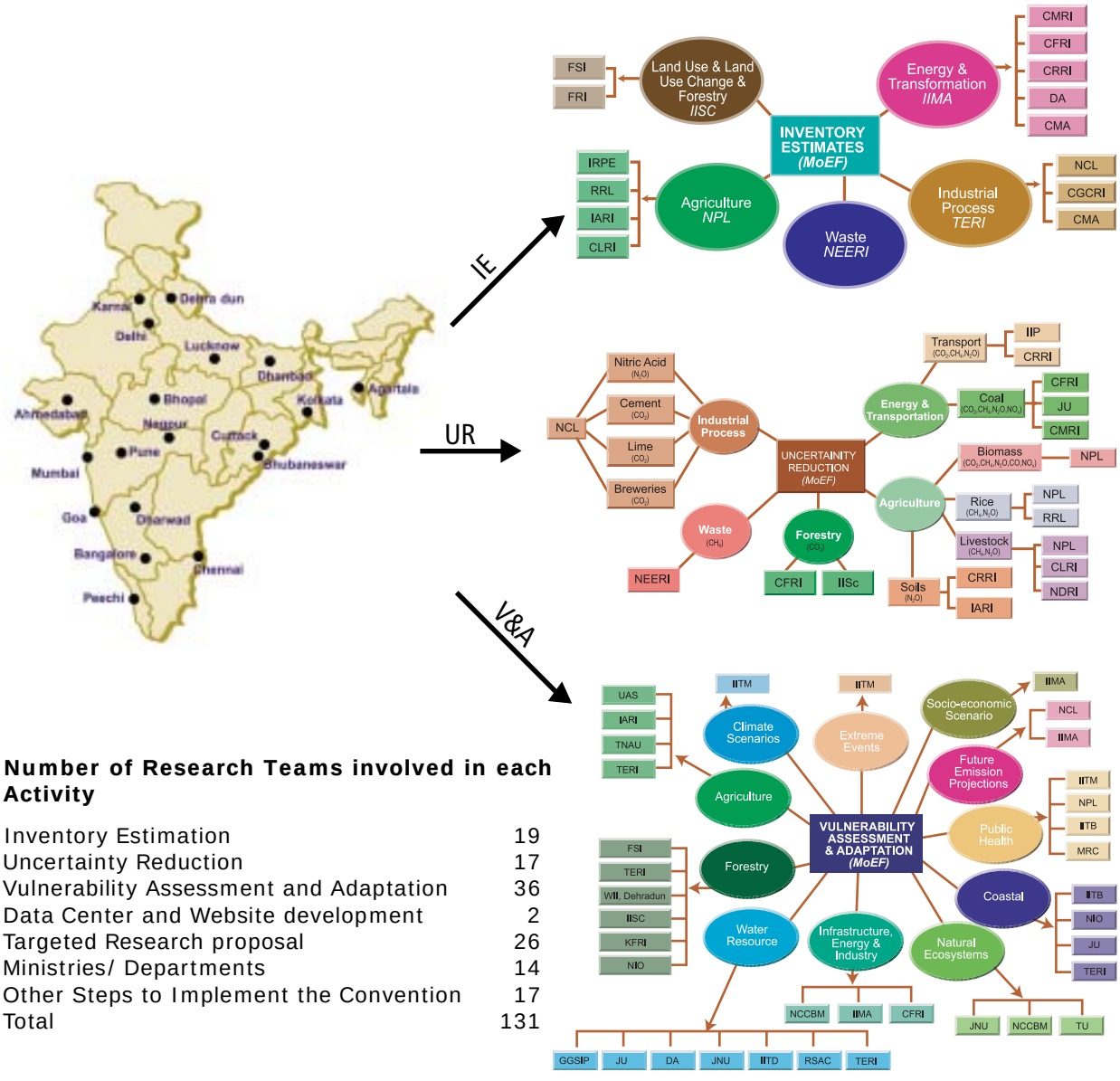
Human Health - Malaria

Over the years, communicable diseases have become more difficult to combat because of development of insecticide-resistant strains of vectors. Malaria is one such disease that has been prevalent over the years, despite government efforts to eradicate it. The climate, vegetation and other socio-economic parameters conducive to its generation are consistently present in most regions in India. Assessments made in INC indicated that malaria may move to higher latitudes, and altitudes more than 1800m. It is projected that 10% more area will be added to the existing area that is likely to offer climatic opportunities for the malaria vector to breed throughout the year during the 2080s, with respect to 2000 (Figure 5).

Output 4: Capacity building, networking and outreach

Several institutional networks were established during INC to facilitate the preparation of GHG inventories for addressing uncertainty issues in inventory estimation and assessing impacts of climate change (Box 2). In all, 27 seminars and workshops were conducted all over India for planning the work, developing linkages between climate change and policy, and for training and raising awareness on thematic issues pertaining to different components of the national

Box 2: Institutional Networks for inventory estimation (IE), uncertainty reduction in inventory estimation (UR) and for Vulnerability assessment and Adaptation (V&A)



Number of Research Teams involved in each Activity

Inventory Estimation	19
Uncertainty Reduction	17
Vulnerability Assessment and Adaptation	36
Data Center and Website development	2
Targeted Research proposal	26
Ministries/ Departments	14
Other Steps to Implement the Convention	17
Total	131

communication. A website *www.natcomindia.org* has been developed for dissemination of information. Further, under the aegis of NATCOM I, a number of publications were brought out in the form of four workshop proceedings, three books, and a number of brochures (see list of NATCOM publications in Annexure), besides encouraging individual researchers to publish their work in reputed national and international journals. (see annexure for the list of publications)

Second National Communication (NATCOM II)

Preparatory phase

Furnishing of information related to implementation of the Convention is an obligation of all Parties to UNFCCC. India utilised a Project preparation and Development Folio (PDF) grant from GEF to prepare the fullscale project proposal to seek agreed full costs for the preparation of India's Second National Communication (NATCOM II). A countrywide consultation process was undertaken with stakeholders representing the government, non-governmental organisations, research institutions, academia, industry, and other interest groups, which

provided inputs towards the development of a fullscale project document. About 250 people participated in these events.

The NATCOM II project proposal, developed in the PDF-B phase process, was built from inputs received in these consultations, and the results obtained and lessons learnt during NATCOM I. The NATCOM II programme of work addresses technical gaps and focuses on prioritised activities taking into account India's national circumstances, priorities, and developmental needs.

Implementation Arrangement for NATCOM II

The Ministry of Environment and Forests is the nodal ministry in the government of India for the subject of climate change and accordingly is the executing and implementing agency for India's NATCOM II (Fig 6), whereas the United Nations Development Programme, India (UNDP, India) is the GEF implementing agency. A National Steering Committee comprising members from different ministries and departments and chaired by the Secretary, Environment and Forests oversees the implementation of the project (see Annexure for members of the committee). A Technical Advisory Committee, also chaired by Secretary E&F, consists of experts in various areas of climate change research and advises on the technical aspects of NATCOM II. The National Project Director, supported by a Project Management Cell, coordinates and supervises various activities of the project.

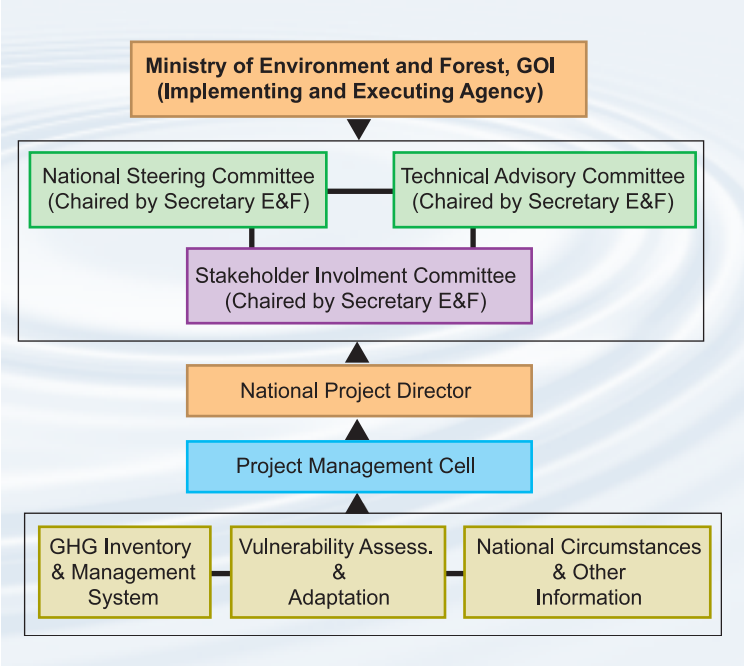


Figure 6: Implementation arrangement for NATCOM II

Scope and Guidelines for preparation of NATCOM II

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

In accordance with Article 4, paragraph 1, each Party shall communicate to the Conference of Parties, through the secretariat, the following elements of information:

- A national inventory of anthropogenic emissions by sources and removals by sinks of GHGs not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be promoted and agreed upon by the COP;
- A general description of steps taken or envisaged by the Party to implement the Convention; and
- Any other information that the 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.

