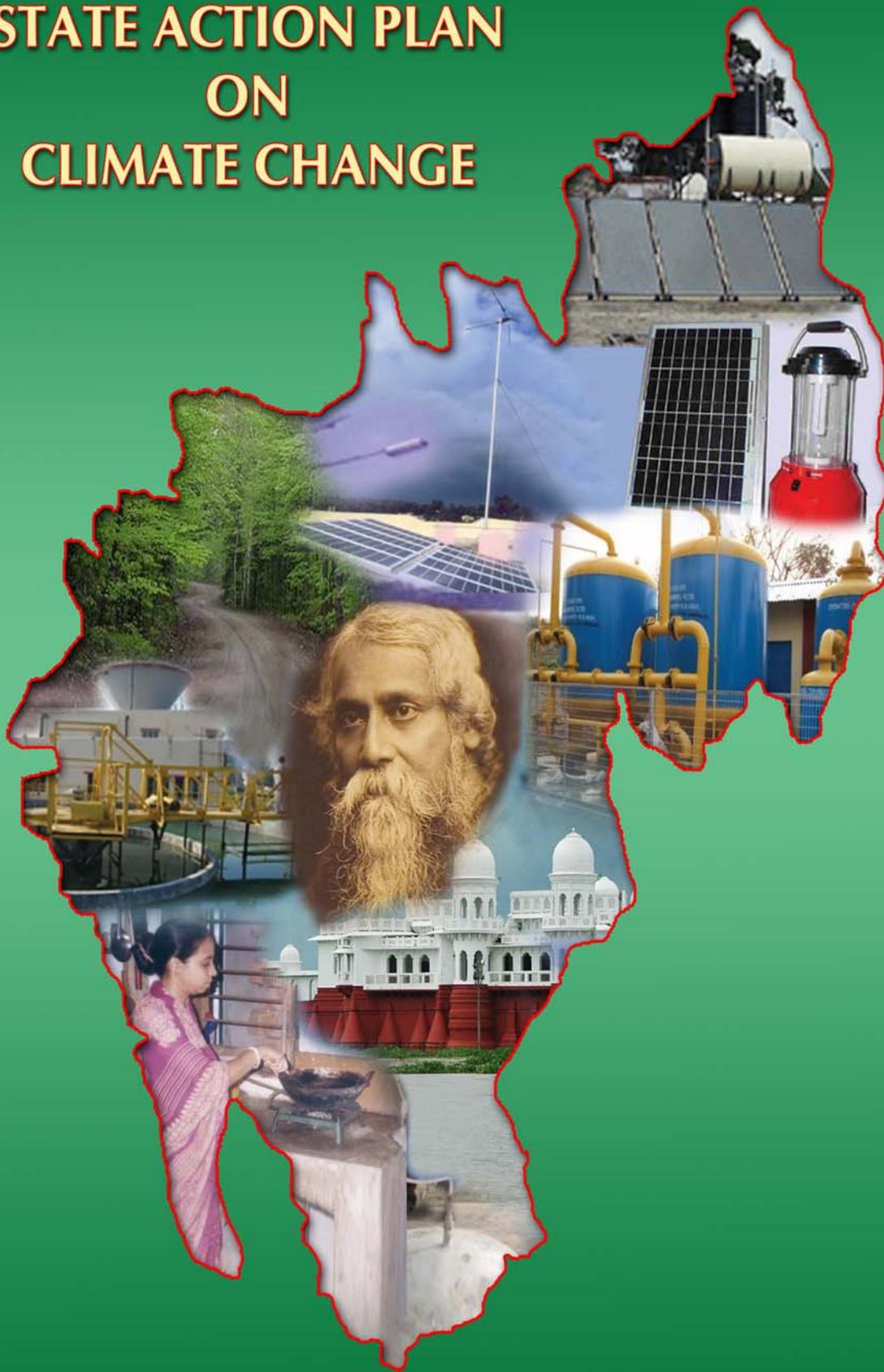


# STATE ACTION PLAN ON CLIMATE CHANGE



Government of Tripura  
Department of Science, Technology & Environment



# MESSAGE





# MESSAGE



# FOREWORD...



## **PREFACE**

Tripura has, as its approach towards development planning, always aspired for and promoted low carbon inclusive growth in consonance with the philosophy of “Vasudhaiva Kutumbakam”, the universe as a family. The state is always committed towards protecting its natural resources which acts as an insurance cover against the catastrophic disruption of life due to the impacts of climate change. In the light of risk and impact assessment highlighted in the research conducted by the Inter-Governmental Panel on Climate Change (IPCC) in their 4th assessment report, the risks of climate change phenomenon is looming large and posing a threat to the human civilization in terms of adverse natural conditions like drought, heat waves, cloud bursts, unusually heavy rainfall, accelerated glacier retreat and depletion of natural resources viz. water, food and ecosystem.

The history has chronicled the destruction and decimation of civilization in the past on account of depletion of natural resources right from the Maya civilization to Khmer Empire in south-east Asia including our very own Indus Valley civilization. It is now estimated that the impacts of climate change, which is a very dynamic process, could this time be grave and catastrophic because of over exploitation of natural resources and manipulation of environment.

The assessment of ecological footprints tells us how the nature has been ravaged for following the path of developmental economy resulting in climate change effects becoming a reality. It would, as a consequence, bring along dramatic migration of population, decline in economic condition, loss of livelihoods and predictions of rivalry amongst the nations for possessing the natural resources as well as realignment of power structure could become a reality.

Tripura, in line with the objective of reducing the green-house gas emission and strategizing adaptation measures has formulated its own State Action Plan for Climate Change (SAPCC) conforming to the national

priorities though the state is locally a carbon negative state. It has taken into consideration its unique climatic and locality factors, its objective is to strategize and strengthen the institutional capacity of its executing agencies and to integrate environment and climate change issues in development planning, policy and sectoral programmes and move towards a low carbon growth path. The Action Plan is prepared with an aim to execute it in a span of five years from 2012-17 with a midway review at the beginning of 3rd year, if necessary. It is expected that the adaptation and mitigation efforts as envisaged shall usher in a new beginning and would not only reduce the ill-effects of climate change factors but shall also produce multiple benefits at the local level in terms of economic development, poverty alleviation, employment generation, energy security and environmental sustainability.

I would like to thank my colleagues in the department of Science, Technology & Environment and other line departments, experts of the sub-committees for their contribution and their considered opinion in finalizing the document. I would place on record the contribution of GIZ and CTRAN Consulting for their help in putting together the different chapters and in drafting the report.

Agartala  
01-11-2011

P. Biswas, IFS  
(Director)

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# **ACKNOWLEDGEMENT**



# **ABBREVIATIONS AND ACRONYMS**



## Executive Summary

The Tripura State Planning Board constituted an Expert Committee on 31-05-2010 to prepare the State Action Plan on Climate Change. This Expert Committee met twice on 21-07-2010 and 13-09-2010. The Expert Committee chose to function through four Sub Committees.: Sub Committee-1: Solar Mission, Energy Efficiency and Sustainable Habitat; in Sub Committee-2: Water Mission; in Sub Committee-3: Himalayan Ecosystem, Green Tripura and Sustainable Agriculture; and in Sub Committee-4: Strategic Knowledge for Climate Change. The task of report preparation in these subjects was coordinated by the expert members of the committee with the help of the officials co-opted from the government departments and academic organisations on the Sub Committees.

The Climate Change Division of Ministry of Environment & Forest (MoEF), Nodal agency is coordinating the National Action Plan on Climate Change in collaboration with GIZ (German Technical Cooperation). Accordingly

GIZ appointed CTRAN Consulting to assist the State Government in the preparation of the Tripura Climate Change Action Plan. The report of the State Action Plan on Climate Change has been presented in the two stakeholder workshops where Nodal Officers and subject experts from concerned research institutes, line departments and NGOs expressed their views. After stake holder deliberations the report was finalized and submitted to the Expert Committee for final approval.

### Special and preferential treatment for the State of Tripura

In preparing this report for the finalization of the State Action Plan on Climate Change for Tripura, the expert committee has kept in mind the efficacy of the National Action Plan on Climate Change in India; and achievement of the voluntary mitigation target will depend on how it gets translated into policy actions at the individual state level. In line with the Government of

India decision, the State of Tripura (though a carbon negative state locally) has decided to formulate a state action plan on climate change that integrates the mitigation and adaptation agenda with the plans underway for the purpose of poverty alleviation and sustainable development of the state. The issues of vulnerability of the state of Tripura to climate change are intimately related to its location and indigenous population. The people of Tripura depend primarily on forests and other natural resources for their livelihoods. The state is yet to be locked into pathways of development which have been termed as unsustainable by the scientific community. The State of Tripura has the potential of earning for the country's maximum carbon credit for mitigation of climate change through afforestation on account of close to 76.95% percent of her land area being still under forests. With a view to ensure that the mitigation potential of Tripura forest gets fully realized; eventually the State of Tripura seeks special and preferential treatment from the government of India. This treatment would have to be accorded by the Government of India in the form of liberal financial support for not only the proposed plans of mitigation and adaptation but also the people friendly development agenda of the state without which it would be difficult to maintain and develop the coping capacity of the poor people of Tripura.

Tripura is known to be prone to various natural and human induced disasters both in recurrent and non-recurrent features. The entire geographic area is prone to Earthquake which is situated on Seismic zone V. Because the State is surrounded by Bangladesh and aerial distance to Bay of Bengal is less than 100 KM, the entire landmass of the State is also prone to high wind and cyclone zone-A which is very high risk zone. The State faces recurrent floods during monsoon and flash floods in hilly areas. The rivers which have come from hills, their river beds are rising due to continuous siltation. Due to this, the floods become furious and causing wide disruption to lives and property. Better part of the State is having hills and hill ranges which are prone to landslides. During summer season, there are high risks of forest fire which affects both lives and property. *Jhum* cultivation is also badly affecting the forest fire and some times, the fire goes beyond control and affects the habitations nearby the forests. In the State, drought is not a common disaster, but there are incidents of dry spells during summer season. In Agartala, the state capital insufficient sewage systems, old buildings, roads which are now seeming to be narrow and the congestion of poorly built houses, etc. exacerbate the vulnerability of city. The main causes of flood in Agartala city and other towns are intense precipitation and backflow

of water from Bangladesh. The development plan of Agartala city and other towns particularly in regard to management of heavy precipitation situation has a close link with trans-border planning process.

The State Action Plan on Climate Change seeks the support of Government of India for the preparation of separate technical proposals for Agartala city and other towns in respect of new construction and development to

meet climate change vulnerability norms. Specific attention is needed for the tasks like the development of lifeline infrastructure development, hazard modification, relocation and rehabilitation, joining up with ongoing hazard risk reduction programmes being implemented by disaster management authorities, prioritized development of settlements of urban poor and indigenous tribal population, and strengthening of regional and rural-urban linkages.

Sl. No	Sectors	Key Priorities				Total Budget (Cr₹)
		Adaptation	Mitigation	Adaptation & Mitigation	Total Activities	
1	Mission on Energy Efficiency	5	5		10	828.35
2	Solar Mission & Non-conventional Energy	3	3		6	1085.11
3	Sustainable Habitat Mission	4	3		7	1196.5
4	Mission on Water	21			21	8005.93
5	Sustainable Himalayan Mission	16	---	--	16	94.70
6	Green Tripura Mission	10	7		18	591.70
7	Sustainable Agriculture Mission	26	--	1	27	795.80
8	Strategic Knowledge Mission	8	3		11	31.00
9	Mission on Health	4	---	---	4	30.48
	<b>Total</b>	<b>98</b>	<b>21</b>	<b>1</b>	<b>121</b>	<b>12659.57</b>

## **Mission Energy Efficiency**

Tripura is highly dependent on power (electricity) being generated through gas thermal route. At the moment all the power plants are operating in open cycle system. As a result they are responsible for substantial carbon emission. Conversion of open cycle based power units to combined cycle is an important climate change related energy efficiency enhancing step for the state of Tripura. It has been estimated that the financing plans for combined cycle require an investment of Rs. 1400 crores. Bringing down the electrical transmission and distribution losses from 31 to 15 % through a time bound programme by 2030 is the other important energy efficiency enhancing step that the State needs to undertake in a systematic way. Steps proposed in this direction also include proposals for encouragement to decentralized power generation wherever possible on the basis of agricultural wastes and solar energy in the rural areas. Measures for energy conservation would include the formulation of a special programme for the introduction of more efficient agricultural pumpsets by Agriculture and Water Resources (irrigation) department. Steps are also required in respect of encouraging the use of efficient lights and star marked domestic household appliances. In the proposed actions, the steps being contemplated include the

conversion of conventional street lights into solar street lights, use of LED based lights, bill boards and advertisement hoardings to use solar energy wherever feasible and deploy timer based models, encouragement to the use of solar gadgets in industry and energy audit in major departments.

## **Solar Mission & Non-conventional Energy**

Tripura gets 1600 kwh of energy per m<sup>2</sup> annually; 1% of surface area can generate 2000 MW of solar power. The State government wishes to use solar power to enhance life of the gas reserve available in Tripura. 23 KW of solar power plants are already under various stages of implementation in the State. Another 68 KW solar power plants are sanctioned and will be implemented shortly. Further, steps in this direction are required to focus on Megawatt power plants which can be connected to grid stations. Much potential exists for the exploitation of solar thermal applications in the area of water heating. Hotels, Guest Houses, Circuit Houses, etc. consume about 8 MW of power through electric geysers. Electric geysers need to be replaced with solar water heaters which are viable. In Tourism sector, the use of solar photovoltaic (PV) and solar thermal systems can help the state to foster eco-tourism. Solar power for remote and inaccessible areas makes much sense in the state of Tripura and would need

encouragement. Suitable policy measures will have to be announced in the area of solar energy in the form of special tariffs, incentives in the form of tax rebates, amendment of building bye-laws for mandatory use of solar hot water systems in commercial areas and public buildings, private houses costing more than Rs. 20 lakhs to opt for the use of solar water heaters in buildings, development of solar park or solar valley to achieve the emphasis required for local manufacture / assembly of various kinds of solar equipment, etc.

### **Mission on Sustainable Habitat**

Transport sector is one of the main emitters of green house gases (GHGs). The State Action Plan on Climate change lays stress on the introduction of more public transport vehicles. The plan proposes switchover to CNG based and electric vehicles. It discourages use of private vehicle. In the case of road sector it proposes the use of setback methods and control of road openings. In the construction sector, the plan promotes green building concept through the introduction of policy support and regulation. It proposes amended bye-laws to be sent to all the Municipalities and Urban Bodies for implementation. Proper training and retraining of architects and engineers in green buildings is suggested as an important agenda

of the state action plan for climate change. The plan proposes to take up special programmes for better urban and rural waste management. It proposes to address the problem of littering through active participation of people. It encourages the government agencies, group enterprises of urban poor and local entrepreneurs to prepare proposals for taking up the activities of power generation, methane bottling and manure production from municipal solid waste and recycling of plastics, glass, paper, etc.

The plan proposes to lay appropriate stress on the carbon neutrality through the use of biomass for meeting the basic needs of energy to achieve synergy of the climate change risk related proposals with the proposals of generation of sustainable livelihoods. It notes that the carbon neutral uses of biomass of all kinds in material and energy development will lessen the burden on forest resources, reduce the consumption of cement and steel and foster the local use of fast growing small wood to encourage the development of local occupations. The government is also planning to prepare a policy of buyback or incentives for encouragement to small biomass gasifiers both for meeting local energy needs and using them for power to be put into grid. The policy will provide for dedicated plantations to tie up and sustain viable operations of biomass gasifiers. The plan seeks

a re-introduction of improved stoves for family / community level at subsidized cost. Pressure cooker use is proposed to be encouraged to increase the fuel efficiency. Hotels, hostels and other community establishments would be encouraged by the government to use kitchen wastes for biogas generation. The plan also proposes to encourage family and community level biogas plants.

### **Mission on Water**

The likely consequences of climate change on the water front in Tripura are (i) decrease in total annual rainfall, (ii) change in rainfall pattern resulting in crop failure for not getting the rain when required and (iii) sudden bursts of rain over a small period of time which may cause floods. The proposed plan conceives urgent action on the fronts of (1) rainfall monitoring, (2) river conservation (3) restoration of water bodies (4) use of ground water and (5) proper drainage system. It proposes that the state should have at least 70 rain gauge stations for accurate measurement of rainfall, which in turn would be helpful in assessing the ground water use and water balance. The plan proposes the creation of additional water-holds to capture rain water to mitigate issues of water scarcity. Water Resource Department as well as Drinking Water & Sanitation Department will prepare separate plans and technical proposals for

the sustainable water harvesting structures.

The challenge of river conservation needs to be addressed at basin level from source to end with institutional arrangements of judicious governance being in place at the level of settlement, watershed, aquifers and river basin by establishing state river authority to give ownership of the problem to a dedicated agency. It is also necessary to have accurate basin level data for all the rivers in the entire state. There is the problem of interest, commitment, participation and involvement; this problem needs to be solved through the social mobilization of people and the development of appropriate institutional arrangements. The plan proposes planned afforestation at the source and in the catchment areas of the rivers. Plans and proposals would be developed for the establishment of sewage treatment plants to stop the flow of untreated sewages into the rivers. Proper management of municipal solid waste will also help in tackling the challenge of river conservation in an effective manner. The plan proposes regulation of large scale drawl of water from the rivers.

Water bodies need protection. Large wetlands / water bodies (like RudraSagar in Melaghar) are shrinking in size. The plan proposes the implementation of immediate steps in respect of reclamation and conservation of large wetlands

like RudraSagar, Hurijala. The plan proposes the development of a concerted programme of conservation of ponds, tanks and *dighis* to be taken up by the government with the help of local self-government bodies and social mobilization of the people. The people need to be mobilized to stop effluents from houses located along four sides of big *dighis*.

### **Mission on Sustainable Himalayan Ecosystem & Green Tripura**

Tripura is a part of Himalayan Ecosystem. Climate change impact on this fragile ecosystem has its fallout in Tripura as well. Agenda for mitigation has been identified. Gap areas, action plans and cost estimations have been worked out. Key priorities identified include steps for (i) increasing reforestation / afforestation activities in degraded forest areas (ii) afforestation of the lands diverted under the RFR Act, (iii) control of the shifting cultivation by encouraging the introduction of sustainable practices of land use, (iv) protection of the existing forest lands from encroachment and illegal land use, (v) increasing planting on non-forest land (vi) Livelihood improvement activities for forest dependent communities (vii) Capitalizing on the funding opportunities in carbon markets

The plan also proposes to the relevant agencies including

department of forests to put up plans to take up the following tasks immediately: a) fire management, b) working plans to establish new land use management systems to support community users, c) undertaking studies on indigenous fast growing tree species to assess their vulnerability to climate change, d) assessing threats to biodiversity and wildlife, e) documentation of traditional knowledge, f) obtaining access to updated knowledge on climate change science and policy developments, g) monitoring of carbon stock and biodiversity at regular interval.

The department of forest proposes to contribute to tackling the challenges identified with regard to river health and water conservation. It will also be participating in a big way in the construction and protection of water harvesting structures. It will undertake river-bank plantations to reduce flood severity and conserve soil and help to improve drainage systems. It will be an active partner of the government in the creation of awareness about climate change and its impact through eco-parks and other activities are also on the indigeous.

Actions needed under the Green Tripura programme aim at the increase in area for afforestation, enhancing the resilience and ability of vulnerable species / ecosystems to adapt to the changing climate and enabling adaptation of forest

dependent local communities in the face of climatic variability.

### **Mission on Sustainable Agriculture**

Agriculture contributes nearly 25% to the net state domestic product. Agriculture and allied sectors provide employment to 51% of total work force in the state. As the problems of soil erosion, siltation, degradation of top soil etc. are also growing in the state of Tripura, improvised agricultural systems and climate friendly cropping practices should be adopted. The Mission proposes rapid screening and strategy assessment through a task force to be formed especially for the purpose in the context of climate change. As the data on water quality, soil health, pest and disease attacks, yields and loss of productivity in different crops and farming systems is not being monitored in a systematic way, the department of agriculture proposes to strengthen this area. In the wake of climate change risk having increased and the government being required to construct the safety nets ranging from organizing insurance payments to taking preventive and mitigating steps in time the state action plan on climate change considers this task to be a key priority area of action in respect of agriculture and allied sectors. Development of livelihood-focused people centric integrated watershed development in rain-fed

areas is designated as the second most important task.

The plan gives a higher priority within the sphere of development of practices of sustainable agriculture to the establishment of water use-efficient micro irrigation methods, construction of individual/community farmponds, development of sustainable soil, water and crop management practices, breeding studies on major crops for tolerance / resistance, improving monitoring and surveillance techniques and establishment of an effective institutional delivery mechanism to promote best practices. In the direction of promoting sustainable agriculture practices, the state action plan on climate change proposes the utilization of bio-resources available in the state of Tripura in the form of local flora including bamboos and even the crops like jute for the implementation of agenda of mitigation and adaptation simultaneously. Organic wastes, plant wastes, leaf litter, droppings etc. need to be used for the preparation of organic manure to tackle the problem of soil fertility and taking the systems of farming in the direction of sustainable crop intensification.

### **Mission on Strategic knowledge**

The mission on strategic knowledge for climate change has to provide leadership and should be considered

upfront in the course of development of plans and proposals for state action plan on climate change for the state of Tripura. The main constraints identified in respect of generation of strategic knowledge in the case of Tripura are insufficient scientific information data base; weak and fragmented knowledge base for impact assessment and selection of technology; knowledge gaps in respect of the impacts of climate change in different sectors and lack of institutional mechanisms for collating, synthesizing and delivering knowledge products for decision making and action. Thus, in the state of Tripura this mission faces the challenge of establishment of state specific knowledge generation and utilization capacity in respect of a wide range of aspects including monitoring of climate change and making of climate change projections for the state, creating GHG inventory and the dominant GHG / CO<sub>2</sub> emitting sectors for the state, assessing the impacts of climate change, analyzing the level of vulnerability of districts, sectors and population groups, evaluating the traditional adaptation and coping practices to climatic variability and extremes, integrating the knowledge of assessments and enabling the planning and mitigation projects, informing and assisting the development agencies to evolve suitable management measures and policies, setting up the mechanisms for the exchange of information needed for strengthening regional

cooperation and empowering and upgrading the capabilities of officials and Local bodies working to take appropriate steps to reduce the risk.

As the Government of Tripura needs to strengthen considerably the existing knowledge base of the state for an effective implementation of above mentioned climate change related functions and activities, the plan suggests a multi-pronged strategy. First of all, there should be a planned upgrading of in-house competencies of the executing agencies (line departments involved) with the implementation of all the missions by setting up within them “in-house nodal teams / groups on climate change to support the secretaries and ministers. Second, the state needs to create an “autonomous institution” capable of specializing in the activities concerning climate change monitoring and assessment and coordinating the work of knowledge generation and of capacity building to galvanize and support the state and its people for an effective response to the impacts of climate change. Third, the Mission on Strategic Knowledge on Climate Change proposes a list of “multi-disciplinary / multi departmental sub missions” formulated on the basis of prevailing gaps in knowledge, expertise and capacity for collective action identified through the submissions of executive departments and academics. Coordinating agencies

and leading partners have been identified on the basis of lead taken and expertise available with them in the case of the proposed activities.

As far as the plan for establishment of an autonomous institution is concerned, the State Action Plan on Climate Change proposes that the institution may be named as “Tripura Institute of Strategic Knowledge for Climate change (TISKCC). It is proposed that it should be founded and created in quick and well measured steps. The mandate of coordination of constitution of all the relevant specialized competencies, which are needed in the state for the execution of proposed sub missions, should be devolved on this institution. As far as the planning office for this institute is concerned, it may be constituted by taking four to five officers on deputation. These officers may be mentored for the period of next one year by the expert members of the committee to be constituted by the Government of Tripura for coordination, oversight and establish a networked institution of Department of Science Technology & Environment (DST & E) centers / groups located within their own respective foster institutions like Tripura University, Agricultural University, NIT Agartala, Medical College, DST and so on. The main tasks would include the establishment of all the proposed

sub missions, locating the persons of relevant academic backgrounds from all over the country to come and work in Tripura in the identified areas / sub missions and nurture for example the nodal centre of Monitoring and Assessment of Climate Change (CMAACC) to take the responsibility for observations, monitoring, modeling, prediction of climate change in respect of extreme weather events and to bring out possible impacts of climate change in key socio-economic sectors. Simultaneously, there would be a need to guide and advise the Department of Science, Technology & Environment and other implementing departments on their regular and Climate Change induced activities both at the State and district level. The set up at the district level also needs strengthening.

The S&T capacity building functions implies undertaking teaching and research and act as a bridging institution for the extension of knowledge to the relevant organizations and people for the benefit of development of the coping capacity of the state. For the sub missions to be run which require very different disciplines and specializations the proposed department / centre / group / unit for S&T capacity building could have different physical locations in order to take advantages of the institution where the domains of knowledge being pursued are relatively more

suitable.

However, it needs to be stated up front that even these nodal S&T groups / centres / departments are located in different places these centres would have to report and be co-ordinated by the institute namely Tripura Institute of Strategic Knowledge on Climate Change (TISKCC). These centres and the institutes are not line departments of the government. While the report expects these groups to be working on the problems identified by the government, industry and society, these groups as well the institute (TISKCC) as such should function as independent expert / academic groups.

Data sharing policy among the departments and agencies is going to be critical to climate change modeling, impact assessment and exchange and upgrading of appropriate solutions. As a result it is proposed that all the missions including the mission on strategic knowledge on climate change should be part of a state level council whose head should be person no less than the Chief Minister.

### **Mission on Health**

Impacts of Climate change on human health possess a vital

relationship with the economic profile and infrastructure availability for the population in the region. It is worthwhile to mention that higher the financial constraint the population is more vulnerable to the impact of climate change. The economy of Tripura is characterized by high rate of poverty, low per-capita income, low capital formation, in-adequate infrastructure facilities, geographical isolation and communication bottleneck. Hence the impacts of Climate change on human health are crucial issue in the context of Tripura.

The proposed plan conceives urgent action on the fronts of (i) Formulating adaptation strategies to reduce the impact of climate change issues affecting human health (ii) studies on Health impacts due to drinking water contamination and temperature variation (iii) human health infrastructure development and capacity building for climate change adaptation (iv) Assessment of health impacts due to malnutrition.

These adaptation strategies are framed with an objective to reduce the vulnerability to the climate change that has already occurred and also to address the health risks projected for the future.



## Background

The State Planning Board in its meeting on 31-05-2010 had constituted a Committee for preparation of State Action Plan on Climate Change. In this regard, order was issued vide memo No. F7(5)-PCD/SPB/09-10/2175-99 dated 15<sup>th</sup> June, 2010 (**Annexure I**) by the Planning department constituting the Committee as follows.

1. Minister, Science Technology & Environment - Chairman
2. Dr. S.P. Gon Chowdhury, M.D., West Bengal - Member  
Green Energy Development Corporation Ltd.
3. Dr. A.K. Mukerji, Member, State Planning Board - Member
4. Principal Chief Conservator of Forests - Member
5. Dr. R.L. Srivastava, M.D., TFDPC. - Member
6. Chairman, Tripura State Pollution Control Board- Member
7. Shri Dinesh Abrol, Scientist, NISTD, CSIR - Member
8. Secretary in-charge of Science Technology &  
Environment Department -Member Secretary

The Committee met on 21-07-2010 and in order to bring greater focus on different sectors, the following Sub Committees were constituted for preparation of State Action plan on Climate Change. Minutes of the meeting dated 21-07-2010 are at **Annexure-III**.

1. Sub-Committee-1 for **Solar Mission, Energy Efficiency and Sustainable Habitat**
  - (i) Dr. S.P. Gonchoudhury, - Chairman  
(M.D., West Bengal Green  
Energy Corporation Ltd)

- (ii) Director (Technical), TSECL - Member
- (iii) Director, Urban development - Member
- (iv) Chief Engineer, P.W.D. - Member
- (v) Director, TRED A - Member
- (vi) C.E.O. A.M.C. - Member
- (vii) Shri B. Chakraborty,  
Engineer (Electronics), DSTE - Convener

2. Sub-Committee-2 for **Water Mission**

- (i) Prof M. Deb, Chairman, TSPCB - Chairman
- (ii) Chief Engineer (D.W.S), P.W.D. - Member
- (iii) Chief Engineer (W.R), P.W.D. - Member
- (iv) Director, Health - Member
- (v) Director, Fishery - Member
- (vi) Shri P.Saha,  
Senior Scientific Officer, DSTE - Convener

3. Sub-Committee-3 for **Himalayan Ecosystem, Green Tripura and Sustainable Agriculture**

- (i) P.C.C.F, Forest Department - Chairman
- (ii) Director, Agriculture - Member
- (iii) Director, Animal Husbandry - Member
- (iv) Director, Horticulture - Member
- (v) Director, Fishery - Member
- (vi) Shri G.S. Raju, Addl. P.C.C.F. - Convener

4. Sub-Committee-4 for **Strategic Knowledge for Climate change**

- (i) Shri Dinesh Abrol  
(Scientist, NISTD, CSIR) - Chairman
- (ii) Director, Agriculture - Member

- |                                                           |            |
|-----------------------------------------------------------|------------|
| (iii) Joint Director, I.M.D                               | - Member   |
| (iv) Head of Department,<br>(Physics, Tripura University) | - Member   |
| (v) Director, DSTE                                        | - Convener |

The Sub Committees presented their reports on 13-9-2010 and various suggestions were given based on which the Sub Committees redrafted their reports and sent to the Science, Technology and Environment Department. The Minutes of the meeting dated 13-9-2010 are given in **Annexure-III**.

A drafting Committee comprising of (i) Shri Sriram Taranikanti, Commissioner & Secretary (ii) Shri Dinesh Abrol, Scientist, NISTD (iii) Shri S.K. Pal, Director, DSTE (iv) Shri D. Chakraborty, Conservator of Forest, Deptt of Forest (v) Shri P.Saha, Senior Scientific Officer, DSTE (vi) Shri B. Chakraborty, Engineer(Electronics), DSTE was

formed which perused the Sub committee reports in its meeting on 29<sup>th</sup> and 30<sup>th</sup> November, 2010. The drafting Committee gave certain suggestions based on which the conveners of Sub-Committees redrafted the material. These were collated and edited by a three member group comprising Shri Sriram Taranikanti, Commissioner Secretary, Shri Dinesh Abrol, Scientist, NISTD and Shri Pranay Saha, Senior Scientific Officer. These were placed before the Committee in its meeting on 28-02-11 and approved with suggestions of incorporating additional features that were not adequately covered in the report. Based on the above, the report was further modified.





## Introduction

Climate Change is undoubtedly one of the most critical challenges faced by humanity to-day and has witnessed increased momentum to coax a coherent global response. Climate change is expected to destabilize the natural eco system, decrease the availability and quality of precious natural resources and initiate extreme events that may claim millions of lives. Recognizing the climate change as a global challenge, India is actively engaged in emission reduction activities through various initiatives out of which National Action Plan for Climate Change (NAPCC) is the most important national programme.

Government of India has announced and released India's National Action Plan for Climate Change (NAPCC). NAPCC will run through till 2017 encompassing a number of climate change mitigation and adaptation initiatives across sectors. The plan proposes eight focus areas, known as National Missions;

- **Solar Energy**
- **Energy Efficiency**
- **Sustainable Habitat**
- **Water**
- **Himalayan Ecosystem**
- **Green India**
- **Agriculture**
- **Strategic Knowledge**

Following the Copenhagen Climate Change Summit, the Govt. of India has also announced a voluntary target of 20-25% cut in the carbon intensity by 2020 w.r.t 2005 baseline. Such target will generate significant pull to transform our domestic economy into a low carbon growth path.

The efficacy of the NAPCC in India and achievement of India's voluntary mitigation target will depend immensely on how it translates the policy actions at the individual State level. The Prime Minister also announced that State Governments would have to present their respective agenda on climate change actions in line with the provisions in the national plan.

The State Government can play a major role in respect of keeping India's commitment towards emission reduction by way of formulating a state level action plan for climate change. The States will also be benefited significantly if State Action Plan on Climate Change is executed in an appropriate manner. In line with the Govt. of India decision, the State of Tripura (though a Carbon Negative state locally) has also decided to formulate state level action plan on climate change.

The issues of vulnerability of the state of Tripura to climate change are intimately related to its location and indigenous population. The people of Tripura depend primarily on forests and other natural resources for their livelihoods. In fact, the State of Tripura is uniquely placed to be recognized as a climate sensitive state. The State of Tripura deserves much attention in respect of climate change from the Government of India. The State of Tripura is not only a state that

has the potential of earning for the country's significant amount of carbon credit for mitigation of climate change on account of close to 60 percent of her land area being still under forests but also a region that is most vulnerable on account of her proximity to Bangladesh which has been declared to be one of the most vulnerable and climate sensitive countries by the world community. Further, the State of Tripura is very much a developing region. The State is yet to be locked into pathways of development which have been termed as unsustainable by the scientific community.

The economy of Tripura is characterized by the near absence of an industrial base, with manufacturing accounting for less than 3 per cent of NSDP. But the State of Tripura has rich natural resources, including gas and forests which can become the basis for a new pathway of sustainable development. Agriculture and the primary sector together account for over fifty percent of the state domestic product of Tripura. A significant number of persons and families in Tripura continue to depend on forests and *jhumcultivation* as their main source of livelihood. Generation of sustainable livelihoods in forest areas, particularly for tribal families traditionally dependent on *jhumcultivation*, enhancement of productivity and sustainability of highland agricultural and

horticultural activities and resource based industrial development are the major developmental challenges. However, the State of Tripura carries a higher burden of poverty compared to other states<sup>1</sup>. Thus, in case of Tripura the objectives of sustainable development (SD) imply a simultaneous realization of the twin goals of environmental security and social justice.

The State of Tripura is a part of the eastern and north eastern Himalayan ecology. The ecology of entire eastern and north eastern Himalayas is threatened by the changes that are expected to arise in climate due to the rise in temperature and pattern of significant changes in rainfall<sup>2</sup>. Through extreme or prolonged stress, climate variability and change can affect the quality, quantity, and reliability of many of the services, natural resources of this larger ecosystem and region provide to the State of Tripura. In other words the changes likely (whose timing, location, coverage and scope are still uncertain) to occur on account of its Himalayan

surroundings in turn are also expected to have a critical impact on food intake, health, and livelihoods of poor people.

The State of Tripura has also climate sensitive region specific features arising out of its location on the international border of Bangladesh. The country needs to recognize that the State of Tripura is a part of one of the most climate sensitive regions of the world in which the people are expected to experience significant increases in frequency and intensity of cyclones, storms, sea-level rise and increased flooding. As a whole the State of Tripura has a vast international border with Bangladesh; the capital city of Agartala is located close to the border area of Bangladesh. Climate sensitive changes undertaken on the side of Bangladesh will have an impact on Agartala town. In this context the problem of climate migrants or climate refugees needs to be underlined as an issue of vulnerability of the state of Tripura to climatic changes.

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<sup>1</sup> The Planning Commission estimates of poverty in Tripura, based on the head count ratios for Assam, are 40 per cent in rural areas and 7.5 per cent in urban areas in 1999–2000. The corresponding all-India numbers were 27.1 per cent and 23.8 per cent for rural and urban areas. Estimates of poverty prepared by the Government of Tripura, however, show a higher incidence of poverty than the Planning Commission estimates. Using the official methodology and data on consumer expenditure from the NSS, it is estimated that 55 per cent of the population fell below the poverty line in 2001–02. Such high levels of poverty are a serious concern, since the majority of the people live in rural areas (HDR, Tripura State 2007).

<sup>2</sup> Extreme weather events like cloud bursts, flash floods or heavy thunderstorms can have severe effects. The problem of land slide is expected to be aggravated in the hilly parts of Tripura.



# National Action Plan on Climate Change

## Introduction

India released its National Action Plan on Climate Change (NAPCC) on 30th June 2008 to outline its strategy to meet the challenge of Climate Change. The National Action Plan advocates a strategy that promotes, firstly, the adaptation to Climate Change and secondly, further enhancement of the ecological sustainability of India's development path.

## Approach to Climate Change

The National Action Plan recognises that climate change is a global challenge and, that it should be successfully overcome through a globally collaborative and cooperative effort based on the principle of equity. The Action Plan expresses India's willingness to play its role as a responsible member of the international community and to make its contribution. However, it emphasises that, this requires not only sustainable production processes, but also sustainable life styles across the globe. In this

effort, every citizen of the planet should have an equal share of the planetary atmospheric space. The Action Plan suggests that the long-term convergence of per capita GHG emissions is the only equitable basis for a global agreement to tackle climate change. The Action Plan assures the international community that India's per capita GHG emissions would not exceed the per capita GHG emissions of developed countries, despite India's developmental imperatives.

## Domestic Action

India's National Action Plan stresses that maintaining a high growth rate is essential for increasing living standards of the vast majority of people of India and reducing their vulnerability to impacts of climate change. Accordingly, the Action Plan identifies measures that promote the objectives of sustainable development of India while also yielding co-benefits for addressing climate change. Eight National Missions which form the core of the National Action Plan

represent multi-pronged, long-term and integrate strategies for achieving key goals in the context of climate change. The focus is on promoting understanding of Climate Change, adaptation and mitigation, energy efficiency and natural resource conservation. While, several of these programmes are already a part of the current actions, the Action Plan seeks to enhance them in scope, and effectiveness and implement them in an accelerated manner through time bound plans.

### **Solar Mission**

This mission aims at promoting the development and use of solar energy for power generation and other uses, as well as to render solar energy competitive with fossil-based energy options in urban areas, industry, and commercial establishments. Its goal is to generate at least 10,000 megawatts of solar power and to create a solar research center, among other things.

### **Mission for Enhanced Energy Efficiency**

This mission seeks to yield savings of 10,000 megawatts by 2012 through the implementation of certain initiatives, such as energy incentives (including differential taxation on energy-efficient appliances); setting up financing platforms for public-private partnerships to reduce energy

consumption through demand-side management programs; and establishing a system for large energy-intensive industries and facilities to trade energy-savings certificates so that they can meet government-mandated reductions in energy consumption, as per the Energy Conservation Act.

### **Mission on Sustainable Habitat**

This mission seeks to promote energy efficiency in urban planning through measures such as putting more emphasis on urban waste management and recycling, strengthening the enforcement of automotive fuel economy standards, using pricing measures to encourage the purchase of fuel-efficient vehicles, and providing incentives for people to make greater use of public transportation.

### **Water Mission**

This mission aims to increase water use efficiency by 20 percent through pricing and regulatory measures, including the recycling of wastewater, increases in irrigation efficiency, and incentives to promote water-neutral or water-positive technologies and groundwater recharge.

### **Mission for Sustaining the Himalayan Ecosystem**

This mission seeks to promote the conservation of biodiversity, forest cover, and other ecological values

in the Himalayan region to help stop the retreat of glaciers, as they constitute a major source of India's water supply.

### **Mission for a “Green India”**

The mission plans to expand forest cover in India by 10 percent through afforestation of 6 million hectares of degraded forest lands.

### **Mission for Sustainable Agriculture**

The mission will foster adaptation in the agricultural sector by supporting the development of climate-resilient crops and the expansion of weather insurance mechanisms, among other measures.

### **Mission on Strategic Knowledge for Climate Change**

This mission will promote “a better understanding of climate science, impacts and challenges.” It calls for the establishment of a new Climate Science Research Fund, improved climate modeling, and increased international collaboration. It will also foster private sector initiatives aimed at developing adaptation and mitigation technologies through venture capital funds.

### **Other Initiatives**

Apart from the eight National Missions, the National Action Plan also envisages other initiatives

aimed at enhancing mitigation and adaptation. These include research & development in the area of ultra super critical boilers in coal-based thermal plants; integrated gasification combined cycle technology to make coal based power generation efficient; setting up more combined cycle natural gas plants; promotion of nuclear energy through adoption of fast breeder and thorium-based thermal reactor technology in nuclear power generation; adoption of high-voltage AC and high-voltage DC transmission to reduce technical losses during transmission and distribution; small and large scale hydro power; promotion of renewable energy technologies such as bio-mass combustion and gasification-based power generation; enhancements in the regulatory/tariff regimes to help mainstream renewable-based sources in the national power system; and renewable energy technologies for transportation and industrial fuels. In addition, the Action Plan envisages effective disaster management strategies that include mainstreaming disaster risk reduction into infrastructure project design, strengthening communication networks and disaster management facilities at all levels; protection of coastal areas, provision of enhanced public health care services, and assessment of increased burden of disease due to climate change. The Action Plan

also highlights the role of Central Government, State Governments and local Bodies in putting in place appropriate delivery mechanisms and building adequate capacity and knowledge in the relevant institutions for effective adaptation and mitigation actions.

### **Institutional Mechanism**

The National Missions are to be institutionalized by the respective Ministries and will be organized through inter sectoral groups. Appropriate mechanisms including

public- private partnership and civil society actions, will be devised, as suited, for effective delivery of each individual Mission's objectives. Comprehensive Mission documents detailing objectives, strategies, plan of action, timelines and monitoring and evaluation criteria of all eight Missions and Other Initiatives are to be developed by December 2008 and submitted to the Prime Minister's Council on Climate Change. The work is to be coordinated by the Ministry of Environment & Forests.

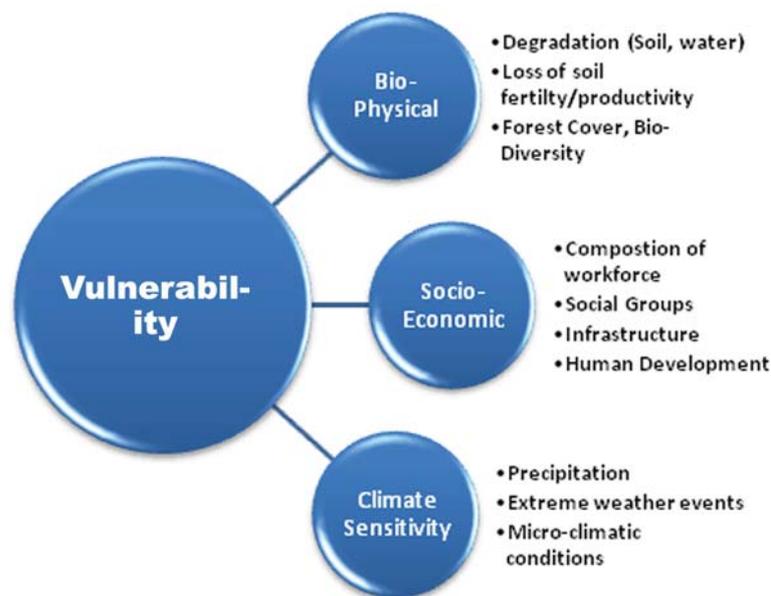


# Vulnerability Analysis

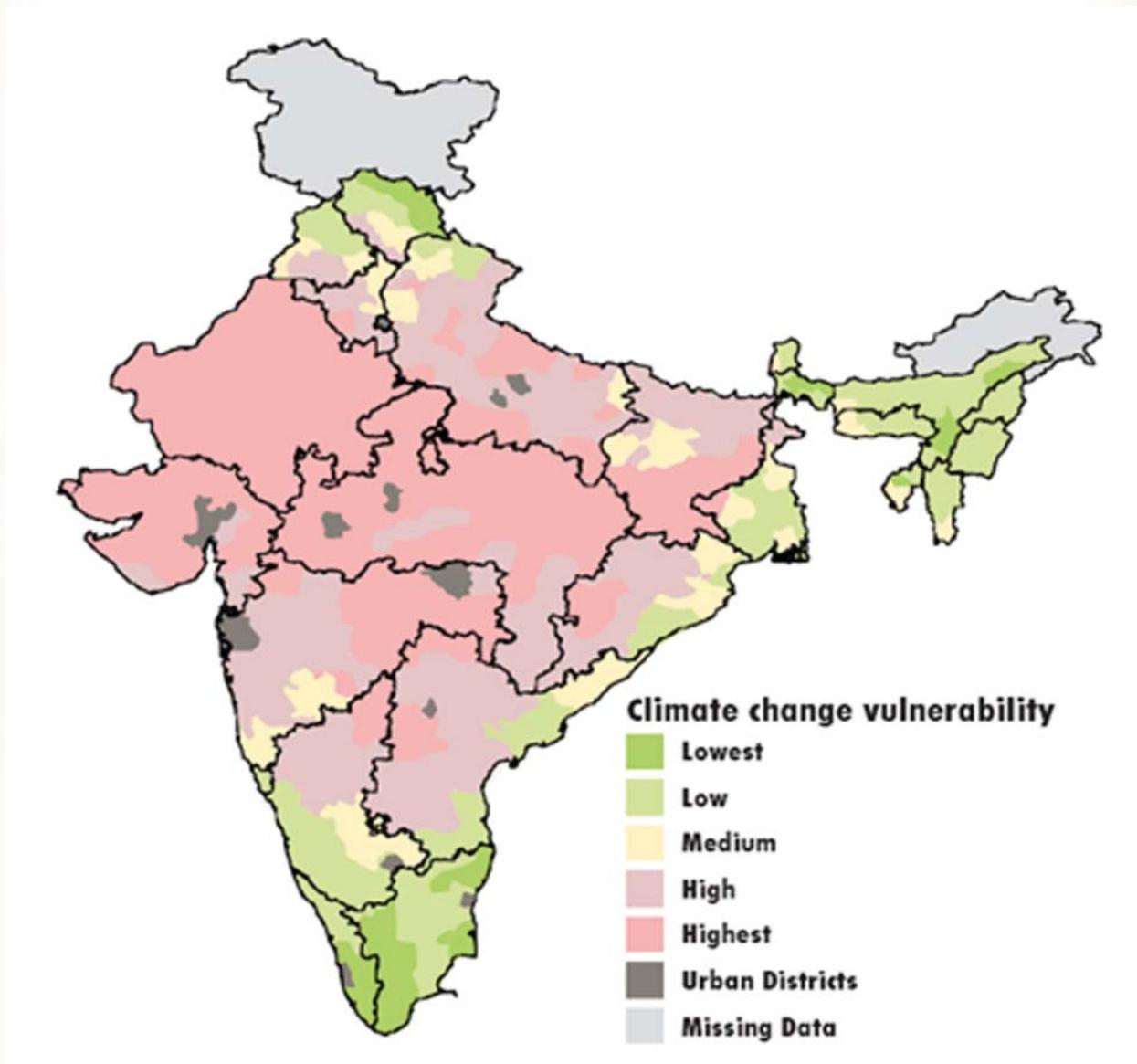
## Introduction

Vulnerabilities arising out of climate change are multidimensional in nature. One sector can compound the vulnerability in the other (e.g. Jhum cultivation can affect forestry). Therefore, to understand vulnerability in its totality one need to understand both sectoral and cross-sectoral parameters. The

vulnerability and adaptive capacities are diverse and also varies from state to state. Sectoral parameters include key sectors of the state's economy and cross sectoral factors comprise (a) Poverty (b) inequality and social discrimination over property rights and (c) access to resources (d) social attrition/migration, and (d) unequal and unsustainable competition for scarce natural resources.