The guidelines for preparation of the initial national communication of non-Annex 1 Parties, adopted vide decision, 10/CP.2, were followed in NATCOM I. Later, at the fifth session of the COP, processes were initiated to revise the guidelines and the COP adopted these at its 8th session in decision 17. The objective of the decision is to:

- enable parties to present the respective information as per Article 12 of the Convention in a consistent, transparent, comparable, and flexible manner;
- facilitate the presentation of information on support required for the preparation of national communications;
- serve as policy guidance to the operating entity of the financial mechanism of the Convention for the timely provision of financial support needed by non-Annex I Parties in order to fulfill their reporting requirements; and
- ensure that the COP has sufficient information to carry out its responsibility for assessing the implementation of the Convention by Parties.

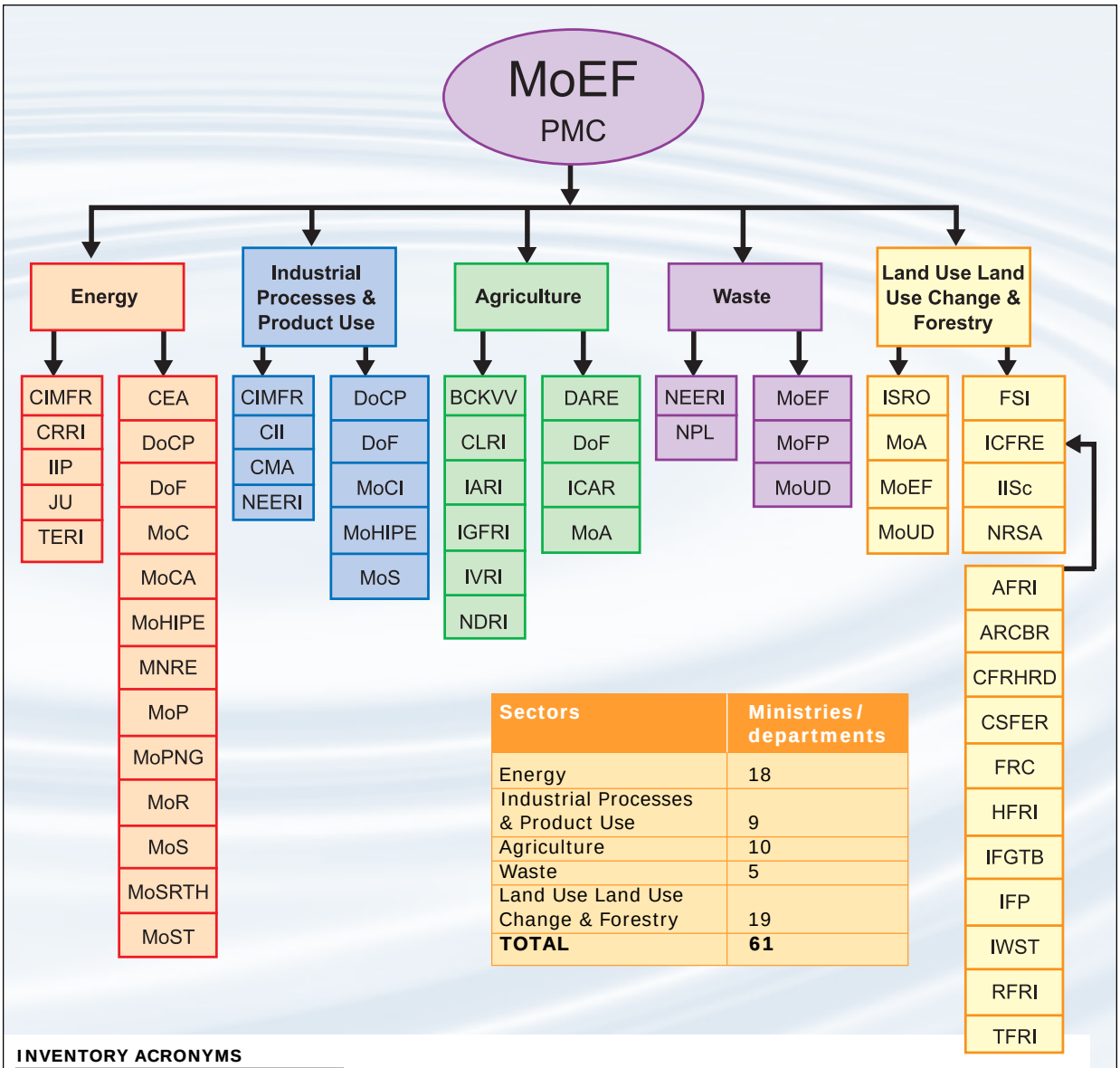
The guidlines for furnishing information for Second National Communication to UNFCCC is contained in the decision 17/CP.8 (see Annexure for guidelines about key reporting elements). These are more extensive than the guidelines enumerated in 10/CP.2. The following sections detail the research activities launched in NATCOM II in keeping with the provisions of decision 17/CP.8.

Activities launched in NATCOM II

NATCOM II continues to engage and has built upon extant networks established during NATCOM I for technical coordination and has further expanded the same for inclusion of stakeholders concerned to the extent possible. The key components of the work programme of NATCOM II that have been initiated include (i) the estimation of greenhouse gas emission inventories by sources and removals by sinks; (ii) refinement of national level impact assessments of key sectors like water resources, agriculture, forestry and natural ecosystems, human health, energy, infrastructure and settlements; and (iii) development of adaptation frameworks at selected study areas by undertaking integrated impacts, vulnerability and adaptation assessment of various sectors.

(i) Preparation of inventory of Greenhouse gases

NATCOM II envisages preparing a comprehensive GHG emission inventory by sources and removals by sinks for the base year 2000 using comparable methodologies (IPCC 1996/ 2006). The scope of improvement with reference to the inventories presented in NATCOM I include (i) estimation methodologies for some key categories identified in NATCOM I, the effort is to move towards a higher tier of estimations for these categories; (ii) refinement of GHG emission factors developed during INC; (iii) new measurements to develop country-specific emission factors for some key categories; (iv) inclusion of additional gases (CO, NO_X, NMVOC, SO_2, HFC, PFC and SF6) to the extent capacities permit; (v) inclusion of additional GHG pools identified in IPCC 2006 guidelines for preparation of national greenhouse gas emission inventories that were not included in INC; (vi) a strong emphasis will be on QA/ QC procedures as identified in IPCC Good Practices Guidance (GPG) 2000 and 2003. The network of institutions for undertaking these activities include research institutions, universities, nongovernmental organisations, industry associations, line ministries concerned, and associated departments (Figure 7).



Sectors	Ministries / departments
Energy	18
Industrial Processes & Product Use	9
Agriculture	10
Waste	5
Land Use Land Use Change & Forestry	19
TOTAL	**61**

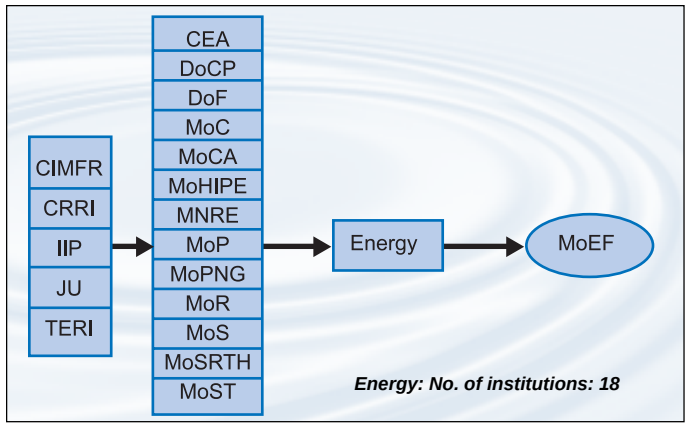
INVENTORY ACRONYMS

AFRI	Arid Forest Research Institute
ARCBR	Advanced Research Centre for Bamboo and Rattans;
BCKVV	Bidhan Chandra Krishi Vishwa Vidyalaya;
CEA	Central Electric Authority;
CFRHRD	Centre for Forestry Research and Human Resource Development;
CII	Confederation of Indian Industry;
CIMFR	Central Institute of Mining and Fuel Research;
CLRI	Central Leather Research Institute;
CMA	Cement Manufacturers Association;
CRRI	Central Road Research Institute;
CSFER	Centre for Social Forestry and Eco-Rehabilitation;
DoCP	Departments of Chemicals & Petrochemicals;
DoF	Department of Fertilizers;
DARE	Department of Agriculture Research and Education;
FSI	Forest Survey of India;
FRC	Forest Research Centre;
HFRI	Himalayan Forest Research Institute;
IARI	Indian Agricultural Research Institute;
ICAR	Indian Council of Agricultural Research;
ICFRE	Indian Council of Forestry Research and Education;
IFGTB	Institute of Forest Genetics and Tree Breeding;
IFP	Institute of Forest Productivity;
IGFRI	Indian Grassland and Fodder Research Institute;
IIP	Indian Institute of Petroleum;
IISc	Indian Institute of Science;
ISRO	Indian Space Research Organization;
IVRI	Indian Veterinary Research Institute;
IWST	Institute of Woods Science and Technology;
JU	Jadavpur University;
MNRE	Ministry of New and Renewable Energy;
MoA	Ministry of Agriculture;
MoC	Ministry of Coal;
MoCA	Ministry of Civil Aviation;
MoCI	Ministry of Commerce and Industry;
MoEF	Ministry of Environment and Forests;
MoFP	Ministry of Food Processing;
MoHIPE	Ministry of Heavy Industries & Public Enterprises;
MoPNG	Ministry of Petroleum & Natural Gas;
MoP	Ministry of Power;
MoR	Ministry of Railways;
MoST	Ministry of Science and Technology;
MoSRTH	Ministry of Shipping, Road Transport & Highways;
MoS	Ministry of Steel;
MoUD	Ministry of Urban Development;
NDRI	National Dairy Research Institute;
NEERI	National Environmental Engineering Research Institute;
NPL	National Physical Laboratory;
NRSA	National Remote Sensing Agency;
RFRI	Rain Forest Research Institute;
TERI	The Energy and Resources Institute;
TFRI	Tropical Forest Research Institute

Figure 7: Institutional network arrangement for greenhouse gas inventory development

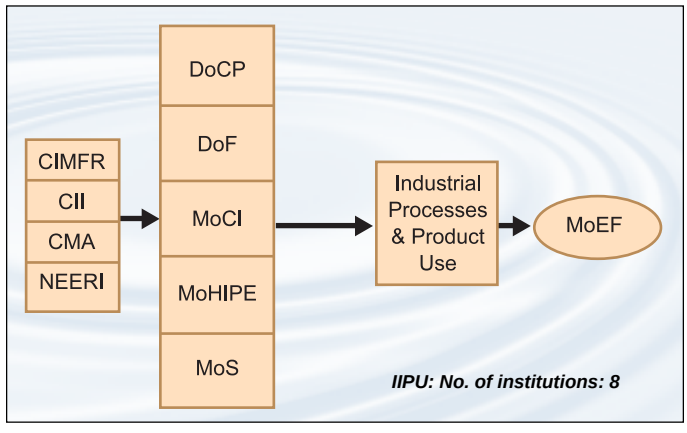
The activities launched for various sectors of inventory development are:

Energy Sector



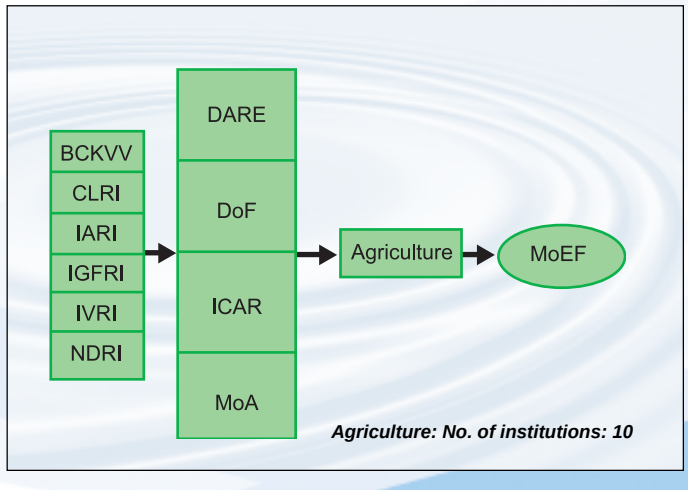
(1) Refinement of NCVs of coking, noncoking and lignite consumed in thermal power plants; (2) measurement of plant-level emission factors of CO_2, CO, NOx and SO_2 by taking into account combustion technology, capacity, efficiency, and fuel variability; (3) refinement of GHG emission estimates from the road transport sector by apportionment of fuel used by different categories of vehicles; (4) refinenement of emission factors for different types of gasoline and diesel driven vehicles incorporating driving cycles; (5) development of a methodology to generate data related to oil & natural gas venting, flaring, transmission and distribution. (6) GHG inventory estimation for the entire sector.

Industrial Processes and Product Use (IPPU)



(1) Refinement of GHG emission estimates from iron and steel manufacturing processes by monitoring the stack emissions at representative integrated steel plants (the most common mode of production of iron and steel in India), and development of correction factors for emissions related to electrode consumption and emissions from the combustion of fuels such as coke oven gas; (2) development of CO_2 emission factors from technology specific dry, wet and semi-dry processes of the cement manufacturing process; (3) as ammonia has been identified as a key category, efforts have been made to measure country specific emission factors to reduce uncertainties in emissions from this category; (4) estimate and compile GHG emission inventories from the IPPU sector.

Agriculture

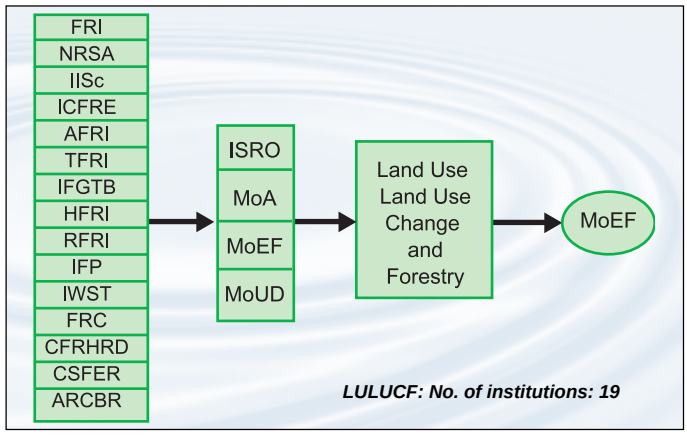


(1) Estimation of N_2O emission factors from croplands, covering all types in India, under different agro-climatic regions having different fertiliser management practices; (2) improvement of CH_4 emission estimates from rice cultivation by ascertaining the role of factors such as soil types, genotypes, water management, manure management practices, etc, in the emission factors, from hotspots identified in INC; (3) undertake region-wise surveys of livestock feed intake, milk

production; (4) undertake direct measurements of CH_4 emission due to enteric fermentation specifically for dairy cattle of different breeds in the country; (5) prepare green house gas inventory from the agriculture sector.

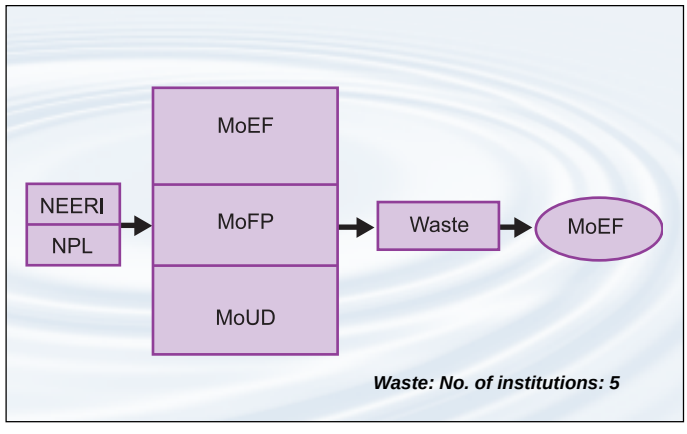
Land use, land use change and forestry (LULUCF)

(1) Assessment of stock change and forests (2) estimating GHG emission by sources and removals by sinks due to change in area under crops, forests, wasteland, settlements and others; (3) assessment of biomass stock, carbon fraction of biomass, biomass growth rates of various types of species (crops/ forests) to be considered under this category; (4) assessment of soil carbon through measurements in different types of land uses.