*The composite profiling done by TERI has been shown below:*



***Climate change vulnerability profile generated by integration of adaptive capacity & climate sensitivity profiles (TERI, 2003)***

The spatial data shows that the Tripura state has low to medium level of vulnerability in several pockets.

(a) Its flat deltaic topography with very low elevation; and its extreme climatic variability is governed by erratic rainfall resulting in variable water distribution over space and

time ((i) decrease in total annual rainfall, (ii) change in rainfall pattern and (iii) sudden bursts of rain over a small period of time leading to flood.);

(b) Other determining factor is its socio-economic indicator; growing concern over geo-hydrological hazards and stress on biodiversity.

- (c) Dependency of the majority of the population on agriculture which is highly influenced by climate variability and change.

This has prompted to design the Climate Change Action Plan in such a manner that the local as well as holistic vulnerabilities are addressed in a cogent manner. In order to prioritise programmes/ schemes and assess their performance vis-à-vis adaptation targets, it is imperative and to take into consideration intended outcomes of these against their impact on the local communities in building resilience to climate change.

#### **Climate Sensitivity: Impact due to sea level rise in deltaic region in Bangladesh**

Most of the planet's fresh water resources are captured in ice caps and ice sheets it is expected that global warming would thaw the ice contained in the polar regions of the world to such an extent that will be brought on ecstatic sea level. For south Asia, IPCC report predicts that monsoon rainfall will increase, resulting in higher flows during monsoon season in the river system. It has also predicted that sea level rise will be between 0.18 to 0.79 meters which will lead to salinity intrusion and coastal flooding. Predictions of sea level rise due to global climate change, and in particular by global warming, are at the forefront regarding the controversy of the climate change

discourse. Different scenarios regarding sea level rise during 21st century are presented within the scientific community, from worst cases such as one meter to less than 25 cm. Distinct regions across the globe could be affected by sea-level in such a manner that likely impacts on ecosystems and human societies could have an adverse effect on the economy of states that are dependent on a number of ecosystems for economic survival.

Tripura due to its proximity to Bangladesh and being in the major river course is likely to be impacted by the climatic variability and extremities in Bangladesh. This gets accentuated through salinity, water discharge sedimentation, monsoon variability as well as the temperature variability associated with rise in surface temperature in the sea. Bangladesh is also vulnerable to many climate change related events. It is expected that climate change will bring changes in characteristics of extreme events and gradual changes phenomenon of the physical and natural systems.

Flood, drought, cyclone, sea level rise etc. are the major climate induced natural disasters which cause loss of livestock, damage pasturelands, increase fodder scarcity, destroy shelters, decrease production, increase management cost through incidence of diseases etc in Bangladesh. In early 1990s, several attempts have been made to

generate climate change scenarios by the use of available General Circulation Models (GCM). The Bangladesh Unnayan Parishad (1994) study reported 0.5<sup>0</sup> C to 2.0<sup>0</sup>C rise in temperature by the year 2030 under 'business as usual' scenario of IPCC. The same modeling effort estimated 10 to 15 % rise in average monsoon rainfall by the year 2030. The study could not draw an inference in relation to change in sea level; however, it commented that both sedimentation and subsidence were likely to complicate an expected net change in sea level along the Bangladesh coast. In deltaic region of Bangladesh, Mirza (1997) used a number of GCMs and developed climate change scenarios based on ensemble technique. The results have been used for the World Bank Study (WB, 2000). By the year 2030, the projected rise in monsoon temperature was 0.7<sup>0</sup>C with a corresponding rise in winter temperature of 1.3<sup>0</sup>C. WB (2000) results showed similarities with respect to result of Ahmed and Alam (1998).

The corresponding rise in rainfall was projected at 11% for monsoon, while a decrease in rainfall by 3 % was also projected for winter by the year 2030. This will significantly impact the main crop paddy in Tripura and even varietal transition may be required due to salinity. The impacts of extreme weather events

especially, cyclone and storm surge on forestry affects poverty and economic growth in different ways. It is likely that the gradual change phenomena such as temperature rise and erratic behavior of rainfall will lead to water demand and drought while sea level rise and salinity intrusion will deteriorate water quality, damage water supply and sanitation infrastructure particularly in the coastal region.

### **Flood, Drought and other climate linked events**

Critical analysis of the available material shows that in Tripura, the flood magnitude is likely to increase by about 25 % in the future as compared to the present. The number of drought weeks during monsoon months shows an increasing trend to the tune of about 25 % increase in future (Ravindranath et al., 2011). This affects the vulnerability of the state in the agricultural sector and adversely affects cultivators, agricultural labourers as well as retail trade which is either based on agricultural produce or non-timber forest products.

### **Bio-Physical Factors and Sectoral Segmentation of Climate Induced Vulnerability in Tripura**

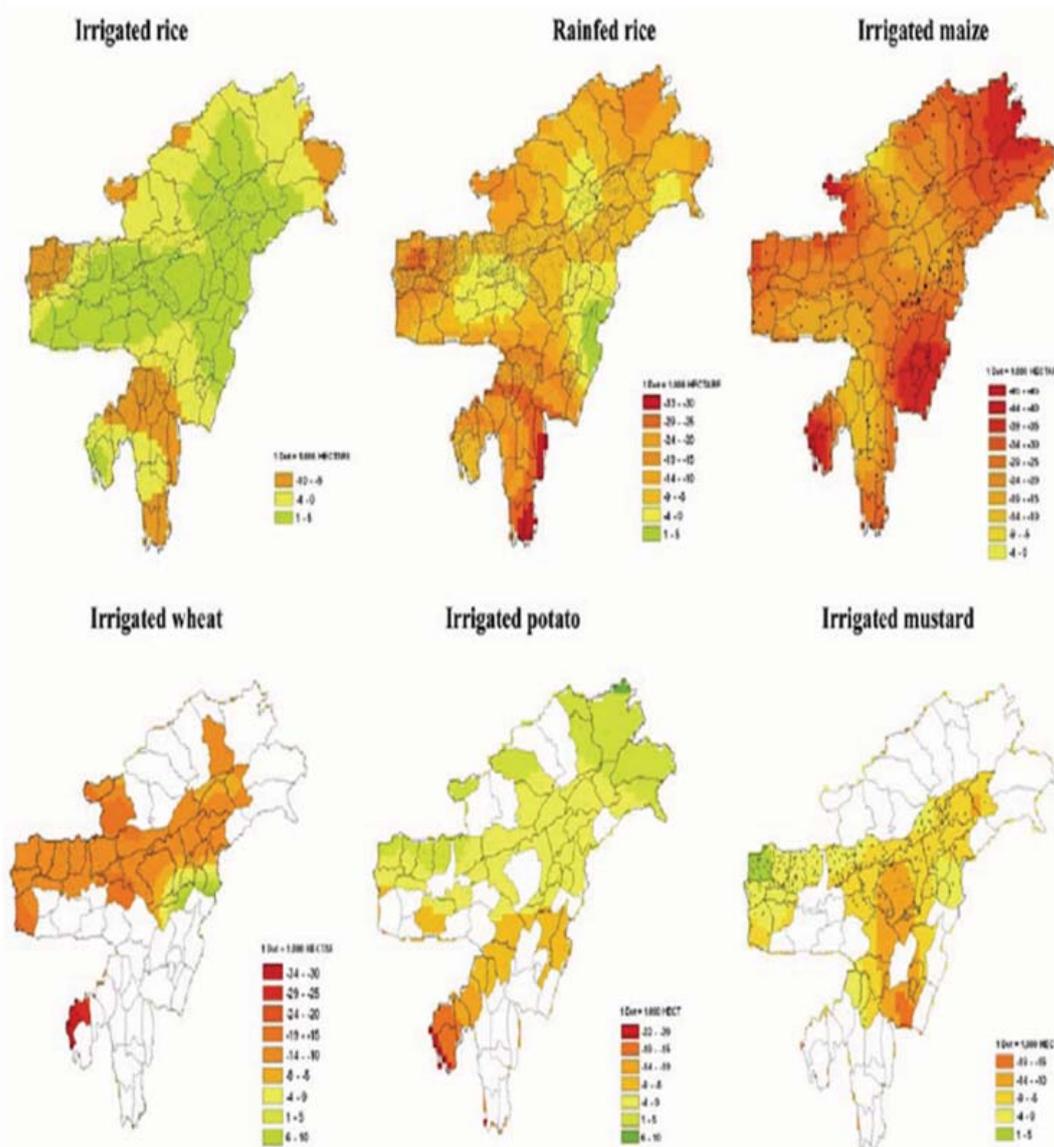
The following table shows the sectoral segmentation of vulnerability in Tripura.

Sectors	Vulnerability	Socio-Economic Risks
Agriculture & Food security	<ul style="list-style-type: none"> <li>• Temperature Stress</li> <li>• High salinity and water-logging</li> <li>• Erratic Precipitation</li> <li>• Loss of soil moisture &amp; fertility</li> <li>• Flood/Drought Conditions</li> <li>• Invasion of parasitic species or disease</li> </ul>	<ul style="list-style-type: none"> <li>• Decline in crop yield and production (Northern Tripura)</li> <li>• Pre-harvest waste, soil nutrient loss, less productivity</li> <li>• Decline in availability of food and increased incidence of malnutrition</li> </ul>
Riverine and Fishing	<ul style="list-style-type: none"> <li>• Storm surges and Flooding</li> <li>• Cyclonic events</li> <li>• Instability of wetlands</li> </ul>	<ul style="list-style-type: none"> <li>• Threat to inland freshwater resources</li> <li>• Threat to livelihood dependent on fisheries and aquaculture</li> <li>• Threat to wetland ecosystem</li> </ul>
Forestry and Bio-Diversity	<ul style="list-style-type: none"> <li>• Maximum decline in open forests and moderately dense forests</li> <li>• Fragmentation of habitats</li> <li>• Slow or no regeneration</li> <li>• Species invasion</li> </ul>	<ul style="list-style-type: none"> <li>• Loss of ecosystems services</li> <li>• Loss of livelihood of people dependent on forest resources</li> <li>• Decline in ambient air and water quality leading to health hazards</li> <li>• Extinction of species</li> <li>• Change in vegetation composition</li> <li>• Soil erosion, top/fertile soil loss</li> <li>• Floods and droughts</li> </ul>
Health	<ul style="list-style-type: none"> <li>• Availability of fresh water</li> <li>• Availability of sanitation facilities</li> <li>• Vector borne diseases (e.g. malaria)</li> <li>• Water logging and higher incidence of water borne diseases</li> </ul>	<ul style="list-style-type: none"> <li>• Increased morbidity &amp; mortality</li> <li>• Increased burden of health care on households in affected areas</li> <li>• More pressure on plant based medicines</li> <li>• Over-exploitation of medicinal plant resources</li> </ul>
Water Resources	<ul style="list-style-type: none"> <li>• Reduced quality of available water resources</li> <li>• Higher run off and uneven stream flow</li> <li>• Decrease in groundwater recharge and reduction in wetlands</li> <li>• Flood and drought conditions</li> </ul>	<ul style="list-style-type: none"> <li>• Stress on water storage</li> <li>• Reduced supply of drinking water</li> <li>• Increased morbidity</li> <li>• Reduced availability of water for industrial and food production purposes</li> <li>• Decrease in water table</li> </ul>

## Seasonality, agriculture and food security

Climate determines the season which in turn has a direct impact on agriculture, the mainstay of the people in the state (3/4th of the population depends on agriculture and a single crop paddy). Over the years implementation of various programmes in the realm of food

and agricultural production, income generation and distribution has substantially improved the general food security situation in vulnerable pockets. The extreme weather events often upset the delicate gains achieved so far. The crop loss due to the combination of weather events has been given below.



*Impact of climate change on yield of irrigated rice, maize, wheat, potato and mustard crops and of rainfed rice in the north eastern region in the PRECIS A1b 2030 scenario. The values are percentage of deviation from current yields. Each dot represents the crop area and its distribution.*

Analysis indicates that the climate change may impact the irrigated rice yields by about -10% to 5%, with majority of the region benefiting up to 5% in the A1b 2030 climate scenario. On the other hand, the impacts on rainfed rice are likely to be in the range -35% to 5%, with a large area losing by about 10%. Irrigated maize yields are projected to reduce by about 40%. In case of rabi season crops, wheat yields are projected to reduce by up to 20%. Potato yields are likely to marginally increase up to 5% in the upper parts of the NE region due to climate change, but in the central parts projected yield loss is about 4%, and in southern parts of the region the negative impacts will be much higher. Irrigated mustard crop is also projected to lose yields up to 10% in majority of the areas.

#### **Agricultural Vulnerability Index (AVI):**

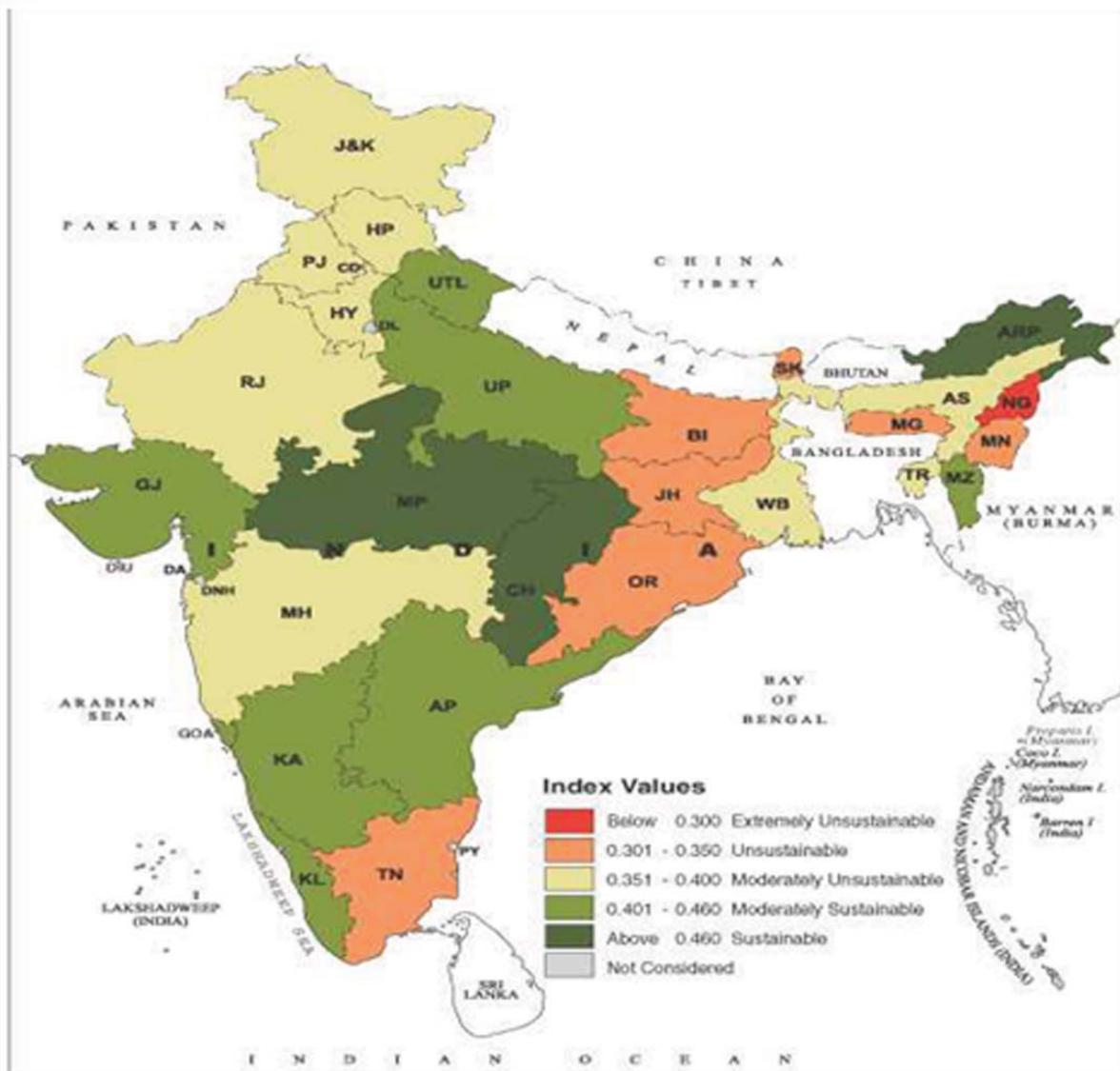
The index which is impacted under a climate change scenario (from the baseline due to the change in precipitation and rice yield as indicated above will have the following impact in Tripura as computed in a study by Indian Institute of Science. The districts

of South Tripura are projected to exhibit decreased vulnerability from moderate to low levels. The other districts do not show much variability from the current scenario.

#### **Food security in Tripura:**

The hunger atlas (WFP, 2011) shows the following picture for Tripura. It shows that the entire part of the state is moderate-high undernourished. The map shows that, the state has already reached a state where food sustenance is moderately unsustainable. The map also indicates that state is proceeding towards more insecurity in terms of physical access because of decreasing per capita food production and availability of the same. The worsening condition of the more vulnerable section of population is revealed from rising price index of middle class people or agricultural labourer relative to others. Along with that decreasing real SDP reveals reduction in economic access to food. This is likely to further aggravate with a climate change scenario and would make the population of the state more vulnerable.

**Sustainability of food security in the state is given below.**



### **Climate Determined Low Productivity**

The analysis in the state of Tripura from a broad GCM and crop model indicate that spatial variations in projected impacts of climate change are mainly due to variations in baseline temperature regimes, projected increase in temperatures, baseline rainfall, projected changes in rainfall, crop and crop management. Areas with projected

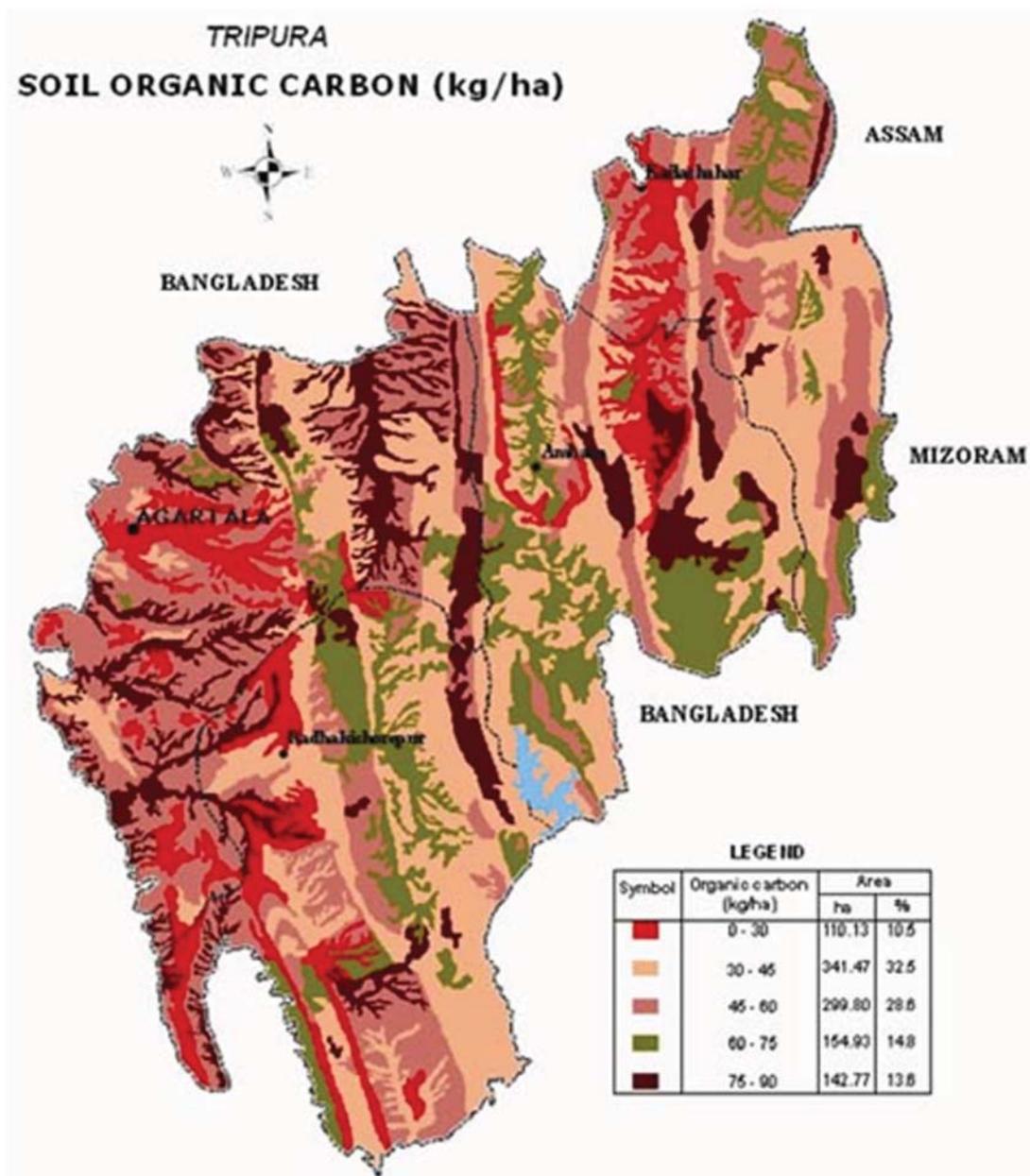
supra-optimal temperatures, reduced rainfall in areas receiving already less rainfall and increased rainfall in already high rainfall zones (causing reduced sunshine duration) are likely to lose. On the other hand, reduction in rainfall in high-rainfall zones can in-fact benefit the crops.

There is also heavy degradation of soil and decrement in the soil organic carbon that affects productivity

and enhances vulnerability. Two categories of soil degradation are recognized in Tripura. The first category deals with degradation by displacement of soil material, principally by water. The second one deals with the internal soil deterioration resulting from loss of nutrients (chemical deterioration)

or through physical processes, including water logging and flooding (physical deterioration). SIS indicates that as much as 60% area of the state is under various types of degradation. If slight and moderate degrees of degradation are ignored, the extent of degradation is nearly 21% area of the state.

### Soil organic carbon status, Tripura

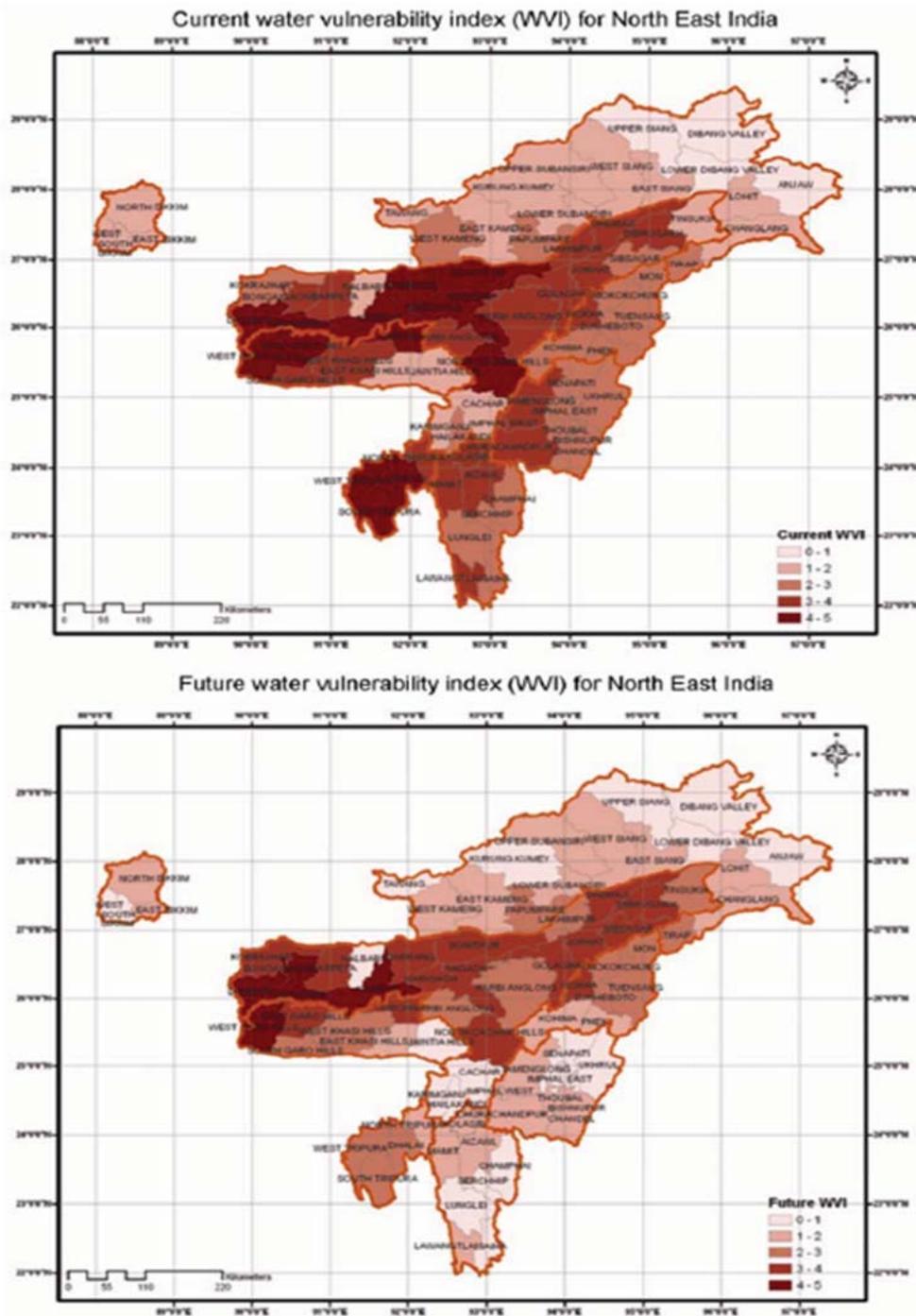


## Vulnerability Associated with water

A study by Indian Institute of Science assessed water vulnerability at the district level for the North East region and in particular

for the two river basins, namely Brahmaputra and Barak. It used Principal Component Analysis Method using water availability, evapo-transpiration (crop water model), drought indicator and flood discharge parameters.

### *Distribution of current and future water vulnerability*



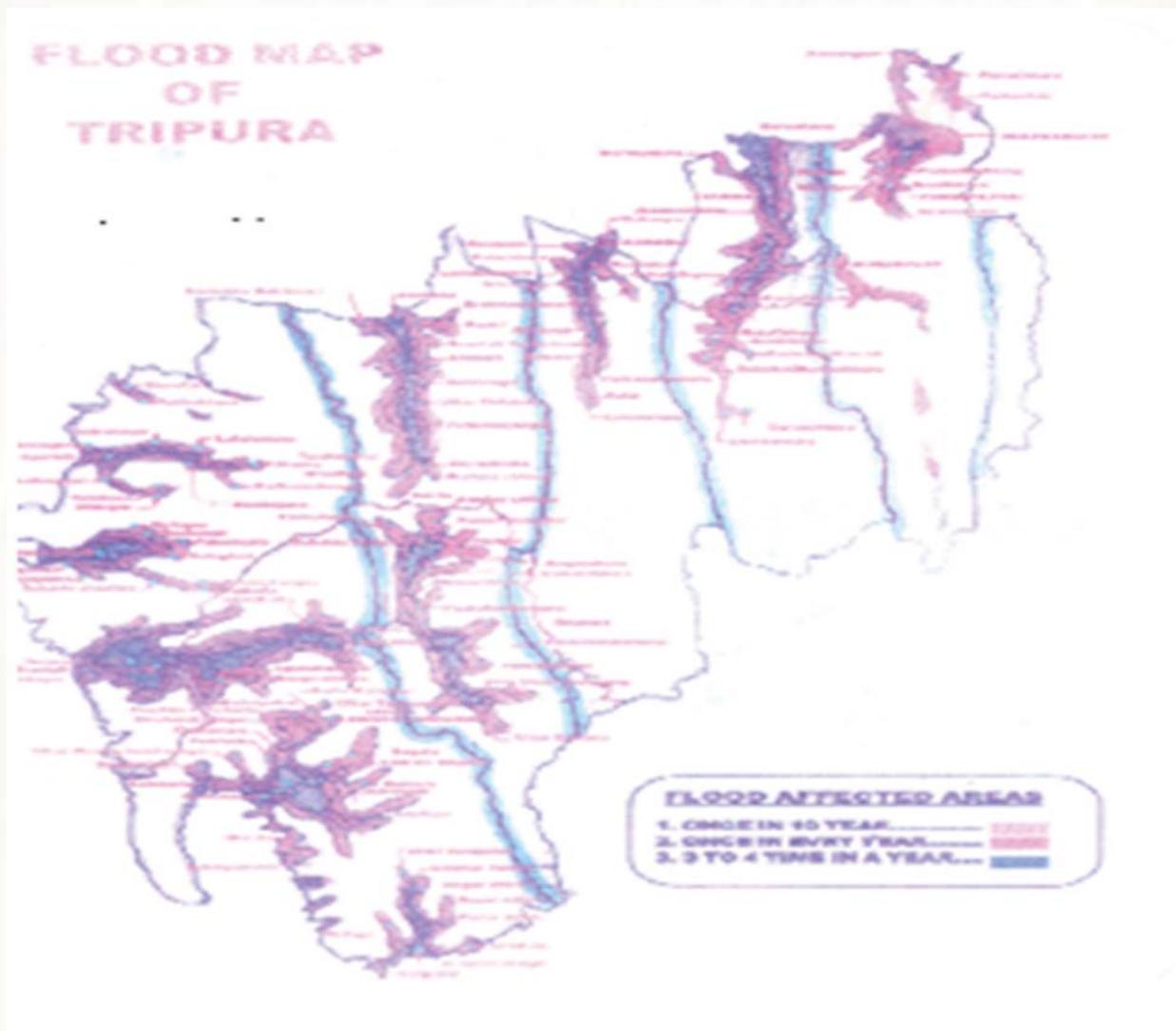
## **Socio-Economic Factors: Poverty and Vulnerability**

### **People in climate stressed regions**

Most parts of the State are rural where about 83 per cent of State's population is inhabited. Upliftment of rural poor as well as improvement in the quality of life of the economically weaker sections of the society has been one of the basic objectives of development planning in the State. Tripura is the second highest in terms of density of population among the North-Eastern States, next to Assam. The estimated mid-year population of Tripura as per 2011 census was 36,71,032 comprising 18,71,867 males and 17,99,165 females. The population of Tripura stood at 36,71,032 as per 2011 census as compared to 31,99,203 as per 2001 census. The population density also enhanced from 305 to 350 per Sq. Km across the decade however the decadal growth rate has declined to 14.75% from 16.03%. The distribution of Tripura's population is uneven across the districts. Nearly 48 per cent of the population of the State lives in West Tripura District. Dhalai is the new district of Tripura and also smallest in terms of population. The findings of the Planning Commission published in National Human Development Report (2001) shows that Tripura ranks 22nd among 32 States and U.Ts

in respect of human development index, based on a composite of variables capturing attainments in income, education and health. The same study positioned the State at 24th rank in human poverty index. Low availability of infrastructure has made the process of development extremely difficult for this economically backward State. The National Highway (NH-44) is the lifeline of Tripura. It remains disrupted in the rainy season due to heavy landslides near Patharkandi (Assam) and Sonarpur (Meghalaya) which is a perennial problem in the State. The railway link is extremely poor, although Agartala, the capital of the State has recently been connected with the railway link by the metre gauge. However, the State does not have any water transport system. This has curtailed the effort relating to diversification, lowered the capacity to respond to climatic events. The State is prone to severe earthquakes. In addition, the state is also affected by disasters like floods, epidemics, fire, cyclone, hailstorm, lightening, road accidents, etc.

The flood map of the state) shows that in West Tripura, Bishlagarh, Sonapmura, Khowai, Teliamura sub-divisions; in South Tripura, Udaipur, Sabroom, Amarpur, Belonia, Santra Bazar; in North Tripura, Dhramanagar, Kailasahar and in DhalaiKamlapur, Manu and Chwamnu areas are flood prone.



**Drought** normally occurs in the State of Tripura due to delayed rainfall in the months of April-May. Deficient rainfall in those months results scarcity of drinking water as ground water level goes down. The impact of dry spell hampers mostly the tribal Jhumia families. Agriculture is affected to a great extent. It also adversely affects the Pisciculture, Sericulture and Tea plantations resulting to production loss in these sectors. Tripura witnessed a prolonged dry spell during 1998-99 causing a loss of Rs.5566.70 lakh for a damaged agricultural area of 31684 hectares.

### Indigenous Communities

Indigenous communities have very high natural resource intensive lifestyle. Since natural resources are highly sensitive to climate change; consequently, the indigenous communities are more vulnerable to climate change. Poverty and social grouping are interlinked; therefore, it is essential to pay special attention to natural resource based eco-system, forest, bio-diversity and water resources. The district wise SC and ST population is given below.

### *District wise SC population (2001)*

District	Rural	Urban	Total	% to total population
1	2	3	4	5
West Tripura	218433	77265	295698	19.3
South Tripura	116870	10437	127307	16.6
North Tripura	73941	8961	82902	14.0
Dhalai	46379	3438	49817	16.2
Total	455623	100101	555724	17.4

### *District wise ST population (2001)*

District	Rural	Urban	Total	% to total population
1	2	3	4	5
West Tripura	367167	19914	387081	25.3
South Tripura	287815	1704	289519	37.7
North Tripura	148845	1655	150500	25.5
Dhalai	164170	2156	166326	54.0
Total	967997	25429	993426	31.1

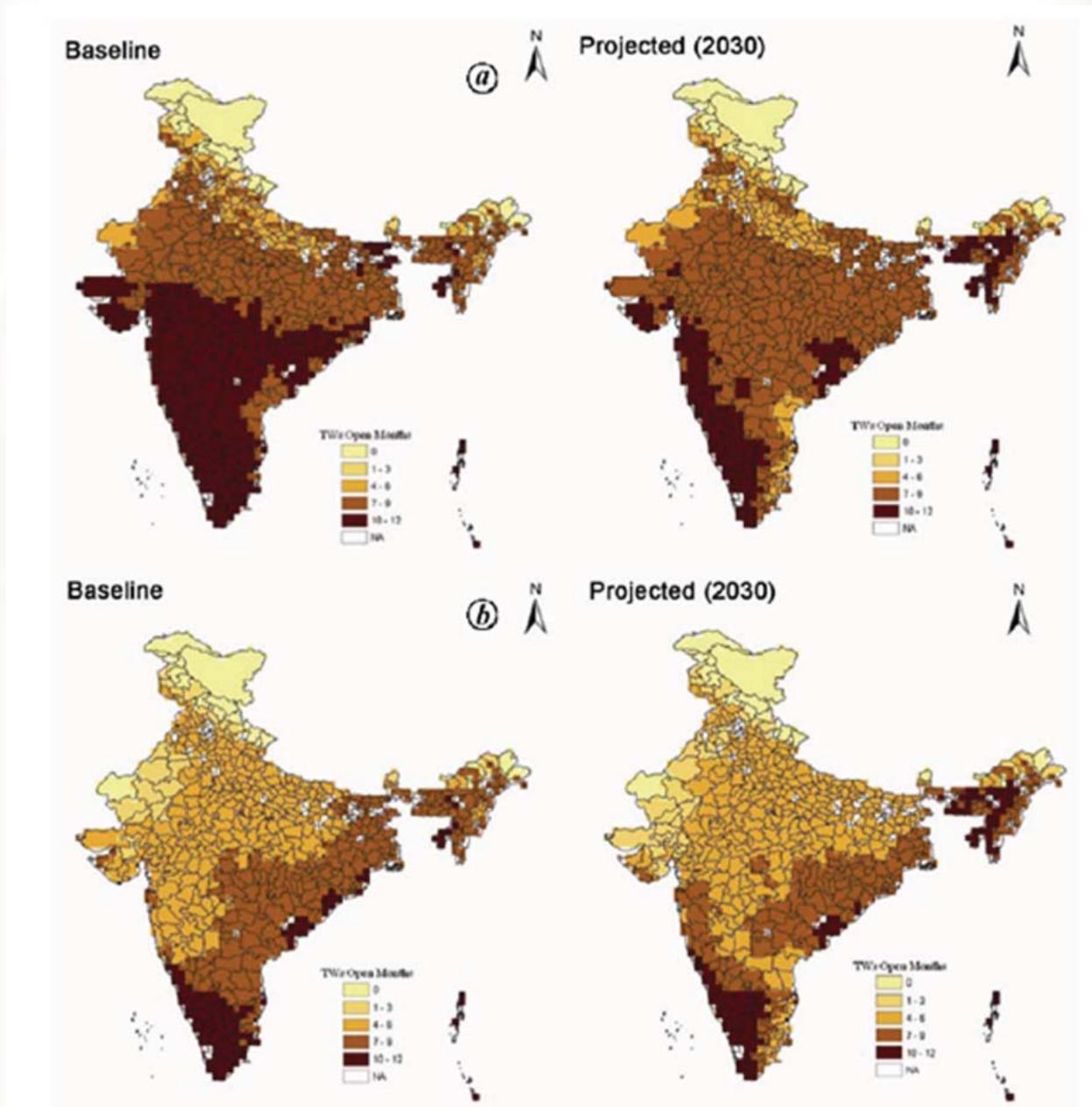
The main occupations of these people are agriculture, animal rearing and wage labour. Agriculture productivity is low in hilly areas. Agriculture is rainfall dependent and Livelihood options are limited to primary activities (agriculture, animal rearing, wage labour, etc.). Majority of households do not have food sufficiency round the year.

#### **Health related vulnerability**

Health related vulnerability affects the household expenditure due to loss in livelihood. While several

diseases are endemic to this region because of its geographical location, the discourse here is on vector borne diseases that are climate linked. Vector Borne diseases (VBDs) are climate-sensitive as the pathogen has to complete some part of its development in insect/arthropod vectors like mosquitoes, sandflies, ticks, etc. and are affected by climatic conditions like temperature, rainfall, relative humidity, wind velocity etc. It is well known that seasonal fluctuations in VBDs are caused by fluctuating climatic conditions (Dhiman et al.).

**Transmission window (TW) of malaria, based on temperature (a) and temperature and relative humidity (RH) (b) using A1B scenario for baseline and by the year 2030.**



The data shows in H1B scenario, three out of four districts for which data is available, the transmission window for Malaria is likely to be open almost 10-12 months in a year.

Therefore, the disease prevalence which is supposed to be confined to only a quarter of the year would increase significantly.

## Gender Dimensions

Gender dimension of climate change is very tricky. Climate change in the state is likely to worsen the water quality in several parts of Tripura. This will make the women and children more vulnerable. In some areas there are reductions in yields of biomass adding to the labour of the women to fetch them for cooking. There are also increased risks to human health with children, women (especially the pregnant) and the elderly in a household becoming the most vulnerable due to lower nutritional status and enhanced air and water pollution. The other important issue is that the women help in increasing the social capital and make the community resilient. It has been seen through the work of SHG groups and especially during the post disaster recovery period. Therefore, it is important to nurture such social capital through the strengthening women's institutions like SHG groups to enhance their resilience.

## Vulnerability in Forestry

Generic methods and tools can be applied to diverse systems for analysing vulnerability interactively with stakeholders (e.g. cognitive mapping or expert judgment) and for building empirical models from observations (e.g. meta analysis or data mining).

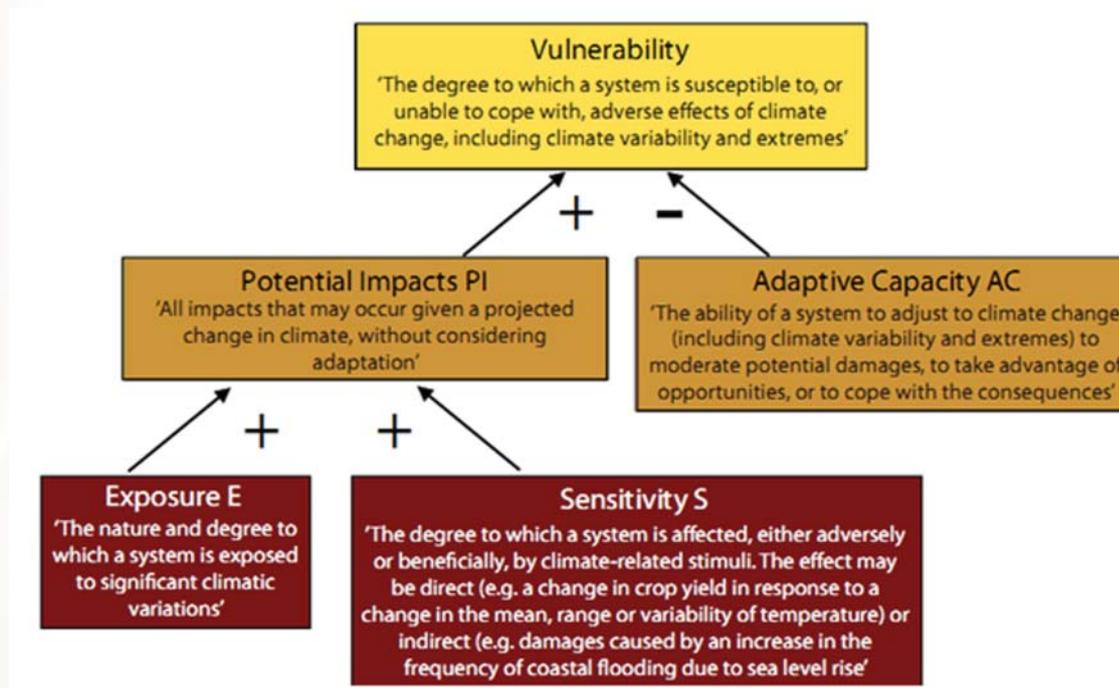
Numerous ecosystem models can

be used for studying the impacts of climate change on forests. Some models are restricted to specific ecosystem processes (e.g. the productivity of managed forests, forest perturbations or specific ecosystem services). Simple bioclimatic models can represent the distribution of ecosystems and help assessing ecosystem vulnerability to climate change. Other simple ecosystem models deal with community and landscape dynamics, with an emphasis on the interactions between species or patches of ecosystems. Other simple ecosystem models work on biogeochemical cycles in ecosystems. Integrated ecosystem models, static or dynamic, consider many ecosystem processes and are generally complex.

Several methods and tools can be applied for assessing the vulnerability of forest-dependent people or sectors. Stakeholder analysis and sustainable livelihoods framework can be used for analyzing stakeholder behaviours and perceptions. Institutional analysis and policy network analysis enable analysis of institutions and stakeholder interactions. Agent-based social simulation is a promising way for simulating vulnerability of social systems to climate change.

According to IPCC (McCarthy et al. 2001), the three main components of vulnerability are exposure,

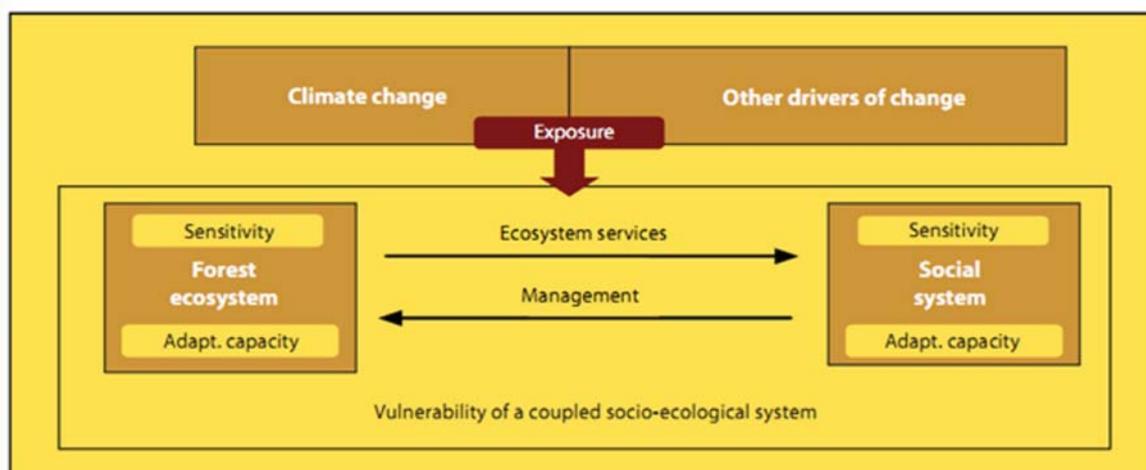
sensitivity and adaptive capacity (figure-1)



The components of vulnerability (definitions are from McCarthy et al. 2001). The signs under the arrows mean that high exposure, high sensitivity and low adaptive capacity induce high vulnerability.

has positive or negative effects to the vulnerability of ecosystems, thus adaptation policies should focus at reducing the vulnerabilities of both ecological as well as social systems. Vulnerability assessment should consider the links between ecological and social systems.

Ecosystem services influences the vulnerability of society and society



# Solar Mission & Non-Conventional Energy

## Introduction

Worldwide two billion people live below the poverty line causing social unrest. The development of a country or a region is measured in terms of technological development, industrialization and socio-economic growth. Human's quest for leading a better and comfortable life and with the present era of massive growth in all the spheres of life, it has compelled him/her to use all available energy sources irrespective of the involved cost and environmental degradation. Even though energy is fundamental to human development and prosperity of the nations; yet, around 1.5 billion people worldwide lack electricity<sup>1</sup>. The forecast based on the recent analysis in around 100 countries<sup>2</sup> confirms that, the greater the equity in power distribution, better the environmental outcomes, including better access to water, less land degradation and fewer

deaths due to indoor and outdoor air pollution and dirty water. The current pattern of conversion and utilization of energy cannot be sustained and one of the most feasible and sustainable direction in which energy could be towards greater reliance on environmentally sound energy systems, particularly new and renewable sources of energy. Therefore, the entire fabric of developmental goals is webbed around a successful energy strategy.

The accumulated evidence depicts that, the power inequalities affect environmental outcomes in a range in any country where poor people and other disadvantaged groups disproportionately suffer due to the effects of environmental degradation. Climate change is admittedly one of the most complex challenges for this century as the speed and intensity of climate change are outpacing the ability of poor rural people and

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<sup>1</sup> Source: Human Development Report, 2011 published by UNDP

<sup>2</sup> Source: Human Development Report, 2011 published by UNDP

societies to cope. The energy sector is of course, a major contributor to the global GHG emissions therefore, must be a key consideration in any energy policy, but ensure for diversity of energy supply and providing affordable energy options are also important issues. The action plan on renewable energy is presented to enable communities to understand the uncertainty of future climatic conditions and engage effectively in a process of developing adaptation and mitigation programs. The climate change action plan for renewable energy sector is strategized in line with the **National Climate Change Action Plan** goal of promoting the country's development objectives while yielding co-benefits for addressing climate change effects.

The renewable energy action plan is developed in the approach of adaptation measures which will help to cope-up with climate change effects and also the mitigation measures to portray the pathway of reducing the carbon emission intensity and achieving the sustainable development.

### **Key Facts of Solar and other Renewable Energy sector -**

The state of Tripura, located in the tail end of India, consists of mostly hilly terrains having negligible water

resource. Tripura is highly dependent on centralized conventional power generation system which is mainly through natural gas. Grid electricity penetration in remote hilly areas of Tripura is techno-economically unfeasible by virtue of geographical disadvantages and scattered household pattern. Moreover, power sector of the state is experiencing problems in the electric utilities like capacity addition, power evacuation, T&D losses, poor PLF, etc. The solution to overcome this situation is to explore and utilize the renewable energy. Promotion and use of renewable based option will not only reduce the strain on the existing forest but will also promote low carbon growth.

Though population of the state has increased at around 14.75% during 2001-2011 and achieved 36,71,032<sup>3</sup> numbers, the rural population in Tripura has decreased in this decade of 2001-2011 from 82.94% to 73.82% which may lead to increase in cost of power distribution in remote villages for dispersed population. With the overall population increase in the state and approximate by 10% increase in urban population, the demand of electricity is also increasing day by day being electricity is a key factor to have a high aspiration to achieve better standard of living. Around 33% of

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<sup>3</sup> Source: Provisional population Data of Census 2011

the state population belongs to tribal community and residing in far flung area where supply of grid electricity is the costliest one.

### **Population distribution of Tripura**

Sl. No	State/ District	Population 2011	Percentage decadal growth rate		Population density per sq. km.	
		Total	1991-2001	2001-2011	2001	2011
1	Tripura	3671032	16.03	14.75	305	350
2	West Tripura District	1724619	18.48	12.50	512	576
3	South Tripura District	875144	6.78	14.44	251	286
4	Dhalai District	377988	10.96	21.70	128	157
5	North Tripura District	693281	26.49	17.32	290	341

**Source: Census 2011**

### **Population distribution scenario of Tripura**

Sl. No	State/ District	Population 2011			Percentage share of population 2001		Percentage share <sup>4</sup> of population 2011	
		Total	Rural	Urban	Rural	Urban	Rural	Urban
1	Tripura	3671032	2,710,051	960,981	82.94	17.06	73.82	26.18
2	West Tripura District	1724619	1,047,345	677,274	73.25	26.75	60.73	39.27
3	South Tripura District	875144	752139	123005	92.92	7.08	85.94	14.06
4	Dhalai District	377988	337513	40475	93.93	6.07	89.29	10.71
5	North Tripura District	693281	573054	120227	89.39	10.61	82.66	17.34

Tripura is a power deficit state. Tripura has been highly depending on electricity from own generation and import from central sector generating stations in the north

eastern region but the power availability from outside of the state is very limited and unreliable due to variety of reasons which includes transmission line constraint passing

<sup>4</sup> Source: Provisional population data from Census 2011

through difficult terrain. Present installed power generation capacity in Tripura is 225 MW including 84 MW gas thermal plant of NEEPCO. The power map of Tripura may be seen at **Annexure-IV**. The present peak demand of the state is 190 MW which is projected to be 700 MW with 8% growth and 800 MW with 9% growth in 2030-31. A 700 MW power plant is coming up at Palatana and another 104 MW power plant is under construction at Monarchak of which the share of the state is 304 MW but, these power plants at Tripura will increase the local emission levels. The power consumption scenario is totally different in Tripura as majority of the power consumption is by domestic sector as 53.64% followed by Public water, irrigation and sewage system, Commercial and industrial sector during 2008-09<sup>5</sup> only less than 1/4<sup>th</sup> power consumption is by domestic sector.

The state is yet to attain the target set in the Govt. of India policy under Rajiv Gandhi GrameenVidyotikaranYojana (RGGVY) of all villages to be electrified by 2009-10 and all households to be electrified by 2012. 456 nos. of un-electrified hamlets is already being electrified through

non-conventional energy systems and electrification of another 341 identified un-electrified hamlets and 29 villages is ongoing which will be completed by 2011-12. There are still few villages and numbers of hamlets those have no access to electricity as per the definition of Electrified Village from Government of India<sup>6</sup>. Lower electrification in the village level is the result of difficult geographical condition, unevenly dispersed population and high incidence of rural poverty.

The conventional primary sources of energy in Tripura are firewood and chips, petroleum products and electricity. Tripura has been depending mainly on own gas and hydro based electricity generation and electricity imported from Central sector generation/other states through grid lines. Electricity is the predominant energy source for urban lighting reported by 91.70% of the households and remaining households are dependent on kerosene sources whereas, rural lighting energy scenario is also majorly through electricity with 69.10% of the households using electricity but still around 30% of the rural households are not getting grid electricity<sup>7</sup>.

Tripura has 60% of its land as

<sup>5</sup> Source: *Economic Review of Tripura for 2008-09 by Directorate of Economics & Statistics, Planning Department, Govt. of Tripura*

<sup>6</sup> Ref: *NEDFI Databank*

<sup>7</sup> Ref: *National Sample Survey 61st Round, 2004-05 by National Sample Survey Organization, Govt. of India April 2007.*

forest area which influences the local habitat's living pattern as reflected through firewood and wood chips usage as primary cooking fuel. Around 91.6% of the rural households in the state are using firewood and wood chips and other major share of cooking fuel is LPG with 7% of the household. Though, the urban scenario is different but, still around 39.40% of urban household is using firewood as cooking fuel. The state of Tripura has considerable gas reserve as reflected through their primary cooking fuel selection in urban household as LPG with 54.40%<sup>8</sup>.

Though the state of Tripura is one of the leading states in North-eastern region of India in deploying renewable energy technologies, still there is huge untapped renewable energy potential. To achieve the grid parity and promote grid interactive solar power, the state govt. can increase the existing renewable power obligation from 1% of total power consumption or generation by the distribution licensee or any party in first two years to 5% and thereby encourage private or public agencies to invest in solar power project in the state.

As the state is getting abundant solar radiation, solar power generation to supplement the grid power as

well to meet the decentralized power needs may be a viable alternative which is a zero emission technology. Agro-wastes could have been another alternative source for power generation with low emission but there are hardly any surplus agro-wastes in the state. The state being rich in bio-resources; power generation through biomass route could be another potential alternative for power generation in low carbon path with planned and dedicated plantations for such projects.

Wind availability is very erratic and requires exhaustive research with a mast and variable height to make the data mapping. As on date, only three wind monitoring stations has been established at 25 m wind mast for 2 years period at Jampui Hills of North Tripura District for wind monitoring in Tripura. Apart from this, recently C-WET is being involved in wind potential survey for two different locations viz, - National Institute of Technology, Jirania, West Tripura district and Kalacherra, Sabroom, South Tripura district at 50 m wind mast in 2 hectare of land area. Even though wind speed is generally favorable in sea-shore areas for power generation and Tripura is very near to Bangladesh sea-shore but, the wind speed in the state is

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<sup>8</sup> Source: National Sample Survey 61st Round, 2004-05 by National Sample Survey Organization, Govt. of India, April 2007

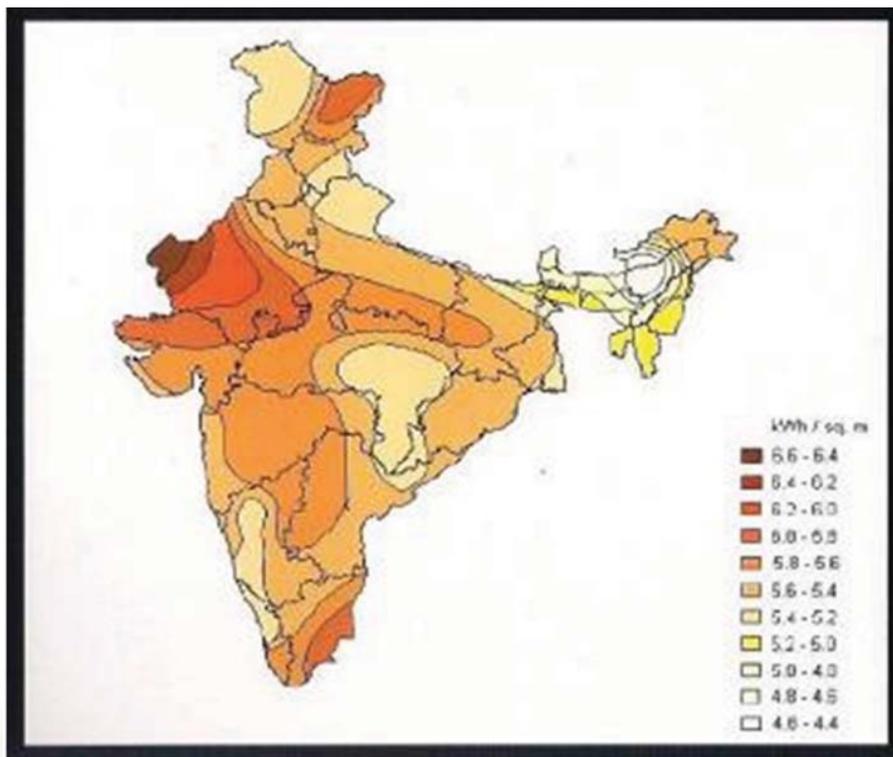
very low. However, the observation is that, at least for four months, the wind speed in the state is favorable for wind power generation therefore; wind hybrid projects are viable for harnessing wind potential in the state. The TREDA has implemented a pilot demonstration project of 2 kWp wind –solar hybrid (1 kWp –Wind + 1 kWp –Solar) during 2008 at the roof-top of VigyanBhawan, Agartala which is performing at moderate level.

The state has seven major rivers namely Manu, Deo, Dhalai, Khowai, Howrah, Gomoti and Muhuri and state hydro power potential is estimated as 21 MW. Around 6% of total power generation capacity in the state is from only hydro power project of the state in South Tripura district named Gumti Hydrel Project with capacity having three units each of 5 MW. Around 60

MU power is generating annually while keeping one unit as stand by. The water availability at the end of the year and prior to the monsoon is almost negligible. Apart from thishydel project, a 1 MW off-grid hydrel project is commissioned.

Though the state government is taking some initiatives for installation of off-grid/ stand-alone solar power systems to cater the decentralized energy requirements, a consolidated plan of action is essential to ensure sustainable growth in this sector as suggested in the following paragraphs. The State of Tripura has a geographical area of about 10,000 sq. KM. The Solar insolation level of various parts of the country could be seen from the following map.

### Potential of Solar Energy in Tripura:



Approximately 1600 kWh of energy per sq. m. is received by the state annually. If 1% surface area of Tripura is kept reserved for generation of Solar Energy, the state can generate 2000 MW of Solar Power which is adequate to cater the need of the state during the period 2030 or it will enhance the life of the gas reserve of the State by almost 30 years. Around 2.11 MW solar power project is the contribution of renewable power in the state. Being solar energy potential is considerable in Tripura, the rural electrification is taken up by solar technology only and the achievement is as follow –

demand of Tripura. It is therefore proposed to mainstream the solar energy received by the surface area of the state and the full potential is achieved either through public investment, private investment or private/public partnership mode. Critical inputs like land, water, electrical and civil infrastructure have to be provided where needed and all these add to the cost of the State.

The state is also possessing bio-resource reserve which is hardly utilized for energy generation purpose but there is almost zero surplus agro-waste exists for energy

Decentralized Solar Power Plant (1 kWp, 2 kWp, 3 kWp and 10 kWp)	21 Nos. – 85 kWp (Completed) 100 Nos. – 160 kWp (Ongoing)
Solar Lantern	15,500 in rural areas and for girl child 20,000 in urban areas is under process
Solar Home Lighting System	5,038 Nos. under solar programme 12,758 nos. under Remote village electrification programme
Solar Street Lighting System	1100 under solar programme 180 Nos. under Remote village electrification programme
Solar Cooker	223 Nos.
Solar water heating system	36000 LPD

Even though the state achievement in solar energy sector from the inception of TREDA is remarkable, the ever increasing energy requirement can only be met up through more no. of decentralized solar power and other

technology project. Moreover, the grid interactive solar power implementation is untapped in the state which can further contribute in state grid to fulfill the power

generation purpose. The state has undertaken biomass assessment study in 6 blocks only hence, state potential is draft estimation only. A pilot project of 1 MW (250 kW

\* 4 units) biomass power plant is taken by the TREDAs at Chamanu, Kshetracherra, Dhalai district and a 100 kW biomass gasifier power plant at Lilagarh tea garden, Chottokhil, Sabroom, South Tripura district for meeting up the decentralized power requirement. In line with the Govt. of India's objective for reduction of indoor air pollution and optimum use of firewood, 75,254 Nos. of improved chullah is distributed in the state under Govt. of India programme. Apart from that, the 1755 Nos. of biogas plant is installed in the rural Tripura for meeting up the household cooking energy demand by using animal waste.

### **Concerns Due to Climate Change**

Outlook towards linking climate change and energy sector are usually centred on mitigation effort because the current fossil fuel based energy generation method is a major contributor to climate change. Developing options of low carbon growth and reducing carbon footprint are important activities towards limiting the degree of future climate change.

Energy and water sector are closely and dynamically linked. All human devised energy systems have water footprint to one degree or others including non-consumptive transfer of river flow in case of hydro power or consumptive use of water in thermal plant and bio fuel plantation. The envisaged climate change could

impact different components of the electricity sector as outlined below:

The projected impact of the variation of precipitation level due to climate change will severely impact the hydropower generation which in turn will change the energy supply scenario at the state level where hydro-generation has a lion's share. Also, the lower availability of water and enhanced temperature level resulting from heat waves will severely impact the cooling process of thermal power project. Power station other than hydro project that bank on availability of water for its operation (for cooling and also as heat transfer fluid) may have to shut down if water level or availability gets too low. Higher ambient temperatures may affect the efficiency and capacity ratings of fossil-fuel-powered combustion turbines. In addition, electricity transmission losses may increase due to higher ambient temperatures.

On demand side, regions that will face warmer temperature and lower precipitation level will result in increase of electricity demand because of higher use of electric gadget resulting to knock on effect on energy consumption and will thereby enhance the pressure on electricity distribution network through increased seasonal demand.

Impact of extreme events due to

climate change on energy sector can damage economic and social infrastructure because of the fact that centralised power plants tend to serve large catchment of population and are also sensitive to climate change.

Biomass still dominates the state

energy profile e.g. fire wood, dung, etc. are more vulnerable to adverse effects of water cycle changes on river catchment affecting the poorest segment of the society.

The envisaged climate change could impact different components of the electricity sector as outlined below.

<b>Possible Climate Change Impacts on the Energy Sector</b>	
<b>Climate Change Indicators</b>	<b>Impacts on Energy Sector</b>
Hydrological Variability (Greater Seasonal and year to year variability in precipitation, more frequent and prolonged extreme events like drought or heavy rainfall)	<ul style="list-style-type: none"> <li>• Variability in Hydropower generation</li> <li>• Variability in water availability for Thermal Generation</li> <li>• Biomass availability vulnerable to water cycle impacts affecting household energy security</li> <li>• Could impact renewable energy generation potential, especially solar thermal</li> <li>• Threat of damage to infrastructure from extreme events</li> </ul>
Increased Temperature	<ul style="list-style-type: none"> <li>• Impacts Hydropower generation in summer months</li> <li>• Increased requirements of water for cooling in Thermal generation</li> <li>• Increased need of energy in household sector for cooling</li> <li>• Could impact renewable generation potential, especially solar</li> </ul>

Assessing the vulnerability of energy supply to climatic events and longer term climate change needs to be formulated with tailor made. A strategic approach is therefore required to be framed up to ensure that timely and effective adaptation measures are taken, ensuring coherence across different sectors and governance to reduce the sectors vulnerability to the impact of climate change.

### **Key Priorities to address climate change concerns**

The key elements for the multi-pronged strategy of the sector for mitigation and adaptation measures were identified after detailed deliberation in the working groups. The priorities are in line with the concerns raised due to impact of the climate change and the states response.

### **Promotion of grid interactive power generation from Solar and other Renewable Energy sources through declaration of State Energy Policy.**

The state of Tripura is highly dependent on carbon intensive fossil fuel based power generation option with an installed capacity of 225 MW. Even though multiple renewable energy technologies already being implemented; still the grid interactive renewable power generation option is unexploited in the state. The objective is to

harness renewable energy sources available in the state including solar technology by creating and enabling policy interventions for diffusion of zero polluting RE technology across the state in a near future and thereby making the regional grid as low polluting.

The following steps will help in achieving the compliance:

- a) Formulation & Declaration of state energy policy for power generation through renewable energy sources.
- b) Declaration of Tariff Policy by Tripura Electricity Regulatory Commission for Solar and other renewable power purchase in line with the National Solar Mission and other programmes of the Govt. of India.
- c) Facilitating private sector participation in solar power generation under Jawaharlal Nehru National Solar Mission (JNNSM) and/or other schemes of Govt. of India through selection of private investors and other support activities through Single window clearance process.
- d) Infrastructure creation for power evacuation to the grid.

The above action of the state government will help in increasing the renewable power share of the state total power generation

and thus contribute in emission intensity reduction objective of the nation. The state power generation during 2010-11 is 764.56 million units which are contributing to GHG emission by 688,104 tCO<sub>2</sub>e. The activity requires no or low cost and will be ease to implementation as it is in line with the national solar mission hence, it is considered as priority action.

**Promotion and facilitation in deployment of Off-grid or decentralized renewable energy generation for electrification, cooking and other thermal energy requirement.**

The promotion and use of off-grid or decentralized renewable energy generation will reduce greenhouse gas emission by both direct and fugitive emission due to substantial decline in fossil fuel or non-renewable biomass usage. In general rural consumers of entire India is not well conversant with the use of electricity and electrical devices. Hence, they should be educated in conservation of electrical measures, such as the use of efficient devices and of alternate energy resources like solar energy, biogas plants etc. The activities are:

**a) Facilitating deployment of stand alone off-grid solar power plant within 100 kW for fulfilling the power demand in dispersed locations under National Solar Mission -**

Providing electricity to rural household or rural enterprises is a key step towards reducing the vulnerability of this particular section of the society who will be more impacted due to changes in climatic condition. Providing electrical energy will empower the people residing at one of the most difficult terrain or far- flung area in the country with the option to sustain under severe impact of climate change be it the increase in temperature or unavailability of water for farming (facilitate irrigation). A typical 100 kWp solar power project will reduce GHG emission of around 150 tCO<sub>2</sub>e annually. Complying with the National Solar Mission to reduce green-house gas emission, the activity is planned through following sub activities:

- i. Undertaking study for solar power feasibility and identification of project location where necessity of decentralized power plant exists.
- ii. Preparation of Detailed Project Report
- iii. Land acquisition and transfer;
- iv. Creation of energy evacuation infrastructure
- v. Undertake implementation - Reduce the grid power dependency by installing standalone Solar Photovoltaic Power plants which can meet

the power demand and provide constant source of power to the inhabitants of villages or dispersed area where comparatively concentric population situated and power demand for commercial activity or revenue earning activity persists. Facilitating installation of standalone solar photovoltaic power plants within 100 kW capacity with following targets-

- Up to 2016-17 is 10 MW
- 2017-18 to 2021-22 is 10 MW
- 2022-23 to 2026-27 is 10 MW

The activity is considered keeping the national solar mission objective and programme scheme so implementation of the activity will not be easy to implement and addition to this is also a cost effective option for providing power to rural and interior areas.

#### **b) Facilitating deployment of 1000 No. Biogas plant -**

The household cooking energy requirement in the state is met through mainly firewood obtained from forest and thereby subsequent increase of strain over the existing forest. This not only reduces the carbon sink but also enhances the vulnerability of the area in light of the proposed climate change impact like top soil denudation

in case of flood or other impact. Moreover, it leads to health hazards for women and children by cooking in smoky kitchens and emission of green-house and other poisonous gases. The State can generate large amounts of energy by way of increasing biogas plants at family & community level. The State which has about 10 lakh cattle can generate upto one lakh cum biogas which translates to 50,000 units of energy or translates to equivalent of 6500 L.P.G cylinders everyday. This itself would meet ¼th of the cooking energy requirement of the State. These numbers can be multiplied many more times if integrated with bio household waste as well as water hyacinth. While at the individual level, these can be used for cooking and domestic purposes. At the community level, these biogas plants can bottle methane which can be used for local rural agro based industries.

As a solution to mitigate the adverse impact the sub- activities planned are -

- i. Awareness creation and capacity building for incremental usage of biogas plant for household and community level cooking or thermal energy purpose.
- ii. Create conducive environment for biogas technology supply chain and promotion of manufacturing and supply of biogas plant instruments in

the state.

- iii. Identification of household and agro based /rural industries for implementation.
- iv. Facilitating deployment of 1000 No. Biogas plant annually in 12th plan period for using cattle waste, household waste as well as water hyacinth and setting up bottling unit at community level to use the biogas in agro based/ rural industries across the state under the Govt. of India programme.
- v. Training to users on operation and maintenance and emergency preparedness of the system.

Hotels, Hostels and other community establishment should be encouraged to use the kitchen wastes for bio gas generation. The subsidy provided by MNRE, should be suitably tapped for construction of such plants and beneficiaries encouraged paying the balance amounts.

The activity is planned keeping in mind the Govt. of India programme – National Biogas and Manure Management Programme and it is very old programme continuing with a good success rate throughout the India. Therefore, implementation of the activity will be an easy process and also a low cost activity will also create employment for support activities in programme

implementation. Apart from this, the activity will contribute in GHG emission mitigation as a typical 2 cum biogas plant using cattle waste will reduce dependency on firewood and fossil fuel consumption and can reduce GHG emission of 1.4 -1.7 tCO<sub>2</sub>e annually.

### **Promotion & Facilitation setting up of Solar Water Heater (SWH) systems in all Govt. establishments under National Solar Mission.**

Use of Solar Energy for Water Heating has tremendous opportunity in Tripura. A large amount of energy is consumed for heating water in hotels, hostels, guest houses, nursing homes, hospitals etc. Solar hot water plants can meet this requirement without any fuel and with zero emission. Besides this option, solar driers can be used for small scale as well as medium scale drying applications like tea processing units etc. There are more than 1200 rooms available in Hotels and Guest Houses of Agartala with a provision of electric geyser which consume about 3 MW of power. Solar Water Heater may be used in place of electric geyser. The Forest Rest Houses, Circuit Houses, PWD Bungalows having provision of electric geysers consume power to the extent of 5 MW. There is a tremendous opportunity to replace these geysers with solar water heaters under National Solar Mission Programme. Around 36,000 LPD Solar Water heating

system is already implemented in SC/ST/ OBC Residential School Boarding/Hostels, Govt. and District Hospitals, Govt. Offices, Dakbanglow and Govt. Guest House etc. in the state whereas majority of the solar water heating potential is still untapped as it has not explored by the commercial and residential segments till now. Approximate 18,500 LPD of solar water heater will be implemented in 2011-12. With an objective of reducing dependency over conventional fuel for meeting the hot water requirement in Govt. establishments of the state and consequential mitigation of greenhouse gas emission; the activities planned are –

- i. Declaration of the target action by the State Govt. through policy mechanism.
- ii. Awareness creation and capacity building for promotion of solar water heater use for water heating purpose across the state.
- iii. Create conducive environment for development of SWH technology supply chain and promotion of manufacturing and supply of SWH systems in the state.

- iv. Pre-feasibility study for SWH system in Govt. establishments.
- v. Preparation of bankable DPR
- vi. Arrangement and management of project fund for implementation.
- vii. Facilitating deployment of SWH system in Govt. establishments –
  - Public Health Centres - 86
  - Hospital - 22 Nos.
  - Govt. Higher Secondary School - 248
  - University, College & Engineering College - 26 Nos.
- viii. Training to users on operation and maintenance of the system

The activity will enhance the solar water heater market in the state and contribute in GHG emission mitigation. The action is chosen as priority considering it's importance, as it is line with the Govt. of India's initiative under National solar mission, enormous GHG mitigation opportunity and feasible option. A solar water heater of 100 litre can prevent 1.5 tCO<sub>2</sub>e<sup>9</sup> GHG emission

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9 Source: FAQ\_MNRE

reductions annually use of 1000 no. SWH of 100 litre capacity each can contribute to a peak load saving of 1 MW.

### **Harnessing renewable energy potential scenario of the state for power generation**

The cumulative achievement on the renewable front has been limited to solar lantern, small solar off-grid power plants, solar water heating system, biogas plants and remote village electrification projects. While performance on tapping solar energy seems rather slow in comparison with the progress nationally. Solar Thermal power generation does not work with diffused radiation, whereas solar PV works with moderately low solar radiation and diffused conditions. While significant potential exists for renewable sources, geographic location, end-use function, technology diffusion and grid-parity pricing will be key determinants in technology penetration. To harness and implement renewable energy technologies a R&D initiative for improved green energy assessment (solar, wind and biomass), technology and operations are planned through following activities –

a. Assessment of Biomass potential and availability for energy generation in the state and demarcation of biomass potential sites in the map. – To access the bio-energy available

in the state and initiate biomass project implementation following sub activities are planned –

- i. Identification of agency for assessment study
- ii. Study on biomass availability for energy generation in the state for demarcation of biomass potential map.
- iii. Risk Assessment of bio- energy sources in anticipated climate change situations (variable rainfall, temperature, extreme events)
- iv. Projection and risk assessment of energy demand.
- v. Conducting detailed feasibility study and identify viable biomass power project
- vi. Promoting biomass based gassifier project in agro based industries
- vii. Awareness programmes and capacity building of nodal agency on technological and regulatory aspect
- viii. Creating conducive scenario for investment in pilot bio-energy based power projects

Assessment of Solar irradiation, temperature, wind speed at district level across the state for solar mapping.–The Solar Radiation Map (Micro level) needs to be studied and suitable locations for setting up of Solar Power Plant will have to be identified for promotion of solar energy projects in the state, Generally 4 Acres of land is required to install 1 MW solar power. The state will as such require large tracts of land for Solar Power and in this regard, degraded land would be the best option. Land bank for setting up of Solar Power Plants can also be considered. Collection of data on degraded land of the state is also needed. With this objective the sub activities planned are –

- i. Assessment of Solar irradiation, temperature, wind speed at district level across the state for solar mapping.
- ii. Risk assessment of solar energy sources in anticipated climate change situations (variable rainfall, temperature, extreme events).
- iii. Risk Assessment of solar energy infrastructure in climate change situations including extreme events.
- iv. Projection and risk assessment of energy demand.

- v. Identification of appropriate sites for various solar energy projects
- vi. Developing Detailed project report for pilot projects
- vii. Awareness programmes and capacity building of nodal agency on technological and regulatory aspect.
- viii. Strengthening of manufacture base and supply chain.

Both the activities will not contribute in GHG emission mitigation as it is largely a research activity to identify the potential of renewable energy in the state and accordingly the state government may plan for the renewable energy promotion and implementation.

**State Govt. by amendment of building bye-laws suitable to state condition will promote and mandate use of solar energy based water heating and/or lighting in all commercial buildings and in private houses costs more than Rs. 20.00 lakhs or as may be decided by the competent authority on time to time. -**

In line with the objective of national solar mission the state govt. will promote and mandate use of solar energy based water heating and/or lighting and as may be decided by the competent authority on

time to time by amendment of building bye-laws suitable to state condition. Apart from the JNNISM, the State could take benefit of other Mission schemes of GOI. For instance the Ministry of New and Renewable Energy (MNRE), Govt. of India, is implementing a United Nations Development Programme (UNDP/Global Environment Facility (GEF) assisted Project on Global Solar Water Heating Market Transformation and Strengthening Initiation: India Country Programme. Under the scheme minimum installed capacity of solar water heating system is 2500 Sq. m. Capital grant and soft loan will be available for implementation of the scheme. The State Government can take advantage of this programme whereinadequatefinancialresources are available. The activities planned for this action are-

- i. Amendment of building bye-law considering state demographic profile for mandatory use of solar water heating systems in all commercial buildings and in private houses costs more than Rs. 20.00 lakhs.
- ii. Enforcement of incentives /rebate on property tax for use of solar water heaters in buildings.
- iii. Designing of simplified compliance procedures for

state and local bodies.

- iv. Commencement of check testing through independent agency and publication of results.
- v. Market transformation in favor of solar water heating equipment's and appliances.
- vi. Awareness campaign to educate consumers and regulators – The awareness creation amongst the consumers and encouragement of potential consumers' to implement the law can be taken through awareness campaigns and workshops. As a requirement of the awareness campaign the preparation of training material in the form of User Guide and distribution to the consumers. The training programmes may be conducted for the regulators to implement the policy in the state and achieve the objective of National solar mission.

The enforcement of building bye-laws is already implemented in few states of India and is a part of National solar mission. Therefore, the enforcement of building bye-laws according to state scenario is a feasible, ease of implementation and low cost option.

**Strengthening of technical capability of existing renewable energy technology service providers and develop new service providers as per the international standard by introducing training course in all ITI's in the state -**

The govt. of India with its several promotional programmes and schemes for renewable energy implementation has supported in development of renewable energy technologies market and number of manufacturers is now in the sector but still the country is lagging

behind to provide technical support in terms of proper and adequate installation, maintenance and repair of renewable energy systems due to insufficient or technical competency. The state of Tripura being located in north -east of India where almost no renewable energy technology manufacturer has any set up is facing serious problem in the above-mentioned aspect. Therefore, the introduction of training course in all ITI's will be beneficial for successful implementation and operation of the renewable energy projects.



# Enhanced Energy Efficiency

## Introduction

Climate change and energy security are foremost challenges of the century. Climate change is likely to result in considerable stress on the socio economic conditions, weather variability and other detrimental impacts. Inefficient and over use of energy on one hand has raised the concern over energy security on the other hand has also resulted in environmental degradation and is likely to exacerbate the causative effect of climate change that will reduce the resilience of the ecosystem towards adaptability. The key ways of addressing the issues are shifting to low carbon economy.

1. Use of Renewable Energy resources for power generation
2. Energy Efficiency through technological innovation and process modification to reduce energy intensity and also incremental generation capacity thereby abating the

requirement of fossil fuel

3. Efficient generation of electrical energy viz. Combined cycle, supercritical technology, Integrated Gasification Combined Cycle (IGCC) are few to name with
4. Judicious use of energy

All the players from different sectors, organization, industry, etc. need to understand changes in the market, strategic and operational threats as energy efficiency becomes a significant factor. The specific risks and opportunities will vary to some extent from sub-sector to sub-sector, from state to state and from one part of the value chain to another.

Energy efficiency is about saving energy, be it electricity or other fuels. Sector wise efficiency improvements increase the total amount of electricity used in order to save a greater amount of fossil fuels and thus reduce in Green House Gas (GHG) emission.

The major barrier towards promoting the measures lies in the bottlenecks in awareness and consciousness. To most of the end user it is not clear on whether energy-efficient products and services can be competitive with existing, less-efficient versions, because of reluctance among potential consumer for upfront initial investment based on analysis. This reluctance is based on the value proposition not having been fully developed and communicated.

Initiatives have been adopted to achieve significant savings in industrial processes, most significantly through use of more efficient electric motors, promoting combined heat and power in place of individual subsystems, combined cycle power generation, utilizing the heat emissions from power plants either to produce additional electricity or for industrial hot water uses and lastly but not the least domestic heating purposes.

Other initiatives include using of star rated home appliances such as refrigerators, fan, ACs, oven, washing machine, LED/CFL, computers, buildings through improved insulation, use of

energy-efficient windows, use of light-colored surfaces that reflect sunlight and heat, solar appliances and promoting more mass transit system. Incentives also can be privailed to encourage sales of low-emission vehicles such hybrids propelled in part by electricity.

### **Power scenario in Tripura**

Tripura highly dependent on natural gas for power generation. Present installed power generation capacity in Tripura is 225 MW including 84 MW gas thermal plant of NEEPCO. The present peak demand of the state is 190 MW which is projected to be 700 MW with 8% growth and 800 MW with 9% growth in 2030-31. No doubt, a 700 MW power plant is coming up at Palatana and another 104 MW power plant is under construction at Monarchak of which the share of the State is 304 MW. But the location of these power plants at Tripura will increase the local emission levels. To meet this huge demand in near future in a sustainable way, a combination of alternatives is to be adopted. The salient features of power scenario (generation, purchased, T & D losses & total power available) in Tripura is as under:

## Summary Statement & Annual Plan 2011-2012 <sup>1</sup>

Sl No.	Particulars	2007-08	2008-09	2009-10	2010-11		2011-12
					BE	RE	Annual Plan
1	Installed capacity (MW) at the end of the year						
	1. Hydal	15	15	15	15	15	15
	2. Steam	0	0	0	0	0	0
	c. Gas	95	95	95	116	116	116
	d. Diesel	1	1	1	1	1	1
	e. Others (Wind etc.)	0	0	0	0	0	0
	Total-1in MW	115.85	111	111	132	132	132
2	Gross generation inclusive of auxiliary consumption (MKwh)						
	Hydel	36.37	50.13	45.87	50	43	50
	Steam	0	0	0	0	0	0
	Gas	583.86	608.49	612.35	795.6	719.32	744.55
	Diesel	0	0	0	0	0	0
	Others (Wind etc.)	0	0	0	0	0	0
	Total-2 in MkWh	620.22	658.62	658.35	795.6	762.6	794.55
3	Overall PLF of Board (Thermal) % (actual generation/ possible generation from available gas)	93.87%	97.83%	93.22%	93.53%	96.60%	93.49%

<sup>1</sup> Tripura State Electricity Corporation Ltd.

4	Auxiliary consumption (MkWh) with % in brackets below.	9.12 (1.47%)	9.63 (1.46%)	9.65 (1.47%)	11.68 (1.47%)	7.50 (0.98%)	7.80 (0.98%)
5	Net generation (2-4) in MkWh	611.1	648.99	648.7	783.92	755.11	786.75
6	Power purchased (MKWh)						
	a. Purchased from Central Sector	511.51	495.3	421.61	482	486.96	482
	b. Purchased from IPPs/ Private Sector	0	0	0	0	0	0
	c. Purchase from others	0	0	0	0	0	0
	Total in MkWh	511.51	495.3	421.61	482	486.96	482
7	Total Energy availability (5+6) in MkWh	1122.61	1144.3	1070.32	1265.92	1242.07	1268.75
8	T & D losses in MkWh						
	a. Transmission losses	75.18	81.59	86.85	90	74.23	85
	b. Distribution losses	187.2	193.77	177.48	168	185.83	170
	Total (a+b) in MkWh	262.38	275.36	264.33	258	260.06	255

Electrical Energy Requirement and Peak Load Demand are important elements of the electrical supply projects. The electrical energy demand represents the productive element which goes into the capital building of the state while peak demand is the operational parameter of the utilization of electrical energy.

However the energy requirement of various consumers is different for different season, time, place and process and energy peak demand charges accordingly. The peak and off-peak demand in Tripura is given below;

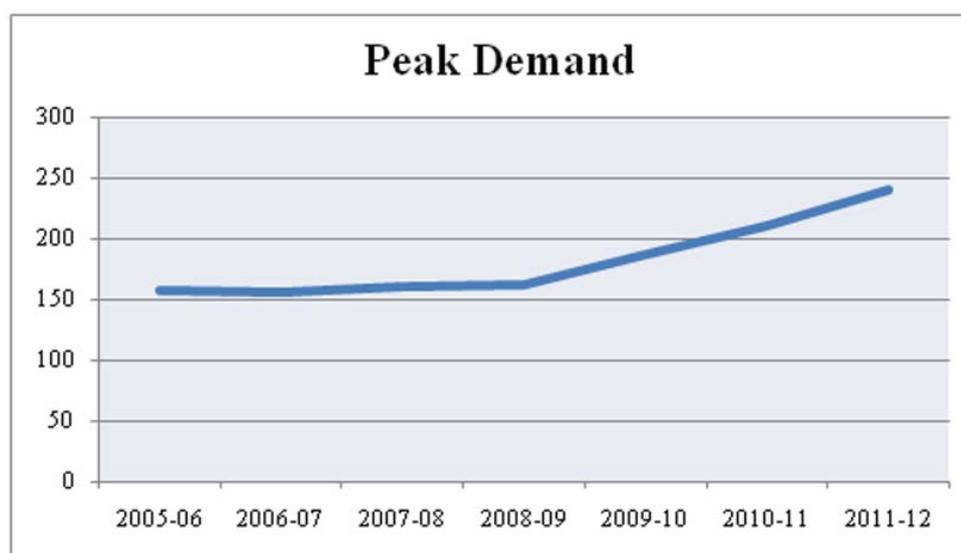
### **Peak Demand<sup>2</sup>**

Year	Peak (in MW)				
	Peak Demand	Peak Demand Met	Short Fall	Own Generation	Import
2005-06	156.1	114.5	41.6	64	50.5
2006-07	155	119	36	74	45
2007-08	160	124	36	79	45
2008-09	162	126	36	81	45
2009-10	187	133	54	83	50
2010-11	210	154	56	104	50
2011-12	240	154	86	104	50

### **Off-peak demand**

Year	Off-Peak (in MW)				
	Off- Peak Demand	Off-Peak Demand Met	Short Fall	Own Generation	Import
2005-06	95	90	5	64	26
2006-07	90	90	0	74	16
2007-08	90	90	0	79	11
2008-09	98	90	8	81	9
2009-10	120	108	12	83	25
2010-11	125	125	0	104	21
2011-12	140	134	6	104	30

### **Peak demand trend of Tripura**



<sup>2</sup> Peak demand trend, TSECL

## Climate Change & Energy Efficiency

Several mitigation initiatives are conceptualized under NMEEE with Bureau of Energy Efficiency (BEE) and Energy Efficiency Services Limited (EESL). NMEEE has strategized the following initiatives, in addition to the policies and programmes for energy efficiency being implemented by BEE. These initiatives are as follows:

- Perform Achieve and Trade (PAT), a market-based mechanism to make improvements in energy efficiency in energy-intensive large industries and facilities more cost-effective by certification of energy savings that could be traded.
- Market transformation for energy efficiency (MTEE) by accelerating the shift to energy-efficient appliances in designated sectors through innovative measures that make the products more affordable.
- Energy efficiency financing platform (EEFP), a mechanism to finance DSM programmes in all sectors by capturing future energy savings.
- Framework for energy efficient economic development (FEEED), or developing fiscal instruments to promote energy efficiency.

The implementation plan of NMEEE seeks to upscale the efforts to create the market for energy efficiency, which is estimated to be about Rs 74,000 crore. The Mission would create conducive regulatory and policy regime to foster innovative and sustainable business models to unlock this market. As a result of implementing NMEEE, we estimate that by the end of five years, about 23 million tonnes of oil equivalent (MTOE) of fuel will be saved, capacity addition of over 19,000 MW avoided, and emissions of carbon dioxide reduced by 98.55 million tonnes annually.

The NMEEE set out a comprehensive strategy, which comprised the following components.

- Create demand for energy-efficiency products, goods, and services by spreading awareness about the efficacy of these products and services, amending government policies and programmes to integrate energy efficiency, preparing bankable projects to stimulate the process, and offering the right incentives to cost-effective improvements in energy efficiency in energy-intensive industries and facilities through certification of energy savings that could be traded.
- Ensure adequate supply of energy-efficient products, goods, and services. This

is being done by creating a cadre of certified energy professionals; promoting energy service companies (ESCOs), standards, and labeling of end-use equipment and appliances; and preparing structured programmes to leverage international financing instruments including the Clean Development Mechanism (CDM) to reduce transaction costs to attract private investment, etc.

- Create and promote the energy efficiency financing platform, set up partial risk guarantee funds, and develop innovative financial derivatives of performance contracts and fiscal and tax incentives for investment in this sector.
- Create and adopt robust and credible monitoring and verification protocols to capture energy savings from all energy-efficiency activities in a transparent manner.
- Take necessary steps to overcome market failures by appropriate regulatory and policy framework to support the measures mentioned above.

Tripura is highly dependent on

power (electricity) being generated through gas thermal route. 216 MW of power out of the total power generated in the State is through Gas thermal route. These power plants operate in open cycle system and hence are responsible for substantial carbon emission. The emission level from the power plants can be significantly reduced and also substantial addition to the installed capacity may be done by converting the existing units to combined cycle systems. Conversion of open cycle power units to combined cycle is an important climate change related energy efficiency enhancing step for the state of Tripura. It has been estimated that the financing plans for combined cycle require an investment of Rs. 455 crores.

Bringing down the electrical transmission and distribution losses from 31<sup>3</sup> to 15 % through a time bound programme by 2030 is the other important energy efficiency enhancing step that the State needs to undertake in a systematic way. Steps proposed in this direction also include proposals for encouragement to decentralized power generation wherever possible on the basis of agricultural wastes and solar energy in the rural areas.

Measures for energy conservation

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<sup>3</sup> 18th Electric Power Survey forcast\_CEA

would include the formulation of a special programme for the introduction of more efficient agricultural pumpsets by Agriculture and Water Resources (irrigation) department. Steps are also required in respect of encouraging the use of efficient lights and star rated domestic household appliances. In the proposed actions, the steps being contemplated include the conversion of conventional street lights into solar street lights, use of LED based lights, bill boards and advertisement hoardings to use solar energy wherever feasible and deploy timer based models, encouragement to the use of solar gadgets in industry and energy audit in major departments.

## Energy Consumption & Saving Potential in Tripura

The electricity demand forecast is an important input for planning of the power sector to meet the future power requirement of various sector of electricity consumption. A planned load growth in industry, agriculture, domestic and other sectors is necessary to have unified growth in all sectors of economy and therefore it is necessary that infrastructure is planned in various sectors of electricity consumption so as to direct the overall growth of economy in rational manner. The electricity consumption by the end user is guiding factor for evaluating the electricity demand for the future. Energy consumption, Energy Requirement and Peak Load category wise & year wise summary of forecast are given below;

### Energy Consumption in MUs<sup>4</sup>

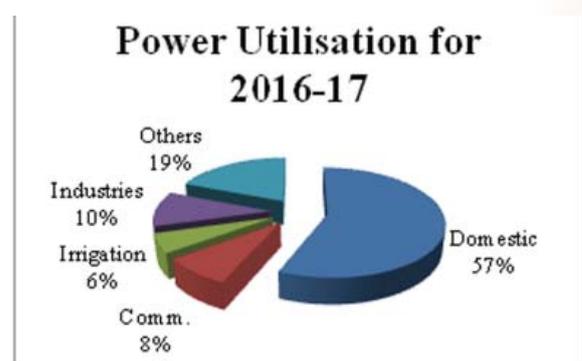
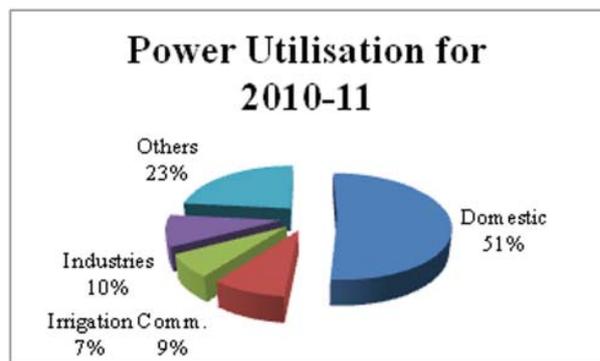
Consumption Categories	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Domestic	262	300	344	389	437	491	552	620	676	731	791	855	924
Commercial & Misc.	47	51	57	63	69	76	84	92	102	112	124	136	150
Public Lighting	24	30	32	35	37	40	43	46	50	53	56	59	62
Public Water Works	45	53	57	61	64	68	72	76	80	84	89	94	99
Irrigation	40	40	43	46	50	53	58	62	67	72	78	85	92
Industries LT	29	35	42	49	58	67	77	88	101	114	129	145	162
Industries HT	17	21	24	24	25	25	26	26	27	28	28	29	31

<sup>4</sup> 18th Electric Power survey Forecast, CEA

Railway traction	0	0	0	0	0	0	0	0	0	0	0	0	0
Bulk supply	47	53	58	62	68	73	80	87	95	104	113	124	136
Total (Energy Consumption)	511	584	656	730	808	894	991	1098	1197	1298	1408	1528	1658
T & D losses-MU	261	262	275	285	291	295	299	404	317	330	342	355	368
T & D losses-in %	33.8	30.96	29.51	28.08	26.48	24.79	23.21	21.66	20.96	20.26	19.56	18.86	18.16
Energy Requirement-MU	771	846	930	1014	1099	1189	1290	1401	1514	1628	1751	1883	2026
Annual Load Factor-%	50.89	49.03	44.5	45	45.5	46	46.5	47	47.4	47.8	48.2	48.6	49
Peak Load-MW	173	197	239	257	276	295	317	340	365	389	415	442	472
Un-restricted Energy Requirement & Peak Load at Power Station Bus Bars	2009 -10	2010 -11	2011 -12	2012 -13	2013 -14	2014 -15	2015 -16	2016 -17	2017 -18	2018 -19	2019 -20	2020 -21	2021 -22
Energy Requirement-MU	771	882	953	1029	1112	1201	1297	1401	1514	1628	1751	1883	2026
Peak Load-MW	173	220	237	254	274	294	317	340	365	389	415	442	472

### Pattern of Utilization

Category	2009 -10	2010 -11	2011 -12	2012 -13	2013 -14	2014 -15	2015 -16	2016 -17	2017 -18	2018 -19	2019 -20	2020 -21	2021 -22
Domestic	51.36	51.43	52.41	53.38	54.15	54.94	55.7	56.46	56.5	56.33	56.14	55.95	55.75
Comm.	9.14	8.81	8.65	8.58	8.54	8.5	8.46	8.42	8.51	8.65	8.79	8.93	9.07
Irrigation	7.78	6.91	6.59	6.35	6.16	5.98	5.81	5.65	5.59	5.57	5.56	5.55	5.55
Industries	8.97	9.55	10	10.1	10.21	10.29	10.38	10.44	10.66	10.92	11.17	11.41	11.63
Others	22.75	23.31	22.34	21.6	20.95	20.29	19.65	19.04	18.74	18.53	18.34	18.16	17.99
Total	100	100	100	100	100	100	100	100	100	100	100	100	100



The energy consumption patterns are changing with the use of advance technology and energy conservation measures initiated by State Government. Efforts have been made to collect the data on electricity saving on account of energy conservation measures in agriculture, commercial, municipalities, SMEs, etc. It has not been possible to capture the electricity saving in all sections of energy consumption. However, the higher weightage provided to

the latest trends in the energy conservation follows the latest trend in technology and energy conservation efforts by various stake holders.