Waste sector

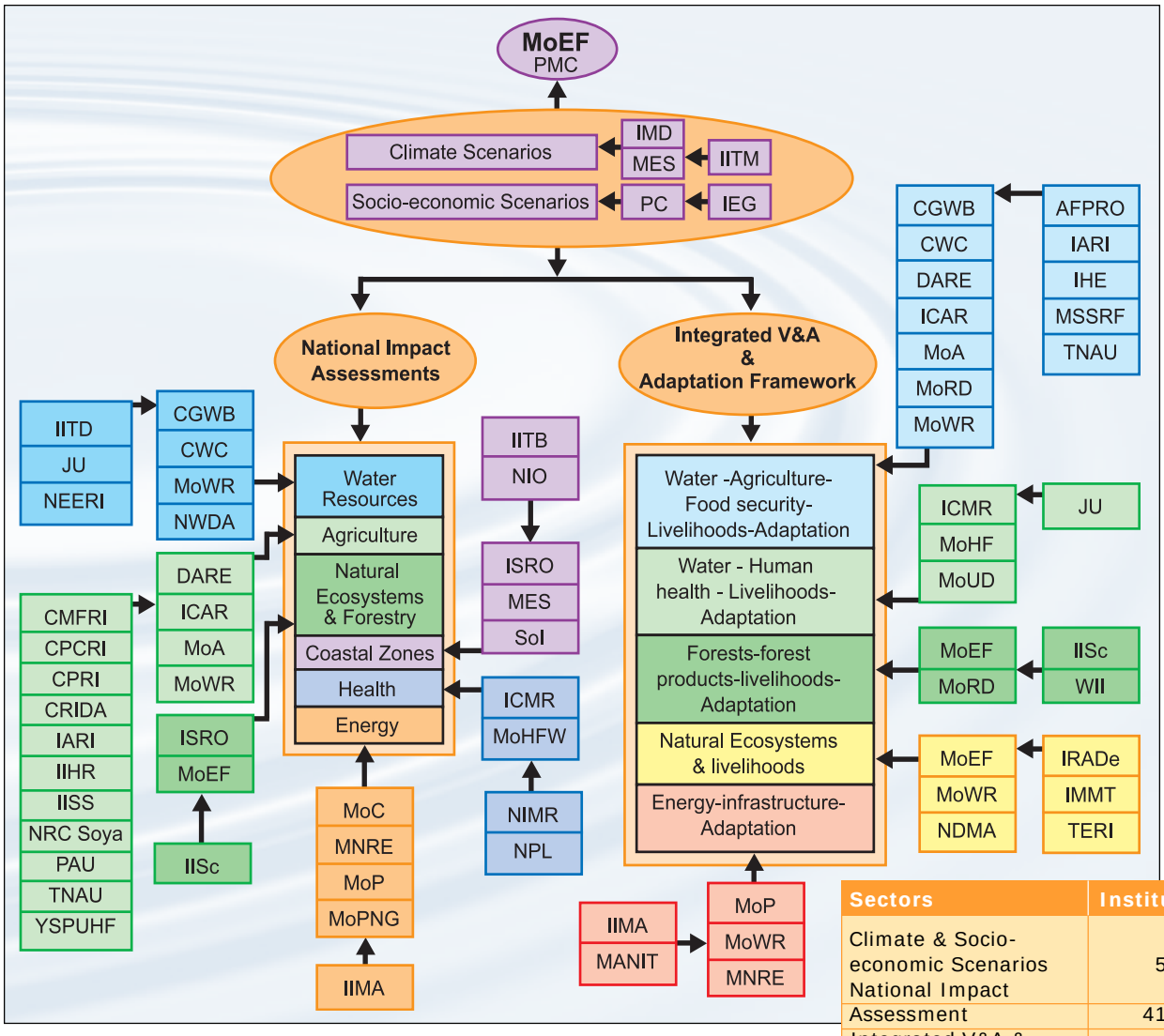
(1) Refinement of CH_4 emission estimates from the MSW handling process by generating data on MSW handling practices for urban areas, composition analysis and estimates of country specific CH_4 emission factors; (2) undertaking round-the-year flux measurements in representative managed and unmanaged landfill areas to develop CH_4 emission factors; (3) improve GHG emission estimate from wastewater generation by undertaking detailed chemical analysis of wastewater in key industries and by developing country-specific emission factors; (4) estimate and compile emission inventory from all categories in the waste sector.



(ii) Vulnerability Assessment and Adaptation

The impact assessments carried out during INC were mostly sectoral in dimension and did not explicitly explore the inter-sectoral linkages and adaptation concerns. The work programme in NATCOM II is designed to ensure that these issues are addressed for key areas, as adaptation to climate change is now imperative in the national context. NATCOM II is in the process of generating multiple climate and socio-economic scenarios at the national scale, improving the national impact assessments of water resources, agriculture, forestry, natural ecosystems, coastal zones, human health with respect to INC. Studies have also been launched to address adaptation issues associated with climate change of key sectors through an integrated assessment method at selected climate hotspots.

In order to develop the science-policy interface, the studies addressing climate change impacts, vulnerabilities and adaptation are being implemented through a network of institutions, comprising research institutions, nongovernmental organisations, government departments, line ministries and, at times, state departments, and local bodies. Eightynine



Sectors	Institutions
Climate & Socio-economic Scenarios	5
National Impact Assessment	41
Integrated V&A & Adaptation Framework	31
TOTAL	77

Figure 8: Institutional Network for implementation of V&A component of NATCOM II

V&A ACRONYM LIST

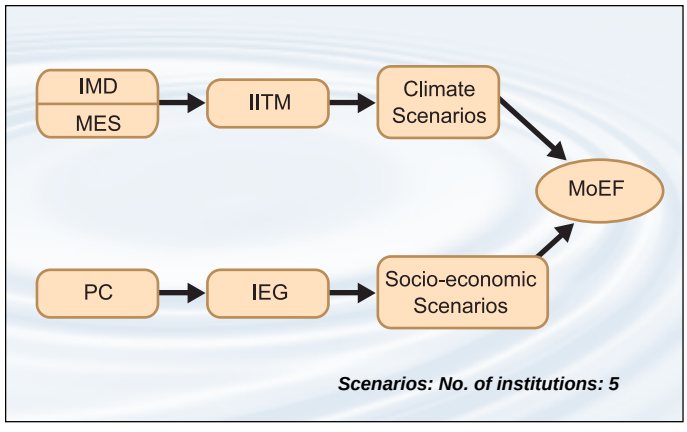
AFPRO	Action for Food Production;
AGWC	Arete-Glacier & water Consultants;
CGWB	Central Ground Water Authority;
CMFRI	Central Marine Fisheries Research Institute;
CPCRI	Central Plantation Crops Research Institute;
CPRI	Central Potato Research Institute;
CRIDA	Central Research Institute for Dryland Agriculture;
CWC	Central Water Commission;
DARE	Department of Agriculture, Research & Education
GHS	
IARI	Indian Agricultural Research Institute;
ICAR	Indian Council of Agricultural Research;
ICMR	Indian Council of Medical Research;
IEG	Institute of Economic Growth;
IHE	Institute of Home Economics;
IIHR	Indian Institute of Horticulture Research;
IIMA	Indian Institute of Management, Ahmedabad;
IISc	Indian Institute of Science;
IISS	Indian Institute of Soil Science;
IITB	Indian Institute of Technology Bombay;
IITD	Indian Institute of Technology, Delhi;
IITM	Indian Institute of Tropical Meteorology;
IMD	India Meteorological Department;
IMMT	Institute of Minerals and Materials Technology;
IRADe	Integrated Research and action for Development;
ISRO	Indian Space Research Organization;
JU	Jadavpur University;
MANIT	Maulana Azad National Institute of Technology;
MES	Ministry of Earth Sciences;
MNRE	Ministry of New and Renewable Energy;
MoA	Ministry of Agriculture;
MoC	Ministry of Coal;
MoEF	Ministry of Environment & Forests;
MoHFW	Ministry of Health & Family Welfare;
MoP	Ministry of Power;
MoPNG	Ministry of Petroleum & Natural Gas;
MoRD	Ministry of Rural Development;
MoUD	Ministry of Urban Development;
MoWR	Ministry of Water Resources;
MSSRF	M.S. Swaminathan Research Foundation;
NDMA	National Disaster Management Authority;
NEERI	National Environmental Engineering Research Institute;
NIMR	National Institute of Malaria Research;
NIO	National Institute of Oceanography;
NPL	National Physical Laboratory;
NRC Soya	National Research Centre for Soybean;
NWDA	National Water Development Authority;
PAU	Punjab Agriculture University;
PC	Planning Commission;
SoI	Survey of India;
TERI	The Energy and Resources Institute;
TNAU	Tamil Nadu Agricultural University
WII	Winrock International India;
YSPUHF	Dr. Y.S. Parmar University of Horticulture and Forestry

institutions are part of this activity. Figure 8 presents a schematic diagram of the institutional network set up for implementing the Vulnerability Assessment and Adaptation Component of NATCOM II.