“Assessment of Electricity Consumption & Conservation Potential in Tripura” carried out by NPC in 2009 provides the following estimates of possible savings in energy consumption, detailed table is given below;

### ***Sector Specific Energy Saving Potential in Tripura ((2007-2008)***

<b>Installed Capacity: 243.8 MW</b>		<b>Total Energy Sales : 397.81 MU</b>			
Sl. No.	Sector Reference	Annual Energy Consumption		Estimated annual Energy Saving Potential	
		In MU	In TOE	In MU	IN TOE
1	Agricultural	23.99		1.437	
2	Commercial	40.63		0.456	
3	Municipalities	46.13		1.573	
4	SME Clusters <sup>5</sup>		601317	0	120263
5	Domestic	220.12		44	
6	Industries	65.35		4.575	
Total		397.81	601317	52.08	120263

### **Electricity Consumption & GHG emission profile of Tripura**

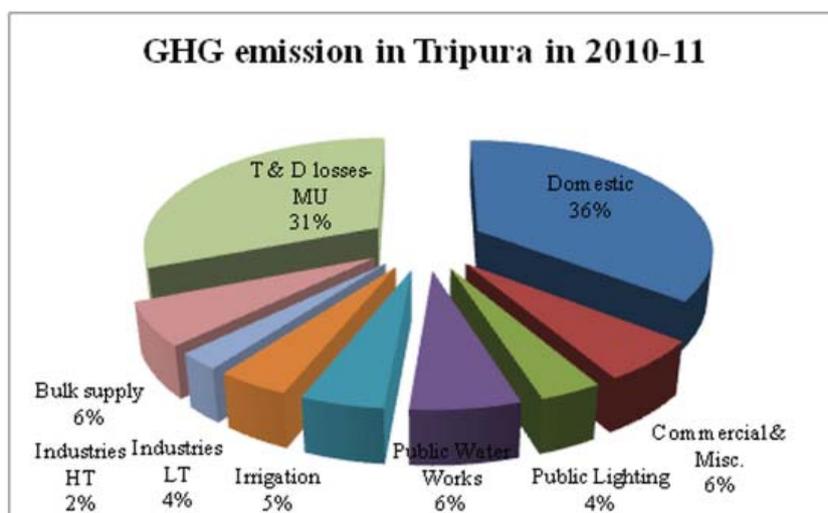
Greenhouse gases (GHG) are emitted owing to combustion of fossil fuel. The major fossil fuels used in Tripura are natural gas, refined oil and crude petroleum. Considering the grid emission factor of the

NEWNE grid of 0.9tCO<sub>2</sub>e/MWh the probable emission are calculated as follows (although the emission factor for gas based generation are lower than the regional grid emission factor however the grid emission factors has been considered under conservative approach)

<sup>5</sup> SME clusters electrical energy savings potential is already included in Industrial Sector

### Sector specific Power Consumption & GHG emission in Tripura in 2010-11

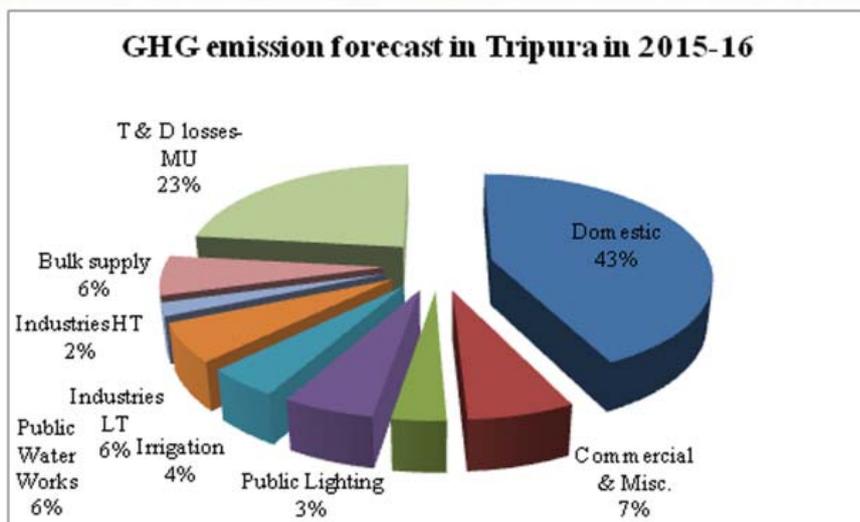
Consumption Categories	In MU <sup>6</sup>	In MWh	Emission Factor tCO <sub>2</sub> e/MWh	tCO <sub>2</sub> e
Domestic	300	300000	0.9	2,70,000
Commercial & Misc.	51	51000	0.9	45,900
Public Lighting	30	30000	0.9	27,000
Public Water Works	53	53000	0.9	47,700
Irrigation	40	40000	0.9	36,000
Industries LT	35	35000	0.9	31,500
Industries HT	21	21000	0.9	18,900
Bulk supply	53	53000	0.9	47,700
T & D losses-MU	262	262000	0.9	2,35,800
Total GHG emission				7,60,500



Sector specific Power Consumption forecast, T & D losses & GHG emission in Tripura in 2015-16

Consumption Categories	In MU	In MWh	Emission Factor tCO <sub>2</sub> e/MWh	tCO <sub>2</sub> e
Domestic	552	552000	0.9	4,96,800
Commercial & Misc.	84	84000	0.9	75,600
Public Lighting	43	43000	0.9	38,700
Public Water Works	72	72000	0.9	64,800
Irrigation	58	58000	0.9	52,200
Industries LT	77	77000	0.9	69,300
Industries HT	26	26000	0.9	23,400
Bulk supply	80	80000	0.9	72,000
T & D losses-MU	299	299000	0.9	2,69,100
Total GHG emission				11,61,900

<sup>6</sup> 18th Electric power survey forecast from CEA



## Reform & Restructuring of the Power Department

In line with the provision and recommendation of Electricity Act, 2003 the Govt. of Tripura has corporatized the State Power Department and created Tripura State Electricity Corporation Limited as fully State own company registered under Company Act, 56. Subsequently TSECL has taken over the entire existing network along with asset of erstwhile Department of Power for operating and maintaining the power supply industry in the State of Tripura. They have already taken some of the energy conservation measures and major advances in the power sector which are given below;

- Installation of 2759 Nos. of Distribution Transformer (DT) meters of 63 KVA and above has been completed and energy accounting started.
- Implementation of SCADA/

DMS project in West Tripura Dist is also in progress and expected to be completed by March 2011.

- In order to calibrate and facilitate testing of energy meter at consumer end, 50 Nos. single phase portable testing kit & 12 Nos. portable three phase testing kit have been already been distributed to revenue Divisions.
- 4 Nos. of 3 phase semi automatic meter test bench has already been installed as Agartala, Udaipur, Ambassa & Kumarghat for the purpose of calibrating & testing.
- 168 Nos. of 11 KV Feeder exists in Tripura as on date and all the feeder have been provided with static trivector meters. Some of the meters are to be replaced by AMR meter as per terms and conditions of R-APDRP.

- TSECL had already engaged consultant for preparation of DPR for implementation of Part-A of R-APDRP. Apart from this NPTI has been engaged for part-B of R-APDRP. The work for Ring-fencing (boundary metering) of 16 project area has already been taken up and the work including purchased of AMR meters are in progress.

### **Future Energy Conservation Potential in Tripura:**

Energy Efficiency provides a powerful cost effective mechanism to achieve a sustainable energy future. Improvement in energy efficiency can reduce the need for investment in energy. Improving energy efficiency will go a long way in enabling India to realize its national aspirations in growing along low carbon routes. In this context, Govt. of Tripura has an important role to play in encouraging various sectors to adopt energy efficiency practices.

*The possibility of energy savings is high in the following sectors of the State.*

- Energy Production ( Gas based Power Systems)
- Agricultural Sector
- Power Distribution System

- Lighting Sector
- Building Sector
- Industrial Sector
- Municipalities

### **Energy saving potential in power plant:**

There is scope to improve efficiency and reduce emissions in the gas based power systems of the State. There are three nos. of gas thermal power plants in operation in Tripura in open cycle mode. By using exhaust gas temperature an additional power can be generated without using extra fuel.

### **Energy saving potential in Agricultural Sector**

There are a large numbers of Agricultural pump sets and Agricultural machineries consume significant quantum of fossil fuels and electricity. Inefficient agricultural pumps may be replaced by star rated efficient pumps. Based on several studies carried out on agricultural pump set efficiency, it has been found that the pump efficiency varies from 25-35% due to various factors. By adopting BEE star labeled agricultural pump sets, the efficiency can be enhanced upto 50-52%<sup>7</sup>.

<sup>7</sup> Combined Summary Report\_NPC 2009

### **Energy saving potential in Power distribution system**

Tripura Power Corporation has an important role to play in making the state level Electricity grid more climate-friendly. The transmission and distribution loss of Tripura is more than 31% and this can be reduced up to 15% on a time bound programme, by the year 2030. Appropriate strategic actions are also required to be taken to reduce the T&D Loss of the State.

### **Energy saving potential in Lighting & Domestic Sector**

Lighting sector alone consumes 30% of the power requirement. Use of efficient light may be made mandatory particularly for commercial organizations and star rated home appliances should be encouraged in domestic sector. The savings potential in rural segment by adopting CFLs and BEE star rated products is 40-50%. The savings potential in urban segment by adopting BEE star rated products is 15-20%. On the whole, the energy savings potential in domestic sector is estimated 20-25<sup>8</sup>%.

### **Energy saving potential in Building sector**

As per Energy Conservation Act, 2001, it empowers the Government

to prescribe the ECBC (Energy Conservation Building Code) for efficient use of energy and its conservation in buildings or building complexes. The ECBC sets minimum energy performance standards for the design and construction of non-residential buildings. Studies conducted by NPC, reveals that energy savings potential in commercial buildings varies from 20-30%.

### **Energy saving potential in Industrial Sector**

The scope of energy efficiency and conservation is the maximum in industry and related activities and various State Government Departments and Municipalities. The State Government may draw up a suitable scheme through Designated Nodal Agency and submit the same to BEE, Ministry of Power for funding. Jawaharlal Nehru Urban Renewal Mission also supports such type of initiatives. Soft Loan is available from Govt. of India on Demand Side Management. The State Designated Agency may formulate proposal in this respect. Incentives are to be provided to the Energy Efficient consumers. Energy Audit may be made mandatory for Small and Medium Industries. Based on several studies & energy audits by NPC, the electrical energy

saving potential in industry sector varies from 7-10%.

### **Energy saving potential in municipalities**

Based on sample studies by NPC, the energy savings potential for street lighting in municipalities & corporations is assessed to be 25%. The energy savings potential for water works & sewage in municipalities & corporations is assessed to be 20%.

### **Others**

The following additional actions are required to be taken for enhancing energy efficiency in different sectors:

- Conversion of conventional street lights into Solar Street Light.
- Usage of LED based lights.
- All Bill Boards and Advertisement Hoardings may use Solar Energy for illumination purpose wherever it is feasible.
- The timer based bill boards and advertisement hoardings may be introduced so that advertisement hoardings are automatically switched off after mid night.
- Encourage use of solar gadgets in Industry.

- Energy audit and Resource allocation. Agartala Municipality or Major Departments like Civil Secretariat, Department of Power, Dept. of Education or Dept. of Agriculture should all be covered under Energy audit. Resources could be allocated based on Energy performance.

### **Key priorities to address the Climate change**

The following key priorities for the sector were identified after detailed deliberation in the working groups. The priorities are in line with the concerns raised due to the negative effect of the climate change and the state's response.

### **Conversion of open cycle gas based thermal power plant to combined cycle systems:**

The state power generation is totally natural gas based (around 95%) and all these power plants are operating in open cycle system and responsible for substantial carbon emission. In addition flue gas temperature of the power plant is around 4500-5000C, which released in the atmosphere and raises ambient temperature. The emission level from the power plants can be significantly reduced and also substantial addition to the installed capacity may be done by converting the combined cycle gas turbine power plants instead of existing open cycle gas thermal

plant. This is planned through following sub activities:

- Undertaking Prefeasibility/ Assessment study
- Preparation of DPR
- Development of project execution planning.
- Financial closure through tapping up of fund and implementation strategy.

### **Development of comprehensive scheme for promotion of energy efficient pumps in agriculture sector:**

Tripura's Agricultural sector consumes 4% of total electricity of the power requirement of the State. Promotion of energy efficient agricultural pump set promises immense opportunity in reducing the overall power consumption, improving efficiencies of ground water extraction and reducing the subsidy burden on the states without sacrificing the service obligation to this sector. It also presents a promising prospect of targeting subsidy to the beneficiary farmers. In terms of electricity saved (estimated 30-40%) by mere replacement of inefficient pump sets. Complying of the action plan is planned through following sub activities:

- Preparation of scheme for financial incentive to farmers on use of energy

efficient agricultural pumps.

- Restructuring of Power Tariff in Tripura.
- Replacement of Inefficient agricultural pumps by energy efficient pumps

### **Reducing Transmission and Distribution (T & D) Losses:**

Reduction of T&D losses is a prime focus of the energy sector since reduction of losses will directly result in reduction of green house gas emission and address energy security. Compliance to the action plan is planned through the following sub activities:

- To assess the current T&D loss pattern and plan implement measures to reduce losses through increase of energy efficiency and reducing pilferage.
- Renovation of Existing transmission and distribution network
- Replacement of Existing Transformer with star rated transformer
- 100% consumer metering to reduce AT&C Losses - Involving Installation of SCADA system and metering arrangement for on-line remote monitoring system right from grid sub-station up to the consumer

end having a connected load of 20 kW and above

- Implementation of feeder level metering at distribution level
- Consumer level metering a cell should be formulated and carry out Vigilance activity
- To introduce franchise model in distribution to reduce commercial losses and better management of the distribution system
  - a. Formulation of Project management unit to facilitate for franchisee for 3 years
  - b. Impart training
  - c. Training and imparting support to prospective entrepreneurs.

### **Decentralised power generation**

The power sector of the state is heavily impacted due to the lack of proper transmission network. Transmission, Sub-Transmission and Distribution lines are very old the Conductors have become brittle and cause more energy losses during transmission. The requirement of evacuation corridor is planned to promote evacuation of power from decentralized renewable energy power projects including micro hydro, Solar (PV & Thermal both), IPP, CPP and promote high

voltage transmission infrastructure for power evacuation and import of power from regional grid. The fulfillment of the overall objective is planned through following sub activity:

1. Encouragement for Decentralized generation of power to reduce the T&D Losses by introducing schemes and policies.
  - a. Undertaking carrying capacity study and resource mapping of each of the districts for setting up possible power project.
  - b. Preparation of techno economic Feasibility report for the requirement of transmission network.
  - c. Applying for Budgetary provision through international funding and private sector investment.

### **Development of policy for mandatory use of efficient light particularly for commercial organizations in the state.**

Lighting are responsible for up to 30% of energy use in the state, and that demand for energy is soaring as construction booms, especially in statelike Tripura. This means lighting can make a major contribution to tackling climate change and energy use. We need to act now because of the lifespan of lightings, and we can act now because the knowledge

and technology to slash the energy consumption are already available. There are three key elements to achieving progress:

- Use less energy
- Replacement of all inefficient lighting system by energy efficient system.
- Use of renewable energy (e.g. Solar PV, lantern, etc).

State Govt. should employ a policy framework on using energy efficient lights in domestic & commercial buildings, Govt. & private offices, education institutes, hospitals, colonies etc.

### **Expansion Conversion of conventional street lights to solar LED/CFL street lights:**

Energy from the light of the sun (photovoltaic) can be used to produce electricity. While the equipment is expensive, maintenance requirements are minimal and there are no fuel costs. They are far less costly for rural areas not covered by grid electricity than building new power plants and grid distribution systems. Energy from the heat of the sun (solar thermal) can be used economically to heat water and homes. Conventional Street lights can be replaced by solar LED/CFL based street lighting system.

- Preparation of pre-feasibility study.

- Fund identification.
- Implementation strategy

### **Maximizing solar power usage and Encouraging use of Solar Gadgets (especially in Industries):**

To the extent of solar gadgets is used, the use of fossil fuel based power and therefore carbon emissions will be reduced. Hence adequate incentives would be provided for the same. Under this initiative, the state will promote both solar photovoltaic as well as solar thermal. An increase in the market penetration of stand-alone solar systems for use by institutions, communities and individuals is proposed. A range of activities – required promotional policy initiatives, survey, feasibility reports, demonstration projects, awareness and capacity building, and strengthening the manufacturing base will be done. All of these will lead to using more solar gadget in the state. Industrial energy measures should strengthen the business case for investing in higher efficiency equipment and solar gadgets. Compliance of the action plan is planned through following sub activities:

- State level policy framework for solar gadgets use
- Using solar PV for outdoor lighting.
- Using solar water heating system.

- Carrying out awareness campaign towards taking up solar system installation and use of star rated devices.
- Supporting state level entrepreneurs to become ESCO.
- Taking up joint pilot project with ESCO companies.

### **State energy audit policy and Implementation of pilot Energy efficiency project and IGEA:**

The Objective of the pilot initiative is to demonstrate the possibility of energy efficiency through implementation of energy efficiency measures. Such action will enhance the capacity of the state nodal agency to undertake similar initiative in the future and also promote taking up such activity amongst the sector. Compliance of the action plan is planned through following sub activities:

- Conducting energy audit by the empanelled organisation.
- Undertaking IGEA.
- Implementation of Pilot energy Efficiency one of the identified pumping Station.
- Implementation of Pilot Energy Efficiency Street lighting Project in one of the ULB area.
- Identifying and empanelling ESCO companies.

### **Promoting Energy Efficiency Practices in the State**

The objective is to create awareness among the sectors (domestic, commercial and industrial) about the benefit and necessity of taking up energy efficiency measures and also the pathway of achieving the same including promotion of use of star rated gadget. Complying of the action plan is planned through following sub activities:

- Identification of Agencies for taking up activity.
- Undertaking sectoral and scoping study of the possibility of energy efficiency across each sector and barrier of taking up the energy efficiency initiatives.
- Undertaking Training Need Analysis Study for the department, preparation of manual and carrying out pilot workshop.
- Carrying out awareness campaign towards taking up energy efficiency measures and use of star rated devices.

**Awareness and implementation for use of CFL and replacing incandescent lamp under Bachat Lamp Yojna, and Umbrella program of BEE:**

Under the Bachat Lamp Yojna (BLY) scheme, good quality & long-life CFLs would be distributed to the grid-connected residential households of Tripura in exchange of an incandescent lamp (ICL) and INR 15. The SDA, Tripura will provide database of households in the project area, assist in the selection of Project Sample Group (PSG), Project Sample Buffer Group (PSBG), and Project Cross-check Group (PCCG) as required in the scheme. The SDA will also provide information available with it for smooth implementation of BLY in Tripura. Comparative analysis of energy usage is given below;

Baseline ICL replaced (Watt)	Rated normal Lumen output (IS 418:2004)	Likely CFL range (Watt)
25	220	5-7
40	345	9-10
60	620	13-15
75	840	15-17
100	1240	20-23
150	2070	37-39
250	2900	52-54

**Encouraging effective fly ash utilization and emission reduction:**

Growing economic activities, population growth and rapid

urbanization have caused a boom in construction activities in developing countries. There is a very strong correlation between these three factors and demand for building materials. One can estimate that about 1,000 billion fired clay bricks are made every year in the developing countries of Asia. Most of these bricks are still today produced in traditional industries with relatively simple and inefficient technologies and low investment. In many countries it is a seasonal activity, starting after rice harvest and rainy season is over. This brick production results in 180 million tons of CO<sub>2</sub> roughly one-third of the total CO<sub>2</sub> emission of the global airline industry. In 2009 NPC has conducted an assessment study on energy consumption in brick kilns and saving potential in Tripura.

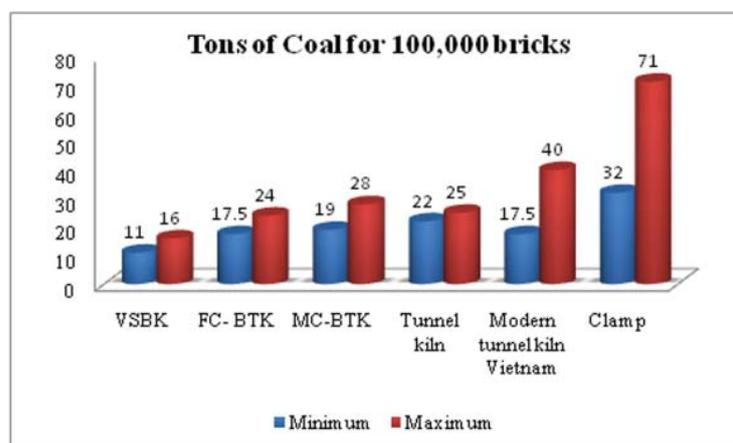


## Energy saving potential in brick kilns in Tripura<sup>9</sup>

Cluster Location	Cluster Type	Total unit listed (nos.)	Estimated total energy consumption (in TOE)	% Saving potential assessed	Annual energy saving potential assessed (in TOE)
4 districts of Tripura	Brick Kiln	259	601317	20	120263

## Comparison of Kilns: Energy use<sup>10</sup>

Type of Kiln	Specific Energy Consumption (MJ/Kg of fired brick)	Specific coal consumption (tons/100,000 bricks)
VSBK (India, Nepal, Vietnam)	0.7-1.0	11-16
Fixed chimney BTK (India)	1.1-1.5	17.5-24
Moveable chimney BTK (India)	1.2-1.75	19-28
Tunnel kiln (Nam Dinh, Vietnam)	1.4-1.6	22-25
Modern tunnel kiln (Germany)	1.1-2.5	17.5-40
Clamp and other batch kilns (Asia)	2.0-4.5	32-71



### Energy consumption in different type of kilns

Overall environmental performance of a brick kiln depends on such factors as energy efficiency which is linked to CO<sub>2</sub> emission, air pollution in the form of CO, SPM, SO<sub>2</sub>, ambient air quality in the vicinity of

the kiln and its impact on humans and vegetation. The following policy actions/studies will be required to mitigate fossil fuel combustion in brick processing units;

<sup>9</sup> Combined study report\_NPC, 2009

<sup>10</sup> Brick by brick: The herculean task of cleaning up the Asian brick Industry

- Compiling information from the several studies and initiatives that have been done on fly ash and developing an operational plan for effective utilization of fly ash, and
- Installing of equipment at the IPPs/CPPs for Nitrous Oxides (NOx) reduction.

**Promoting Demand Side Management (DSM) and energy efficiency:**

DSM and energy efficiency will reduce the demand for energy and therefore reduce carbon emissions. Under this initiative, a comprehensive policy and plan to save energy use in order to reduce the demand–supply gap and contribute towards climate change abatement will be done. This will

include the following activities:

- Implementation of utility level DSM measures,
- Awareness Generation for Energy Conservation,
- Promotion and implementation of the National Bureau of Energy Efficiency’s Energy Conservation Building Code (ECBC) for widespread adoption in the state to reduce the energy consumption in buildings,
- For proper energy monitoring, capacity building of energy auditors, strengthening existing Energy Conservation Cell under the Energy Department supported with manpower and infrastructure.

# Sustainable Habitat

## Introduction

For a period of more than hundred years Tripura had been shaped on the line of similar institutions in British Indian Towns and the genesis of its real existence could be traced from a peculiar process of transformation from a Maharaja Ruled organisation to one ruled by Law and Act. Tripura is the 2nd smallest state in terms of area, but the 2<sup>nd</sup> most populous state in the North Eastern Region. Tripura is a land-locked State, surrounded by Bangladesh on its north, south and west. The length of its international border is 856 km.

The state Government of Tripura had played an important role in the process of urban development and management. The issues of

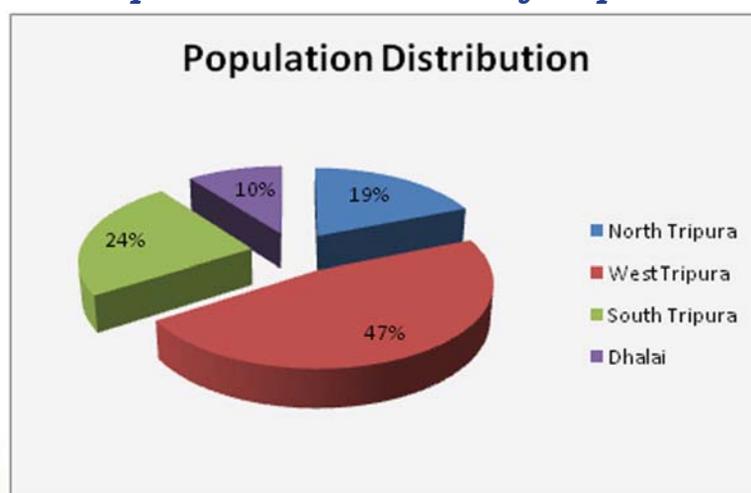
habitat are considered to be the vital indicators for assessing the living condition of human population in an identified geographical area. The incidence of urbanization ranges from 26.7% in West District to a mere 6% in Dhalai. The urban population is thus unequally distributed, with West District accounting for 75% and Agartala, the capital, alone accounting for 35% of the urban population of the State (Tripura HDR, 2007).

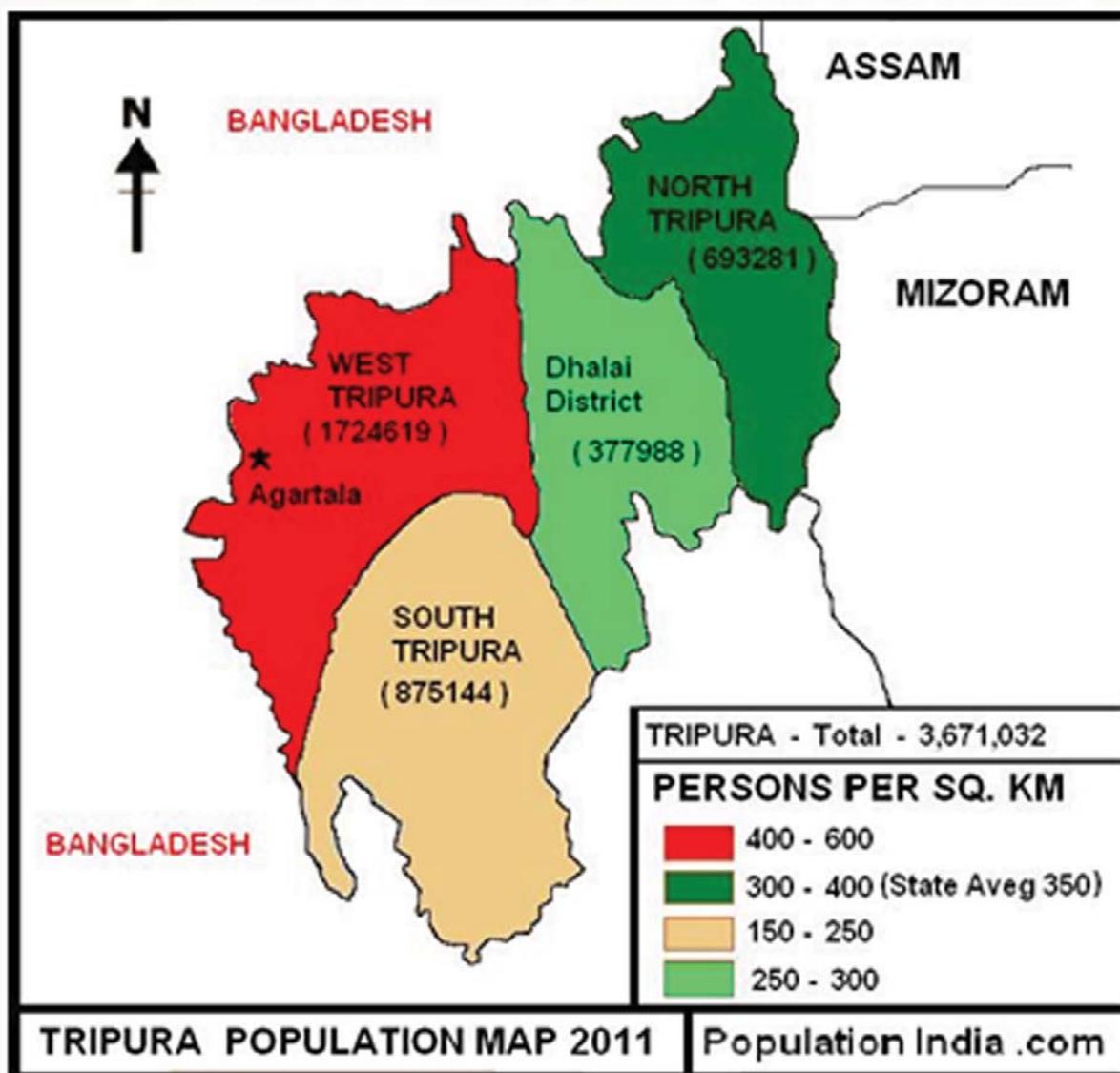
## Population Statistics of Tripura

Description	2011	2001
Actual Population	3671032	3199203
Male	1871867	1642225
Female	1799165	1556978
Population Growth	14.75%	15.74%

Source: Census 2011

## Population Distribution of Tripura





The Agartala Municipal Council and Fifteen Nagar Panchayats have been implementing the urban development projects and the urban local bodies have also been carrying out various development activities in their respective jurisdictions.

There are increasing urban problems of overcrowding and growth of slums, scarcity of water supply, inadequacies of public health and sanitation system, mismanagement of waste disposal. The existing urban infrastructure

for service delivery is increasingly insufficient, even for provision of core urban public services such as water supply, sanitation and sewerage, urban roads and solid waste management. Sanitation possesses major problems with the absence of any sewerage system in urban areas resulting in drainage of domestic effluent into nearby rivers and streams leading to contamination of water sources. Absence of storm water drainage poses problems of water logging and flooding, causing landslides



is important to consider other data that integrate the state of the climate system over space and time. These include such climate parameters like rainfall and humidity. The houses types of the State, about 42.65% Kutcha (clay mud walls), 0.05% stone walls laid in mud and 0.39% Pucca brick walls. These Kutcha and Stone wall houses are vulnerable to receive severe damage including collapse in moderate intensity of earthquakes.

Higher rainfall occurring during this period causing floods in low lying areas and erosion of land throughout most of the State has become a regular feature in the State. The State has in the past witnessed worst form of disasters

caused by floods rendering normal life paralysed by way of disruption of means of communications caused due to damage of roads and bridges and also blockage of roads due to landslides.

With rapid urbanization, the production of municipal solid waste has increased to a great extent. The city of Agartala with a population of 400,000 people generates about 300 MT of mixed garbage every day. Garbage produces methane which is 21 times stronger gas than the carbon dioxide. Production of MSW in Agartala Town and other Nagar Panchayats could be seen in Annexure-VI. The menace of littering is another issue requiring immediate attention as this is



causing soil degradation due to loss soil porosity and choking of sewerage the later being the alarming situation as most of the sewerage drains are open here. The potential GHG emissions from the degradation of solid waste will be approximately 2.94 lakhs tones of CO<sub>2</sub> within next 5 years.

The transport sector in the state is one of the main emitter of Green House Gas. It has been estimated that the number of vehicles in the State will double every five years carrying significant quantum of emission.

The Present Fossil Fuel Requirement of the State is as follows:

- Petrol – 30 million litre on annual basis.
- Diesel – 72 million litre on annual basis.

*(Source: - Consumers affairs and civil supplies department)*

This will go up significantly unless appropriate steps are taken. Generally 20 – 30% of the emission comes from the transport sector. There is enough scope to reduce the emission level in the transport sector. This amount of petrol consumption will account for approximately 3.45 Lakh Ton CO<sub>2</sub> and diesel consumption will account for approximately 9.7 lakh Ton CO<sub>2</sub> emissions within next 5 years.

There has been a tremendous growth in the state in the construction sector. The consumption of cement, steel etc. has increased many folds causing emission at National Level. Consumption of construction materials in Agartala Town and other Nagar Panchyat could be seen in below. This is exclusive of construction materials required by CPWD and Border Road etc. the requirement of steel and cement by PWD for construction activities could also be seen below.

Construction materials	Amount	Unit
Steel materials consumed in the state for PWD works*	90,000	MT per year
Cement consumed in the state for PWD works	110,000	MT per year

\* There is an annual growth of this consumption @ 15%  
*(Source: PWD, Govt. of Tripura)*

The amount of steel consumption can account of approximately 10 lakh Ton CO<sub>2</sub> emissions within next 5 years.

### Key Priorities

As the hub of economic activity, capital city and other towns drive the vast majority of the states' energy use and are major contributors to Green House Gas emissions. Because they are home to major infrastructure and highly concentrated populations, cities are also vulnerable to the impacts of climate change, such as warmer temperatures, unusual rainfall, landslides. At the same time, better urban planning and policies can reduce energy use and Green House Gas emissions and improve the resilience of urban infrastructure to climate change, thus shaping future trends. Lack of suitable livelihood and employment facilities further added to the unsustainable exploitation of natural resources. Moreover, the region being in the neighborhood of Bangladesh, one of the most vulnerable countries of the world in respect of natural calamities is in unique situation unlike any other state of India and requires special attention in initiatives on mitigation and adoption measures under the sustainable habitat mission.

Under a policy scenario where national emission reduction strategies are implemented,

aggregate mitigation costs can be reduced if economy-wide environmental policies are complemented by urban policies, such as congestion charges or increasing spatial density. This is due to complementarities with other policy objectives, such as lower local pollution and health benefits, and enhancement of city attractiveness and competitiveness through lower local pollution levels. Within the identified key priorities with high importance four actions are adaptation activities and three actions are mitigation activities. The high priorities identified based on the basis of cost effectiveness, cost-benefit, feasibility, ease of implementation and overall sustainability. Within the Sustainable Habitat five key priorities are under the Urban sector, one key priority under transport sector and one key priority is under PWD department. The total budget proposed for the eight key priorities along with sub activities is 199.65 Crore INR.

There are multiple opportunities for the mitigation activities to explore the carbon markets with several mechanisms like Clean Development Mechanism (CDM), Voluntary Carbon Standards etc. The revenue generated from the mitigation activities can be used for the effective operation of the activities. Involvement of State Government through "climate-conscious" urban planning and

management can help achieve national climate goals and minimise tradeoffs between environmental and economic priorities at local levels. Local authorities can help achieve national climate goals through resilient urban policies to reduce energy demand and improve resilience to climate change. National governments can help create a sound institutional foundation and knowledge base to support local decision makers engage with stakeholders to identify and carry out cost-effective actions.

State governments are taking serious action on climate change, even in the absence of national policies through local regulations, urban services, programme administration. The capital city can stimulate green jobs by raising consumer awareness, raising the eco-efficiency of local business, facilitating cleantech start-ups and supporting training programmes.

- **Capacity building and research initiative through improvement of knowledge base for climate change adaptation**

The state emphasises on the need to enhance capacity of the officials on climate change implications and possible adaptive and mitigating measures so that they could include climatic considerations in their departmental planning as well as day to day operational and monitoring

activities. Beginning with a training needs assessment for all relevant departments and agencies, training modules especially on solid waste management, water management and efficient distribution of supply and delivery and urban management would be conducted and training imparted. Capacity building would also be extended to awareness generation of residents on good practices such as source segregation of waste and energy efficiency.

The key priorities identified based on the cost effectiveness, feasible options, sustainable and easy to implement with respect to the present condition of state. New or reformed institutions are needed to enable state governments to facilitate capacity building and decision-making on climate change at the local level. A comprehensive capacity building programme on climate change is necessary which will help to build awareness and increase of knowledge base of the officials responsible. This activity will help in increase of knowledge base and awareness for the officials, policy makers in better climate change adaptability. This action is necessary before implementing any climate change mitigation initiatives as comprehensive knowledge base is required for better understanding and better implementation of the initiatives. Department of Urban Development will be the primary responsible department for this

key priority action and its sub activities.

- **Water usage management through improved urban drainage, sanitation management and drinking water quality to reduce Climate change impacts**

Lack of access to piped water or an alternative source of safe water nearby, and lack of sanitary facilities are often considered key indicators of unhealthy housing, leading to high disease burdens in both rural and urban areas. Though the availability of safe water to the household (63% of houses) is not good enough, excreta disposal facilities in the area are widely available to households in Tripura. In addition to quantitative impacts, climate change will have water quality implications. Higher temperatures are likely to affect water quality in lakes through increased thermal stability, which inhibits water circulation. This results in reduced oxygen concentrations and an increased release of phosphorus from bottom sediments.

In order to provide for unforeseen climatic extremes such as floods in urban design, build provisions for storm water flow, and prevent contamination of water streams due to flooding, these aspects would be incorporated into the urban design. More frequent rainstorms

will also overload the capacity of sewer systems and wastewater treatment plants more often. The plan will include installation of liquid waste treatment facilities, provision of new sewerage system, including the sewage treatment plant, collection network, outfalls and sewer cleaning equipment, both rehabilitation of the existing water supply and distribution systems and construction of new systems, constitution of water use societies for regular monitoring of services, leak detection and water quality monitoring. Water conservation and enhanced efficiency would help in adapting to water shortage during climate induced dry spells as well as mitigate indirect GHG emission from usage of energy. Saving of 1 MW energy will reduce GHG emission of 6000 ton CO<sub>2</sub> equivalent per annum. It would also lead to energy conservation by reducing energy consumption at pumping stations, wastewater treatment plants and other relevant facilities. Activities will include bulk and household water metering and capacity building exercises.

- **Climate friendly Solid Waste management systems implementation to mitigate GHG emissions from degradation of solid waste**

The MSW management decisions made by mayors, county executives, and city and county councils and boards can impact the release of

greenhouse gas (GHG) emissions that contribute to global climate change. Emissions of CH<sub>4</sub> result from the decomposition of biodegradable components in the waste stream such as paper, food scraps, and yard trimmings. The potential for global climate change caused by the release of GHGs is being debated both nationally and internationally. Solid waste management subprojects include construction and upgrading of landfill sites, transfer station, storage and parking facilities for the collection vehicles and procurement of collection and disposal equipments, as eligible under the subproject selection criteria for the Investment Program. The activity is proposed to establish an integrated waste management plan for cities including measures to improve efficiency of existing solid waste and sewerage management systems, and incorporate a plan for management of construction and demolition (C&D) waste, biomedical waste, and domestic hazardous waste.

Composting and treatment of Municipal Solid Waste in Agartala Town and other district towns are very important in regard to control of methane emission. This can generate about 5 MW power from Municipal Solid Waste through RDF route. Generating power from waste materials will reduce GHG emission of about 1.42 lakhs tons of CO<sub>2</sub> equivalent in next 5 years.

While composting of 438 TPD MSW will avoid methane emission which will be about 3.32 lakhs ton CO<sub>2</sub> equivalent in next 5 years.

About 15 acres of land would be required for such type of project. The project may be taken up on public/private partnership basis. Agartala Municipality may become a partner of the project. For small district towns the garbage could be utilized as manure in proper scientific manner. At present there are many technologies to process the garbage. Methane bottling plants could also be explored. The bio non-degradable part of the garbage may be separately handled and utilized for construction of rural roads or filling up of ditches and other low lying areas.

The Urban Development Department may draw comprehensive plan for power generation from Municipal Solid Waste and manure production from Municipal Solid Waste and implement the project either through public/private partnership basis or fund made available through Jawaharlal Nehru National Urban Renewal Mission (JNNURM) sources. MSW projects are also highly suitable to attract CDM benefits.

The problem of littering can well be managed with development of suitable linkage or setting up of appropriate infrastructure for recycling of plastics, glass, paper

etc. With active participation of people, this can be a sustainable source of livelihood for a larger section of urban population. Measures to reduce greenhouse gas emissions and adapt to expected climate change impacts will put additional pressure on city budgets and increase the need for additional public resources. These mitigation activities will reduce significant amount of GHG emissions and the revenue flow from the sale of emission reductions will help in sustaining the projects.

- **Disaster risk reduction through from adverse climate change impacts**

Tripura state falls under the seismic zone V which is most vulnerable to earthquake disasters. Climate change and urban disaster risk are the two biggest challenges for Tripura as it faces the consequences of unprecedented rates of population growth, urbanisation, economic development and GHG emissions. Most of the towns and the capital city lies in a mountainous high terrain region where natural hazards strike so all the towns will be considered for appropriate measures to reduce its vulnerability. Urban Department will formulate building guidelines with provision for disaster resistance construction, design and materials and will promote traditional environment-friendly & energy-efficient and earthquake resistant housing and

buildings in urban and rural areas for different agro-climatic zones, flood plains and consideration of seismic vulnerability of the state. Master plans for cities and towns will include the disaster risk of the zones within the state of Tripura. Understanding the function of the land management and revenue department to protect land from encroachment; land revenue code, ownership titles as provided in the present Land Law of Tripura and reformulation of land tenure policy to enable sustainable urban development is necessary.

The city of Agartala is highly vulnerable to climate related issues mainly due to its close proximity with the international border. The development plan of Agartala City and other towns particularly in regard to management of heavy precipitation situation has a close link with trans-border planning process. A number of studies have shown that low lying areas of Agartala and other cities/towns bordering with Bangladesh are vulnerable to a range of risks related to climate change including flooding. The main causes of flooding in Agartala city and other Towns are intense precipitation and backflow of water from Bangladesh. Many portions of Tripura which is surrounded by Bangladesh in 85% of its border have Saucer topography and consequent problems with drainage.

The city of Agartala suffers from

recurrent flood problems. During normal rainfall of about 3-4 hours, the central part of the city is flooded. Around 24% of the population is affected by floods. Though saucer topography, unplanned and unregulated urbanization, low capacity drainage and sewerage infrastructure insufficient to cope up with growing urbanization etc. contribute to the recurrent flooding events, but a very important contribution to this comes as backwater flow from Bangladesh when a combination of tidal conditions in the Brahmaputra basin and high rainfall cause the water in Haora river and Katakhal to be higher than the average contour of the city. It is also therefore difficult to address this issue without addressing the issues of siltation, drainage etc in Bangladesh. Here more than mitigation issues, adaptive issues would play a role.

Backflow of water from Bangladesh and its impact in Tripura needs to be considered in the context of Climate change and its impact. A detailed technical and feasibility study for prescribing mitigating and adaptive strategies needs to be undertaken. A similar study is also needed for other Nagar panchayats / villages located near international border and alongside rivers.

- **Promote and facilitate setting up green building for upcoming commercial buildings in the state**

### **through policy and regulation measures**

Though the concept of Green Building is new in the country, within a short time Green Building concept has become popular. The Green Buildings are coming up in different parts of the country. There is also a need for construction of more Green Building favouring use of available Eco friendly construction materials like sustainably available wood / bamboo, bricks & tiles in the local areas. Use of Solar energy both in active and passive manner is also necessary through change of Building bye laws.

The Government of Tripura may promote green building concept aggressively through policy and regulation measures. Like other States the building bye-laws could be amended by incorporating the above items in the building and providing appropriate incentives for the people. The Architects and Engineers could be properly trained for construction of such type of building. All the Government buildings may become green through administrative order. The PWD and the Housing Board may prepare the new building bye-laws which could be sent to all the Municipalities and Urban Bodies for implementation. MNRE, Govt. of India provides incentives to the Municipalities for amending the Building Bye-laws. Capacity Building in construction of green building is an important

area. The knowledge level of PWD Engineers, Private Engineers and Architect requires to be enhanced keeping in view the need of climate friendly design of building both in private and public sector. Significant quantum of emission could be reduced through adoption of Green Building Programme.

The expenditure to be incurred for converting Public buildings into Green buildings is to be appropriately estimated. This mitigation activity can reduce GHG emissions by conservation of energy.

- **Promotion of eco-friendly road construction methods and capacity building of stakeholders**

Bitumen is used in road construction as a binder for the purpose of retaining the cover aggregate, and providing a waterproof seal to the pavement. It is a natural constituent of petroleum is refined to separate the various fractions (petrol, kerosene, distillate etc.) and recover the bitumen. Bitumen emulsions allow warm and cold mixtures to be used in a large range of pavement solutions. This means much less use of energy to heat aggregates, and far fewer emissions. Cold mix in situ recycling is the best way to recycle properly, avoiding transportation and optimising the use of existing material. Use of virgin material is thereby minimised as is removal of planings

to landfill. Flexibility of use comes into the equation: the laying season is extended with cold mixtures. There are none of the health and safety issues that can be associated with heat and fumes. Bitumen emulsions are a large part of the solution for pavement preservation. The technology is proven; and often results in solutions that are less expensive than those achieved by other techniques. Government of Tripura is planning to implement the usage of bitumen in roads and highway construction. Government is also planning to introduce a Pilot project on Rubberized Bitumen usage in Road Construction.

The construction industry has one of the highest impacts on the environment in regards to energy use, material use and waste products. Construction waste recycling is the separation and recycling of recoverable waste materials generated during construction and remodeling. Packaging, new material scraps and old materials and debris all constitute potentially recoverable materials. In renovation, appliances, masonry materials, doors and windows are recyclable. Extensive programs for recycling and reuse of materials have been developed to take care of waste and end-of-life products. While these efforts are strong and have become part of industry practice, this is not sufficient to create sustainable products over entire life cycles.

- **Reduction of direct or indirect GHG emission transport management and vehicular pollution control**

It may be noted that the growth rate of vehicles in the city of Agartala is significantly high. The road will be congested within short period. Since the Agartala Town is having a very small area, the concentration of vehicle on per sq. km basis will be relatively high and vehicle movement would be at less than optimum speed carries increased emissions. The emission from such vehicle will cause a problem in near future. The public transport system in the city of Agartala is not adequate. Public Transport generally cause less pollution and use less road space as, per passenger pollution and road space is less in larger vehicles such as Buses. Therefore, Transport Department may take special drive on introduction of more public transport rather than encouraging private vehicles.

Shift towards public transport

or Mass Rapid Transit system, improved urban infrastructure, low emission vehicles, electric vehicles in Agartala Town and appropriate urban planning are essential steps to have towards low carbon economy. CNG vehicles are most appropriate for Agartala & other small Towns since Tripura has a good gas-reserve. Considering these facts, implementing this mitigation action considered as high priority and additional revenue from the sale of emission reduction units will help in sustaining the activity.

The State may take a major programme on switching over to CNG based vehicles and electric vehicles in the city of Agartala. This will help significantly in reduction of emission. Concept of electric mini bus as tried in China, especially in small cities, could also be introduced for Agartala or district head quarters. National Policy on Bio fuels as approved by Govt. of India may be adopted by the State as a mitigation programme.





# Water

## Introduction

The economy of the State is 'closely tied to its natural resource base' and climate –sensitive sectors one of which is water. Climate Change may affect the water sector very adversely. It is necessary to have an effective Action Plan to face the situation. Tripura is a North-eastern State having an annual rainfall of approximately 2200 mm. It is feared that Tripura's total annual rainfall is decreasing. But it is not that Climate Change will cause decrease in rainfall everywhere. In some places the quantum of rainfall may even increase substantially. Due to undulated land pattern Tripura has mainly to keep itself prepared to tackle the issue of shortfall in rainwater. Excess rainfall will have easier drainage through the valleys. In addition to rainfall, ground water & its usage, reclamation & conservation of water bodies, Rivers & Streams (cherras) and quality of water are issues which need to be addressed.

The likely consequences of Climate

Change in the water front in Tripura are (i) Decrease in total annual rainfall (ii) Change in rainfall pattern resulting in crop failure for not getting the rain when required (iii) Sudden bursts of rain over a small period of time which may cause flood.

The normal annual rainfall in Tripura is 2196.4 mm. In 2008 the actual rainfall amounted to 1,804.8 mm. In the current year (2010), Tripura has received nearly 30% less rain during the period January-September. These scenarios are likely to repeat in future and would therefore require appropriate adaption and mitigation plans.

## State Water Mission Action Plan

The State Action Plan under National Water Mission can be conceived in different dimensions

- Rainfall related
- River Conservation
- Retention of Water bodies
- Ground water

## **Rainfall**

It is necessary to accurately record and assess the rainfall data in the State. This will enable appropriate tapping of this purest form of natural water. In this connection it may also be mentioned that Tripura should have at least some 70 rain gauge stations for having more accurate rainfall data as well as ground water picture.

Assuming that the annual rainfall in Tripura may be reduced by upto 25% due to Climate Change, Tripura will still get an annual rainfall of 1650 mm. If the major portion of this rain can be arrested by creating additional water-holds and utilized in equitable manner

there will be no crisis of water in Tripura. Depending on this assumption the Water Resource Department is currently engaged in identifying new spots for setting up new rain water holds. The Drinking Water & Sanitation Department has chalked out plans to put up various sustainable structures in their Action Plans for the year 2010-2011.

## **River Conservation**

There are 10 major rivers in Tripura. These are Haora, Gomati, Manu, Khowai, Dhalai, Juri, Deo, Feni, Muhuri, Burima. All these rivers flows into Bangladesh and are integrated with Brahmaputra Ganges - river basin system in Bangladesh.



River Conservation requires to be done at basin level-from source to end, instead of the earlier city-centric corrections. It is, therefore, necessary to have basin level data for all the rivers in the entire state. Along with the rivers, similar issues relating to **cherras** also will have to be taken care of. Generation of river-basin data will require at least twelve months for knowing the behaviour of the river in different parts of the year. This work can be entrusted with some agency.

In generating basic physical data about the rivers, help can be taken from the Tripura Space Application Centre as well. The Fishery Department also has comprehensive details about the water-bodies. Details about river flows are also available with Central Water Commission.

Most of the **rivers** of the state are in bad shape. These are rainfed seasonal rivers maintained in non-rainy seasons by ground waters existing in the hills. The rain pattern has already started to change, total annual rainfall is showing a decline, number of rainy days is decreasing and occasional huge amount of rainfall over a short span of time are threatening sustainable agriculture.

Conservation of rivers should be taken up immediately. At present, the ownership of rivers in the State needs to be quickly looked into. It

should be a multi departmental body including all stakeholders. Therefore, a **State River Authority** will have to be constituted immediately. At the local level, the community will have to be involved in conservation of rivers. A water audit both in terms of quantity & quality needs to be periodically undertaken. Incentive for performance can be developed.

For conserving the rivers it is essential to have a tie up with the Forests Department for afforestation at the source and in the catchment areas of the rivers. There being no Sewage Treatment Plant in the state, the sewage ultimately flows into the rivers. It is therefore necessary to set up sewage treatment plant at required towns. It is also essential to have proper management of Municipal Solid Waste as at present the ultimate destination of these wastes is the rivers making them unfit for use.

The quantum of water flow is also important for the maintenance of rivers. Regulation will also have to be imposed on large scale drawl of water from the rivers. Such users will have to make alternative arrangements or pay a price for using this common resource.

Climate change may also cause large scale inundation of neighboring Bangladesh. Such inundation will spill over to Tripura as well. Backflow of water through these rivers is also critical. Care has to

be taken that such backflow does not bring quality problems along with issues of floods. In this regard, a joint action is also required with Bangladesh.

### **Water Bodies**

Large wetlands/water bodies (like Rudra Sagar in Melaghar and Dumbur lake) in the state have been shrinking in size as a direct consequence of human interventions. If action for restoration of these water bodies is delayed further, these will soon become extinct. These water bodies, in addition to holding huge amount of water help in maintaining a buffer zone which mitigates the natural extreme of excess/shortfall in water flow. Besides, they support a large number of aquatic lives and are good bio-diversity spots.

For reclamation and conservation of large wetlands like Rudra Sagar, Hurijala etc. the State Wetland Authority will have to take up all the steps. Similar steps have to be taken at other levels for protection of other water bodies. Issues need to be addressed at all levels and in all dimensions –administrative, political and technical.

Conservation of ponds, tanks and dighis will require restoration (re-digging) of the old sources in most cases. Effluents from houses located along four sides of big dighis are directly discharged into the dighis. Even municipal drains, in some places, are ending up in the dighis. This needs to be corrected. Households should have sanitary toilets with soakpit arrangements. Collection arrangements through Cess pool should be worked out. All



municipal water should be treated and sent only to streams and not to Ponds.



### Ground Water

Ground water will be a very important source of water supply especially in times of Crisis when surface water is limited. Hence it is necessary to maintain its quality and quantity. In view of large scale development work going on in Tripura, some crisis of ground water may crop up in and around Agartala in future if ground water is lifted in huge quantity. A policy decision on this needs to be taken. It is also essential to ensure that groundwater is not contaminated by percolation of impure surface water. Hence maintenance of Surface water is very critical for ensuring quality ground water.

Usage of ground water needs to be backed with accurate data about its portability. Periodic testing of water quality is an essential component and corrective measures need to be taken. The excessive presence of iron in deep tubewell water can be taken care of by setting up iron removal plants. However, the issue of disposal of Iron rich waste needs to be suitably addressed.

### Drinking Water and Related Issues

The Drinking Water Supply department (DWS) is responsible for providing sustainable safe water & sanitation facilities and services along with promoting hygiene practices among the people.

To this effect, the PWD (DWS) has set an objective of providing safe and adequate drinking water to all households in all habitations of the State at the shortest possible



**SURFACE WATER TREATMENT PLANT**



**IRON REMOVAL PLANT**

time. For this purpose, a range of schemes to tap both surface, ground and rain water are under implementation which include, surface water treatment plants, deep tube wells, small bore tube wells, spot sources like ordinary hand pump(OHP), mark-II/III, RCC well, sanitary well, masonry well etc. and roof top as well as community rain water harvesting structures. Status of drinking water supply sector in the State is given at Annexure

The excessive iron content in ground water poses a major challenge to water supply system in Tripura. The department has to give priority to install more iron removal plants at all deep tube wells and small bore tube wells. Apart from that, there

is an urgent need to appropriately dispose the iron rich water so that it does not get back into the ground water stream.

Surface water can be a useful source for drinking water purposes provided it is not contaminated. Household waste, litter, concrete interventions for natural water bodies and disturbance of bio cycle are all contributing to increase the pressure on the ground water system. These need immediate redressal and the surface water tapping is to be exploited to the maximum. Similarly, Rain water harvesting in the State has to be exploited to the utmost. If all the households in the State are covered by Rain Water system, this would

itself be sufficient to provide a per capita daily availability of 60 litres. As such, the potentiality of the sector should be given emphasis especially due to the contamination in Surface, Ground and Flowing waters in the State.



Sanitation & Drinking Water go in tandem. There is a need to have safe disposal of the Sanitary Waste in the State ensuring zero disposals outside the Septic tank System. No flows should be in the drains, ponds and Rivers. Cess Pool collection backed with legal & regulatory measures need to be taken to ensure compliance.

Litter on the roads, improper disposal of household waste and commercial grocery waste mostly on public roads, cultural habits such as Pan/tobacco chewing and their disposal in public spaces all have a disastrous impact as these ultimately find their way to the Water bodies, Rivers etc and adversely affect their quality. Educative measures backed with

Strong regulatory backing are the need of the hour.



Climate Change can bring an adverse effect on the drinking water availability in the State. There needs to be more decentralised system of Water quality measurement where the schools and colleges could be involved. This would encourage the Local Administration to find local solutions for their drinking Water requirements.

### **Adaptation Pathways in Water Sector.**

Land and water management are critical to addressing poverty. There is also equity issue involved in its management. There are perceived conflicts in its availability, usage, distribution, allocation both sectorally and inter-sectorally. The resource-based livelihoods of the rural poor, and the vulnerable living conditions of the urban poor, pose enormous development challenges throughout the state. The anticipated impacts of climate

change will exacerbate most of these challenges and further imperil poverty reduction efforts.

### **Key Priorities**

The NAPCC has established a National Water Mission. Its broad objective is to ensure Integrated Water Resource Management, and plans to achieve this by efforts in the areas of water conservation, waste minimization, and inter as well as intra state water equity. Basin level management strategies will be reconsidered to deal with rainfall variability and changes in water flows.

1. Regulatory Conservation measures for surface water management.
2. Protection and conservation of ecological health of river.
3. Optimum utilization and management of ground water resources through effective institutional measures.
4. Better access to safe drinking water and environmental safeguard

Basin level management strategies will be reconsidered to deal with rainfall variability and changes in water flows. The mission will seek to optimize the efficiency of existing irrigation systems as well as expand irrigation networks. Measures to increase storage capacity will also be considered. A framework to increase water use efficiency by

20 % is also being developed. This will incorporate initiatives to reduce fresh water use in urban areas.

Tripura has already begun addressing these issues, with a focus on retarding watershed degradation and development of degraded areas. However, it is essential that such efforts are in line with the addressal of climate change concerns, and with the National Action Plan of Climate Change. Below is a list of high priority actions combining mitigation and adaptation strategy.

### **Regulatory Conservation measures for surface water management-**

Water stress is already high, improved management is critical to ensure sustainable development. Water resources management affects almost all aspects of the economy, in particular health, food production and security; domestic water supply and sanitation; energy and industry; and environmental sustainability. If addressed inadequately, management of water resources will jeopardize progress on poverty reduction targets and sustainable development in all economic, social and environmental dimensions. Hence, such regulatory conservation measures for surface water management through already identified actions will address and involve the practitioners and policymakers of water resources management, sectoral decision-

makers as well as those who shape policy regarding climate change. Following are some of the suggested action points-

- Creation of new minor storage/irrigation tanks
- Protection and Conservation of large wetlands/waterbodies (like Rudra Sagar )
- Embankment raising in preventing high flood level
- Development of GIS supported Data-base/ status maps for all the existing water sources
- Information on status of runoff, water level, sedimentation during different seasons
- River conservation measures and river health monitoring- sewerage Management.
- Formation of Basin Authority for river conservation and Management.
- Anthropogenic activities vs climate change and their impact on landslide, soil erosion and decaying river courses of the major rivers & other major water bodies of Tripura
- Formation of Ecological monitoring and research cell in Water Department to coordinate with other research organization for feedback

### **Protection and conservation of ecological health of river.**

With climate change and other environmental impacts the river health and its ecosystems become vitally important. Under this initiative, a research study should be conducted in different basins to determine the environmental flow that will be required to sustain the health and the aquatic ecosystems. Based on the outcomes of this research study, the area action will be identified, planned and implemented. Following are some of the suggested action points-

### **Optimum utilization and management of ground water resources through effective institutional measures.**

In water scarce areas, there is a potential for climate change to make water availability even more acute. There should be proper identification of areas for new creation as well as renovation and protection of water bodies. Ground water recharges options to take care of both domestic and agriculture options in the region. Following are some of the suggested action points-

- Ground water recharge-position/ scenario for the last 30 years in Tripura and ground water modelling.
- Impact of recent climatic change on groundwater condition in Tripura: Monitoring and geo-spatial mapping for sustainable agriculture development.
- Installation of Shallow Tube-well / Deep Tube-well (STW/DTW) for irrigation.

### **Better access to safe drinking water and environmental safeguard**

As indicated in the National water Mission, promotion of integrated water resource management will get an additional focus as an effective response to climate change. In this context, research and studies specially projection of impact of climate change on surface and ground water including its water quality will be more emphasized and strategic protection measures will be adapted accordingly. Following actions pointed out as follows-

- Setting up Iron removal plants to remove excessive presence of iron in water
- Setting up Surface Water Treatment Plant for supplying of Quality

### **Water**

- Proper management of rural Solid Wastes and liquid wastes
- Assessment of arsenic contaminated water areas /bodies/ground water sources
- Installation of Small Bore Tube Well / Deep Tube-well (SBTW/DTW) Spot Sources (like OHP, Mark-II, Ring well etc) for drinking Water.
- Extensive Awareness Generation Programme about Safe use of drinking water & sanitation.
- Setting up of Block level water testing laboratory for drinking water parameters
- Setting up of Scientific Research Laboratory for drinking water& waste water parameters

### **Time Frame**

The above propositions can be conceived as a two phase Action Plan:

- (i) The first phase consisting of plans already drawn up by the implementing departments such as Water Resources and Drinking Water & Sanitation which would have been broadly based on the above mentioned

plans.

- (ii) The second phase consisting of what is to be done over and above the first stage.

The second phase of the Action Plan will start with identifying and inventorizing all kinds of water sources existing in the State. The sources to be included are the surface water sources such as ponds, tanks, *dighis*, lakes, large water-bodies like Rudra Sagar, Hurijala etc.

Inventorization of ground water sources will include all existing deep tube-wells. A ground water status map for the entire state also has to be prepared. The water source inventory should also indicate the water quality of the sources identified and inventorized.

The identification and inventorization of water sources can be done pooling together the data available with Drinking Water & Sanitation Department, Water Resource Department and the Department of Fisheries. But inclusion of water quality data of the identified sources will require engaging some out-side agency.

Once the data-base/status maps for all existing water sources become available, corrective action for each of the sources will have to be taken up depending on the distortions they have. In view of large number of such water sources, actions to be

taken will have to be staggered. Apart from requirement of huge funds, technical and delivery capacity also require time.

Many of the activities that are to be taken under Water Mission fall under the jurisdiction of one or the other Government Department. Hence the Department under which a Water Mission Activity will fall will be the implementing Department of that activity.

The activities under Water Mission falling under the implementing Departments may already be in their normal field of activity and for these funds may already be available with them. But there will remain many areas which do not fall in the normal activity areas of the implementing departments. In such cases funds will have to be procured from sources from which such funds are available.

Climate change may bring in new diseases as the temperature-humidity scenario in the changed condition may make it suitable for vectors which did not find the area suitable to thrive earlier. Climate change may also increase the risk of being attacked by many water-borne diseases. Health Department may take necessary actions in this regard.

### **Financial Resources**

Financial Resources required are dependant on the amount of work to

be undertaken. The fund required in respect of new water holds to be developed by the Water Resource Department can only be estimated once the sites are identified and nature of work finalized. Sources of fund need to be identified. For river and lake conservation projects some fund may be available from National River Conservation

department. For projects like reclamation and conservation of water bodies such as Rudra Sagar, Ministry of Environment & Forests (MOEF) may be approached. For Sewage treatment plants, funds from Ministry of Urban Development need to be tapped. Apart from the above, for small works MGNREGA funds could be tapped.

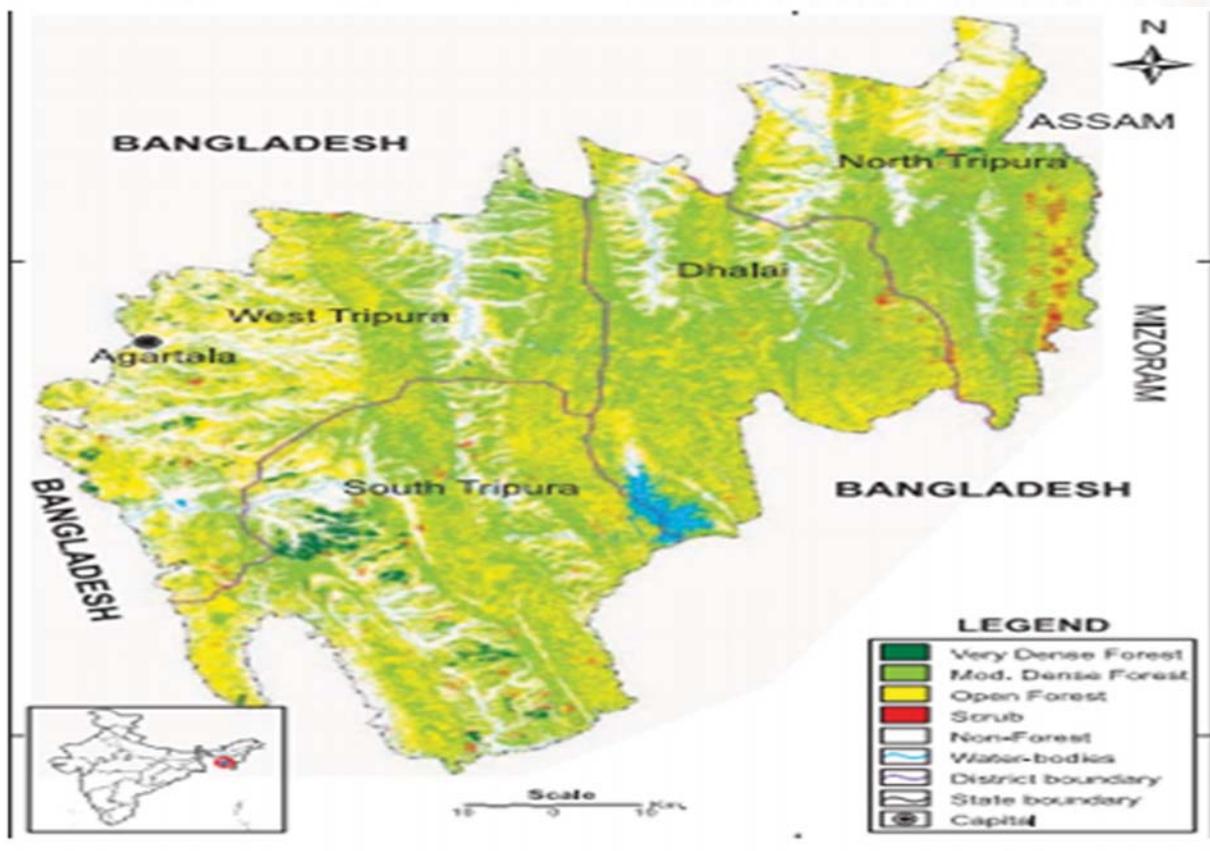


# Sustainable Himalayan Ecosystem

## Introduction

Tripura is a part of Himalayan Ecosystem and the Climate Change impact on this fragile Ecosystem has its own impact in Tripura as well. It faces problems of Soil erosion, siltation, degradation of top soil etc which would affect the forest cover and biodiversity. This

requires special attention to combat the situation by way of different methods such as afforestation, improvised agricultural system etc. The practice of Agriculture and Plantation development must on one hand adopt climate friendly practices and on the other be in a position to adapt to the situation that arise.



Source : FSI 2009

## Key Facts

Tripura is mainly a hilly territory with altitudes varying from 50 to 3080 ft above sea level. At the ecosystem level, the State exhibits a part of Mountain ecosystem with moderate hill ranges and forest ecosystem. In between these two dominant ecosystems lies the freshwater ecosystem comprising 10 major rivers, numerous wetlands, undulating high lands of narrow and broken plates cover extensive areas (Deb, 1975). Phyto-geographically, Tripura belongs to the sub-zone of Northern Burma (Hooker, 1909) which includes Mizoram, Chittagounj Hills in Bangladesh and Arakan in Myanmar, besides Andaman Islands. While a strong affinity with flora of Eastern Himalaya can also

be noted and palm species in Nepal and Sikkim is also recorded in Hilly terrain of Tripura.

## Physiography

The major hill ranges in the Tripura are the Jampoi, SakhamTlang, Langtarai, Athara Mura and Bara Mura. The highest peak of the state is Be-talang-Shiv (3,200 ft) in the Jampoi hill range. A number of broad and elongated valleys - Agartala - Udaipur - Sabrum, Khowai - Teliamura - Amarpur - Silachari etc are located between the north-south trending, parallel to sub-parallel high ranges (topographic highs) such as the Baramura - Deotamura ranges, Atharamura ranges, Langtari ranges, Sakham ranges and the Jampui hill ranges.



**Table Altitude wise Forest Cover**

Altitude	VDF(Sq km)	MDF(Sq km)	OF(Sq km)	Total (Sq km)
0-500 Mt	111	4,736	3,170	8,017
500-1000 Mt	0	34	22	56
Total	111	4770	3,192	8,073

**Source: FSI Report 2009**

### Mountain River System

The State has 10 major rivers running over a total length of 903

km across the State. All these rivers have watershed/catchments areas of over 9400 ha covering 6 major hill range.

### The Major Rivers in Tripura

River (length in Km.)	Location	Catchment Hill Range	Combined Catchments (hectare)
Howrah (35.90)	Agartala	Baramura	400
Gumati (163.40)	Sonamura-Udiapur	Baramura	2492
Khowai (166)	Khowai	Atharamura	1328
Dhalai (75.85)	Kamalpur	Atharamura- Longtharai	630
Manu (140)	Kailashahr	Longtharai	2278
Juri (79)	Dhramnagar	Jampui	482
Feni (86.80)	Sabroom	Baramura- Deotamura	505
Burima (50)	Bishalgarh	Baramura	414
Deo (50)	Jampui	Sakhan-Jampui	328

**Source : State Environment Report**



## Climate

The climate in Tripura displays characteristics that are typically of the hilly and mountainous region. The change in the topographical features of the region can also cause a change in the climatic conditions in Tripura.



## Biodiversity

Tripura belongs to one of the two “Hot Spot” of India amongst 18 identified in the World. The species diversity of Tripura is largely known

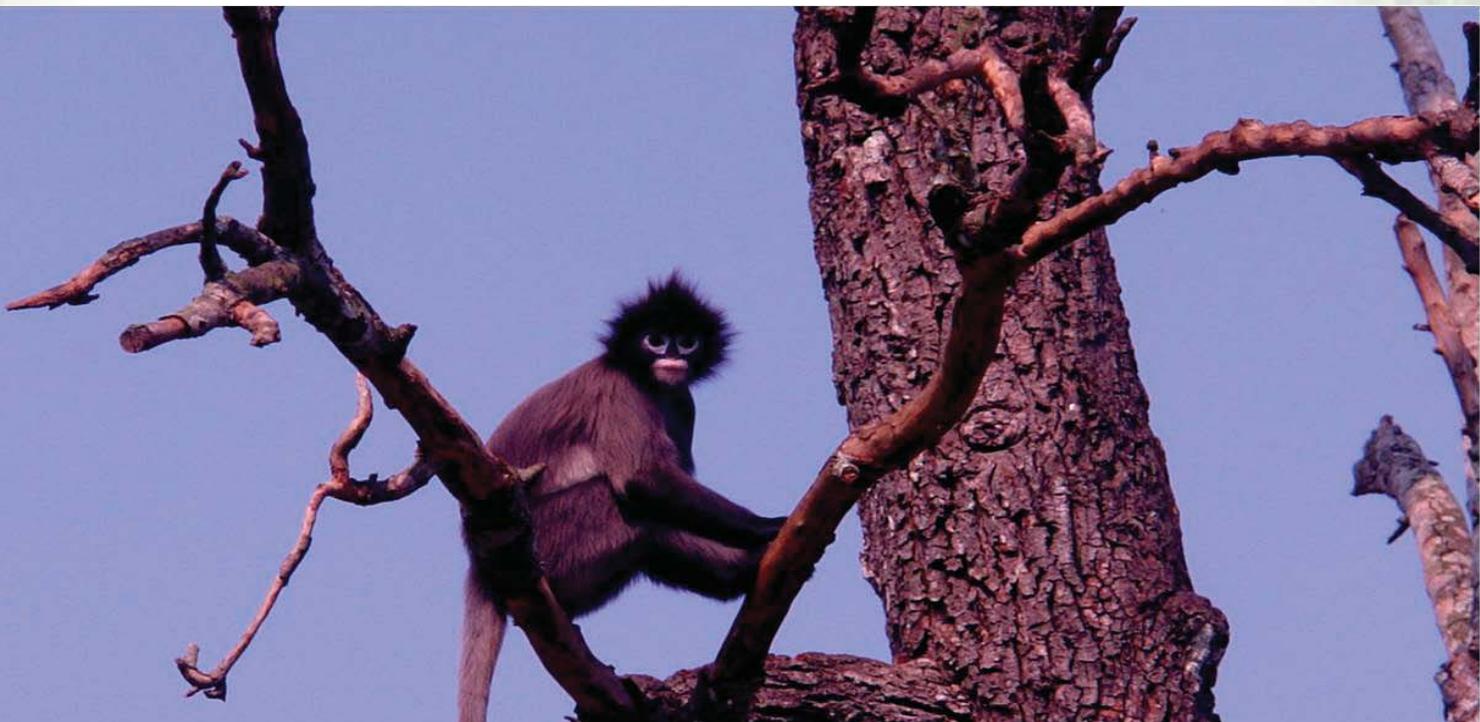
from Floral and Faunal diversity studies.

## Floral Diversity

The range of floral diversity is significant with nearly 1463 of the 17,000 species or 8.6% Angiosperms (Flowering plants) known from India is recorded in Tripura (0.3% land of India). A total of 1546 species other than Bacteria, Fungi, Mosses, etc. belonging to 862 genera and 192 families of Flora have been recorded (Deb, 1981, 1983) of which 86% are widely distributed in India. Around 20 of the species available in the region are currently considered as Rare or Threatened.

## Fauna

The richness of fauna could be attributed to its unique biogeographical location and zoogeographical position. These also include some of the highly rare, endemic and endangered species, viz., Spectacle Monkey, Hoolock gibbon, slow loris, capped langur,



Phayre's langur, stump-tailed macaque and pig-tailed macaque. The other endangered and threatened mammalian species in Schedule 1 of Wildlife (Protection) Act, 1972 are elephant, sloth bear, Indian wolf, Binturong, leopard, marbled cat, leopard cat, Chinese pangolin and sparrow, etc.



Apart from the rich diversity of mammalian species, tripura could be regarded as one of the unique habitats for a large number of varied bird species, reptilians, amphibians, fishes and invertebrates.

### Soil

The soil in the valley is fertile with rich alluvial deposits and therefore suitable for the cultivation of paddy, jute, oilseeds, pulses, fruits and vegetables. About 54.5% of the land is under forest. Only about 24.3% area is available for agricultural use

### Key Issues

#### Soil Erosion

The issues of soil erosion and soil under flooding raised serious environmental concerns in the state. Soil erosion factors have been grouped under 8 class categories. The maximum area come under class 2-2 in the middle level of erosion (26.2%), while insignificant erosion is noted in class 1-0 (19.0%) and highest level of erosion is noted in class 4-3 (10.4%) to class 3-2 (16.2%)

## Soil Erosion in Tripura

Class	Area in ha.	Percentage
4-3	109730	10.4
3-4	39588	3.8
3-3	10804	1.0
3-2	169630	16.2
2-2	274360	26.2
2-1	206278	19.7
1-1	33986	3.2
1-0	199384	19.0
Water bodies	5047	0.5
Total	1048807	100.00

[Source: NBSSLUP, 1997]

## Land use Pattern

Fragmentation of land holding is continuing as a part of social phenomenon. Small and Marginal farmers constitute 95% of total holding while the area occupied by them is only 74%. Average size of holding has declined from 1.25 hectares in 1976-77 to 0.56 hectare in 2011 and this is the lowest amongst other seven sister state of NE Region. This is increasingly creating pressure on the Ecosystem services and goods.

Category	Number of Holding (In Nos)		Area Operated (In Ha.)	
	No	%	Ha	%
Marginal Farmers (Below 1 Ha)	4,05,788	84.64%	1,25,992	46.66%
Small Farmers (1 – 2 Ha)	54,598	11.38%	74,940	27.76%
Semi Medium Farmers (2- 4 Ha)	17,032	3.55%	43,438	16.09%
Medium Farmers (4 - 10 Ha)	1,803	0.37%	9,309	3.45%
Big/Large Farmers (above 10 ha)	207	0.04%	16,305	6.03%
Total	479428	100%	269984	100%
FRI Act Settlement (Land and Beneficiaries are identified)	117000		1.78,000	

Source: Annual Plan 2012-13, Agriculture Department

**Land degradation:** Land degradation in Tripura is mainly caused by shifting cultivation, large-scale deforestation, and improper land use. Research establish gradual decline in soil pH, organic carbon, clay ratio, available NPK and exchangeable Ca and Mg in shifting cultivation site within a

three year cycle. On the other hand, terraced agricultural land produced an appreciable rise in available NPK but fall in exchangeable acidity and available Fe and Mn contents. In the agro-forestry system, rhizosphere soil under the cover of some tree species indicate rise in soil pH, organic carbon, water

holding capacity, available NPK and exchangeable Ca and Mg but an inconsistent change in available Fe and Mn was noted.

### Climate Change Impacts on the Himayan Ecosystem:

The assessment of impact of climate change on forest ecosystems has clearly demonstrated the possibility of adverse implications for biodiversity and a large decrease in net primary productivity of forest. Such a projected shift or change in forest types is likely to lead to large-scale forest dieback and loss of biodiversity. Forest ecosystems are already subjected to socio-economic pressures

leading to forest degradation and loss, with adverse impacts on the livelihoods of the forest-dependent communities. Climate change will exacerbate the stress on forest ecosystems. Development of adaptation strategies is constrained by uncertainty in the current projections of climate parameters and impact assessments. Further, there is a need for models where adaptation can be incorporated into impact models. However, given the general accepted knowledge in the sector, certain priorities can be chalked which will have a positive effect on the sustenance of the Eco System

Issues	Impact	Pathways
<b>Warmer and drier summer conditions</b>	Reduced growth rates, Increased disturbance through fire and insects, Changes in wood quality and quantity, Reduced regeneration success, Increased competition from exotics (vegetation, insects, and diseases)	Identification of suitable genotypes through provenance trials, Development of technology to use altered wood quality and size, Inclusion of climate variables in growth and yield models, Development of "fire-smart" landscapes
<b>Higher precipitation long dry spell and more extreme weathers</b>	Landslide and flood	Disaster risk reduction, Socio-economic adjustment (water allocation management)
<b>Rainfall inhibition</b>	Draught like situation and loss of vegetation, impact on food security and community livelihood	Conservation measures and policy formulation for forestry
<b>Jhum Cultivation for agriculture</b>	Increased degradation/ GHG Gas Emissions	Better dialogue and diversification of agro-forestry and agricultural system
<b>Impacts on the Biodiversity</b>	Floral Distribution & Regenerations	Conservation and Management

## Key Priorities

The following key priorities for the sector were identified after detailed deliberation in the working groups. The priorities are in line with the concerns raised due to the negative effect of the climate change on the Soil Erosion, Biodiversity, Wet Land and Research Studies needs on the Vulnerable Wildlife Populations. They are also addressing the cross cutting issues like Capacity building of Policy Makers on Ecosystem & Climate Change, grazing and monitoring of Carbon stocks & Vulnerable Wildlife populations.

### Protection of existing forest lands from encroachment and illegal land use

As per statistics available with the Forest Department, 47,758 hectares of forest land is under encroachments as on 31-12-2010. The position is alarming and needs special attention to tackle the deforestation taking place in the region. Such initiatives will protect carbon sink and facilitate sequestration of GHG. The strategic framework is developed to undertake initiative to protect existing forest from further degradation. The framework includes

1. Monitoring eviction of illegal encroachments on forest land in the State by the State level

Monitoring Committee (SLMC) under the chairmanship of the Chief Secretary of the State. The Committee would fix responsibility of the field formulations including the Revenue Officials to prevent/evict encroachments on the forest lands.

2. Discourage illegal encroachment through Circle level Committees.
3. Circle-level and Divisional level Committees to deal with the encroachments and subsequent evictions in the forest lands.
4. Divisional level Committees to review settlement claims of the people in occupation of forest land

### Protection of forests and forest land from soil erosion

Five major land classes could be identified in the state. About 19% of the area belong to class-5 and form the main food grain producing area in the State. About 6.7 % of land is grouped under class-3, which is composed of very narrow interm hill valley; more than 53% land belong to class-1& 2 where topography is major limiting factor for appropriate use, but can be made suitable for the tree crops, plantation crops, horticulture crops and spices.

### **Soil Erosion Table**

<b>Class</b>	<b>Category</b>	<b>Area in Sq km</b>	<b>% Age to total geography area</b>
1	High Area	4000 3	38%
2	Tilla land with moderate steep slopes	1600	15%
3	Tilla land with gentle to moderate slope	700	6.7%
4	Rolling Topography	2149	20.5%
5	Plain land	2042	19.8%
<b>Total Geographic Area</b>		<b>10 491</b>	<b>100%</b>

**Source : Approved Annual Plan 2011**

Very severe to moderate erosion area recorded as 25% of Tripura due to removal of vegetation cover. Total soil area under degradation come to 508000 ha or little less than 50 percent of the total geographical area of the state. Considerable portion of the above area encompassing forest are susceptible to soil erosion. Protection of forest from the impact of soil erosion is planned

1. Construction of check-dams, terracing, Agrostology methods, soil-stabilization plantations etc will be taken in Tripura State. These measures are also useful for re-charging ground water reserves, to provide employment and livelihood support systems.
2. Plugging of gullies which will also restore and rejuvenate the soil fertility status.

**Encourage cultivation of traditional varieties of crops and horticulture by promotion of organic farming, enabling farmers**

**to realize a price premium.**

The State is quite rich in fruits and spice crops. There are 60 different fruit crops cultivated in Tripura. The indigenous fruit crops have huge genetic variety, viz. banana with good number of biotypes and jackfruit with 28 variables. Other indigenous fruits include Amra, Guava, Ber, Gulapzam, Zamrul, Bael, Satkara, Taal, Totka, Gaab, Kamranga, Sharifa, Chafta, Jalpai, Karamcha, Dalim, Paniphal etc. The uniqueness and attractiveness of eco-system emanates also from biological systems inclusive of critical habitats and species, ecosystem structure derived from diversity which supports indigenous mountain farming systems with economically and ecological sustainability of important crops. However, the traditional varieties of horticulture crops have been replaced with high yielding hybrid varieties in Tripura. But the tolerance of these hybrid varieties to the extreme events of climate variability is very minimal so the

conservation of traditional varieties is very crucial.

### Conservation and Management of two major Wetlands Rudra-Sagar and Gumiti Reserve

Tripura supports a rich diversity of inland wetland habitats. There are 408 Wetlands in Tripura covering an area of 98.58 Sq km. Conservation of wetlands in Tripura will support wide range of flora, fauna specially avifauna including haldipakhis, jungle crow (*C. macrorhynchus*), red bulbul (*Pycnonotus cafer* and *jocosus*), green bulbul (*C. aurifrons*), king crow or pechya

(*Dicrurus adsimilis*) and also home for many inland fish varieties. All these wetlands fall in following six categories:

#### Wetland Categories of Tripura

Type of Wetland	Area (Sq.Km.)	No of. Wetlands
Lakes/ponds	25.04	74
Oxbow lakes	3.60	84
Water logged (seasonal)	15.43	222
Reservoirs	53.22	5
Tanks	1.36	19
Waterlogged	0.30	4
Total	98.95	408

Source : Annual Perspective Plan 2011-12

#### Major Wetlands in Tripura with Ecological Priority

No.	Name of the wetland	Rank	use
1.	Gumati reservoir (Dumbur lake)	1	M
2.	Rudrasagar (Nirmahal)	1	M
3.	Sepahijala reservoir	2	M
4.	Trishna wetlands	2	M
5.	Sttar Mia's Haor	2	M
6.	Batapara lake(Agt)	3	M
7.	College Tilla lake	3	M

Source: Annual Perspective Plan 2011-12

The co-management of two major wetlands viz RudraSagar (Notified under Ramsar Convention on Wetlands (1971) and The List of Wetlands of International Importance 2010) and Gumiti reserves were selected for the conservation.

Proposed activity involves in mapping of vital parts of hydrological

cycle, catchment area development, water quality monitoring, and conservation of biological diversity to support wide range of ecosystem services such as waste assimilation, water purification and livelihood improvement of local communities. This exercise will also help in flood mitigation, ground water recharge and micro climate control in Tripura State.

## Grazing Policy on domestic bovine population

The domesticated cattle population including bovine population in Tripura showed a sharp increasing trend over the years. It is estimated that 60% of the livestock graze in the forest land. This also resulted in loss of biodiversity also resulting into increased runoff, soil erosion and adverse water quality. The current livestock grazing far exceeds the carrying capacity of the forests and causing destruction of young growth of the forest and habitat for the wild animals.

### Tripura Live Stock Census

Item	Item	Number
A. Crossed (Cattle) :	Total Cattle (Crossed)	31,900
B. Indigenous (Cattle)	Total Cattle (indigenous) Nos.	4,51,009
C. Buffalo	Total Buffalo	7,678
D. Sheep	Total Sheep	3,646
E. Goat	Total Sheep	6,45,614

**Source: Livestock's Census – 2007**

This activity proposed in light with the livestock grazing in bio-diverse areas, which is destructive to nature. But on the other hand, Cattle are an integral part of the rural economy for marginalized groups in protected area and other areas where alternative employment

opportunities are very limited. Hence the reduction or removal of cattle may not be a viable option as it will adversely affect the livelihood of these vulnerable communities. A more pragmatic approach of rotational grazing would be fruitful for preservation of protected forest areas and ecological sensitive areas in Tripura. So it is important to frame Grazing Policy on domestic bovine population with the aim to involve local people by supporting sustainable management of natural resources through alternative income generating activities. This policy will form strategy for Sustainable management of bovine population and explores how far a reduction of browsing animals is acceptable or feasible in the context of Tripura.

### Undertaking studies on indigenous (at least five) tree species to assess their vulnerability to climate change

Climate change is a stressor that has direct or indirect influence on the processes that impact ecosystems in terms of the tree regeneration, propagation and their distribution. Changes in the Tripura biophysical environment due to the Climatic variability can alter the stable dynamic equilibrium that exists between biotic and abiotic components leading to the stress on the ecosystems. Limited research studies are available on the Tripura Ecosystem, particularly related to

the vulnerability of the indigenous trees species.

Such studies are urgently required for restructuring of controlling variables and processes that can shift an ecosystem state with different levels of service provisions.

### **Endanger & Threaten Tree Species of Tripura (State Afforestation Policy)**

It is necessary to evaluate the long-term effects of climate change on forests and determine current and future actions to respond to climate related stress. As a part of the action the nodal department has planned to undertake research studies to identify the issues of adaptation measures concerning tree genotypes particularly indigenous tree species. Following tree are planned to be considered for research.

### **Knowledge Management on climate change and policy developments**

Climate change is likely to have a significant impact on forests and forest-dependent communities of Tripura; however, limited research has been conducted in this direction so far.

The approach strategized are as follows:

- (1) The research should aid development of strategies for adapting to climate change.
- (2) Increase awareness of the forestry community on climate change to facilitate adaptation.
- (3) Evaluation of forest resources in response to climate change.

Scientific Name	Local Name	Habitat
1. Duabanga grandiflora	Ramdala	Tree
2. Adina sessifolia	Haludehaki	Tree
3. Michelia montana	Champasundi	Tree
4. Magnolia pterocarpa	Dulichampa	Tree
5. Lochio spermum	Haldesimul	Tree
6. Canarium stricum	Dhup	Tree
7. Aquiloria melacensnis	Agar	Tree
8. Pterocarpus santalinus	Raktachandan	Tree
9. Santalum album	Chandan	Tree
10. Elaocarpus prunifolia	Ban jalpai	Tree
11. Mangifera sylvatica	Laxmi am	Tree
12. Cyathea gigantea	-----	Tree
13. Podocarpus nerlifolius	-----	Tree
14. Xantolis assamica	-----	Tree

- (4) Identifying the barriers in implementing adaptation in forest management
- (5) Framing forest policies to facilitate adaptation.
- (6) Developing Monitoring protocol

Activities on the habitat of the wildlife is planned to be thoroughly studied and measures to reinstate the habitat of the threatened and endangered species.

### Monitoring of carbon stock and biodiversity at regular intervals

### Studies to assess the impact of climate change on the endangered and vulnerable wildlife species in the state

In the terrestrial ecosystems the common wildlife at present are on the decline due to economic development and urbanization. Moreover the forest degradation has severely resulted in the loss of wildlife habitat which in-turn has great impact on the food pattern of the several important species and their migration to inhabited areas. This has also resulted in the man-animal conflicts in various areas of the state. The impacts of the climate change coupled with Anthropogenic

The study carried out by Forest Survey of India (FSI,1991) has shown the average number of stems and volume per hectare (in all strata i.e. miscellaneous, miscellaneous with bamboo, plantation, and shifting cultivation). The situation has slightly changed now due to increase in plantation area but volume per ha in different strata expected to be remains more or less the same. The Study is planned to estimate the current carbon stock in the forests of Tripura as regular monitoring of carbon stocks will give realistic estimates of growing stocks and removals form the forest. This will also help in gaining incentives from the carbon Markets.

### The growing stock of the Tripura Forest

Stratum	Area (km <sup>2</sup> )	Forest area(% of Geo. Area)	Volume (m <sup>3</sup> )/ha (weighted average)	Total Volume (million m <sup>3</sup> )
1. Hardwood (misc) forests	1829	17.43	26.18	4.79
2. Hardwood (misc) mixed with bamboo	484	4.61	29.84	1.44
3. Bamboo forests	938	8.94	9.07	0.85
4. Plantations	2221	21.17	20.69	4.28
5. Shifting cultivation	840	7.81	5.34	0.52
<b>Grand Total</b>	<b>6292</b>	<b>59.98</b>	<b>85.12</b>	<b>11.88</b>

Source: FSI, 1991

## Removals

Produce	Recorded removal in MU	Unrecorded removal in MU	Actual removal in MU	Value per unit (in Rs)	Value in Lakhs
Timber	0.012	0.034	0.046	2000/m <sup>3</sup>	680
Fuel wood	0.043	2.194	2.236	200/m <sup>3</sup>	4388
Thatch	0.13	0.213	0.343	80/ton	170
Fodder	--	1.53	1.53	500/ton	7650
Bamboo	109.76	75.50	184.26	50000/million	38
<b>Total</b>					<b>12926</b>

*Source: Draft Perspective Plan 2007-13 , Tripura Forest Department*

The Tripura biodiversity Board presently focusing on survey of biodiversity consisting of various taxa of fauna and flora. Once the survey is completed and the available species including the endemic and rare, endangered and threatened species are to be monitored.

Monitoring of carbon stock and biodiversity at regular intervals is necessary to gauge the success of the various programmes implemented. Under this initiative, developing a new and independent organization – a ‘Forest Monitoring Agency’ – under the Forests Department will be constituted. Roles, responsibilities, authorities and resources for this new and independent organization will be formulated.

### **Awareness creation on biodiversity conservation and its relation with the climate change to the Policy makers**

The biological diversity of any

geographical region is estimated at the level of ecosystem diversity, species diversity and genetic diversity. Tripura is located in the Bio-geographic zone of 9B-North-East Hills and possesses an extremely rich bio-diversity. Out of 350 plants used in Unani and Ayurvedic Systems of Medicine, about 132 species are found in Tripura, some in wild and some cultivated. There are 56 medicinal plants used by tribal practitioners or Achai for various diseases.

It is necessary to sensitize the front line managers, policy makers and essentially staff in all levels of the Forest Department for capacity building to adapt to climate change as part of a sustainable forest management plan. The idea is to enable them to integrate climate change concerns in all state and district level activities so that development is sustainable and would finally address the Climate Change impacts on the livelihoods.