The specific activities launched so far in the V&A component of NATCOM II are as follows:

Climate and Socio-economic scenarios

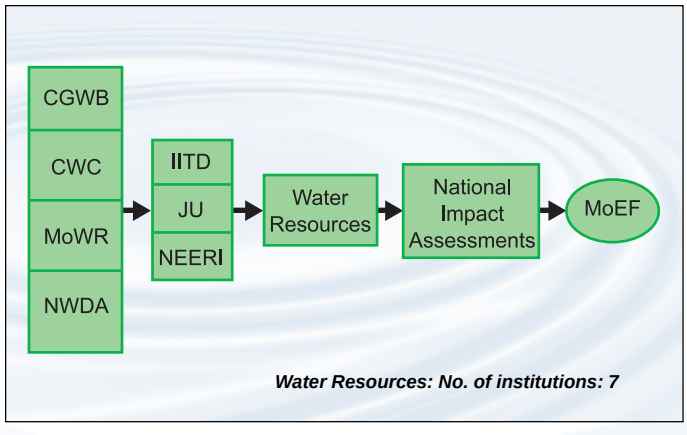
Climate scenarios: In NATCOM II, high-resolution climate change projections are being developed using the latest version of regional climate model PRECIS for IPCC-SRES A2, B2 and A1B scenarios. The nature of possible changes in the frequency and intensity of extreme weather and climate events and monsoon, associated with the expected climate change over India, will be examined.



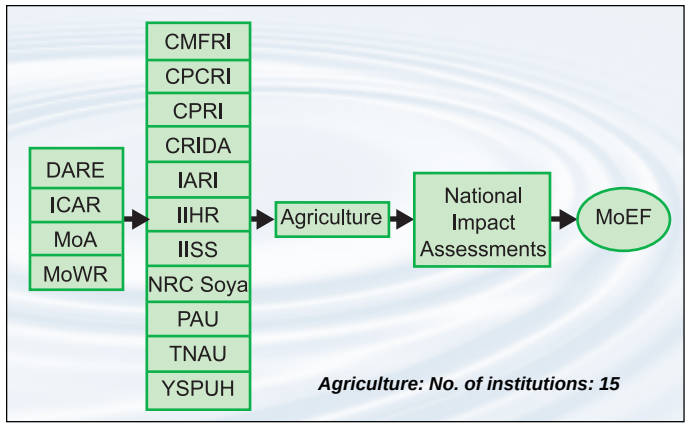
Socio-economic scenarios: The socio-economic scenarios for India are being developed in line with the national plans for development and associated projections for population and economic growth in the short and medium term timelines. Data on population density, level of urbanisation, national and sectoral GDP, etc. will form the basis of these scenarios. The socio-economic scenarios would integrate the effects of climate variability and consequent changes on society and economy and explore several coherent directions for the future (i.e. different storylines) analogous to the IPCC SRES scenarios.

Refinement of National Impact Assessments

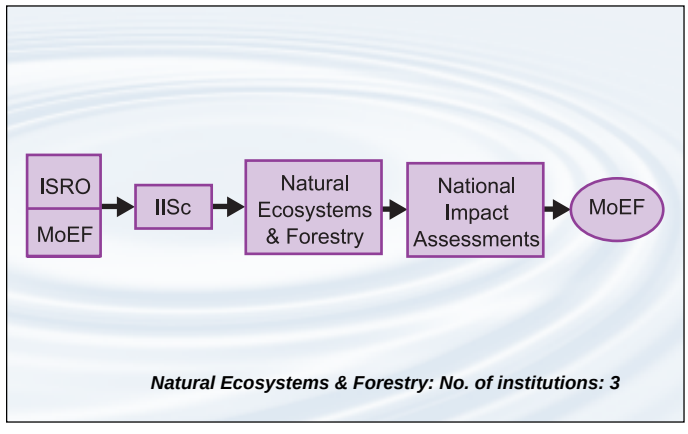
Water resources: The activities under this component include (i) improvement of the existing assessment of run-off in the major river basins in India using SWAT model, based on latest climate change scenarios and incorporating the major human-made interventions on the river basins in the modelling. The study will also demonstrate floodplain zoning using hydraulic modelling and the likely status of extreme events on selected sub-basins of a flood-prone river; (ii) assessment of water availability during extreme hydrological events under future climate scenarios in the eastern Indian river basins such as that of Damodar, Mahanadi, Subarnarekha, Kangsabati, Kaliaghai, Ajoy, Teesta in North Bengal and Sikkim, and Howra in Tripura; (iii) a review of status of Himalayan glaciers in India and likely impacts under a climate change scenario; (iv) a review of glaciers and underground water availability in India in the current climate and impacts of climate change on the same; (v) an assessment of water demand at a national scale in medium to long term timescales.



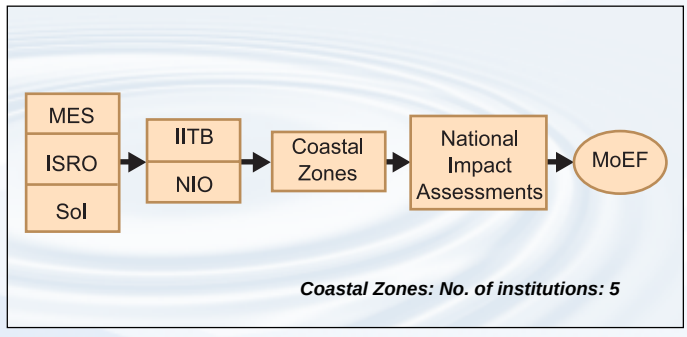
Agriculture: The climate change impact assessment studies in this category would be using



crop models in association with the outputs of regional climate models. The assessments would include impacts of climate change on (i) cereals in different agro-ecological regions and identification of vulnerable crops and regions; (ii) major irrigated and rainfed crops of Tamil Nadu; (iii) rice/wheat and other crops in Punjab; (iv) castor and oilseeds in major production regions; (v) apple and horticulture crops in Himachal Pradesh; (vi) selected vegetables and fruits grown in dominant soil types, using different crop management practices in the major agro-ecological zones; (vii) major legume crops (soybean, groundnut, chickpea and pigeon pea) in selected regions of India using simulation and modeling; identification of possible management options to mitigate the adverse impact of climate change on major legume crops; (viii) plantations that are perennial in nature; (ix) potato production in the Indo-Gangetic plains; (x) major cotton species across different agro-ecological regions of India for the 2020s and 2050s.



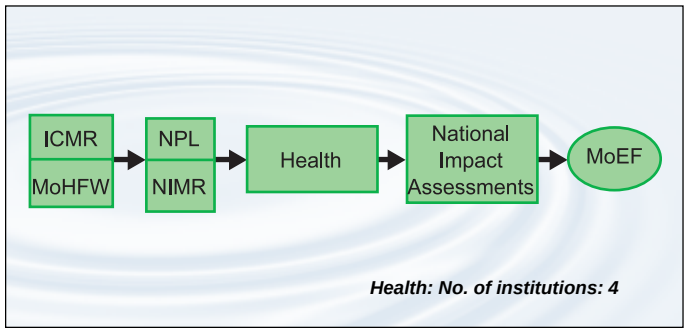
Natural ecosystems including Forestry: Biophysical models in association with regional climate change scenarios are being used to assess (i) the impact of climate change on forest ecosystems at national and regional levels in terms of the shifts in boundary of forest systems, forest ecosystem change matrix, changes in species mix and species vulnerability to identify the vulnerable forest ecosystems, regions and hotspots. Additionally implications of climate change on biodiversity, biomass production and net primary productivity are also being studied. (ii) An assessment of impacts of climate change on marine fisheries in India is also being carried out in association with the assessment of the breeding habitats, parameters affecting fish breeding and their linkages with atmospheric and sea surface temperature.



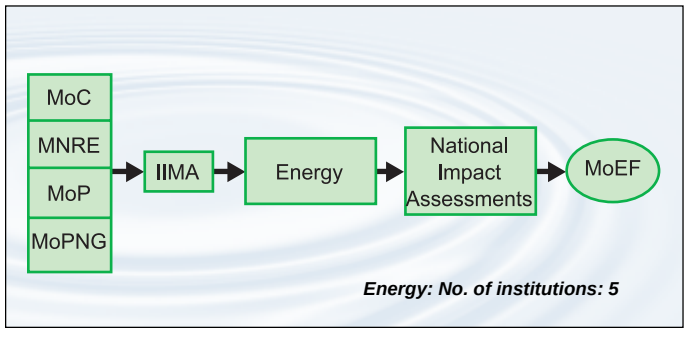
Sea level rise and Coastal zones: The impact assessment studies in this sector include (i) an assessment of the impacts of climate change on tropical cyclones in the Arabian Sea and the Bay of Bengal in different climate scenarios (A1 and B2); (ii) impacts on storm surges in the Bay of Bengal for future climate scenarios using the wind fields and surface atmospheric fields from the regional climate model PRECIS; (iii) an estimation of return periods of extreme sea level events; (iv) an assessment of sea water incursion due to sea level rise in selected locations of the Indian coasts using GIS at selected low lying regions such as Nagapattanam, selected

areas along the Orissa or West Bengal coasts and in Mumbai; (v) an assessment of impacts of sea water incursion on the coastal infrastructure, agricultural activities and livelihoods in the most vulnerable districts along the east coast identified in INC.