### **Establishing observational and monitoring network to assess ecosystem health including freshwater systems**

Monitoring of environmental indicators in the Tripura is a major activity for the Sustainable Himalayan Mission. The proposed observational and monitoring research network component will focus on ecological indicators of environmental and economic changes. This indicator system includes sub-groups such as Hydrological, Territorial Biomes and others. Historical and current data on terrestrial ecosystems, freshwater ecosystems (streams and lakes) and datasets from mountain farming systems will be collected and analyzed. The research will also study the watershed hydrology and water balance in the region. These networks and other studies will further strengthen the data collections activities and generation of multi-location meteorological data. Data generation will be multi-centric and involve time series. The mission will address the major issue of standardization and interoperability of data generated.

This exercise envisages a coordinated and comprehensive monitoring network that can provide the information necessary for policy makers to make informed decisions and to adapt their actions as needed, and assure effective stewardship of ecosystem and freshwater

resources. In developing such a network in research, collaborations from national and international reputed research agencies will be considered.

### **Strengthening regional cooperation through established mechanisms for exchanging information with countries sharing the Himalayan ecology**

In consultation with South Asian Association for Regional Cooperation (SAARC) Universities a knowledge sharing platform for the regional cooperation on Himalayan ecology is planned to be established. The collaboration of Research institutes and regional organizations is recognized as one of the key priority by working group committee members. The knowledge sharing framework will work with National and International research institutes to assess the climate change impacts on Himalayan Ecology particularly on the glacier melting, avalanche floods and climate induced risk management.

This knowledge platform can play great in assessing and monitoring climatic risks in Tripura as this State is highly vulnerable to the floods from Himalayas, neighboring states and Bangladesh.

### **Documentation of the People's Biodiversity Registers and Biodiversity Conservation**

Indigenous Communities in the

Tripura are depending on the local biodiversity and bio-resources for their livelihoods. These people through their observation, practices, and experimentation have developed traditional knowledge on these resources. Working Group recognized importance of the documentation of traditional knowledge and to publish the list of rare, endangered and threatened species in their territory and to launch special programs for conservation.

Local bodies will be entrusted to constitute a Biodiversity Management Committee with the task of preparing, maintaining and validating people's biodiversity register (PBR) in consultation with local people. The registers will have details of the access to biological resources and traditional knowledge granted. This activity will facilitate the effective implementation of the Biological Diversity Act 2002.

### **Undertaking studies and investment promotion of NTFP and indigenous forest resources for adaptation of climate change**

The Tripura state is rich in forest resources and villagers of forest fringe areas are mostly dependent on forest resources. For the livelihood improvement of forest fringe villagers, government of Tripura wants to encourage enterprise activities that will add value to its forest products in the process to generate more income

and employment. The primary forest products identified within the Tripura state are Bamboo, Cane, Fuel wood, Timber, Broom grass and Medicinal plants. Tripura government will provide enterprise development support which will include the provision of business development and financial services and policy support for forest based sustainable livelihood promotion.

### **Ecotourism promotion for biodiversity protection and sustainable livelihood**

Tripura has the wide varieties of hilly terrains, luxuriant valleys, rivers, lakes and rich flora & fauna. Hence tourism is an activity, which, if properly managed can give fairly sustainable economic incentives to the local people residing in the region. Proposed activity is in line with realizing conservation potential and growing interest in wildlife tourism promotion in the State. This activity requires a multidisciplinary approach, careful planning (both physical and managerial) and strict guidelines and regulations that will guarantee sustainable operation. It is possible with inter-sectoral involvement and linkages between forest department, India Tourism Development Corporation, private entrepreneurs including travel and tour operators, hotel and resort owners, local communities and non-governmental organizations.

The activity is planned through Pre-investment feasibility study, DPR

preparation and implementation of eco-friendly and responsible tourism to enable local communities to gain livelihoods, while leveraging financial, technical, and managerial capacities of investors.

**Take measures to regulate tourist inflows into mountain regions to ensure that these remain within the carrying capacity of the mountain ecology**

Tripura is known to be a home of scenic beauty since time immemorial and also hosts a number of ecotourism sites across the State. Unfortunately, most of these places lack adequate facilities of transportation, accommodation, waste disposal and other amenities. While promoting the ecotourism, policy makers also need to consider the carrying capacity of the sensitiveness of the ecosystem; otherwise excessive tourist flow might adversely affect ecosystem. Hence the proposed policy action will be considered in the planning of the ecotourism projects so that the inflow of the tourist will be regulated. There is an urgent need to develop and implement guidelines for sustainable tourism in the State encompassing the concept of carrying capacity of the area.

**Documentation of Medicinal Plant resources in Tripura**

Tripura has one of the oldest, richest & most diverse cultural traditions associated with use of medical

plants. There are large number of village based herbal medicines practitioners who have traditional knowledge of herbal home remedies of ailments & nutrition. The herbal medicines used by rural people including tribal have not yet been documented. Compiling an exhaustive inventory of medicinal plants in the State is the need of the hour. So far about 266 species of medicinal plants (68 trees, 39 shrubs, 71 herbs and 88 climbers) have been identified and documented in Tripura. Although these medicinal plants are less popular but possess a surprising breadth of knowledge on medicinal plants and the specific ailments that they cure. Many of these plants grow in the wild and have never been cultivated. Extensive forest degradation has made several specimens rare and hard-to-find. Conserving them ensures their availability for scientific investigation and serves to propagate this ancient art, thereby enriching indigenous knowledge in medicine.

So as a part of the proposed action documentation of medicinal plants in line with National Medicinal Plants Board (NMPB) guidelines on Good Agriculture Practices (GAPs) on the pattern of Good Agriculture and Field Collection Practices (GACPs) developed by the World Health Organization (WHO) for medicinal plants is planned to be carried out.

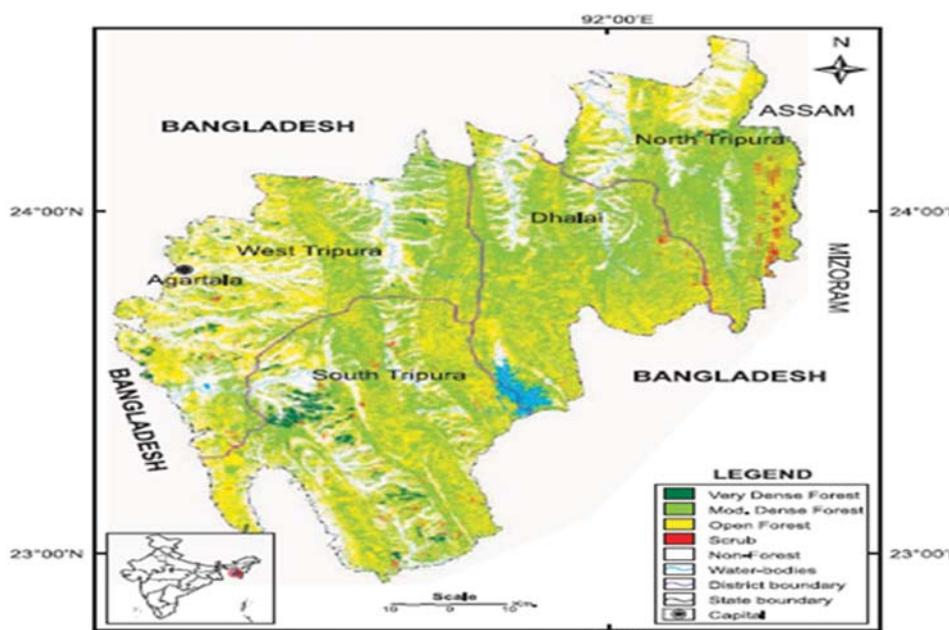


# Green Tripura Mission

## Introduction

The state of Tripura, with a geographical area of 10491 km<sup>2</sup> is predominantly hilly (60%) & is surrounded on three sides by a deltaic basin of Bangladesh. The State has 76.95% forest cover of its geographical area as per latest Forest Survey of India 2009 report. The majority of the forest land lies in notified forest and also significant forest cover lies under the management of communities and individuals. Forests have been playing a very important role in

the socio economic development of the Tripura. The State enjoys different types of evergreen forests and water bodies as well as areas of unique floral and faunal varieties. However, the major constraints for the state are higher deforestation rates due to jhum cultivation and forest degradation. Due to this the majority of the forest area comes under the open forest and medium dense category; and only 1% of forest cover comes under the highly dense forest with the canopy cover more than 40%.



The consequences of Climate Change Impacts on Forest Productivity, Water Cycle, biodiversity loss and forest fires are likely to be the maximum for poor and marginalised people in Tripura those depend almost exclusively on natural resources. The major environmental problems result from population pressure, conversion of forest land into agricultural fields, deforestation, urbanization, mining and industrialization. The increasing anthropogenic stresses of various kinds are likely to further aggravate the environment in the future. Climate change impacts can be minimized by conservation of forests and biodiversity. Policies will be integrated with the protected forest management for preservation of the catchment areas.

Under the National Action Plan for Climate Change, India there is a separate National Mission for Green India which recognizes the forestry sector as one of the most

effective carbon sinks to mitigate and adapt to the Climate Change and its indispensable role in the conservation of ecological balance and biodiversity restoration. Green Tripura is prepared as per the guidelines of National Climate Change Action Plan-Green Mission.

### Key Facts

Tripura forest has rich floral biodiversity with rare species of orchids and medicinal plants. The recorded forest cover of the State is 8073 km<sup>2</sup>, which is 76.95% of the State's geographical area. In terms of forest canopy density classes the State has 111 km<sup>2</sup> very dense forests, 4770 km<sup>2</sup> moderately dense forest and 3192 km<sup>2</sup> open forest. However, the above given figure clearly shows that more than 50% area of the State is either non-forest or open forest and only 1% of the area is covered by very dense forest.

**Table : District Wise Forest Cover in 2007 (area in km<sup>2</sup>)**

Districts	Geographical area	Very Dense Forest	Mod. Dense Forest	Open Forest	Total	% of Total area	Change	Scrub
Dhalai	2402	3	1329	671	2003	83.39	-24	11
North Tripura	2039	10	925	541	1476	72.39	-32	34
South Tripura	3057	73	1390	1013	2476	80.99	-22	23
West Tripura	2993	25	1126	967	2118	70.77	-22	7
Total	10491	111	4770	3192	8073	307.54	-100	75

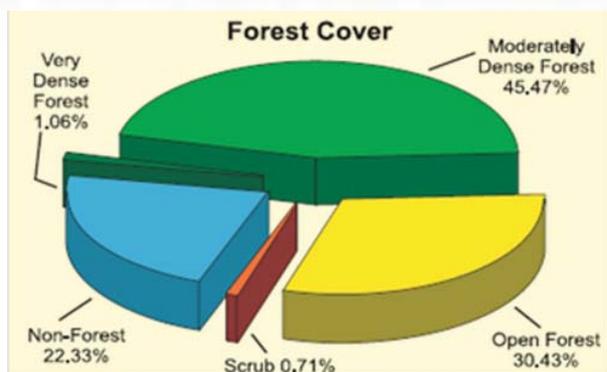


Fig: The distribution of forest cover in Tripura State (Source: FSI 2009)

### The Joint Forest Management (JFM):

JFM started in the State in 1991. There are 374 JFM Committees managing about 0.10 million ha of forest area which is about 17% of the forest area of the State. More than 33,000 families are involved in this programme, of which around 17,000 families belong to the Scheduled Tribes (FSI, 2009). An initial result of progress of Joint Forest Management (JFM) in the State has shown an overall increase in the level of forest protection and productivity, but the results are not consistent with each site. Level of awareness, attitude of forest officers, regular income flows, clear benefit sharing arrangements with identified communities and transparent sharing mechanism have been some of the key factors in developing successful JFMCs. Keeping in view these factors, Joint Forest management may be expanded significantly to cover all the areas of degraded forests, which can be rehabilitated through protection only or through protection plus enrichment planting. To make

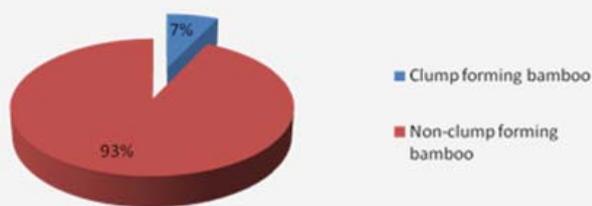
the Joint Forest Management Committees (JFMCs) more effective and to ensure their empowerment, institutions of local self governance would be involved in formation and functioning of JFMCs. Benefit sharing arrangements would be made more explicit and improved such as creation of user group fund to empower the user groups with sufficient resilience against financial crisis and shocks.

Bio-diversity of the state is dwindling at an alarming rate. Pursuant to the need for conservation and development of bio-diversity in situ, a network of 4 sanctuaries had been established in the state during the last decade. The State is located in the Bio-geographic zone of 9B-North-East Hills and is extremely rich in bio-diversity, which is getting increasingly threatened. Situated in the Indian sub-region of Oriental Zoo-geographic region, local flora and fauna bear a very close affinity and resemblance with floral and faunal components of Indo-Malayan and Indo-Chinese sub-regions. Bamboo plays a very vital role in the economy of the State as it serves the artisan & non-artisan users of the state. The bamboo forests of Tripura may be fitted into the following types & sub types as per Champion & Seth classification.

A total of 19 species of bamboo are reported in the state primarily Barak (*Bambusa balcooa*), Bari (*Bambusa polymorpha*), Mritinga

(*Bambusa tulda*), Muli (*Melocanna baccifera*), Kai (*Bambusa nutans*), Paora (*Bambusa teres*), Rupai (*Dendrocalamus longispathus*), Dolu (*Neohuzeaua dullooa*), Makal (*Bambusa pallida*), Pecha (*Dendrocalamus hamiltonii*).

**Weight of Bamboo found in state**



The research on status of flora identifying 379 species of trees, 320 shrubs, 581 herbs, 165 climbers, 16 climbing shrubs, 35 ferns, 45 epiphytes and 4 parasites (Total 1,545 taxa) reveal that there are 50 plants species restricted to Tripura and its neighbouring States. Out of them 7 are endemic and 18 are rare plants. *Angiopteris evecta*, a fern and *Gnetum montanum*, a giant climber belonging to Gymnosperm are two rare species but occur in profusely in Trishna Sanctuary. Tree ferns (*Cyathia spp.*) which are also primitive and endangered are found in South Tripura. There are 24 species of orchids of which and *Dendrobium* has the highest species diversity (14 species). Endangered orchids like Blue vanda (*Vanda caerulea*) and Red vanda (*Renunthera imschootiana*) are found in the state.

There are 266 species of medicinal plants in the State (68 trees, 39 shrubs, 71 herbs and 88 climbers). Maximum value of Plant-Diversity Index (Shannon-Weiner) reported is 5.23, which generally ranges from 3-4, indicating presence of a variety of species uniformly.

According to latest estimates, there are 90 mammal species in Tripura from 65 genera and 10 orders. Seven primate species have been documented in Tripura out of a total 15 found in India. Of these primates, slow loris and stumped tailed macaques have become rare. Phayre's langur (locally known as 'Chashma Banar'), has a very restricted distribution in India, and is found in Tripura. Hoolock gibbon is the only ape and found in India and is also found in Tripura, though, its population is on decline in Tripura. Ornithofauna comprises 342 reported species in the State, of which about 58 are migratory species one near threatened species – the darter.

The State has 10 major rivers running over a total length of 903 km across the State. All these rivers have watershed/catchments areas of over 9400 ha covering 6 major hill ranges.

### Key Issues

Shifting agriculture, logging, mining and other human activities have been responsible for fragmentation,

destruction and degradation of the forests in the state. High rainfall and hilly terrain have further accentuated the impact of human activities on the forest. Shifting cultivation (jhumming) has been identified as one of the main human impacts influencing biodiversity in Tripura. Over the last few years a new class of shifting cultivators has emerged that has adopted non-traditional forms of jhumming, which have been responsible for the loss of biological diversity in the state (Gupta, 2010).

A significant number of persons and families in Tripura continue to depend on forests and jhum cultivation as their main source of livelihood. In 1961 there were about 25,000 families dependent on shifting cultivation which rose to 51,265 families in 1999. In the year 2007, the Forest Department completed a first-ever Census enumeration of hard core shifting cultivators and found that 27,278 families were involved in this most destructive form of cultivation. As per the Forest department of Tripura the area under shifting cultivation is 840 km<sup>2</sup> which is 7.81% of the geographical area covered by forests.

The Forest Department's document (2000) noted an alarming rise of incidence of unauthorised felling causing an estimated amount of loss of Rs. 18.5 crore in annual revenue. The fast growth in population

(density 350 per square km., 2011 census) in the State, coupled with poor infrastructure and lack of alternative livelihood options resulted in mounting pressure on forest and forestland. This has also led to reduction in per capita forest area from 0.97 ha to a present level of 0.18 ha and encroachments and over exploitation of forest resources. Forest fires are common and frequent in the plains (around 20% of the total forest area of the State) as the villagers, at the end of winter, set fire to get flush of new grass for their cattle. (*Forest Dept, 2006*)

It is estimated that 60% of this animal population graze in the forest area and cause soil compaction and heavy damage to the forest plantations and natural regeneration areas (*Forest Dept, 2006*). The intensity of such disturbances, especially near the habitation, is far beyond the carrying capacity of the forests. Improving infrastructural networks and stop smuggling of forest resources are the key concerns of the forest departments.

### **Adaptation Pathways**

Ecological restoration of forests will have a mitigating effect on climate change besides addressing the concerns of poverty alleviation and biodiversity conservation. Therefore, forests have to be conserved and managed in a sustainable manner with the active participation of

local communities so as to ensure a continuous flow of benefits to all stakeholders, present as well as future.

Afforestation programmes will be taken up in the State. Sal, Teak, Gamar Garjan, Koroi, Agar, Arjun, Bahera, Bamboo, Medicinal plants and other miscellaneous species will be raised further. The productive potential of forests will be optimized by scientific management in accordance with working plan prescriptions and simultaneously the unique aesthetic value of forest landscape of the State will be sustainably managed and utilised through eco-tourism or nature tourism.

Adequate infrastructure, trained manpower and matching financial resources will be the pre-requisite for sustainable use of forest resource. In the backdrop of the essential need for maintaining a healthy forest resource, the valid concern for its continued depletion and degradation, and, also being aware of the close association between people and forests, the Government of Tripura, accordingly will adopt this policy.

Conservation, sustainable management of forests and enhancement of forest carbon stocks should be encouraged to offset emissions from core sectors of energy, industry and transport. Forest carbon stocks need to

be conserved and enhanced by reforestation of regeneration deficient and open forest areas. Unutilized areas suitable for tree growth shall be afforested by planting fast growing species to meet the energy requirements of local population in order to offset use of fossil fuels. Technologies for efficient conversion of energy from biomass may also be developed and popularized.

### **Key Priorities**

#### **Enabling adaptation of forest dependent communities to climatic variability**

The impact of the climate change has its direct impact on the resources of the State which in-turn can badly affect the livelihood and income of the local people. The employment potential of the people can be easily improved by imparting training in nursery raising, NTFP cultivation and harvesting, tailoring, carpentry, masonry, driving, computer applications etc. Emphasis is to be given to capacity building of the people, to take up alternate employment opportunities. By providing awareness and exposure through audio-visual aids and meetings under various rural development programmes, local communities shall be informed and provided improved technology in farm sector. Information and communication technology (ICT) offers new opportunities for

accessing information on emerging technologies and markets in more effective ways. ICT enables people living in far flung rural areas to take advantage of the poverty reducing opportunities offered by new technologies and marketing. The potentials for using ICT to widen access are important and compensate for the constraints imposed by poor linkages.

Various other schemes need to be formulated for forest dependent workers in order to produce industrial raw output and to maintain the desired percentage of forest coverage of about 40% of the total geographical area of state. The indigenous people may also be encouraged to undertake cultivation of cash crops like rubber, citronellas, pepper etc. The proper distribution of rubber seedlings and other planting material as well as for implementing some state and Central Government sponsored schemes for forest developmental works shall be precedence. A close liaison between the Forest Development and Plantation Corporation, Panchayats and local people shall be established to treat those forest areas which are having potentiality of income and livelihood generation. The below given adaptive capacity building strategy may be implemented to tackle the situation.

- Increase awareness and education within the forestry

community about adaptation to climate change.

- Determine the vulnerability of forest ecosystems, forest communities and society.
- Develop present and future cost-effective adaptive actions.
- Manage the forest to reduce vulnerability and enhance recovery.
- Monitor to determine the state of the forest and identify when critical thresholds are reached.
- Manage to reduce the impact when it occurs, speed recovery, and reduce vulnerability to further climate change.

Linkages between concerned department and these organizations like Krishi Vigyan Kendra (KVK), Village Forest Community's (VFCs) and extension wing of state forest department is very important. Therefore, the extension activity in areas of agriculture, forestry and horticulture has to be coordinated by providing technical guidance on management of all natural resources and any adverse climatic effects in this State.

### **Promotion of Urban Forestry**

Urban forests play a significant role in reducing levels of carbon dioxide and other greenhouse gases (GHG) in the atmosphere. Urban tree plantation (avenue as well as

city sub-urbs plantation) reduce atmospheric carbon dioxide (CO<sub>2</sub>) through sequestration and reducing GHG emissions by conserving energy used for space heating and cooling. Tree shade reduces summer air conditioning demand, but can increase heating energy use by intercepting winter sunshine. Lowered air temperatures and wind speeds from increased tree cover can decrease both cooling and heating demand. Air conditioning and heating savings result in reduced GHG emissions from power plants. Reduced emissions can be substantial, especially in regions with large numbers of air-conditioned buildings, long cooling seasons, and where coal is the primary fuel for electric power generation.

Urban forests emerge as an exciting opportunity to mitigate climate change, ameliorate air pollution, helps in improving overall water regime and nurture biodiversity in urban environment. Urban forests have been providing environmental services along with supply of fuel wood to urban poor. NSSO in 2006 estimated that around 21% of urban households use fuel wood as primary source of cooking. Increasing trend in urbanisation also has led to deterioration of air quality, increase in air temperature, increased noise level, alongwith water and land pollution thus emitting more GHGs in the atmosphere. Due to the unprecedented developmental

works in the Tripura the plantation of suitable tree species are urgently required. Plantation of indigenous fast growing species including species with ornamental values will be given preference. The selection of the area, extent taken up for treatment and choice of species may be finalized after consulting local inhabitants of the area. However, plantation in and around the recreational or public parks, lakes and water-bodies, colleges and schools, Government and non-government offices, along the roads and railway strips and around markets/shopping malls shall be given due importance. It is also important to insure that tree species meet the eligibility requirements, produce GHG reductions that are additional to a baseline, are sustained for at least 100 years, and do not detract from management of existing trees as well as emissions associated with their maintenance.

### **Agro Forestry and Social Forestry Promotion in Tripura to enhance Carbon Sinks**

Interest in terrestrial carbon sequestration has increased in an effort to explore opportunities for climate change mitigation. The Carbon sinks of forests and wood products helps to offset sources of carbon dioxide to the atmosphere, such as deforestation, forest fires and fossil fuel emissions. Proper design and management of agro-forestry practices can make them

effective carbon sinks and they can also serve to protect biodiversity to different extents. Being the best alternative to the shifting cultivation Agro-forestry is able to satisfy a large diversity of socio-economic needs in a sustainable way and has a direct impact on the micro-climate of the area.

Agro-forestry may contribute to human well-being in Tripura through a number of ways: by providing additional income, by increasing food security through a higher diversity of agricultural products (e.g. fruits, nuts, medicinal plants and edible oils), by providing fuelwood and construction material and thus reducing deforestation and controlling the adverse impacts of the climate change. Intervention of site specific Agro-forestry systems in Tripura state is also necessary to reduce the destruction of resources by shifting cultivation practices which will also help in controlling the emission levels.

It is well recognized that Social Forests and their ecosystems provide both products and services for local livelihoods. This makes social forestry an invaluable component of climate change mitigation and adaptation strategies implemented at the local level. Good forest management by local communities and indigenous peoples is exactly the type of effective and efficient response that will encourage and facilitate other forms of climate change adaptation.

The most practical support to forest dependent communities and indigenous people is to ensure that they have secure rights over forests and other resources, and are able to use those resources to diversify and strengthen their livelihoods. Planting of trees along roads, railway lines, rivers, streams and canals, and other available lands under State, institutional or private ownership is highly encouraged in social forestry. Development of tree crops and fodder species on village and community lands in partnership with local people of Tripura should be encouraged. The concerned department will provide planting material, guidance about selection of species, propagation/ plantation methods and sustainable harvesting of the resources to the local people. In this way development of agro-forestry and social forestry for improvement of carbon sinks will help in carbon sequestration of about 10 ton CO<sub>2</sub> equivalent per Hectare of area.

### **Rehabilitation of shifting cultivators and the restoration of shifting cultivated areas**

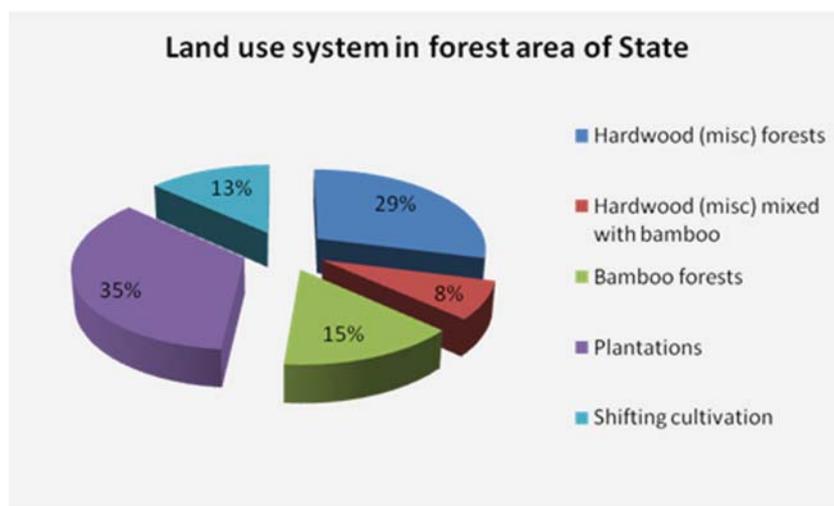
The huge forest areas burnt every year for preparation of jhum fields in Tripura not only degrade the soil and vegetation but also increase the GHG content in the environment. Exploitation of forests beyond their sustainable capacity has resulted in degradation and thereby severe impairment of their ability to

provide environmental benefits. The effects of degradation of forests are already visible in drying up of perennial water sources at many places in Tripura. It has accelerated the intensity of soil erosion, flash floods, silting up of reservoirs, loss of biodiversity and forest productivity. The destructed sites in the Tripura need to be rejuvenated on priority basis. Shifting cultivation can be replaced by suitable agro-forestry systems which provide range of benefits apart from providing environmental and social values. The adaptation of crop rotation to raise wild varieties of short as well as long duration crops at the same time would be helpful in recovering some percentage of crop yields even in the adverse climatic conditions.

tree species as they are directly related to the traditional and ethical values of the people. Sacred Groves are the loose ends of relict virgin forests which are quite different from the surrounding degraded forests. Thus these can serve as micro-level biodiversity hotspots. They also in a variety of ways contribute positively in reducing the impact of the climate change by creating carbon sinks in the form of worship and protection of sacred trees, sacred forests, sacred ponds etc.

Indigenous technical knowledge regarding the conservation of sacred groves needs to be respected and community systems need to be incorporated into the social and

### ***Land-use system in Tripura Forest area***



***Source: Draft Perspective Plan Tripura 2007-2013***

### **Conservation and promotion of Sacred Groves in Tripura**

The sacred groves can play a great role in conserving several important

biodiversity management plans of the area. While recognizing the social and cultural beliefs of indigenous communities of forest fringes villages in Tripura the Working Group has

decided to support Conservation and promotion of Sacred Groves in Killa, Jampui, Teliamura etc covering an area of approximately 100 acres. It is desired by the Forest Department of Tripura to carry out an in-depth survey and documentation of traditional conservation strategies, in collaboration with local societies and organizations which can be used to better understand how sacred groves have responded and adapted to changing climatic conditions.

### **Valuation of existing forest wealth of Tripura**

Conventional forest valuation approaches do not account for discretions foresters have in making key irreversible decisions, such as when and if to harvest in the light of uncertain future decision variables. Furthermore, where they are sufficiently sophisticated as to make explicit forecasts of future valuation parameters such as log prices at harvest date, as is the case for discounted cash flow (DCF) analysis, they do so with unavoidable imprecision. These shortcomings - as well of those of even less sophisticated methodologies such as cost- or transaction-based valuations - become telling when attempting to assess the impacts of long-term climate change policies on forest values. Climate change policies can affect both forest value and optimal forest management, as they relate to and affect future decisions regarding the conversion

of forest land into different other entities.

Complete forest valuation has not been conducted in Tripura till date. Considering natural forests in Tripura, the commercial and direct value of forest is not sufficient for evaluation of the forest resources. The direct annual revenue from forests of Tripura State is estimated to be only Rs. 300 lakhs. However the subsidy that flows to the rural economy on account of free removal of five items of forest produce has been conservatively estimated to be Rs. 12,926 lakhs, which is about 5.57% of State Domestic Product (SDP). This does not take into account edible fruits, tubers, medicinal plants and many other non-timber forest produce. The total Forest valuation is required in the state to identify the actual forest revenue and its contribution to state GDP. Climate Change Action Plan working group recognised the importance of the total valuation of forest resources to better appreciate non marketable eco system goods & services.

The valuation of the forest resources is one of the most important tasks for the proper protection and conservation. Survey to assess the bio-resources including the forest wealth of the state shall be made following the national and international criteria and indicators. There are many uses of forest that are directly or indirectly consumptive

and durable or non-durable. These are conservation, recreational benefits, the commercially available benefits (i.e. newsprint, cardboard, building materials, edible fruits, woods, fuel woods etc.), eco services (i.e. bio-diversity, climate regulation service, soil erosion control, etc.)

The major thrust areas in this activity are:

1. Developing multi-product and multi-tier forest plantations which tend to maximize diversity, ecological benefits and economic benefits accruing to local people.

### **Forest Statistics of Tripura**

**2006**

Year	Forest area (Sq. Km.)	Major Forest Product	Minor Forest Product	Value of Total
1994-95	6292.68	98.07	63.80	161.87
1998-99	6292.68	28.40	58.19	86.59
1999-00	6293.68	29.94	78.59	108.53
2000-01	6292.68	60.52	121.33	181.85
2001-02	6292.68	107.22	94.22	201.44
2002-03	6292.68	163.62	120.95	284.57
2003-04	6294.29	89.67	108.26	197.93
2004-05	6294.29	96.48	71.61	168.09
2005-06	6294.29	136.65	78.32	214.97

*Source: Draft Perspective Plan Tripura 2007-13*

### **Improvement of Tree Canopy covers by enrichment plantations**

One of the best tools of improving the tree canopy is enrichment plantations in the moderately dense and open forests of the State which have a direct impact on the climatic conditions of the area. This will increase the productivity of the existing forest area and supports continued eco system goods and services. This activity will also help in effective implementation of the Tripura State Afforestation Policy.

2. Promoting plantation of indigenous species which have become endangered or extinct.
3. Increasing the productivity of natural forests and plantations by providing appropriate research inputs and management practices.

Development of tree crops and fodder species on village and community lands in partnership with local people. Encouraging farm forestry and agro-forestry by providing quality growing stock and other technical inputs to farmers

and developing market linkages for proper sale of their produce is very essential.

### **Promoting rural households to adopt fuel wood efficiency and improved Chulhas, Biogas Etc.**

The state is rich in bio-resources and energy derived from these resources are of low emission as well as sustainable in nature. Major source of cooking fuel in the state is yet fuel wood. This is used in traditional *chullahs* having an efficiency of the level of 10-12%. According to estimates of the World Health Organization, more than 1.6 million deaths and over 38.5 million disability-adjusted life-years can be attributable to indoor smoke from solid fuels affecting mainly children and women. Significant improvement in efficiency in this sector can be achieved through use of improved chullahs thus saving the forest as well as reducing the emission level. The State will take suitable action plan for introduction of improved stoves for family / community level at policy level or through subsidized cost. These interventions to suppress or reduce indoor exposure include behavior changes, improvements of household ventilation, improvements of stoves, and, outstandingly, transitions to better and cleaner fuels.

Biomass gassifiers may be encouraged for installation by small entrepreneurs / industries

on suitable buy back policy or incentives. Dedicated plantation for such plants should also be tied up. Biomass gassifiers can generate power to feed the grid or to cater the decentralized requirement of power in villages. Alternative fuels, such as LPG, are easier to use, produce fewer emissions and cause less exposure to pollutants. Cook stoves will also have social (e.g. time-saving), ecological (e.g. tree-conserving) and economic (e.g. fuel-saving) benefits. The Ministry of New and Renewable Energy (MNRE), Government of India has been promoting improved cook stoves (IC) which could significantly save fuel wood and thus reduce pressure on the forests. This activity will reduce GHG emission in the State.

### **Strengthening of Forest Department (Infrastructure & Capacity Building)**

Capacity building measures shall be undertaken for personnel in forest and environment sector to improve their skills and professional competence keeping in view the arduous nature of their duties, often in remote and inhospitable places. For effective implementation of forest and environmental laws, regular trainings on legal aspects of forest and environmental issues need to be conducted for forest personnel. Adequate infrastructure and professionals need to be provided to meet the training requirements of all levels of forest staff keeping in

view the current needs and future trends in forestry management and administration.

These adaptive measures will help in the proper conservation and proliferation of forest quality and cover within the state which will help in better carbon sequestration in near future.

### **GIS based Monitoring and Evaluation programme**

Global information system is also an important tool to digitise the evaluation and scientific management of the resources. It plays a great role in monitoring, creation or demarcation of reserve forests, creation of National parks/ Wildlife Sanctuaries including afforestation / reforestation areas. In order to ensure an integrated approach at village/cluster/sub-landscape/sub-watershed level, the forest department will need new capacities. The Mission would support upgradation of the Range Office into a forest and wildlife resource centre (with library, documentation, map room, GIS and MIS cell facilities).

GIS-based framework helps in gaining a scientific understanding and to make informed decision making on Deforestation analysis and implementing successful reforestation programs and sustainable forest management.

Teams of Subject Matter Specialists

at Range and Division level (on contractual basis) will bring in new knowledge and skills. The arenas include: Information and Communication Technology (including RS/GIS capabilities), community mobilization, watershed/Soil moisture /water harvesting; finance, ecological restoration / REDD issues etc.

### **Forest Fire management**

Management of forest fires is an important aspect of forest protection. Forest Survey of India (1993) has estimated that forest fire has led to heavy to moderate degradation of around 6.16% of the forests. The forests atop all the hills in the State get burnt due to Jhum fire which spreads to nearby forest areas. This cause's immense harm as catchments completely wipes out regeneration (natural as well as artificial). It also adversely affects already threatened wildlife species. The main constraints in control of forest fires are lack of communication facility for early detection of forest fire and also the lack of firefighting equipment. Proper equipment and trained manpower shall be needed for effective management of forest fires in vulnerable areas. Involvement of local communities in prevention and control of forest fires need to be further strengthened through incentive based mechanism. Removing fire hazards, creating fire lines, improving fire monitoring

systems and quick identification and reporting systems are very significant for prevention and management of the forest fires in the state. This action will help in protecting the forest area which will lead to better GHG sequestration in near future.

### **Strengthening local level institutions about Forest Management Climate Change Adaptation including community forests**

Given the fast changing rural scenario with increase in the number of educated unemployed/underemployed youth, the Mission would support development of youth cadres to lead the charge at the local level. Support of research institutions, universities/colleges from local area, Forest Department and NGOs would help develop this cadre as Self Employed Change Agents (SECA). The cadre of community youths will help Mission activities at the local level with active support of Forest Department and other agencies. This will also augment capacity of Forest Department to facilitate Mission activities with existing regular staff.

Extensive capacity building and training is also required for forest communities. These activities are to building adaptive capacity among Community Forest Management Institutions and communities towards Climate Change Adaptation

for increasing the forest cover, protection and reduce the climate change impact. This can be planned and proceed as component under JFM for better capacity building and training of the stakeholders and JFMCs.

### **Livelihood improvement Activities**

Climate change impacts are already being observed, signaling an urgent need for response measures that minimize current vulnerabilities. By protecting and enhancing the natural services that support livelihoods, vulnerable communities can maintain local safety nets and expand the range of options for coping with disruptive shocks and trends. The forest dependent communities are mainly economically fragile and rely on forest resources for a range of basic needs like food, shelter, clothing and heating. Promotion of alternative livelihood improvement activates such as Rubber plantation, Bee Keeping, Poultry and engagement in protection activities will motivate the communities to protect the forest and to gain economic benefits. Enhanced outlay for developmental works have resulted in creation of 9.83 lakhs mandays during the year 2004-05. The people get gainful employment in collection of bamboo and minor forest produce and selling them in the market and other ancillary activities such as value additions. This adaptive measure will help in

improvement of livelihood of the forest dependent communities and also encourage forest conservation which will ultimately result in GHG sequestration.

### **Increasing plantation activities on outside forest land**

The State has a forest cover of its 8073 Sq. Km of geographical area as per the FSI which is around 77% of State's Geographical area. Out of the total forest cover more than 50% of the area constitutes Open Forest, Non-forest and Scrub forests. It is planned to double the area to be taken as a target for next 10 years i.e. the project period envisaged. This constitutes total plantation target of 268,560 ha. This target is proposed to be achieved through enrichment planting within the forest area, outside the forest areas, etc. on mission mode as was conceived under this Green India Mission. The interventions needed for the State include Assisted Natural Regeneration, Artificial Regeneration, Pasture Development, Bamboo Plantation, Mixed plantation of NTFP species and Energy Plantation on the outside forest land in Social Forestry Model

### **Establishment of Mission Directorate**

Department of Forest, Government of Tripura wants to establish a mission directorate, for Monitoring and Evaluation of forest development

program of Tripura. The body will coordinate all forest development issues to achieve the desired target for climate change adaptation and mitigation. The establishment of mission directorate will ensure the proper implementation of the key activities which is of prime focus for reducing the climate change impacts and adaptation strategy formulation by enhancement of the forest quality and cover within the state.

### **Establishment of Wildlife corridors for wildlife conservation**

Maintaining biodiversity in the context of a changing climate will require biodiversity management strategies beyond those of an individual park or reserve. The most important strategy will be leveraging our current system of nature reserves by creating corridors of connectivity between protected areas. To help animals survive climate change, setting aside nature reserves isn't enough to flee habitats made inhospitable by shifting climes; they also need "corridors" between wilderness areas. The protected area network of the Tripura is spread over the four wildlife sanctuaries covering an area about 6% of the total geographical area of state. There is no designated National Park in the State however; the Forest Department has proposed to constitute one National Park out of about 40 km<sup>2</sup> core areas of the Trishna Wildlife Sanctuary

and one more Wildlife Sanctuary (Atharamura WLS) especially for the conservation of elephants.

Wildlife corridors and animal rescue centres shall be further developed. Special attention will be given to address the man-animal interface through a joint mechanism between agencies such as Forest Department, Forest, Wildlife Protection Department, Revenue Department, Police, Local Administration and local institutions and by creating awareness amongst general public.

### **Enhancement of community livelihood through Biomass and NTFPs**

The economic development of forest dwellers is heavily dependent on Biomass and NTFP, as these people live in the forest fringe areas where land is inhospitable and agricultural yield is not only low but also uncertain. Training and information related to cultivation, non-destructive harvesting, value addition and marketing channels must be provided to the target groups. Package of practices for cultivation of medicinal plants shall be developed and farmers will be encouraged to undertake cultivation of such medicinal plants and tree species on non-forest lands and private lands. Value addition and processing of non-timber forest produce within the State need to be encouraged along with development of market linkages and trade

related information so that these are not exported in raw form, and producers get remunerative price for their produce. Therefore, high importance will be accorded to making forest policies and strategies for the sustainable management and marketing of NTFP and the development of the forest fringe dwellers, in particular, scheduled tribes, whose livelihood is closely bound with the issue of sustainable production.

### **Sustainability of afforestation activities through income generation from CDM and Voluntary Markets**

The Clean Development Mechanism (CDM) aims to direct private sector investment into emissions-reduction projects in developing countries while promoting sustainable development in these countries. Tripura Forest Development & Plantation Corporation Limited (TFDPC) has implemented and also planning to implement vast plantation projects on degraded lands with the participation of rural communities within the state. TFDPC efforts in raising plantation of Rubber in more than 11000 hectares in the degraded forest areas has resulted in to a significant increase of forest cover which can compensate in Reducing the Emission from Deforestation and Degradation (REDD) mechanism. REDD+ is a climate change mitigation mechanism that would

compensate Tripura for keeping their forests standing and also conserve more habitat and ensure greater ecosystem services functions. The funding from REDD or REDD+ on TFDPC Rubber Plantation areas will boost scaling up Rubber Plantation and promoting increasing conservation based livelihood in the local communities in Tripura.

The objective of this activity is to reduce poverty in relation to an environment that enables active participation of rural communities in an array of climate change mitigation activities. This activity enables the communities to gain carbon revenues for the existing and future plantation programmes under TFDPC.

### **Certification of Rubber wood coming from Sustainably Managed Forests**

Forest Certification is still in very nascent stage in India. To address this issue Green India Mission has specially emphasized on promoting the Forest Certification. In line with the National Mission, Green Tripura proposed this activity to promote Forest Certification for the TFDPC Rubber plantation to fetch premium price for its Rubber.

Forest certification was introduced in the early 1990s to address concerns of deforestation and forest degradation and to promote the

maintenance of biological diversity. Initially pushed by environmental groups, it quickly evolved as a potential instrument to promote sustainable forest management (SFM). This SFM certification of TFDPC Plantation enable premium market price for the Rubber. This activity will increase the revenue inflow which will be used for sustainability, conservation of the rubber plantations and livelihood improvement of the dependent communities.

### **Energy Conservation within Rubber Processing federation of TFDPC**

A detailed energy audit in TFDPC Rubber Industry involves data collection, measurement, comparison of measured data with a standard benchmark, analysis of data, identification of losses, identification of energy saving potentials and recommendation for reduction in operating cost. The primary objective of Energy Audit is to determine ways to reduce energy consumption and provide the basis for planning a more effective use of energy throughout the organization in accordance to the best practice benchmark in the sector. This action will help in reduction of energy consumption in the processing plants and also reduce the GHG emissions to the atmosphere.

# Sustainable Agriculture

## Introduction

Agriculture is the dominant sector of State's economy with a contribution of nearly 30% to the Net State Domestic Product (NSDP). The sector provides employment to 51% of total work force in the states and it is the single largest private sector occupation. Availability of cultivable land is one of the main constraints in the state. Tripura enjoys a typical monsoon climate with variations ranging from sub-tropical to temperate conditions in hilly areas. The climate of Tripura exhibits a strong seasonal rhythm. In Tripura the monsoon period is lasting for about 5 months from May to September which is the longest season of the State. The amount of total annual rainfall in the State varies between 1500 mm. to 2500 mm. The maximum and minimum temperatures during winter are 27°C and 13°C and in summer are

35°C and 24°C respectively.

The pH values of Tripura Soils vary from 4.05 to 6.05 and more than 90% of the Soils of Tripura pH is below 5.6 and slightly acidic in nature. On an average 52.1%, 22.5% and 25.4% soils are medium, low and high in organic carbon content respectively. About 60.5% soils are deficient in phosphorous, 26.9% soils are medium and 12.6% are high in available phosphorous content. Low available phosphorous content is related to strongly acidic soil condition. In the State as a whole 67.3% of the Soils are low, 24.7% soils are medium and 8.0% soils are high in available potash content. Shifting cultivation prevalent in the region is responsible for removal of most fertile top soils from slopes.

Importance of the climate threat to agriculture is now explicit, but the exact magnitude is doubtful

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- 1 (<http://www.agritripura.in/Agriculture/Pages/agro.htm> accessed 3rd November, 2011)
  - 2 (<http://www.agritripura.in/Agriculture/Pages/agro.htm> accessed 3rd November, 2011).

because of complex interactions and feedback processes between the ecosystem and the economy. Climate-related factors will affect productivity of agricultural sector in coming decades are: changes in temperature, precipitation, carbon dioxide (CO<sub>2</sub>), fertilization, short-term weather variability and surface water run-off. Due to change in the climate factors in Tripura there will be higher incidence of droughts and floods which will affect both rainy (*kharif*) and winter (*rabi*) season crops. In Tripura numbers of high-value crops are grown during the rabi season, so the negative impact on farmers' economy would possibly be higher and since Tripura is agricultural based economy, naturally the GDP will be affected. The research on the relationship between crop yields and changes in rainfall, temperature and CO<sub>2</sub> concentration and their effect on yield changes are very few. So some Adaptation and mitigation strategies is urgently needed to address the impact of climate

change on agriculture through new research and proper interpretation of the accumulated research results under different agro-climatic settings.

Three types of Green House Gas (GHG) generates from agriculture are

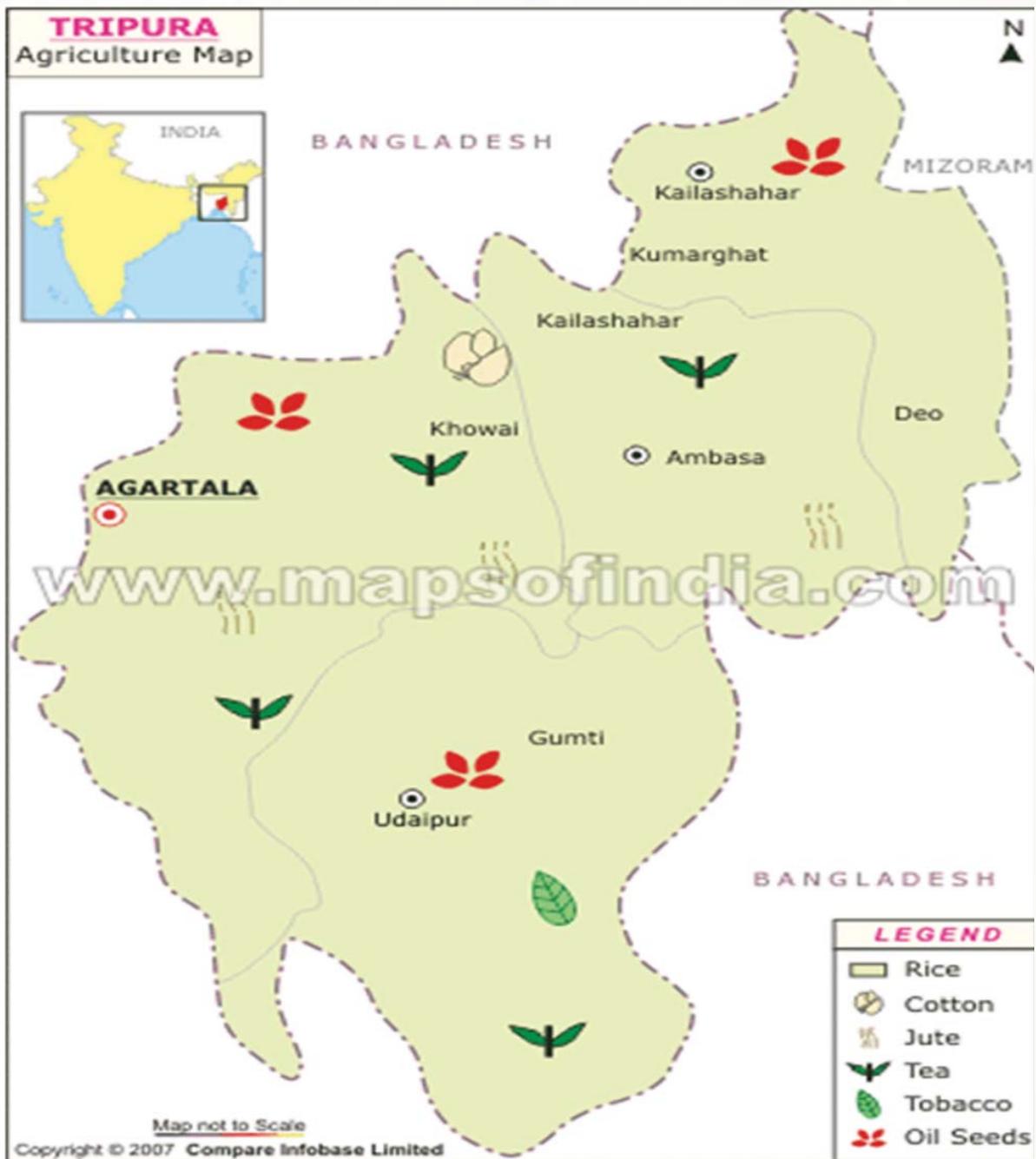
- 1) Methane (CH<sub>4</sub>) emissions from irrigated rice production,
- 2) Nitrous Oxide (N<sub>2</sub>O) emissions from the use of nitrogenous fertilizers and the release of CO<sub>2</sub> from energy consumption from groundwater pumping for irrigation.

Livestock-based Methane emissions are also significant in agriculture sector. But from the above three sources we have huge opportunities for cost-effective mitigation of GHGs in agriculture sector of Tripura. Tripura Government already incorporated some of the mitigation activities by which they can mitigate GHG emission from agriculture sector.

#### GHG Emission in Tripura Agriculture

Region	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	PFC	HFC	SF <sub>6</sub>	Total
World (million Mt)	28,485	6, 408	3286	108	381	60	38,726
India (million Mt)	1222	548	71	3	8	2	18,53
Indian Agriculture (million Mt)	0	317	58	0	0	0	375
Tripura Agriculture (Gg)*		19	0.04	0	0	0	412

Source: WRI, 2009, CURRENT SCIENCE, VOL. 87, NO. 3, 10 AUGUST 2004\*



Source: Maps of India.

### Key Facts of Agriculture:

Paddy is the major crop in Tripura which contributes about 98% of the total food grain production. (*Annual Agriculture Plan 2010-11*) The rest of the cultivable area are used for wheat, maize, pulses, oilseeds, potato, vegetables, different fruits

& plantation crops, tea and rubber cultivation.

The year being divisible into three crop seasons namely pre-kharif, kharif and Rabi. Pre-kharif, kharif is dependent on rainfall of pre-monsoon and monsoon followed by Rabi on irrigation and seepage

water. Availability of rainfall is one of the most important factors in the field of agriculture. The following

table is giving provisional existing crop distribution pattern of Tripura (2009-10\*).

Crops	Area in Hectares	% to total Gross cropped Area
Paddy	244600	54.54%
Maize	1918	0.43%
Wheat	700	0.16%
Pulses	6170	1.38%
Oilseeds	3423	0.76%
Jute & Mesta	1194	0.27%
Cotton	965	0.22%
Sugarcane	859	0.19%
Horticultural Crops	94107	20.98%
Tea	7977	1.78%
Rubber	45459	10.14%
Others	41120	9.17%
<b>Grand Total</b>	<b>448492</b>	<b>100.00%</b>

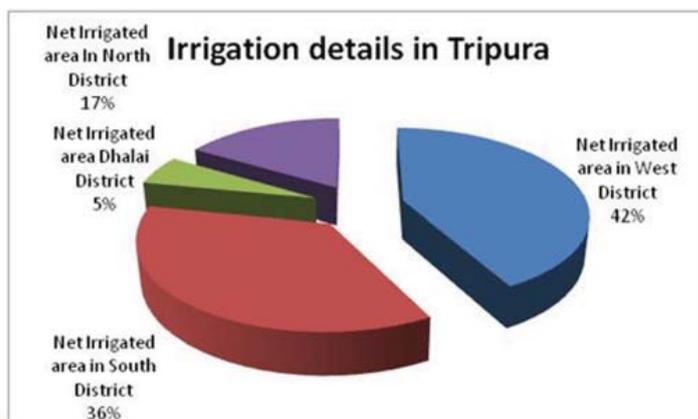
Source: Approved Annual Agriculture Plan 2010-11, Tripura, \*Provisional

Total Gross irrigated area in Tripura is 1, 17,000 ha, out of which 51,018 ha are under net irrigated area. Out of net irrigated area maximum land is under West Tripura District.

#### Details of Irrigation activities

Sl. No.	Item	Unit	Tripura (2008- 09)
1.	Gross Irrigated area	Ha	1,17,000
2.	Net Irrigated area	Ha	51,018
3.	Net Irrigated area in West District	Ha	21,520
4.	Net Irrigated area in South District	Ha	18,325
6.	Net Irrigated area Dhalai District	Ha	2,778
5.	Net Irrigated area In North District	Ha	8,395

Source: Approved Annual Agriculture Plan 2010-11, Tripura



Source: Approved Annual Agriculture Plan 2010-11, Tripura

## Land classification of Tripura

Sl.No.	Category	Area in Sq. Km.	Percentage to total geographical area
1	High Area	4000	38%
2	Tilla land with moderate steep slopes	1600	15%
3	Tilla land with gentle to moderate slope	700	6.7%
4	Rolling Topography	2149	20.5%
5	Plain land	2042	19.8%
Total Geographical Area		10491	100%

Source: Approved Annual Agriculture Plan 2010-11, Tripura

In the present scenario of Tripura's Agriculture, the government wants to do some GHG analysis, so that they can reduce their GHG emissions in Agricultural sector through proper Mitigation and Adaptation activities. The agriculture sector will have to be ready with its future plan of action against upcoming uncertainties of climate change.

### Key Priorities

According to the estimate, agricultural practices account for 20% of India's total emissions; thus, cost-effective reductions in agricultural emissions could significantly lower India's overall emissions (IFPRI, 2009). Agriculture has immense opportunities for cost-effective mitigation of GHGs. Through discouraging the use of carbon-intensive electricity for extraction of groundwater from deep aquifers we can mitigate CO<sub>2</sub> emission.

SRI method of rice cultivation can reduce methane emissions from traditionally irrigated rice

Within the identified key priorities with high importance 27 actions are adaptation activities and 1 action is mitigation activity. The high priorities identified based on the basis of cost effectiveness, cost-benefit, feasibility, ease of implementation and overall sustainability. Within the 28 key priorities are under the Agriculture and Allied sector 12 key priorities are under Agricultural and Horticultural Sector, 8 key priorities are under Animal Resource Development Department (ARDD), 4 key Priorities are under Department of Fisheries and 4 Key Priorities are under Indian Council for Agricultural Research (ICAR) with Department of Biotechnology. The total budget proposed for the eight key priorities along with sub activities is 795.80 Crore INR.



- **Rapid screening and strategy assessment of State agriculture policy**

Taking consideration of different climatic scenario, arising due to change in rainfall and temperature, lots of uncertainty may affect the agriculture. So short terms as well as long term agriculture policies related to the inputs for the production of crops such as cereals pulses and oil seeds along with irrigation and fertilizers need to be screened in view of the possible climate changing scenario along with strategic assessment. Thus the modifications to be required in implementation approaches may be identified to cope up with the climate change.

- **Climate Change Impact studies on Coconut and Orange Production**

The impact of climate changes on horticultural sector in particular is a matter of concern. Particularly

Tripura is endowed with favourable geo-climatic conditions for horticulture. The vulnerability of low-capital horticulture to climate change however, depends upon the climatic condition. The affected farmers can adjust the production of horticultural crops to changing climates. Framers of Tripura depend highly on the agriculture for their livelihoods and are likely to be most affected by the climate change. Government of Tripura wants to determine the appropriate adaptation and mitigation strategies for the farmers; so they can adapt to climate change without getting affected. Therefore, an understanding of the impact of climate change on horticulture crops especially coconut and orange in the Tripura is likely to be critical for the distributional effects of climate change as well as the potential benefits of policies to reduce its harmful effects. So a research is necessary on impact of climate change on horticultural

crops especially for coconut and orange.

- **Undertaking capacity-building**

Climate change being a new challenge for agriculture/ fishery, precautionary measures are to be undertaken for the better management of land, water & crops in the context of climate risk through capacity building and technical support to the farming community of Tripura. Stakeholder's consultation, training, workshops and demonstration exercise are to be carried out keeping note of agri-climatic information, sharing & dissemination for the field functionaries of department of agriculture. New technologies related to climate change are also to be disseminated by use of information technology with the initiative of the related department. Regional data base for the soil, weather, crop genotypes, sustainable land use patterns and water resources are also to be developed.

- **Risk management in agriculture and allied sectors**

New credit and insurance mechanism should also have to be devised to facilitate adoption of desired practices. Wherever in the event of any risk due to vagaries of climate change, compensation for farming community is to be

arranged so that, they may not reject new initiatives or technology related to climate change. This will give economic security from the calamities of climate.

- **Breeding studies on major crops for tolerance/resistance**

Climate change may cause devastation through drought and flood like situations resulting into change in crop physiology and an increase in insect pests and diseases. To combat the situation, breeding strategies are to be under taken for development of genotypes of different major crops having climate resistant characteristics to these multiple stresses. Thrust should also be given to develop resilient crops for better water and nitrogen use efficiency which may result in reduced emissions of Green House Gases. Besides these programme for germplasm conservation to maintain the species through Gene Bank may be under taken which may be exploited as breeding material and also for release of varieties which are suitable under biotic and abiotic stress conditions due to climate change.

- **Establishing an effective institutional delivery mechanism to promote best practices on climate change**

In the coming days the Agriculture Sector of Tripura will be required to cope up with the impact of

climate change. Though the nature & location of impact cannot be predicted earlier, for that the institutional delivery mechanism in respect of Agriculture, Horticulture, Soil & Water conservations along with Research needs to be strengthened to cope up with the climate changing scenario. The department is to analyze weather data to identify the trends in climate variations and its effect on agriculture and horticulture production. This knowledge will be transferred to the farmers through cluster level training and in this way farmers will be able to make suitable decision about their cropping pattern.

- **Utilization of Bio-resources (Organic wastes, plant wastes, leaf fall droppings etc) towards preparation of organic manure**

Organic wastes, plant wastes, leaf litters and droppings will be subject to degradation and production of methane in the atmosphere. Utilisation of these organic matters for production of organic manure is necessary to mitigate the adverse impact of methane emission to atmosphere. By means of vermicomposting or aerobic composting process in a pit system of 3m X 2M X 1 M will reduce 9 ton of CO<sub>2</sub> equivalent per year. Such small scale decentralized vermicompost pits will help in preparation of organic fertilizer and also help in mitigating the

unavoidable methane emission to the atmosphere.

- **Developing livelihood – focused, people- centric integrated watershed development in rain-fed areas**

Climate change is likely to cause high variability or rainfall, drought and dry spells and flash floods during the rainy season. At the grass root implementation level, the integrated watershed approach is the most appropriate way to cope with these changes. Both agricultural growth and enhancement of land productivity is to be ensured in these rain fed areas that are vulnerable to climate variations. Livelihoods interventions are to be implemented in the form of cropping system strategy, Pisciculture, livestock promotion, non timber forest products collection, marketing and various other land based income generating activities. In this regard, for ensuring sustainable fishery some measures should be taken which can also address the climate change concern in the sector. As a part of the livelihoods intervention, steps are also taken to improve the quality of life through improved sanitation and other health interventions. There is enough evidence of success in implementing projects under the Tripura Watershed Development Mission. There will be a continued investment in integrated watershed development programmes in climate

sensitive areas and in furthering their replications across Tripura.

- **Development water use-efficient micro irrigation methods and individual/community farm ponds**

Water availability is expected to become uncertain due to climate change. This will require the development of water-use efficient micro irrigation methods such as different drip irrigation systems and individual/community farm ponds to cater to their water requirements. This initiative will be implemented as a demonstration project in selected areas. These adaptive measures in the agricultural sector will help to cope up with the scarcity of the water which may affect by uncertain rainfall within the state. It is observed that micro irrigation methods also help in reducing the energy consumption in water pumping activities.

- **Developing sustainable soil, water and crop management practices**

Popularization and implementation of Integrated Nutrient Management (INM) along with soil amelioration, improved methods to conserve soil and water and preparation of soil fertility map for the state is required to be under taken from time to time. Precision use of available water along with efficient crop management practices like System of Rice Intensification (SRI) and dry

land farming will have to be under taken to cope up with drought like situations which may arise due to climate change.

- **Improving pest monitoring and surveillance technique**

Climate change may influence the present pest scenario by increasing or decreasing insect pest or disease, infestation/incidence and severity. To combat the situation improvement in monitoring and pest surveillance is required. Appropriate new farming techniques for plant protection measures will be undertaken on the basis of information gathered from monitoring and surveillance.

- **Research study on the Climate Change Impacts on the Reproduction of Cattle, worm infestation, milk Production and vector borne diseases for domestic animals**

Heat stress has been accounted to decrease reproductive performance in dairy cows. In Tripura there are a number of changes in reproductive performance that have been reported. The effects on reproduction can be prolonged and impact the animal for months after the heat stress exposure. Temperature and rainfall variations have increased the incidence of vector-borne diseases. To minimise the impact of climate change on animal health and reduce the adverse effect of vector borne diseases, the state plans to carry out a study on impact of climate

change in livestock and poultry, ensure vaccination of farm animals against contagious diseases, deworming and early disease warning system, develop a breeding policy and use biotechnology to breed genetically climate resilient breeds of farm animals and increase the availability vaccines.

Due to heat stress milk production for cows also decreases. This decrease can be either transitory or longer term depending on the length and severity of heat stress. These decreases in milk production can range from 10 to 25% or more. If heat stress lowers milk production in early lactation dairy cows, potential milk production for the lactation will be decreased. Dairy cows in later lactation may recover slowly from the effects of heat stress. Two dairy plants have been setup in Tripura. One is at Agartala and another is at Dharmanagar with capacity 19000 and 4000 liter per day respectively.

- **Adaptability good milch breed of cattle such as Sahiwal, Gir and Red Sindhi, Jersey and Holstein cross, rearing and bio gas production with milk chilling plant**

Indigenous animals are strong, are endowed with quality of heat tolerance, resistance to diseases and ability to thrive under extreme nutritional stress. Out of three breeds Milch breed is one of them. Milch breeds, like Shaiwal, Red Sindhi and Gir which calves between

40 to 50 months and produce 1000 to 2000 liters in lactation and have a calving interval of 15 to 18 months. non descript cattle gives first calve at an age of 60 months, and produce about 500 Kgs in a lactation and have a calving interval between 20 to 24 months. Non-descript cattle will be bred with exotic semen to produce cross breed with Holstein Friesian or jersey and maintain 50% exotic impenitence. In Tripura Red Sindhi, Tharparkar can also used upgrading non-descript cattle. The cows of these breeds are of high milk yields and the male animals are slow or poor work animals. The milk production of milk breeds is on the average more than 1600 kg per lactation. Jersey breed was developed from the island of jersey in the English Channel off the coast of France. The Jersey is one of the oldest dairy breeds, having been reported by authorities as being purebred for nearly six centuries and the Milk yield is 5000-8000 kg. Holstein Friesian is originated in Holland. This is by far the best diary breed among exotic cattle regarding milk yield. On an average it gives 25 liter of milk per day, whereas a cross breed H.F. cow gives 10 - 15 liter per day and Milk yield - 7200-9000 kg. These breeds will help in enhance the economic sustainability of the farm based economic development. This adaptive measure will also help in the food security and economic upliftment of the farm sectors of the state.

Generation of biogas is possible from the degradation of manure produced from the cattle. State of Tripura is having about 10 lakhs of cattle population. From the generated dung up to 100000 m<sup>3</sup> biogas can be generated which translates to 50,000 units of energy or translates to equivalent of 6500 LPG cylinders every day. This would meet about 25% of the cooking energy requirement of the state. This activity will address the energy security of the state and also will mitigate the emission of GHG to the atmosphere.

but also the fluctuation of the temperature. This naturally occurs during the temperature change from daytime to night time. Government of Tripura wants to do a research study on impact of temperature increase on Broiler production. The research study will help to understand and develop better adaptive strategies for poultry production. This activity will also help in food security of the state and economic benefit of the poultry farms.



*Jersey and Holstein Friesian*

- **Study on Performance of Broiler Production in High temperatures**

High temperatures coupled with high humidity can be shocking to commercial broilers. Heat stress interferes with the broilers comfort and suppresses productive efficiency. Although increased heat is seen as a major problem in poultry production, egg production. Studies show that it is not only the excessively high temperatures,

- **Integrated watershed management for Fodder and nutritional security**

Integrated watershed management is the key issue to prohibit land degradation, draught and poverty. Agriculture and water are closely linked. Agricultural productivity has to be increased significantly within the state through development of watershed. This will in one hand reduce the soil erosion in surrounding area and introduction

of leguminous species will also enhance the availability of fodder for the livestock and also can enhance the nutritional security of the area. Integrated land and water resources management, efficient use of water resources and safe reuse of waste water are vital for climate change adaptation. In Tripura the government wants to begin adaptation efforts now, because institutions and the infrastructure will bind the patterns of water use and behavior for years to come. Due to Integrated watershed Management the average productivity of arable land will increase and can be attributed to large area under improved varieties and higher cropping intensity.

- **Research study on supply of animal feedstock and feasibility of rubber seed cake as feedstock in drought seasons**

Due to increase in summer season and uncertain rainfall, the state might face shortage of animal feedstock. This will lead to the population degradation of the livestock which will lead to the economic stress. Tripura has huge production of rubber seeds which is underutilised within the state and can be used as alternative feedstock for animals during draught or extended summer season. Government want to conduct a research study on feasibility of rubber seed cake as a feedstock of animals which might be helpful for

overall climate change adaptation of animal population during the natural calamities.

- **Adaptability of low input technology like Kuroialer, Gramapriya and Kalinga Brown**

The organised sector poultry industry has been clocking a healthy annual growth of nearly 5.7 per cent in egg production and 12.5 per cent in broilers output. But the rural poultry sector has not displayed such dynamism. The latest available numbers reveal that chicken population in the rural areas has grown from 63 million to only 73 million in the past 35 years, resulting in static, if not lower, per capita consumption. The position of Tripura is also same.

The main constraint in Tripura is the lack of suitable birds for rural poultry. Although the native chicken varieties are strong, well-adapted to harsh living conditions and relatively immune to many of the common diseases of commercial poultry birds but their productivity is low. The birds bred specifically for commercial poultry farming, on the other hand, are unsuitable for backyard poultry farming as they cannot survive under those conditions. Nor is the technology for commercial poultry rearing suitable for rural areas. It will also not be economically viable to try out the modern poultry management in the

backyard poultry due to high input costs.

Therefore, a different kind of poultry management technology, besides suitable breeds of chicks, for the rural sector is needed. The different types of birds developed for rural poultry rearing include Vanaraja, Gramapriya and Krishi-bro and Kalinga Brown. While Vanaraja is a dual-purpose breed for producing both eggs and meat, Krishi-bro is meant largely for broiler production. Gramapriya is a good egg-laying breed.

- **Capacity Building and training of farmers**

Some of the known mechanisms could contribute to the development of climate-smart agriculture. Some more knowledge however remains unknown and needs to be further studied. Research and development of varieties, including livestock, which are more robust to drought and flood. It is also important to address knowledge gaps in many areas of Agriculture and allied including for example in cost-effective approaches for assessing soil carbon and more broadly in assessment of the greenhouse gas profile of agricultural systems. Networking and knowledge sharing between research and knowledge institutions, synergy in research activities, and development of joint approaches should be supported between producers' organizations,

non-government organizations, private sector and research institutes. Farmers' advisory systems should be recognized and are important to address climate change.

- **Capacity building and welfare activities of fishing communities**

Fish is an important constituent of daily diet of 95% of Tripura's population. The present fisheries and aquaculture resources of the State comprise 7,878.76 ha of open water fisheries (1200 km of rivers – 4728.96 ha + one reservoir – 3049.34 ha + one lake – 100.46 ha) and 22,164.26 ha of aquaculture waters (Ponds & Tanks – 13,685.33 ha + Mini-barrages – 8,478.93 ha). A seven year's Perspective Plan of Deptt. Of Fisheries of Govt. of Tripura, aimed to achieve nutritional self-sufficiency (availability of 13 kg/ capita annually, i.e. about 36 g/ capita a day), was initiated in October, 2004. By the terminal year of the Plan (2010-11), the total fish production in the State could be raised to 49,231.32 MT, making available 14.12 kg/ capita of fish for its 34.87 lakh fish eating population (95% of total). However, the actual consumption of fish in the State was much higher (18.32 kg/ capita), requiring import from other states of the country as well as neighbouring Bangladesh. This necessitates further increase in local fish production which has

been planned during 12<sup>th</sup> Plan by the State Govt. (to make available 19 kg/ capita of fish at the end of Plan period).

The existing demand and the anticipated challenges in the State, besides developmental measures, would require better multi-scale understanding of the impacts of climate change and the interacting contribution of fisheries and aquaculture to food and livelihood security. Climate change will increase uncertainties in the supply of fish, both from fisheries and aquaculture. Such uncertainties will impose new challenges for risk assessment, which is commonly based on knowledge of probabilities from past events. Data for determining effects of past climate change at best cover no more than a few decades, and may no longer be an adequate guide to future expectations.

With State being surplus in seed production (2010-11 production being 363.8 million as against requirement of 205.8 million) no specific effort is required for its quantitative increase. But with genetic deterioration having set in in the existing stock, a serious effort is needed for its qualitative improvement. Capacity building of the fishers in the private sector to meet the present and future qualitative improvement as well as adoption of modern technologies to increase productivity is an

important requirement for future development. Department is in the process of establishing district/block-wise training centres which can provide technical support for water and soil analysis along with required training to fisher/fish farmer communities. The existing fishing methods are mostly traditional and can be modified and improved with capacity building and training, accompanied with support services, through these training centres.

The growth of the sector has ample opportunity to increase the earning capacity of the people of the State. This in itself justifies a major investment for the required development of fisheries in the State to bridge the gap between the demand and supply, besides generating additional employment opportunities. Government of Tripura has taken initiatives for water body conservation/ reclamation to improve their fish yield besides environmental considerations.

- **Impact assessment of climate change on fishery**

The dominant form of life in all the water covering most populace of the earth are the fishes, the largest class of vertebrates. However, during monsoon (June-August) when the rivers swell enormously and inundate the adjoining low-lying areas, certain fishes, viz cartelagenous and large sized cat

fishes migrate from major rivers of Bangladesh into territory. Fishes related to the group cytariophysy, viz., carps, catfishes and loaches are also commonly found in almost all rivers. Small in size but bright and silvery in colour, some of their species like chela, katari, chapkhori (or chapila), etc., are popular among the common people for their taste and moderate price. The major carps of the subfamily cyprininae belonging to the species katla, rui, katibaush, ghania, bhagna, mrigal, etc., are also raised by the households in their own ponds and tanks. Smaller varieties of the same origin like sarputi, puti, etc., and different varieties of pabda (silvery white fish) belonging to the Siluridae family are also found in abundance in jheels, tanks and rivers.

The state's large marshy and water areas offer ample scope for a good crop of closed-water fishes every year. The State's fishery department has taken steps in this direction. Apart from developing new water areas for increasing fish production, the Government has made sincere attempts to ensure that the fruits of fishery development schemes benefit the fishermen.

Freshwaters are rich in aquatic biodiversity and a large part of the indigenous aquatic flora and fauna is under threat of extinction due to change in temperature and water stress. The study will help in development of adaptive strategies

for fishery sector.

- **Study of impact of Climate Change on the indigenous fauna of aquatic ecosystem and open waters**

Aquatic ecosystems are one of the critical components of environment. It is essential contributors to biodiversity and ecological productivity and also helps in lowering the temperature at local level and also provides a variety of services for human populations, including water for drinking and irrigation, recreational opportunities, and habitat for economically important fisheries. However, aquatic systems have been increasingly threatened, directly and indirectly, by human activities. In the aquatic system, at least 129 species of fishes are recorded belonging to 32 families, and 11 order, the largest number of species being from the family Cyprinidae (49 species, including Rohu, Katla, Kalbasu, Puthi, Mahasheer, Chela, etc.) which has been recorded that the majority of the fishes are common to both Indo-Gangetic drainages and South East Asian fish fauna. The occurrence of some marine and estuarine fishes *Pisodonophis boro* (eel), *Tenualosa ilisha* (Hilsa), *Nematolosa nasus* (Bloch) and *Johnius coitor* (big eyed jewfish) may be attributed with the riverine migration to Meghna and Gumti system from Bay of Bengal. The fishes of the State include 11

vulnerable species three endangered species and three rare species (Table-42). At 9 species endemic to India are recorded from Tripura (*Barman, R.P, Pisces, Fauna of Tripura, Vol.-1, Zoological Survey of India*). In addition to the challenges posed by land-use change, environmental pollution and water diversion, aquatic systems are expected to soon begin experiencing the added stress of climate change. The effect of climate change on fisheries which will increase temperature and may lead to early maturity and breeding of fishes this required for further analysis. Climate change is stress sensitive to freshwater of Tripura, which are already adversely affected by a variety of other human impacts, such as altered flow regimes and deterioration of water quality. In Tripura 1200 Sq Km rivers and 0.05 ha Reservoirs and 0.13 ha tanks and ponds are the major water sources. Wetlands are a critical habitat for many species that are poorly adapted for other environmental conditions and serve as important components fisheries. Aquatic ecosystems have a limited ability to adapt to climate change. Government of Tripura has taken an initiative to do a research work on climate change impact on aquatic ecosystem.

- **Rubber Plantation Impacts on Fisheries**

Rubber is one of the fast growing species in Tripura. The state is

facing serious water deficiency in summer season. It is anticipated that depletion of water tables or aquifers may be due to rubber plantation. The government of Tripura wants to do a research study on impact of rubber plantation on fisheries sector. Ground water depletion will lead to water scarcity in the surrounding area and will also affect the ground water table. This may lead to the contamination of the impurities to surrounding aquatic system. Fish population and its productivity may get hamper due to this effect. The study will help in formulation of adaptive measures in near future.

- **Contingency Crop Planning**

Climatic variability is a major feature of Tripura's agriculture and therefore crop production is greatly conditioned by climatic risks and variabilities. To develop a healthy early warning system of spatio-temporal changes in weather as well as other environmental parameters, contingency crop planning is very much necessary. Due to uncertain monsoon period reservoir levels go down, shallow wells dry up and tank irrigation has low capacity to support crops. For efficient conservation and utilization of rain water and in dry season, tactical approaches to mitigate the adverse effects of weather aberrations Long-term strategic approaches are necessary. To address impacts of climatic uncertainties on agriculture sector, Government

of Tripura has decided to prepare sustainable land use planning for 40 Blocks for agricultural development, preparation of Block wise agro-climatic Atlas and crop calendar and Farm health card. The government also wants to assess the seasonal soil moisture of the state. This knowledge and information will help to strategise adaptive measures during climate stress condition.

- **Agro-meteorological data Acquisition and Management**

Agriculture is very much dependent on climatic variables such as temperature stress, rainfall pattern, flash floods etc. For formulating proper agricultural planning and use of agricultural technologies, application of agricultural meteorology is highly needed. Weather and climatic data bases are necessary to accelerate the generation of climate resilient crops, analyses and forecasts that affect agricultural cropping and management decisions, irrigation scheduling and other preparedness for natural calamities and ecosystem conservation and management.

Agro-meteorological station networks are basically designed to observe the data of meteorological and biological phenomena together with supplementary data as disasters and crop damages occur. The method of observation can be divided into two major classes

- these are manually observed or automatic weather stations (AWS). Government of Tripura is planning to use the satellite remote sensing technology for block wise agro-meteorological data for its complementary nature to the traditional methods. This activity will help in better preparedness before any natural calamities.

- **Approach to increase cropping intensity with diversification options under variable climatic condition**

The agricultural system has been divided into two areas i.e., food security and commercialization, but Crop diversification not only addresses food security and commercialization, but also makes judicious use of land, water and other resources. The crops which are commercially feasible locally in Tripura and have higher comparative advantage that can be taken into account so that there will be an inclusive growth which contributes to poverty alleviation. Due to changes in temperature and irregular rainfall the agricultural productivity is hampering. To improve the access to and adoption of water conservation practices water conservation technologies are effective ways to maintain cropping intensity and can provide opportunities to diversify into high-value crops, reducing reliance on rain-fed field crops. Inter-annual storage of excess rainfall can be

another effective way to maintain cropping intensity and smooth instability in yield caused by climate variability.

- **Supply of plant nutrients in an eco-friendly way**

Agricultural intensification requires increased flows of plant nutrients to crops. Supporting higher uptake of nutrients and higher levels of stocks of plant nutrients in soils is a prerequisite for higher yields. This intensification results in larger amounts of crop residues, manures and organic wastes from the consumption of agricultural products, which are sources of plant nutrients. Excessive applications

of nutrients and inefficient use of residues and wastes with improper cropping management systems, is a consequence in plant nutrients loss and which leads to economic loss to the farmer. An inadequate and insufficient plant nutrient supply creates an adverse depletion of plant nutrient stocks on the farm, which is also an economic loss for the farmer. So to increase the crop productivity the studies of Microbial Diversity and Formulation of Effective Bio-fertilizer Under Variable Climatic Scenario is necessary. Government of Tripura also wants to establish of Bio control Unit to Study the efficacy of Various Bio Control Agent for eco-friendly Plant Protection Measures.



## Strategic Knowledge Mission

### Introduction

In dealing with the formulation of proposals for vulnerability assessment and measures for adaptation and mitigation, it should be considered upfront in the course of development of plans and proposals under State mission on strategic knowledge for climate change for the state of Tripura. Reduction and mitigation of disasters depend on the coping capacity of the vulnerable population; poverty makes way for hazards becoming disasters.

Climatic changes are expected to severely impact those who are mostly dependent on natural resources for their livelihoods. Climate variability can fundamentally drive processes of impoverishment through direct and indirect routes: (1) Direct: Severe or repeated climatic shocks can push vulnerable households into a persistent poverty trap when their individual coping responses involve divestment of productive assets such as land or livestock, (2) Indirect: Climate uncertainty

causes inability to anticipate when climatic extremes will occur, which acts as a disincentive to investment, innovation, and development interventions.

The main aim of the State mission on strategic knowledge is not only limited to the reduction of green house gases (GHGs) but include building the adaptive capacity of the vulnerable population. If we are treating the above guiding principle as sacrosanct, then the peoples plan processes of development should interpret the task of building of adaptive capacity to include the challenge of innovation capacity building for sustainable development among the vulnerable population. While formulating the proposals for vulnerability assessment and measures for adaptation and mitigation, this approach demands the development of strategic knowledge not only for monitoring and assessment of vulnerability but also for assessment of alternatives becoming available in respect of technology systems and for promotion of decentralized

capacity for management of development, adaptation and mitigation. Thus, the state mission on strategic knowledge for climate change would be required to plan for feeding into the peoples plan processes for the development, adaptation and mitigation measures to be formulated in an integrated manner.

### *The mission challenge*

The mission on strategic knowledge for climate change faces the challenge of establishment of state wide knowledge generation and utilization capacity in respect of a wide range of themes. Accordingly, the primary aims of the mission is defined here are to develop in a time bound manner a **sustainable state wide capacity** for the generation of strategic knowledge with a view:

- To monitor climate variability and make climate change projections for the state.
- To build GHG inventory and identify the dominant GHG/CO<sub>2</sub> emitting sectors, industries (district wise) in order to enable selection of mitigation opportunities.
- To model and plan for the climate sensitive regions (urban under rural local bodies) assess the impacts of climate change, analyze the vulnerability of regions/districts, sectors and

population groups and evaluate the traditional adaptation and coping practices to climate variability and extremes.

- To integrate the processes of assessment of vulnerability, knowledge and data of natural resources, institutions and capacities with the bottom up approach to enable the planning of adaptation and mitigation projects for the benefit of climate sensitive sectors, regions and population groups.
- To enable government including its policymaking bodies in the climate resilient policy-formulation function.
- To inform and assist the development agencies to evolve suitable adaptation and mitigation measures.
- To empower and upgrade the capabilities of people to take appropriate steps at their own level for the reduction of risk.
- To strengthen regional cooperation through the establishment of mechanisms for exchanging information with regions sharing the borders and ecology of the state of Tripura.

From the above stated primary aims it is also clear that the state mission on strategic knowledge for

climate change is expected to serve not just as support mission for generating and providing strategic knowledge for all the other state missions with in-built capacities for continuous and mid course changes in trajectories of transition in development processes. But as the actions required to be taken for climate change induced disaster risk reduction it has to be undertaken in collaboration with the people and their own state of knowledge and capabilities must also be upgraded. The state mission on strategic knowledge should not be interpreted just as limited to the generation of knowledge. It should also include the challenge of building of the coping capacity of the people of the state as a whole. Steps are required to be planned and taken for the development of their own anticipatory and response capacity in all parts of the state at all levels.

Further, it is also necessary to realize that the formal knowledge producing sector would benefit from the local knowledge available to the people in respect of the management of natural resources and the reduction of climate change induced disaster risks. The advantage that they possess on account of accumulated experience and wisdom must be utilized and made a part of the strategic knowledge that the state of Tripura needs to create in order to deal with climate change. While undertaking actions

for the building of adaptive capacity of the people the formal knowledge producing sector would also be gaining if the activities and linkages developed are also conscious of the use and value of local knowledge. The formal knowledge producing sector will have the chance to pursue the collection of ground truth and practice triangulation. In the implementation of the state action plan the people as a whole would not be passive agents and be better involved in the actions under planning for adaptation and mitigation.

In pursuance of the above discussed primary aims the Tripura's State mission on Strategic knowledge should aim to build a dynamic knowledge system which is capable of

- (1) Informing and supporting the State Government agencies in respect of actions that are required to be undertaken for responding effectively to climate change in the state of Tripura,
- (2) Undertaking simultaneously action on the objectives of building of coping capacity of the local bodies and mass organizations that are directly accessible to the people of the state in respect of the implementation of adaptation and mitigation measures and

- (3) Practicing interdisciplinary orientation, learn from and dialogue with the people, continuous learning and self-reflection in the process of knowledge generation.

**Barriers / constraints in respect of generation of strategic knowledge are:**

- Insufficient observational and scientific information data base.
- Weak and fragmented knowledgebase for impact assessment and selection of technology choices.
- Knowledge gaps in respect of the impacts of climate change in different sectors of economy.
- Absence of a system of technology watch.
- Lack of institutional mechanisms for collating, synthesizing and delivering knowledge products for decision making.

**Mission objectives**

Coming to the details of actions to be taken to realize the above said primary aims the detailed objectives of the Tripura State Mission on Strategic Knowledge for Climate Change (TSMKCC) are recommended as follows:

- a) building the state’s relevant

human and knowledge capacities which can capture, process, store and apply knowledge needed for vulnerability assessment and risk reduction;

- b) building the state’s relevant institutional capacities which can nurture long-term repository and organizational structures & system for long-term observations, studies, understanding and forewarning of likely changes;
- c) building the state’s relevant capacities for evidence based policy formulation & implementation to meet the challenge of adaptation & mitigation to have a coordinated response in the state of Tripura; and
- d) Building the state’s relevant capacities for continuous learning and pro-active designing of development strategies that also reduce risk, enhancement of ecological sustainability and protection of vulnerable sections of society.

**Key Issues that the state is likely to face**

**Variation in Weather Conditions**

The Intergovernmental Panel for Climate Change (IPCC) projects that climate may warm globally by 1.4 to 5.8 degree centigrade by

the next 100 years and over the Indian region the warming may be about 2.1 to 2.6 degree centigrade in the 2050s and 3.3 to 3.8 degree centigrade in the 2080s (Shukla et al., 2003). As far as the impacts are concerned, the amount of rainfall is projected to increase in the north-east region as a whole. However there would be variations in its spatial pattern, with some pockets showing increase and some pockets indicating decrease in rainfall. In the study entitled “Key findings of a study on Impact & Vulnerability Profiles of North East Region”, the likely consequences of climate change in the rainfall pattern in Tripura are that while there will be a marginal decrease in total annual rainfall and the state of Tripura would also face an increase in extreme weather related events.

### **Vulnerability of population of Agartala to climate change related events**

Urban flooding is a recurring phenomenon that Agartala Town faces every year during the monsoon Period. The local population has learned to adopt by developing a number of coping strategies for facing such periodic episodes of flooding. However, climate change is likely to intensify this problem through a combination of more intense local precipitation, channel flooding, Border area flooding. If such intense precipitations are accompanied by extreme weather

events such as cyclone, it can lead to wide spread and severe flooding that can bring the town to a standstill for a few days. As the impact of flooding is likely to grow in the time horizon of 2030, the town needs a comprehensive and effective strategy that invests in both soft and hard infrastructure to tackle flooding problems of Agartala town. The goal of the strategy should be to reduce the percentage of people affected by flooding and sewage related diseases in Agartala. Target the most vulnerable wards.

### **Vulnerability of population due to impact on water bodies**

The likely consequences of climate change in the water front in Tripura are (i) decrease in total annual rainfall, (ii) change in rainfall pattern resulting in crop failure for not getting the rain when required and (iii) sudden bursts of rain over a small period of time leading to flood. The normal annual rainfall in Tripura is 2196.4 mm. In 2008 the actual rainfall amounted to 1,804.8 mm. In the current year (2010), Tripura has received over 20% less rain during the period January-August.

### **The challenge of Sustainability of Agriculture**

The Department of Agriculture has undertaken efforts to collect information from the Central Water Commission offices for the

major rivers of Gumti, Feni, Haora, Khowai, Dhalai, Manu, Juri etc. A paper regarding study on water system analysis on Haora river basin at Tripura was published in May 2008 by Datta et al of National Institute of Technology, Agartala in collaboration with School of Water Resources Engineering, Jadavpur University, Kolkata. The study brings out that even if we take into account the scenario of medium and low emissions the finding predicts decreased water flow in Haora which could affect the availability of water in West Tripura and Agartala in practice. It notes that decreased peaked flows would be lending to loss in carrying capacity. The Department notes that information regarding the other rivers is being explored from the Central Water Commission. It suggests that a systematic study on a project basis, which is technically sound and time bound, has to be undertaken for the preparation of a long term plan strategy for all the seven rivers along with feeding cherras and rivulets to deal effectively with the growing problem of sedimentation which would impede drainage.

The Department of Agriculture proposes the establishment of weather station in each panchayat. Generation of crop statistics at the panchayat level is a pre-requisite for assessment of crop loss under poor environment caused by climate change. In the absence of

any weather reports based on data collected over several years, crop productivity and crop loss if any, cannot be properly correlated to weather conditions, for ultimate consideration under the National Agriculture Insurance Scheme.

The Department of Agriculture would like the IMD to impart training to workers to keep records and dispatch to the headquarters for collation and compilation.

The Department of Agriculture has urged that to ensure sustainable ecology against the forces of climate change and provide support to short duration crops favoured under the situation, the creation of water harvest structures on table top of tilla land, should be encouraged to follow the scientific approach. It also notes that among the horticultural crops, crop-cutting experiments are conducted only on potato, for the rest which include plantation crops, fruits, vegetables, flowers and spices, there is need to pursue a thoroughly scientific procedure for regular reporting of data and statistics and to monitor the loss or gain caused by biotic and abiotic factors including climate change. The Department notes that in the hilly terrain of the state receiving substantial rainfall, though the land is interspersed with innumerable rivulets, due to coarse soil, a very poor humus content and prevalence of unpurified organic

matter in the forest of land (due to poor microbial population for want of cow dung which acts as a starter) or lack of sufficient quantity of organic manure, any departure from normal rainfall and weather becomes limiting to the crop to invite economic crisis for the farmers. The Department notes that the problem is more challenging in the border area of the state where boundary walls have been constructed impeding drainage outside. The impounded water is a constraint in realizing the optimal productivity. The Department is of the view that the panacea lies in identifying a third party, who under agreement would work in collaboration with the department to undertake panchayat level crop-cutting experiments for final compilation and completing necessary statistical exercise. The Department is of the view that to monitor the changes taking place due to changing environment and evaluate the effect through the use of new agricultural technology a separate integrated project should be urgently taken up.

### **The growing challenge of geo-hydrological hazards**

From the researchers of Tripura University it is learnt that unscientific and unplanned usage of land together appear to be adding to the impact of the climate change and thereby aggravating different types of geo-hydrological hazards. It is noted that landslides

and soil erosion are the most pervasive natural problems that undermine the overall economic and cultural development of the hilly tracts of whole Tripura State. Growing landslide events during the past few years caused much soil erosion in the state. It reveals that vulnerable geological structure, steep and unstable slope, porous soil, deforestation, unplanned and unscientific usage of land along with heavy and concentrated rainfall are primarily responsible for the establishment of such a vicious cycle of denudation which is assumed to be an annually recurring phenomena in the state of Tripura. The nature of rainfall has also been erratic in terms of its occurrence period (not total rainfall). The problems become acute when huge amount of rainfall takes place within a very short period of time. Both of these hazards generate huge amount of sediment load. The areas susceptible to landslides in the state are mostly existing along the road network, whereas soil erosion takes place in and around deforested barren lands, agricultural lands and along the river banks. Hence, there exists a crying need to delineate stable and unstable areas in a realistic manner to arrest such hazardous phenomena.

The only trunk road (NH 44) which connects the whole state of Tripura with other north eastern states and treated as the lifeline of Tripura remains closed almost

during entire monsoon period due to landslide events. Temporary rescue works are carried out by the local administration to the individual problem areas but long term measures are almost missing. Lack of proper data base, literature, maps, technical details and planning are the main drawbacks of such remedy which deserves immediate attention. Sediments produced by such hazards are carried down to the lower courses of the major rivers of Tripura, deposited within the valley bottom and thereby reduces the depth of the rivers. In most of the peak monsoon periods of high rainfall the lower courses of the rivers fail to carry excess amount of water (discharge) and thereby creates flood and river bank erosion causing huge amount of resource loss. If this situation continues for a long time, most of the major river will tend to turn into their dying phase and will fail to serve the society. Thus, it is the high time to take proper measure to address the problem scientifically. This can only be attempted through the preparation of long term data base related to changing areas of forest cover, agricultural land, construction sites, daily rainfall and temperature, cross-section, discharge and sediment load of the major rivers, detailed zonation studies, vulnerability and risk analysis those are still lacking in the state.

### **Lacking in organized multidisciplinary research capabilities**

Analysis of these inputs makes it quite clear that vast knowledge gaps exist at the level of the state in respect of the impacts of climate change. These gaps can be suitably researched upon and tackled at the state level only through the establishment of teams capable of undertaking multi-disciplinary research. It is also obvious that there are many more issues about which knowledge gaps exist and would be identified if the state mission on strategic knowledge for climate change is launched and starts coordinating the processes of knowledge generation and dissemination. Efforts would have to be taken up to involve the researchers and build their capacity to cope with the gaps existing in the state of knowledge.

It is also understood that in this area of interdisciplinary research the capabilities are at the moment inadequately established in the state of Tripura. The scoping of investigational activity is not a one-off exercise and has to be treated as a continuing activity. Adaptation projects require knowledge and data of natural resources, institutions and capacities. Long term monitoring of impacts at the regional level is an important requirement in this area. Capabilities would need to

be built at the state level in respect of application of known models and limitations of models and data would have to be understood. Gaps in capabilities have been recorded at the level of regular monitoring itself.

To meet the challenge of generation and dissemination of strategic knowledge on climate change has outlined the first set of thoughts and it is understood that much learning is going to take place in regard to even what kind of gaps exist and how they could be filled best in the state where the overall knowledge infrastructure is in the need of considerable upgrading.

There are a number of constraints that limit at present the ability of the knowledge system available within the state of Tripura to deliver the required and expected outcomes for effective action in respect of climate change on the part of the government as well as the people.

### **Approach and Strategies to address the gap areas**

Some level of relevant competencies seem to already exist in the Government departments, State level public sector organizations, research institutions, university and colleges, local self government institutions, mass organizations and trade unions. While drawing this mission document some of these competencies have been

mobilized in a preliminary way. There are also some S&T based non-governmental organizations working on climate change in the state of Tripura which can be mobilized to document and assimilate the local knowledge available with the people. The Tripura's state mission on strategic knowledge needs to plan its activities and programmes in conjunction with the other four or five missions under planning as a part of the state level action plan on climate change. It is also recognized that planning would need to be consciously undertaken at all the levels for the upgrading of competencies in respect of all the identified tasks and challenges.