***Human Health*:** This component includes (i) improvement of the study carried out to assess the impacts of climate change on malaria with respect to INC by including socioe-conomic parameters that control the transmission windows in addition to the climate parameters, (ii) an assessment to map the likely extent of dengue, under given climate change scenarios; (iii) a study to understand the impact of climate change on health ramifications due to heat stress.



Energy: Climate change is projected to impact energy supply and demand. Energy demand side would be affected in sectors, specifically residential, commercial, and transport. Changes in space cooling and heating requirements, and water pumping needs would be the main drivers of energy demand changes. The supply side changes would mostly be reflected in the renewable energy sectors, namely in, hydro power generation, wind energy production and in biomass based energy. Keeping such impacts in view, this activity would estimate the likely impacts on Indian energy supply and demand side systems under a reference scenario without a change in demand pattern and with climate change. The project would also construct a framework for analyzing and integrating the supply and demand side impacts.



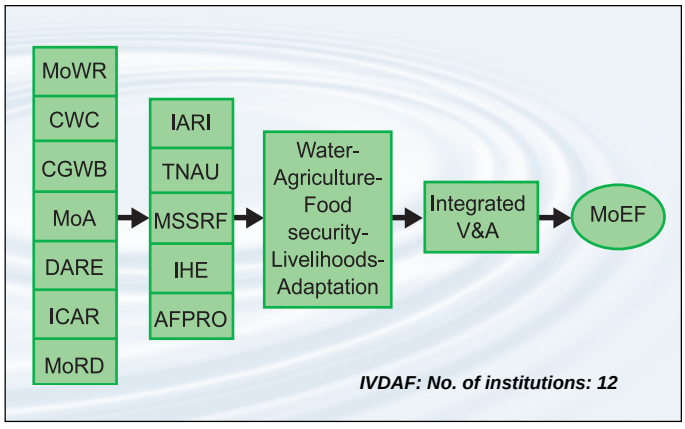
- **Integrated Assessments of Impacts, Vulnerability and development of Adaptation Frameworks (IAIVAF)**

This component focuses on case studies in identified hotspots to assess the climate change impacts on various sectors and the associated physical and socio-economic vulnerabilities. The focus is to assess the current coping mechanisms operational at the local level (indigenous strategies/policies and programmes/institutional mechanisms/ technological options and risk sharing measures) to combat climate variability, and identify the incremental measures required to cope with the adverse impacts of climate change and develop adaptation frameworks that will feed as inputs to the development of a national framework for adaptation. The studies designed under this component of NATCOM II include:

- Linkages between water resources, agriculture productivity, food security and livelihoods
- Human health associated with climate change and the changing profile of extreme events
- Impacts on forests and other natural ecosystem products and vulnerabilities of livelihoods dependent on them
- Natural Ecosystems and Livelihoods; and
- Vulnerabilities of energy systems and infrastructure due to the changing temperature and precipitation patterns.

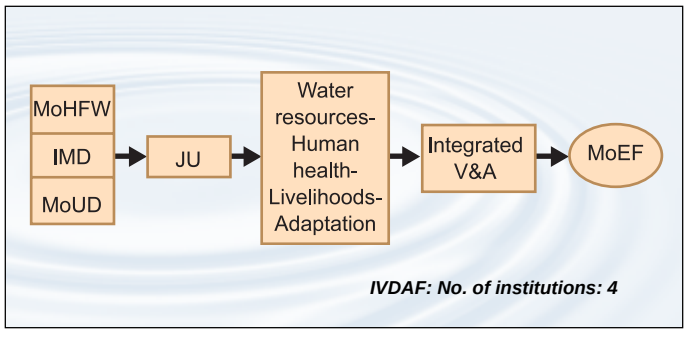
IAIVAF-1

Water-Agriculture-Food Security-Livelihoods-Adaptation: Five individual studies are being carried out under this category at various climate hotspots in India covering different aspects of agriculture with an aim to develop adaptation frameworks. The studies include (i) an assessment of impacts on crops cultivated under rainfed conditions in the Indo-Gangetic plains and associated livelihoods; (ii) impacts on cropping systems in all the agro-ecological zones of Tamil Nadu and consequent vulnerabilities of associated livelihoods; (iii) an assessment of the vulnerability of the agriculture system and livelihoods in Nagapattanam in the Cauvery delta; (iv) an integrated assessment of impacts and vulnerabilities to livestock, fodder availability, and associated livelihoods due to climate change in selected regions in India.



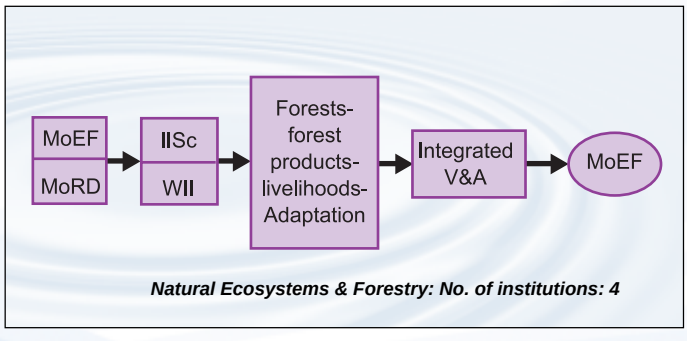
IAIVAF-2

Water-Agriculture-Human Health-Livelihoods-Adaptation: An assessment of impacts and vulnerabilities due to climate change in the short to medium-long term future timescales, primarily for the 2030s, 2050s and 2080s, has been undertaken with a special focus on water-related health impacts in a selected urban centre. The steps towards the development of an adaptation framework would include the development of a quantifiable accounting framework, monetary valuation of vulnerabilities, possible adaptation strategies in the study area and in general for urban areas, a decision tool to understand vulnerabilities and portfolio of adaptation strategies given the net costs, and a tool to mainstream climate extremes and adaptation strategy.



IAIVAF-3

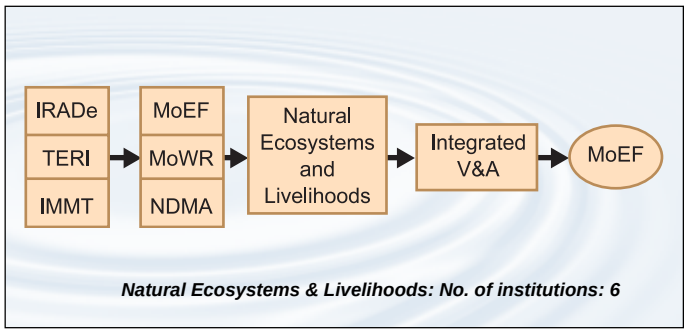
***Forests- Forest products-Livelihoods-Adaptation*:** Given the importance of forest products to livelihoods and local economies, it is important to assess the implications of climate change, the adaptive capacity of forest-dependent communities and develop adaptation strategies, especially in biodiversity rich ecosystems. The Western Ghats and the Central Indian forests have been identified as the hotspots vis-à-vis the impacts on their biodiversity where the case studies are being undertaken. The two studies under this component include (i) a case study to assess implications of climate impacts on forest product yield and flow, and associated livelihoods in the biodiversity rich Western Ghats, besides developing preliminary adaptation



strategies; (ii) an integrated assessment of impacts and vulnerabilities on forests and associated livelihoods in the Central Indian region and developing an adaptation framework as the forestry sector in Madhya Pradesh plays an important role in the socio-economic upliftment of the people, especially the tribals forming a quarter of the total population of the state and being almost entirely dependent on forestry for their livelihood.

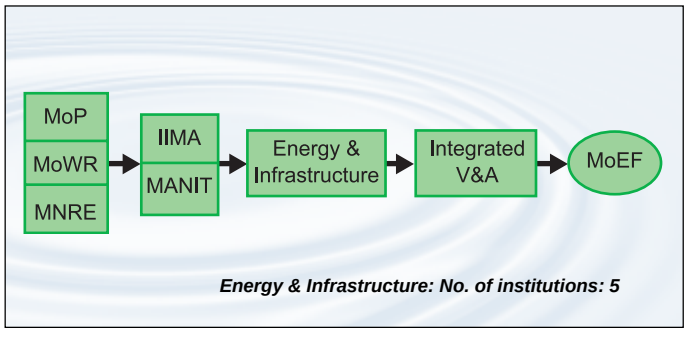
IAIVAF-4

Natural Ecosystems and Livelihoods: This component includes (i) a case study on the implications of climate change on mountain ecosystem including vulnerability assessments of region and vulnerable sectors like forestry, water resources and agriculture and their impact on livelihood; (b) an assessment of impacts and vulnerabilities in the North Eastern region on water resources, forests and livelihoods owing to environmental degradation and climatic change and (c) an assessment of impacts of climate change on water resources, crop yields, and on mangroves due to sea water intrusion in the Brahmini-Baitarinin river basin in Orissa.



IAIVAF-5

Energy systems and Infrastructure: This component of the NATCOM involves two tasks: (i) an integrated assessment of impacts of climate change on built environment and development of an adaptation framework as local climate and environment are influenced by built areas, and urban livelihoods are already facing a range of weather-related risks such as heat waves, air pollution episodes and flooding, with climate change expected to compound these problems; (ii) an assessment of impacts of climate change on hydropower. Hydropower generation is most likely to be impacted by climate change that would influence livelihood, agriculture, commercial systems and transport.



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1. Secretary
   Ministry of Environment & Forests
   Paryavaran Bhawan, CGO Complex
   Lodi Road, New Delhi-3

Members

2. Additional Secretary (Climate Change)
   Ministry of Environment & Forests
   Paryavaran Bhawan, CGO Complex
   Lodi Road, New Delhi-3

3. Principal Adviser (Environment)
   Planning Commission
   Yojna Bhawan, Parliament Street
   New Delhi-1

4. Principal Adviser (Energy)
   Planning Commission
   Yojna Bhawan, Parliament Street
   New Delhi-1

5. Secretary
   Department of Agriculture, Research & Education
   Ministry of Agriculture
   Krishi Bhawan, New Delhi-11

6. Secretary
   Department of Agriculture & Cooperation
   Ministry of Agriculture
   Krishi Bhawan, New Delhi-11

7. Secretary
   Department of Economic Affairs
   Ministry of Finance
   North Block, New Delhi-1

8. Secretary
   Ministry of Non-Conventional Energy Sources
   Block-14, CGO Complex,
   Lodi Road, New Delhi-3

9. Secretary
   Ministry of Science & Technology
   Technology Bhawan,
   New Mehrauli Road, New Delhi-16

10. Secretary
    Department of Coal
    Shastri Bhawan
    New Delhi-1

11. Secretary
    Ministry of Power
    Shram Shakti Bhawan
    New Delhi-1

12. Secretary
    Ministry of Heavy Industries & Public Enterprises
    Udyog Bhawan, New Delhi-1

13. Secretary
    Department of Road Transport & Highways
    Ministry of Shipping, Transport & Highways
    Parivahan Bhawan,
    New Delhi-3

14. Secretary
    Ministry of Petroleum & Natural Gas
    Shastri Bhawan,
    New Delhi-1

15. Secretary
    Ministry of Water Resources
    Shram Shakti Bhavan
    New Delhi-1

16. Secretary
    Ministry of Health and Family Welfare
    Nirman Bhawan
    New Delhi-11

17. Secretary
    Ministry of Earth Sciences
    Block No. 12, Mahasagar Bhawan
    CGO Complex, New Delhi-3

18. Secretary
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    Krishi Bhawan, Dr. Rajendra Prasad Road
    New Delhi-1

19. Secretary
    Department of Chemical and Petrochemicals
    Shastri Bhawan
    Dr. Rajendra Prasad Road
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20. Secretary
    Department of Fertilizers
    Shastri Bhawan
    Dr. Rajendra Prasad Road
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21. Secretary
    Department of Industrial Policy and Promotion
    Ministry of Commerce and Industry
    Udyog Bhavan, New Delhi-11

22. Secretary
    Ministry of Steel
    Udyog Bhavan, Maulana Azad Marg
    New Delhi-11

23. Director General
    India Meteorology Department
    Ministry of Science & Technology
    Mausam Bhawan
    Lodi Road, New Delhi-3

24. Joint Secretary (UN)
    Ministry of External Affairs
    South Block
    New Delhi-1

25. Representative
    United Nations Development Programme
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26. Joint Secretary (Climate Change)
    Ministry of Environment & Forests
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Key Elements of 17/CP.8

Key elements of 17/COP.8 related to the preparation of greenhouse gas emission inventories and the impact, vulnerability and adaptation assessments are as follows:

i) National Greenhouse Gas Inventory

Each non-Annex I Party shall, as appropriate and to the extent possible, provide in its National inventory, a gas-by-gas basis and in units of mass, estimates of anthropogenic emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) by sources and removals by sinks.

Non-Annex I Parties are encouraged, as appropriate, to provide information on anthropogenic emissions by sources of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6).

Non-Annex I Parties are encouraged, as appropriate, to report on anthropogenic emission by sources of other greenhouse gases such as carbon monoxide (CO), nitrogen oxides (NOx) and non-methane volatile organic compounds (NMVOCs).

Other gases not controlled by the Montreal Protocol, such as sulphur oxides (SO_x), included in the IPCC guidelines, may be included at the discretion of the Parties.

Non-Annex I Parties are encouraged, to the extent possible, and if disaggregated data is available, to estimate and report CO_2 fuel combustion emissions using both the sectoral and the reference approaches, and to explain any large differences between the two approaches.

Non-Annex I Parties should, to the extent possible, and if disaggregated data is available, report emissions from international aviation and marine bunker fuels separately in their inventories. Emission estimates from these sources should not be included in the national totals.

Non-Annex I Parties are encouraged to describe procedures and arrangements undertaken to collect and archive data for the preparation of national GHG inventories, as well as efforts to make this a continuous process, including information on the role of the institutions involved.

Table 1 and 2 below give a description of the reporting format of the national greenhouse gas emission inventories estimated from anthropogenic sources.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_x (Gg)	NMVOCs (Gg)	SO_x (Gg)
Total national emissions and removals	X	X	X	X	X	X	X	X
1. Energy	X	X	X	X	X	X	X	X
A. Fuel combustion (sectoral approach)	X		X	X	X	X	X	X
1 Energy industries	X		X	X	X	X	X	X
2 Manufacturing industries and construction	X		X	X	X	X	X	X
3 Transport	X		X	X	X	X	X	X
4 Other sectors	X		X	X	X	X	X	X
5 Other (please specify)	X		X	X	X	X	X	X
B. Fugitive emissions from fuels	X		X		X	X	X	X
1 Solid fuels			X		X	X	X	X
2 Oil and natural gas			X		X	X	X	X
2. Industrial processes	X	X	X	X	X	X	X	X
A. Mineral products	X				X	X	X	X
B. Chemical industry	X		X	X	X	X	X	X
C. Metal production	X		X	X	X	X	X	X
D. Other production	X				X	X	X	X
E. Production of halocarbons and sulphur hexafluoride								
F. Consumption of halocarbons and sulphur hexafluoride								
G. Other (please specify)	X		X	X	X	X	X	X
3. Solvent and other product use	X			X			X	
4. Agriculture			X	X	X	X	X	X
A. Enteric fermentation			X					
B. Manure management			X	X			X	
C. Rice cultivation			X				X	
D. Agricultural soils			X	X			X	
E. Prescribed burning of savannahs			X	X	X	X	X	
F. Field burning of agricultural residues			X	X	X	X	X	
G. Other (please specify)			X	X	X	X	X	
5. Land-use change and forestry	Xb	Xb	X	X	X	X	X	X
A. Changes in forest and other woody biomass stocks	Xb	Xb						
B. Forest and grassland conversion	X	X	X	X	X	X		
C. Abandonment of managed lands		X						
D. CO_2 emissions and removals from soil	Xb	Xb						
E. Other (please specify)	X	X	X	X	X	X		
6. Waste			X	X	X	X	X	X
A. Solid waste disposal on land			X		X		X	
B. Waste-water handling			X	X	X	X	X	
C. Waste incineration					X	X	X	X
D. Other (please specify)			X	X	X	X	X	X
7. Other (please specify)	X	X	X	X	X	X	X	X
Memo items								
International bunkers	X		X	X	X	X	X	X
Aviation	X		X	X	X	X	X	X
Marine	X		X	X	X	X	X	X
CO_2 emissions from biomass	X							

Notes: Shaded cells do not require entries.

*[a] The following standard indicators should be used, as appropriate, for emissions by sources and removals by sinks of GHGs: **NO** (not occurring) for activities or processes that do not occur for a particular gas or source/sink category within a country, **NE** (not estimated) for existing emissions and removals which have not been estimated, **NA** (not applicable) for activities in a given source/sink category which do not result in emissions or removals of a specific gas, **IE** (included elsewhere) for emissions and removals estimated but included elsewhere in the inventory (Parties should indicate where the emissions or removals have been included), **C** (confidential) for emissions and removals which could lead to the disclosure of confidential information. [b] Do not provide an estimate of both CO_2 emissions and CO_2 removals. "Net" emissions (emissions - removals) of CO_2 should be estimated and a single number placed in either the CO_2 emissions or CO_2 removals column, as appropriate. Note that for the purposes of reporting, the signs for removals are always (-) and for emissions (+).*

Table 2: National greenhouse gas inventory of anthropogenic emissions of HFCs, PFCs and SF6

Greenhouse gas source and sink categories	HFCs[a,b] (Gg)			PFCs[a,b] (Gg)			SF6[a] (Gg)
	HFC-23	*HFC-134*	*Other (to be added)*	*CF_4*	*C_2F_6*	*Other (to be added)*	
Total national emissions and removals	X	X	X	X	X	X	X
1. Energy							
A. Fuel combustion (sectoral approach)							
1 Energy industries							
2 Manufacturing industries and construction							
3 Transport							
4 Other sectors							
5 Other (please specify)							
B. Fugitive emissions from fuels							
1 Solid fuels							
2 Oil and natural gas							
2. Industrial processes	X	X	X	X	X	X	X
A. Mineral products							
B. Chemical industry							
C. Metal production	X	X	X	X	X	X	X
D. Other production							
E. Production of halocarbons and sulphur hexafluoride	X	X	X	X	X	X	X
F. Consumption of halocarbons and sulphur hexafluoride	X	X	X	X	X	X	X
G. Other (please specify)							
3. Solvent and other product use							
4. Agriculture							
A. Enteric fermentation							
B. Manure management							
C. Rice cultivation							
D. Agricultural soils							
E. Prescribed burning of savannahs							
F. Field burning of agricultural residues							
G. Other (please specify)							
5. Land-use change and forestry							
A. Changes in forest and other woody biomass stocks							
B. Forest and grassland conversion							
C. Abandonment of managed lands							
D. CO_2 emissions and removals from soil							
E. Other (please specify)							
6. Waste							
A. Solid waste disposal on land							
B. Waste-water handling							
C. Waste incineration							
D. Other (please specify)							
7. Other (please specify)	X	X	X	X	X	X	X
Memo items							
International bunkers							
Aviation							
Marine							
CO_2 emissions from biomass							

[a] *Parties may wish to express HFC, PFC and SF6 emissions as either potential or actual. Potential emissions should be estimated using the tier 1 approach of the IPCC Guidelines. Actual emissions should be estimated using the tier 2 approach of the IPCC Guidelines.*

[b] *Parties reporting HFCs and PFCs should provide emission estimates on a gas-by-gas basis, that is, disaggregated estimates by chemical expressed in units of mass (Gg), as indicated in the table (e.g. HFC-23), where information is available. This should be done by inserting a column for each HFC and PFC gas for which emissions do occur in the country. The gases in the column headings are given as examples only. Other gases to be reported in this table include HFC-32, HFC-41, HFC-43-10, HFC-125, HFC-134a, HFC- 152a, HFC-43-10mee, HFC-143a, HFC-227ea, HFC-236fa, HFC-245ca, C3F8, C4F10, c-C4F8, C5F12, C6F14, and any other GHG with high global warming potential not covered in this list.*

(ii) General Description of Steps Taken or Envisaged to implement the Convention

- Each non-Annex I Party shall, in accordance with Article 12, paragraph 1(b), communicate to the COP a general description of steps taken or envisaged by the Party to implement the Convention, taking into account its common but differentiated responsibilities, and specific national and regional development priorities, objectives and circumstances.

- In doing so, non-Annex I Parties should provide information on their vulnerability to the adverse effects of climate change, and on adaptation measures being taken to meet their specific needs and concerns arising from these adverse effects.

- Non-Annex I Parties are encouraged to provide information on the scope of their vulnerability and adaptation assessment, including identification of vulnerable areas that are most critical.

- Non-Annex I Parties are encouraged to include a description of approaches, methodologies and tools used, including scenarios for the assessment of impacts of, and vulnerability and adaptation to climate change as well as any uncertainties inherent in these methodologies.

- Non-Annex I Parties are encouraged to provide information on their vulnerability to the impacts of, and their adaptation to, climate change in key vulnerable areas. Information should include key findings, and direct and indirect effects arising from climate change, allowing for an integrated analysis of the country's vulnerability to climate change.

Acronyms

Words	Terms
UNFCCC	United Nations Framework Convention on Climate Change
COP	Conference of the Parties
NATCOM I	Initial National Communication
GHG	Green House Gas
NCV	Net Calorific Value
IPCC	Intergovernmental Panel on Climate Change
SWAT	Soil and water Assessment Tool
GEF	Global Environmental Facility
QA	Quality Analysis
QC	Quality Control
IPCC-GPG	Intergovernmental Panel on Climate Change-Good Practice Guidance
FOLU	Forestry and Other Land Use
MSW	Municipal Solid Waste
IPCC-SRES	Intergovernmental Panel on Climate Change- Special Report on Socio-economic Scenarios
PRECIS	Hadley Center Desktop Model
HadRM2	Hadley Center Regional Model (2)
IPPU	Industrial Processes and Product Use
CO_2	Carbon di-oxide
CH_4	Methane
N_2O	Nitrous oxide
UNDP	United Nations Development Program
CO	Carbon mono-oxide
NO_X	Oxides of Nitrogen
NMVOC	Non-Methane Volatile Organic Compound
SO_2	Sulphur di-oxide
HFC	Hydrofluorocarbons
PFC	Perfluorocarbons
SF_6	Sulphur Hexafluoride

NATCOM
INSTITUTIONAL SPREAD

AHMEDABAD
- Decision Craft Analytics
- Indian Institute of Management

ALLAHABAD
- Centre for Social Forestry and Eco-Rehabilitation

AIZAWL
- Advanced Research Centre for Bamboo and Rattans

BENGALURU
- Indian Institute of Science
- Indian Institute of Horticultural Research
- Institute of Woods Science and Technology

BHOPAL
- Maulana Azad National Institute of Technology
- Indian Institute of Soil Science

BHUBANESWAR
- Institute of Minerals & Materials Technology

CHENNAI
- Central Leather Research Institute
- M.S. Swaminathan Research Foundation

CHHINDWARA
- Centre for Forestry Research and Human Resource Development

COIMBATORE
- Tamil Nadu Agricultural University
- Institute of Forest Genetics and Tree Breeding

DEHRADUN
- Forest Survey of India
- Forest Research Institute
- Indian Institute of Petroleum
- Indian Council of Forestry Research and Education

DELHI
- Arete-Glacier & Water Consultants Pvt. Ltd
- Cement Manufacturers' Association
- Central Road Research Institute
- Confederation of Indian Industry
- Indian Agricultural Research Institute
- Indian Institute of Technology
- Integrated Research and Action for Development
- Institute of Economic Growth
- Institute of Home Economics
- Malaria Research Centre
- National Physical Laboratory
- The Energy and Resources Institute

DHANBAD
- Central Institute of Mining and Fuel Research

GOA
- National Institute of Oceanography

HYDERABAD
- Forest Research Centre

INDORE
- National Research Centre for Soybean

IZATNAGAR
- Indian Veterinary Research Institute

JABALPUR
- Tropical Forest Research Institute

JALANDHAR
- Central Potato Research Institute

JHANSI
- Indian Grassland and Fodder Research Institute

JODHPUR
- Arid Forest Research Institute

JORHAT
- Rain Forest Research Institute

KARNAL
- National Dairy Research Institute

KOLKATA
- Jadavpur University
- Bidhan Chandra Krishi Vishwa Vidyalaya

KOCHI
- Central Marine Fisheries Research Institute

KASARAGOD
- Central Plantation Crops Research Institute

LUDHIANA
- Punjab Agriculture University

MUMBAI
- Indian Institute of Technology

NAGPUR
- National Environmental Engineering Research Institute

PUNE
- Indian Institute of Tropical Meteorology

RANCHI
- Institute of Forest Productivity

SHIMLA
- Himalayan Forest Research Institute

SOLAN
- Dr Y.S. Parmar University of Horticulture and Forestry

UDAIPUR
- Action for Food Production

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