Given the urgency of the challenge on the ground facing the state much of the competencies that the state of Tripura needs to constitute the state level systems of strategic knowledge for climate change would have to be accomplished and established in the course of implementation of the identified tasks and activities for the reduction of climate change based disasters related risks itself. It is also therefore recognized that a significant part of the mission for strategic knowledge would need to be built as well defined units working as an integral part of the in-house competencies of the executive agencies. But all such units would be required to maintain active links with the structures and constituents of the state mission on strategic knowledge for climate change. These

in-house competencies are required to be constituted in a planned manner by the executing agencies in the course of implementing the state action plan for climate change itself.

However, it is also clear that in the state of Tripura more, diverse and higher levels of competencies are also required to be established to manage the climate change related risks. A set of advanced competencies which need to be created with the aim of imbuing them with specialized or nodal functions in the form of new institutions would be established in the midst of universities or research institutions to give appropriate environment for knowledge production. It is also suggested that the system of strategic knowledge for climate change needs to be established as a distributed system among institutions of relevant knowledge domains working in a networked form for the realization of the detailed objectives of the Tripura's state mission for strategic knowledge. Competence upgrading activities would not be limited to the state level bodies but also extend to all the other levels and made to function in a manner of horizontal networks.

The proposed approach for addressing the knowledge gaps and mobilization of strategic knowledge in the areas related to climate change are as follows:

- 1) Strengthen and prioritize ongoing and planned programmes of the state of Tripura in respect of developing adaptation and mitigation activities.
- 2) Increase the spatial and temporal coverage and resolution of regional impact of climate change in the state of Tripura.
- 3) Develop the state level capacity in distributed form but networked through the activities and programmes identified as a part of the mission.
- 4) Widen the scope and activities of knowledge generation for observation, monitoring, assessment and actions relating to the management of climate change induced risk.
- 5) Use existing delivery structures for knowledge dissemination and application.
- 6) Create knowledge networks with selected core knowledge generating and applying institutions as nodes that are linked and involved in the development of activities through a wide range of knowledge partners.
- 7) Use extramural research system to undertake the widening of activities of

knowledge generation and delivery.

- 8) Create new knowledge institutions by leveraging and supplementing existing strengths as far as possible when needed.
- 9) Develop and provide knowledge and information services and products for use at specific and different levels, for example, develop internal knowledge alert system, risk assessment reports, regular reports on base line information and indicators, policy briefs, discussion papers on scenarios and choices, etc.

For the realization of the above described approach to mobilization of strategic knowledge including the implementation of the mission it is proposed that the mission office should be built as an organization which is designed to promote sharing of data and knowledge, ensuring the flow of resources to all the linked organization for climate change risk management activities, pro-actively designing programmes and activities to partner with and assist the linked organizations in the management of resources and risk and enabling the institutions and agencies, irrespective of the level at which they work, to assimilate, develop, use and act on the new knowledge and information becoming available to the mission office through the knowledge networks.

A legislation to establish a new authority with the representatives of all the different stakeholders / agencies as members of the council governing its activities can be brought out. The Chief Minister should head the authority and the Minister of Environment and S&T should be vested with the necessary executive powers to operationalise and develop the state level action plan on climate change. The Mission Office of the state mission on strategic knowledge for climate change would be under this authority and be responsible for the design and implementation of this mission as well.

### **Activities and programmes**

As the Tripura's state mission on strategic knowledge for climate change sees its objectives to be arising out of the aim of need to build the human and knowledge, organizational and institutional, evidence-based policy implementation, continuous learning and pro-active designing capacities for vulnerability assessment and risk reduction, it is proposed that in the state of Tripura as a part of the time bound (short, medium and long term) programmes and continuing activities the followings are to be included in the state mission on strategic knowledge of climate change:

- a) Activities aimed at mapping of

the knowledge base and data resources relevant to climate change for the mobilization of state specific strategic knowledge are required to be implemented and identification of the institutional support to be provided for the formation of state wide knowledge network and networking of the state level institutions.

- b) Activities aimed at the identification of the knowledge gaps that need to be filled at the state level are required to be undertaken with regard to the areas of climate change impacts on important socio-economic sectors like agriculture, health, natural resources, eco-system, health, biodiversity, etc
- c) Activities aimed at the generation and development of knowledge base needed for the development of foresight, assessment and decision making activity with a view to undertake the improvement in and elaboration of sustainable development pathways in the light of responsible climate change related actions
- d) Interventions aimed at bringing about a significant improvement in the observations of key climate and biogeochemical variables and development of benchmarked baseline data which would be available to all departments and organizations;
- e) studies are required to be formulated and implemented in a collaborative manner in the state level research institutions for the conduct of research on basic phenomena, measurements of key climate and biogeochemical variables including changes in eco-systems and land use change & land cover change, and the possible feedbacks on climate change, climate science with region specific modeling, effects of climate change on different types of ecosystems;
- f) programmes are required to be initiated for the assessment of vulnerability of most sensitive populations / occupation groups and areas in the state of Tripura to climate change;
- g) state specific exercises are required to be formulated for an assessment of various technological scenarios and alternatives for meeting the objectives of sustainable development;
- h) Studies aimed at design of the improvements and changes in the policies, strategies, plans and programmes of development of the state are required to be undertaken;
- i) Activities and programmes

are required to be initiated with the objective to actively gain from and contribute to the activities being planned under the national action plan on climate change (NAPCC) for sustaining the eastern and North-Eastern Himalayas ecosystem and development of the north-eastern region as a whole;

- j) Initiatives are required to be formulated for the strengthening of the state level activities for disaster risk reduction with a view to leverage the plans under development at the national level for international cooperation with Bangladesh and Southeast Asia;
- k) Activities are required to be identified and undertaken for ensuring that practical knowledge gaps in respect of risk management are also bridged in collaboration with the expertise and knowledge available with the vulnerable groups;
- l) Activities and programmes are required to be implemented for enabling the people to plan and undertake decentralized actions for coping with the vulnerabilities of their own area of reach
- m) Activities and programmes are required to be developed for the creation of institutional and

knowledge capacity aimed at capacity building interventions at the various levels including establishment of a nodal institution to be located in the midst of Tripura University with the relevant knowledge base dedicated to undertaking the mobilization of strategic knowledge,

- n) Programmes and activities are required to be undertaken for strengthening the knowledge infrastructure and research base capable of undertaking climate change related research, observational, monitoring and assessment activities, creating dedicated centers for the generation and application of relevant robust knowledge, encouraging the participation of the individuals working in the state level organizations in the knowledge networks that are now under formation at the national level;
- o) Schemes to be formulated and initiated for the building of the state- level human capacity through a climate change research and fellowship programme

### **Proposed Actions to Address Objectives and Goals of the Mission**

For an effective implementation of climate change related activities in the State of Tripura the government

needs to strengthen considerably the existing knowledge base of the state. First of all, there should be a planned upgrading of in-house competencies of the executive agencies involved with the implementation of all the missions. Second, there is also the need to create an institution capable of specializing in the activities concerning climate change monitoring and assessment and coordinating the work of knowledge generation required to be undertaken

in the state to galvanize the state and its people for an effective response to the impacts of climate change. In order to implement the state level action plan the state of Tripura urgently needs an anchor for the production of strategic knowledge. This anchor should have the capacity to anticipate and provide support to the government as well as the people. A nodal level S&T capacity building institution can alone serve this mandate.



## Key Priorities

### Formulation of Tripura Institute of Strategic Knowledge for Climate Change (TISKCC)

It is proposed that Tripura Institute of Strategic Knowledge for Climate Change (TISKCC) has to be set up to provide for S&T capacity building in climate change. It should be founded and created in quick and well measured steps. The mandate of coordination of supply of all the relevant specialized competencies which are needed in the state for the execution of sub-missions of the mission on strategic knowledge for climate change be devolved on this specialized institution. The Government would nurture this specialized institution to be developed as a distributed set of competencies which are networked for the purpose of S&T capacity building by this organization. The State level nodal institution for S&T capacity building needs to be consciously developed as a knowledge hub for the spokes that would also need to be strengthened as in-house units for knowledge production in the departments and agencies of the state government. The role of S&T capacity building demands that as far as possible its constituent establishments and competencies should be located and operate from within the environment of research institutions or universities. However, the TISKCC per se could be a cell within the Department of

Science, Technology & Environment and should be independent of other administrative duties of the department. There should be a facility for both internal and external channels of entry. However, the subject specialists should be drawn on deputation from the concerned departments. At the execution level at the districts, there should be convergence the departmental activities, the sectoral activities and the inter-departmental convergence should be given particular focus. There is a need to strengthen district level activities focusing on coordination, monitoring of activities, reporting & testing facilities as well as an information dissemination & campaign. For the proposed structure of TISKCC refer to *Cross Cutting and Implementation level Issues in Climate Change*. This would have an Organic link with the departments as well as the various centres and field level agencies.

### Establishment of Centre of Monitoring and Assessment of Climate Change (CMAACC)

As a first step, it is proposed to the Government to establish immediately nodal Centre of Monitoring and Assessment of Climate Change (CMAACC) to take the responsibility for observations, monitoring, modeling, prediction of climate in the state of Tripura and preparation of reports on the possible impact of climate change in respect of extreme weather events

and to bring out possible impact of climate change in key socio-economic sectors. It is also proposed that CMACC to function from the environs of Tripura University which has the supporting knowledge domains being already cultivated to some extent in the state of Tripura.

The CMACC would have to be nurtured by the Government to ultimately spawn a number of units / departments / centers in the relevant knowledge environs in the state to take up the work of generation of strategic knowledge for the proposed sub-missions on a) climate change impacts monitoring and assessment, b) biomass based development initiatives for adaptation to climate change, c) initiatives for the implementation of measures of adaptation and mitigation in the fields of interest to the state, e. g, health, water, forests, etc., d) energy related technological innovations, e) assessment of impacts of responses to climate change and f) human capacity building. The CMACC would treat the mandate of spawning a number of specialized competencies in the relevant knowledge environs quite seriously.

As a networked institution the above said larger institutional setup of TISKCC would be made responsible for the coordination of generation of strategic knowledge for climate change needed by the state and the institution would

also treat itself as responsible for bringing an improvement in the performance of the state with regard to S&T capacity building in climate change. The S&T capacity building functions implies undertaking teaching and research and acting as a bridging institution for the extension of strategic knowledge to the relevant people for the benefit of development of the coping capacity of the state. The nodal S&T capacity building institution would have to be developed to operate as a networked system which is capable of undertaking research, education and extension in all the domains of knowledge production and transfer in a coordinated manner. For the sub missions to be run which require very different disciplines and specializations the nodal units for S&T capacity building could have different physical locations and be allowed to take advantage of some other institutions where the domain of knowledge is more appropriate and suitable for them.

It is expected that this new institution would be able to build the capacity required for absorbing all the relevant data and knowledge being produced at the national and regional level. The mandate of this institution is not limited to the function of S&T capacity building of the state agencies and covers the people of the state as a whole in respect of the challenge of development of coping capacity, particularly its S&T capacity

component. As this new institution is also expected to generate the new location specific knowledge with regard to climate change, the CMACC will have to put in place the detailed plans for the implementation of the proposed sub missions and their nodal teams within a period of six months starting from the approval of the mission on strategic knowledge for climate change.

As the planning and implementation of the proposed sub-missions of the mission on strategic knowledge for climate change would be the responsibility of the proposed S&T capacity building institution, It is proposed that the TISKCC to collaborate with the line departments and all the other agencies and undertake the handholding activities in respect of knowledge transfer and technology implementation for their improved performance.

The TISKCC should have the responsibility of preparing

the plans and programmes of research, teaching and extension in collaboration with the partnering organizations in respect of their respective areas of knowledge domains. The process of S&T capability building in climate change is expected to be dominated by the collaborative mode of activities.

As there is no effective mechanism to network the climate change related knowledge generating institutions this new nodal institution would also have the responsibility to benchmark the data and knowledge being generated in the in-house units of the line departments and developmental agencies. Data sharing policy among the departments and agencies is critical to climate change modeling and simulation of responses. At the national level the national knowledge network (NKN) is expected to serve as the underlying common infrastructure to support data sharing and collaboration.



An outline of the proposed submissions for which the CMACC would be preparing detailed plans

and following up their establishment is as follows.

Name of the sub-mission	Coordinating centre	Leading partnering organizations
Climate change impacts monitoring and assessment	Tripura University	IMD, Agartala, Deptt of Agriculture, Department of Water Resources, Department of Forests, Department of Science & Technology & Environment
Development of information system for the generation and dissemination of agrometeorological knowledge	Agricultural College, Agartala	IMD, Department of Agriculture, Department of Water resources
River conservation	NIT, Agartala	State River Authority
Sustainable utilization of ground water	Tripura University	Department of water resources.
Landslides and related hazards	NIT, Agartala	Municipalities and panchayats
Biomass based development initiatives for adaptation to climate change including horticulture and biomass processing industries	Tripura Renewable Energy Development Agency (TREDA)	Department of Forests, Department of Agriculture, Department of Industries, Department of Science & Technology & Environment
Biodiversity monitoring	Tripura University	Department of Forests, Colleges and Schools
Initiatives for implementation of the measures of adaptation and mitigation in the field of public health	Agartala Medical College.	Health department, municipalities, PHCs and panchayat bodies
Town planning, buildings and construction technology	NIT, Agartala.	Department of Urban Development, town planning units of local self governments, PWD
Energy related technological innovations for mitigation of climate change (Biomass gasifiers, Chullahs, solar energy utilization)	NIT, Agartala	Department of Power, Transport, PWD, Department of Science & Technology & Environment
Technology watch, foresight & assessment, climate change response impact assessment extramural research, human capacity building, S&T international and regional cooperation and linkages,	A separate centre to be located in NIT, Agartala	Department of Science and Technology

**Compile a data base of past weather related information and damage caused by extreme weather related episodes and facilitating study to identify the possible weather variability and associated vulnerability**

With the aim to strengthen the understanding of the vulnerability of Agartala from weather related events caused by climate change effects it is required to compile a data base of past weather related information and damage caused by extreme weather related episodes. The State's existing research set up would need considerable strengthening. Research teams need to be formed with a view to encourage the scientists working in the concerned knowledge domains to develop hydrological, hydraulic and storm drainage models to identify vulnerable areas and determine physical damage estimates resulting from climate change effects, assess economic, social and environmental impacts resulting from such climate change events. Without filling the knowledge gaps the Government of Tripura would not be able to formulate appropriate adaptation proposals to cope with damage arising from climate change effects and explore strategies to mitigate them.

From the proposals of researchers working in Tripura University it is understood that recent climatic change is influencing widely seasonal

distribution of precipitation (rainfall) and surface runoff pattern which is affecting groundwater conditions. It has been noted that besides the natural change some man-made factors are also influencing the groundwater conditions. Loss of vegetation cover by settlement growth along with other human interventions in nature will not only seriously affect on climatic change but also play vital role for changing the groundwater condition. Status needs to be monitored in both temporal and spatial scales. User friendly preparation of groundwater maps is necessary to provide regular basic information about soil conditions and water potentiality to the local farmers for sustainable agriculture development in remote hilly villages of Tripura.

The Department of Agriculture has noted that agricultural statistics compilation and collection remains primarily confined to major agricultural crops. At present, crop insurance benefits are extended only against rice and potato cultivation to the farmers. The Department is proposing that a separate agency for reporting agricultural statistics be established immediately. The Department of Agriculture is concerned about the macro and micro nutrient status of soil and suggests that a planned intervention is needed for ensuring an effective nutritional management of different crops. It takes note of the latest

report of National Bureau of Soil Survey (NBSS) which has stated using remote sensing technology and GIS that the entire soil of the state ranges between slightly acidic situation to highly acidic situation causing fixation of phosphates and immobilization of several micronutrients. It notes that the environmental change is already causing direct and indirect changes in the availability of organic matter and humus in the soil, which otherwise acts as a buffer to impede drastic changes in pH. It seeks to promote the judicious use of rock phosphate etc because of lack of organic manure that could help to restore equilibrium of available nutrient through normal activity of beneficial microbes. Further, it has also proposed studies on nutrient application and crop uptake in different land situations, topography and varied soil classifications in order to understand and monitor the influence of edaphic and environmental interaction in relation to climate change. The Department of Agriculture is interested in undertaking a thorough study for monitoring of the status of useful microbes under changing environment in traditional non-cultivated forest land and proposes to compare the results with traditionally cultivated soil before and after chemical fertilizer application. It notes that there is only one central bio-fertilizer laboratory to monitor the quality

in various laboratories within the state.

### **Setting up of weather monitoring stations (AWS)**

The likely consequences of climate change in the water front in Tripura are (i) decrease in total annual rainfall, (ii) change in rainfall pattern resulting in crop failure for not getting the rain when required and (iii) sudden bursts of rain over a small period of time leading to flood. Indian Meteorological Department (IMD), Agartala is conscious of the knowledge gaps existing in respect of weather related changes and is proposing to install five more automatic weather stations (AWS), four automatic rain gauges (ARG) and one Agro-AWS. IMD is also proposing to install more observatories.

### **Capacity Building on Climate Change**

Climate change is a relatively new issue. Awareness within the department of Government of Tripura and the concerned line department, businesses and civil society associated with different sector needs to be strengthened. Awareness is the first step. The next step is to build the capacity-knowledge, skills and resources – to be able to address the climate change concern. This is again a need of all the individual sectors. The key approach formulized are:

- Capacity building of personnel in the service department
- Exposure visit for capacity building

**To build GHG inventory and identify the dominant GHG/CO<sub>2</sub> emitting sectors, industries, districts, municipalities in order to enable selection of mitigation opportunities.**

While all the individual departments and sectors recognize the climate change relevance, there is no data or information (barring few) to the extent to their sectors contribute to the overall emissions. So each department should formulate a cell to monitor the GHG emission and inventories it. Such information can thereafter be analyzed to formulate strategy towards reducing the emission through technological innovation including technology transfer and process modification.

Identifying and inventorizing all kinds of water sources existing in the state (include generation of database for ponds, tanks, dighis, lakes and big water-bodies) with focus on water quality.

According to the Department of Water Resources of Government of Tripura, the normal annual rainfall in Tripura is 2196.4 MM. In 2008 the actual rainfall amounted to 1804.8 mm. Tripura is also likely to experience a change in rainfall pattern resulting in crop failure

for not getting rain when required. Further, the State may also get subjected to sudden bursts of rain over a small period of time leading to flood. Although the State of Tripura is fortunate in respect of groundwater resources (only one third potential has been utilized so far) and there will be no crisis of water in the state, but the proposed action plan of the Department of Water Resources identifies the lack of inventory of water sources as a knowledge gap. It states that the second phase of the Action Plan will have to start with identifying and inventorizing all kinds of water sources existing in the state. A groundwater status map for the entire state will also have to be prepared. The water source inventory would also be focusing on the water quality of the sources. It also states that inclusion of water quality data of the identified sources will require some outside agency. The Department notes that generation of database for ponds, tanks, dighis, lakes and big water-bodies will be an exercise being taken up probably for the first time and may require engaging some outside agency as well.

In view of large scale development work going on in Tripura, the water resource Department recognizes that some crisis of ground water may also crop in and around Agartala if ground water is lifted in huge quantity. In this connection, it projects that Tripura needs to

obtain more accurate data on rainfall and groundwater picture. It has been suggested that Tripura should have at least some 70 rain gauge stations.

### **Conservation of River Aquatic Resources**

Research study has triggered the concern that climate change would result into adverse impact on water availability due to increase of atmospheric temperature as well as decrease of rainfall threaten the livelihoods of population dependent on fisheries for their livelihoods. It is pointed out that Zooplanktons being a vital resource of fresh water are considered as water quality indicator species on the one hand and nutritious food-organism for the fishes on the other. The increase of atmospheric temperature and gradual decrease of rainfall and the said phenomenon is suppressing the potential reproductive performance in the zooplankton in general and in rotifer in particular. It is noted that this in turn can cause a shortage of natural food resources for the fishes directly and affect the survival potential of the fish larvae in the fresh water. Some of the fish species are also receiving direct threats due to change of climatic features such as atmospheric temperature and rainfall. For increasing their population, these species breed once in a year only. Due to gradual decrease of rainfall during the period of gonad

maturation of fish, spermatogenesis is seriously affected in males. Once the optimum temperature and rainfall are not available in the fresh water environment, the fertilization will not be occurring in that season so it may lead to termination of life of a particular fish species. The researchers noted that in this way, a number of fish species are getting lost in the freshwater rivers of Tripura. They propose to undertake research to find out about the trend of occurrence of CO<sub>2</sub>, water temperature and rainfall in different seasons in the river ecosystems of Tripura with a view to identify the male fish species where spermatogenesis is being suppressed due to climate changing features.

### **Development and implementation of Biomass based initiatives for adaptation to climate change including horticulture**

Research study has established that atmospheric pollution and climate change is likely to present major threats to biodiversity in the state of Tripura and therefore it is essential to develop an understanding of the nature and extent of their impacts. In situ monitoring allows changes in biodiversity to be detected and quantified and therefore provides objective evidence on which to develop scientific understanding, policy and management responses. It is proposed that underlying causes of change in biodiversity must be

identified before an appropriate response can be made. The impacts of climate change and air pollution are particularly difficult to identify with a high degree of confidence. One of the main reasons for this is that air pollution data is rarely measured on continuous and coherent basis at different sites. So potential relationships in between air pollution and climate change can only be assessed by using correlated measurements. Only then the use of statistical techniques to compare trends at different monitoring sites with contrasting environmental conditions would give best results. This would be particularly powerful in a permanent network where sites are strategically selected to maximize the contrast in air pollution and climate change regimes.

### **Study on Biotechnology intervention for increasing the production of milk**

The climate change is subjected to impose threat on food security and malnutrition and also may impose threat to livelihood of livestock's. Biotechnological intervention is required to facilitate increase in production of milk.

### **Studies on impact of Urban Migration on the resilience of the urban ecosystem**

The current urban model is already constrained due to weak or outdated urban management practices,

inappropriate planning systems, unsustainable service delivery models, and lack of focus on the urban poor - negate the benefits of agglomeration economies in Indian cities by distorting land and housing markets, rendering cities non-creditworthy, and leaving the urban cities with expensive yet poorly functioning urban services. Such situation is further worsen by out moded urban management techniques, constraints on water supplies and natural resources, lack of urban Infrastructure upgradation, finance autonomy issues, overlapping and fragmented functions between ULBs and state government and lack of functionaries and over and above the problem of urban poverty and slum.

A study is required to understand the current carrying capacity of a region and develop effective strategy towards

1. Quality and provision for infrastructure for all areas (which should limit risks of flooding for the whole city area, not just for the wealthier areas);
2. Quality of provision for disaster-preparedness (including warnings, measures taken to limit damage and, if needed, good provision to help people move to safer areas quickly).
3. Quality of planning for and

coordinating disaster-response (for instance rescue services and appropriate emergency and health care services) and reconstruction (to help those who have lost their homes and livelihoods) which should aim to improve resilience, but seldom achieves this.

4. Improving the extent to which

poorer groups can buy, build or rent “safe” housing in “safe” sites.

5. Enhancing the degree to which local government creates an enabling environment for local civil society action to contribute towards addressing the practical aims identified above.



# Health

## Introduction

Accrued empirical evidence has already established climate-disease relationship. Public health which is highly dependent upon the availability of adequate quantity and quality of food, safe drinking water, decent home protected against disasters, a reasonable income and good social and community relations (WHO, 2003) is projected to be affected by climate change (Rahman A, 2008). Such adverse impact includes morbidity and mortality due to increased heat, air pollution effect, malnutrition, water borne diseases like diarrhoea, cholera, typhoid and gastroenteritis, and vector borne diseases such as malaria. Tripura already has a combination of many of this human health related issues. Such issues are likely to be exacerbate due to climate change.

The possible climate related health impacts envisaged are<sup>1</sup> :

1. Progressively increased health burden because of increased proliferation of climate sensitive diseases and premature death (high confidence)
2. Altered distribution of some infectious disease vector that might proliferate due to climate change (medium confidence)
3. Altered distribution of some allergenic pollen species (high confidence)
4. Increased heat wave related death (medium confidence)
5. Projected trends in climate change related exposures of importance to human health
  - a. Increased malnutrition (due to deterioration in nutritional health arising from crop failure, which is caused by droughts and especially by high night temperatures that result in reduced cereal yields) and consequent disorders,

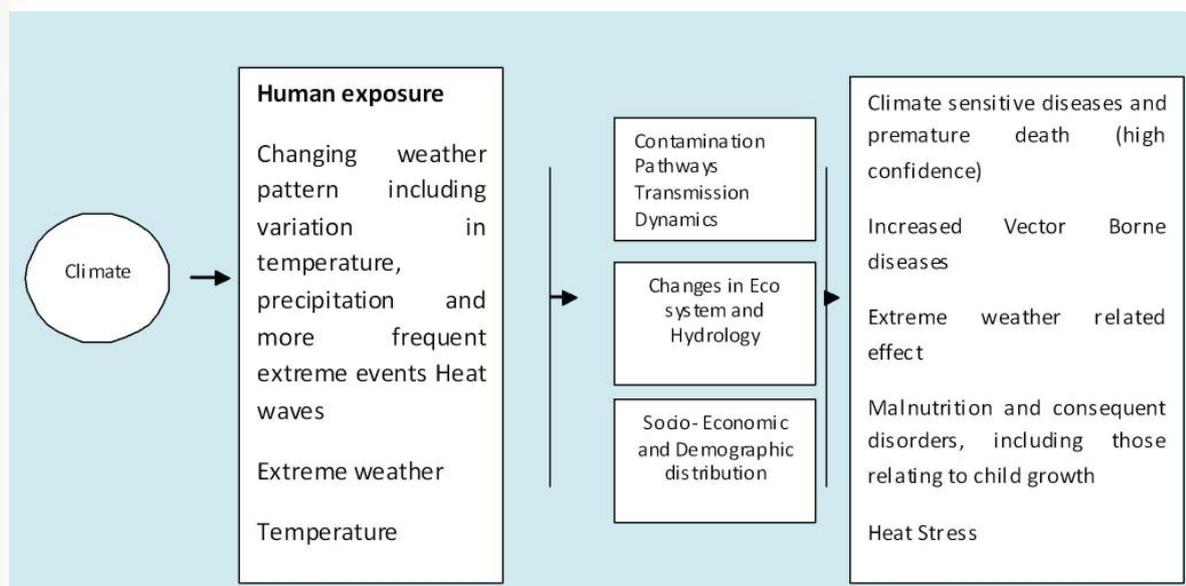
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<sup>1</sup> 4th Assessment Report IPCC

including those relating to child growth and development highly linked with the economic conditions (high confidence)

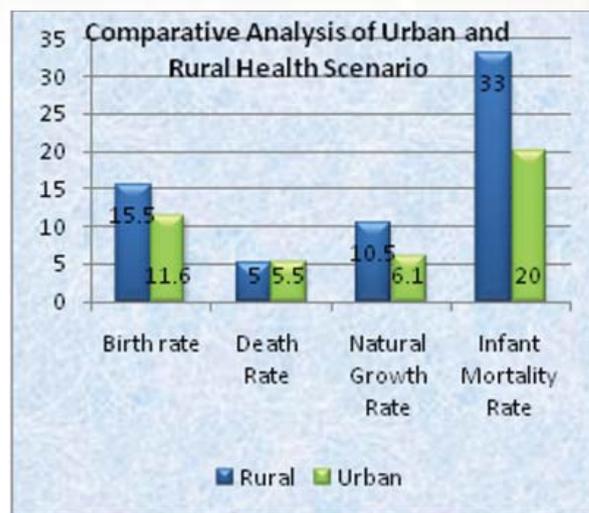
- b. Increase the number of people suffering from death, diseases, injury from heat waves, flood, storms, fires and drought (high confidence)
- c. Increase burden of vector and water borne diseases
- d. Increased cardio respiratory morbidity and mortality associated with ground level ozone.

The possible health related adverse impact is likely to damage human well-being and prosperity substantially and especially among the population having lower capacity to combat the impacts and access to medical facilities. The region wise impact would however vary depending on the adaptive capacity and strategy configured, demography, factors governing microclimatic condition of the region, socio economic condition, preparedness and awareness among the population on general health related issues.



## Key Facts about the Sector

The section intends to present the overview of the health status of the state that has formed the basis of strategy development. The parameters include overall health scenario, diseases outburst, morbidity and associated mortality, health risk and available infrastructure. Although the fact remains that trends of diseases over years are not exclusively driven by the impact of climate change but the issue persists that the existing health scenario is most likely to deteriorate under weather variability and overall human health impact may escalate with respect to their virulence and spread to hitherto diseases free area.

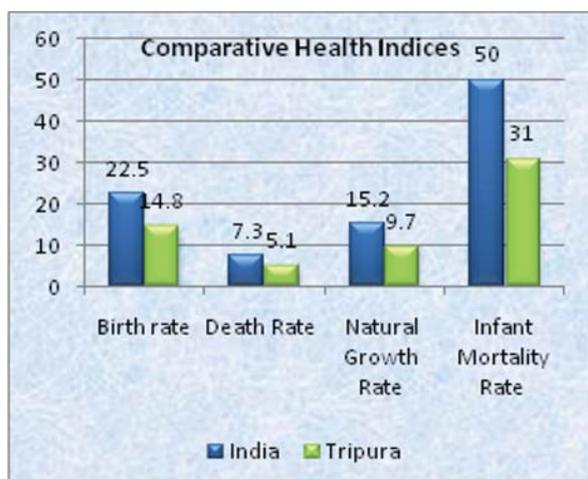


## Economic Situation

Impacts of Climate change on human health possess a vital relationship with the economic profile and infrastructure availability for the population in the region. It is worthwhile to mention that higher the financial constrain the population faces the more is it vulnerable to the impact of climate

## Demographic Characteristics

	Birth rate			Death rate			Natural growth rate			Infant mortality rate		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
India	22.5	24.1	18.3	7.3	7.8	5.8	15.2	16.3	12.5	50	55	34
Tripura	14.8	15.5	11.6	5.1	5	5.5	9.7	10.5	6.1	31	33	20



change. Tripura is a small state in the country after Goa and Sikkim with an area of 10,491.69 Sq. km surrounded by Bangladesh on its north, south and west sharing an international border of 856 Km (84 per cent of its total border) rest 53 km border with Assam and 109 km border with Mizoram.

The economy of Tripura is characterized by high rate of poverty, low per-capita income,

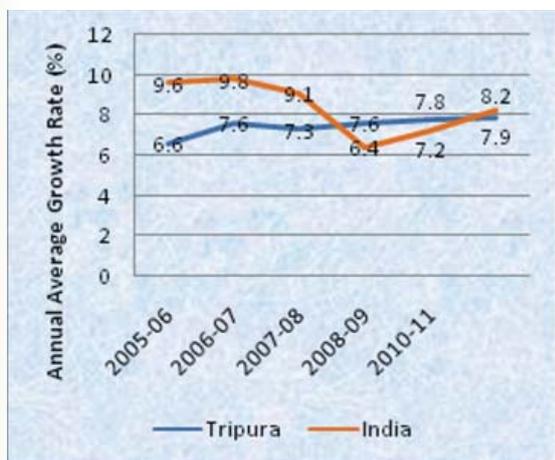
low capital formation, inadequate infrastructure facilities, geographical isolation and communication bottleneck, inadequate exploitation and use of forest and mineral resources, low progress in industrial field and high un-employment problem. The economy of Tripura is agrarian with more than 50 per cent of its population depends on agriculture for livelihood and contribution of agriculture & allied activities to the Gross State Domestic Product (GSDP) is 23 percent making the state much more susceptible to the variation of climate change.



### Medical Infrastructure

Health is a state subject in India where the policies and infrastructure are planned and developed by the state government. Health and Family Welfare Department Govt of

	1972	1978	1998	2010
Tripura's Per Capita annual Income at current prices (in Rs.)	502	928	11,012	38493
Gross State Domestic Product at current prices (Rs. in crore)	NA	175.34	3298.34	16327.89
Tripura - annual average growth rate	2.57%	NA	5.24%	7.90%
National - annual average growth rate	2.86%	NA	6.50%	8.20%



Tripura leads the health initiative in the state. The department operates through its two directorates namely Directorate of Health Services and Directorate of Family Welfare & Preventive Medicine.

Directorate of Health Services looks after State Hospitals, District and Sub-Divisional Hospitals and Ayurvedic & Homoeopathic Hospitals whereas Directorate of Family Welfare & Preventive Medicine are responsible for Community Health

Centres, Primary Health Centres and Sub-Centres meant for primary health care services.

The health service in the states comprises of 925 State run medical institutions in 2009-10 (including 20 Hospitals (including Homeo/ Ayurvedic), 90 Primary Health Centre, 748 Dispensary/Sub Centre, 113 family welfare clinic and others).

### Key Issues

#### Increase in morbidity/mortality due to increased incidence of Vector Borne diseases:

Epidemiological study has established the linkage between climate changes and malaria as the development of the parasite takes place in a mosquito which being a cold-blooded creature is sensitive to climatic conditions such as temperature, rainfall, relative humidity and wind velocity. At increased temperatures the rate of digestion of blood meal in mosquito increases which in turn accelerates the ovarian development, egg laying, reduction in duration of gonotrophic cycle and higher frequency of feeding on hosts thereby enhancing the probability of transmission as reduction in the duration of gonotrophic cycle and sporogony are related with increased rate of transmission .

The minimum temperature required

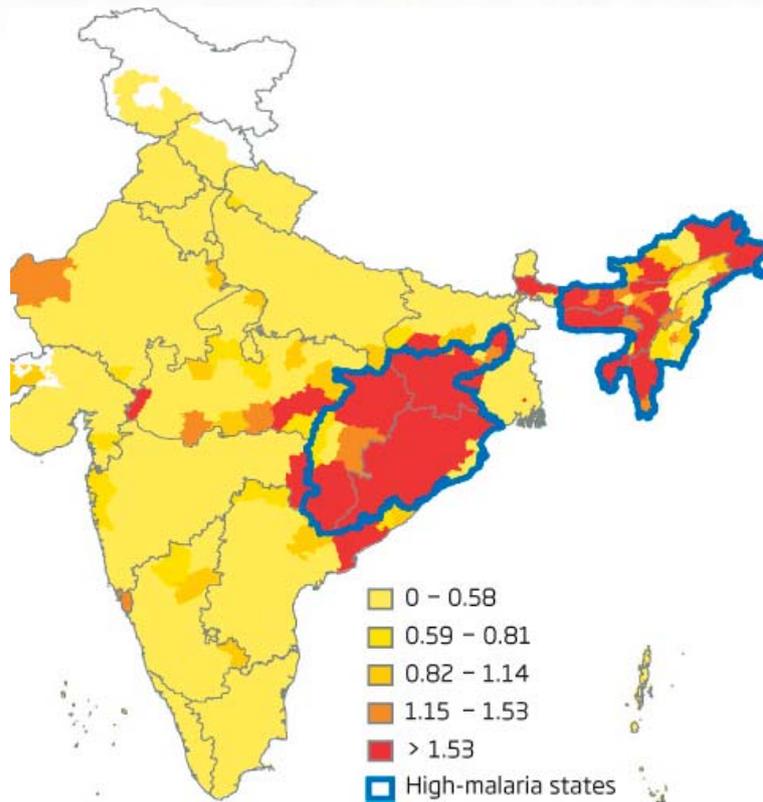
for development of *P. vivax* and *P. falciparum* parasite in anopheline mosquitoes is 14.5 –16.50C and 16.5 –180C respectively (Martens et al. 1995) which increases due to decrease in temperature till 320C where after there is high mortality in mosquitoes (Martens, 1997).

A relation between the temperature and duration required for the completion of sporogony of the parasite in anopheles mosquito is presented in the table below <sup>iii</sup>:

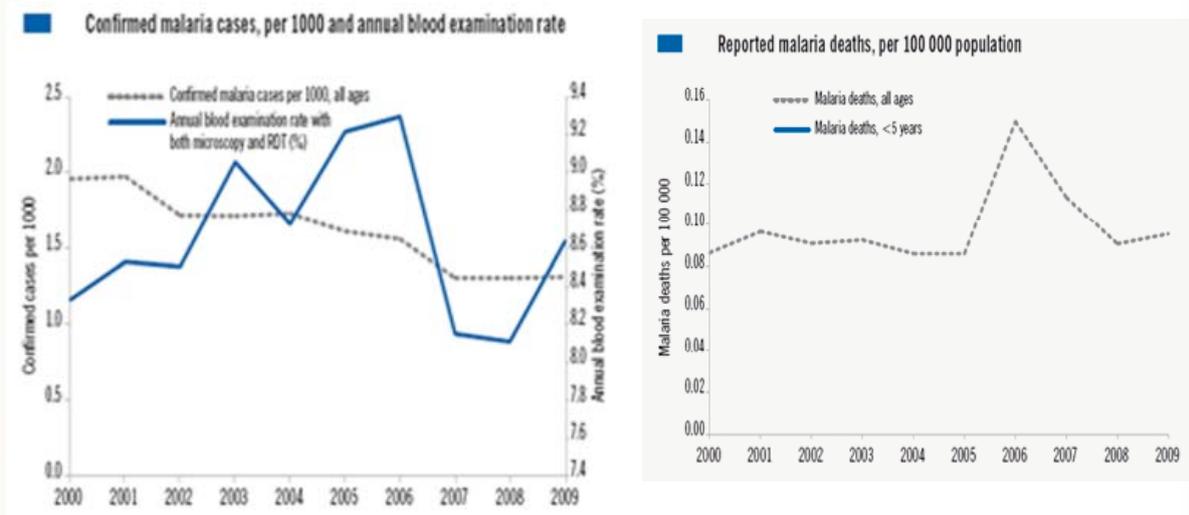
Parasite Species	No. of Days required for sporogony at different temperature	
	200C	250C
<i>P.falciparum</i>	22-23	12-14
<i>P.vivax</i>	16-17	9-10
<i>P.malarie</i>	30-35	23-24
<i>P.ovale</i>	Not known	15-16

*Epidemiological Profile (World Malaria Report 2010)*





*The above representation indicates the susceptibility of the states to the incidence of Malaria.*



**Projection Scenario:**

The baseline scenario indicates that the southern part of Tripura has its transmission windows

open for 10-12 months and will persist in 2030's, with increase in temperature.

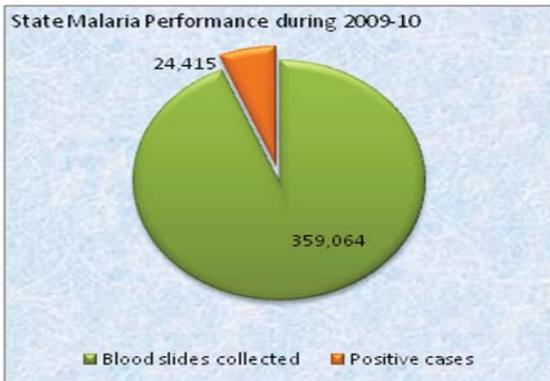
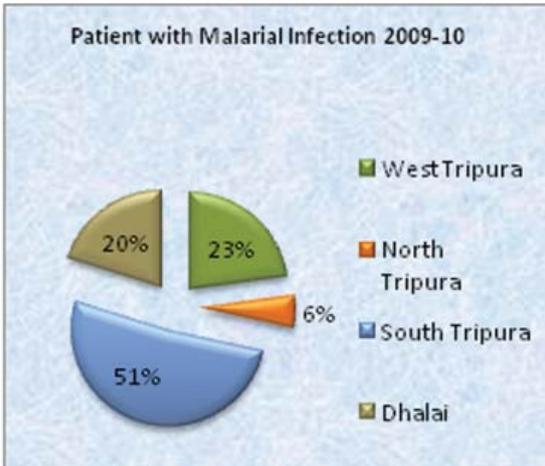
TWs of Malaria in Tripura based on temperature (A1B Baseline and projected scenario by 2030)								
	No of Districts	No. of months open for Malaria Transmission						
		0	1 to 2	3	4 to 6	7 to 9	10 to 12	Data Not Available
Baseline	4	0	0	0	0	0	3	1
Projection	4	0	0	0	0	0	3	1

TWs of Malaria in Tripura based on temperature and RH (A1B Baseline and projected scenario by 2030)								
	No of Districts	No. of months open for Malaria Transmission						
		0	1 to 2	3	4 to 6	7 to 9	10 to 12	Data Not Available
Baseline	4	0	0	0	0	0	3	1
Projection	4	0	0	0	0	0	3	1

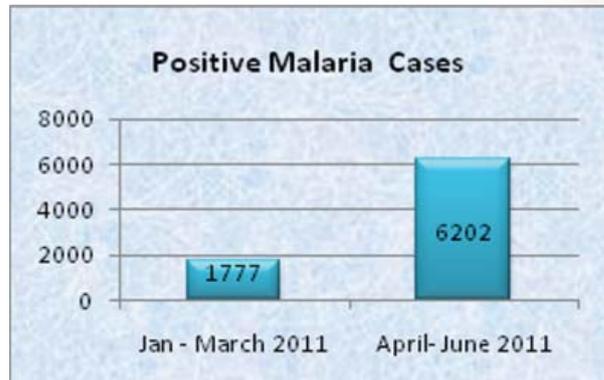
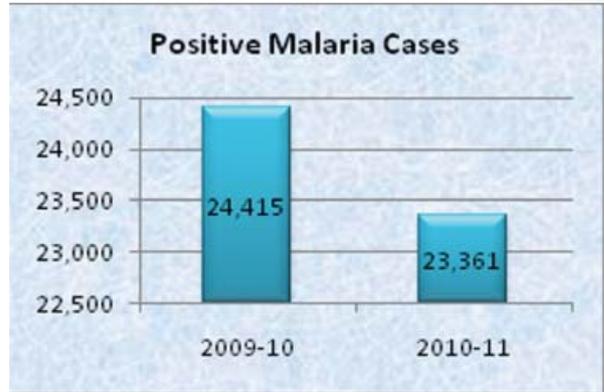
### State Profile

Cumulative number of indoor and outdoor patient in the four districts of Tripura during 2009-10 was 30,277 with maximum cases in South Tripura

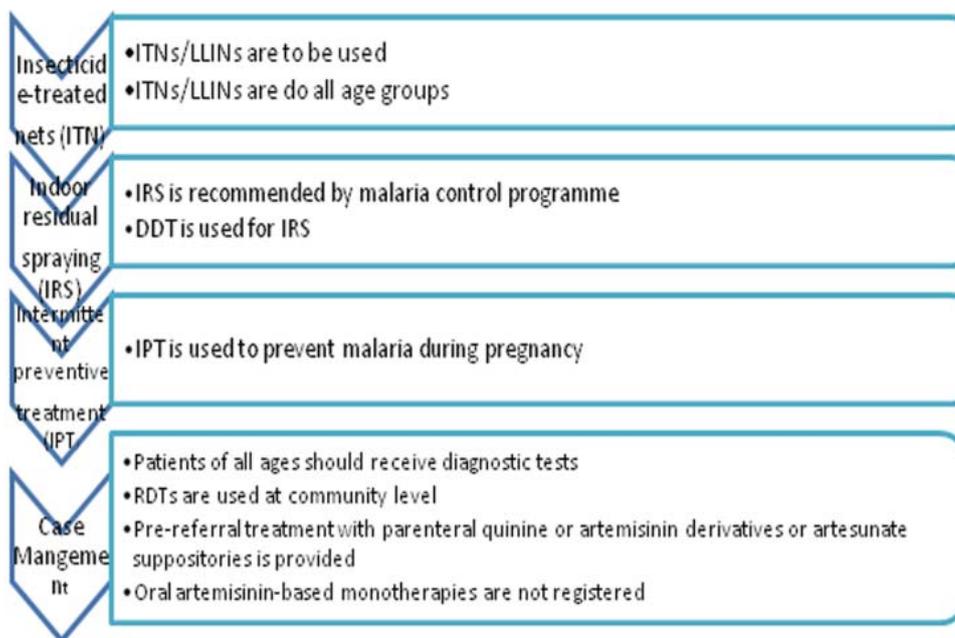


### Comparative Analysis of Malarial Incidence

Although the number of malarial incidence cases decreased across 2010-11 compared to 2009-10 the statistical input has shown a rise in the positive case in the first quarter of 2011-12 in compared to the last quarter of 2010-11.



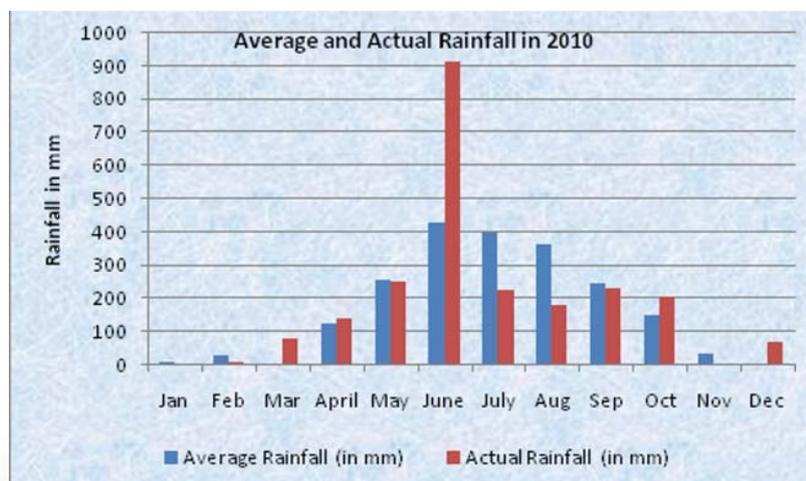
## Strategic Framework



## Enhanced exposure to Water Borne Diseases

Water borne diseases is subjected to be proliferated under the indirect impact of climate change. Such incidence can be classified as water borne (ingested) and water washed (caused by lack of hygiene). Tripura being situated in flood prone area, most of the times is vulnerable in the aftermath of flood due to unavailability of safe water supply, hygienic food availability, improper sanitation and improper bio-waste

disposal leading to mass casualties' condition. Direct impacts can be categorised under incidence like diarrhoea, vector-and rodent-borne diseases like malaria, leptospirosis; skin and eye infections; and psychological stress. The indirect health consequences are usually owes to damage to water and sanitation infrastructure, damage to crops and disruption of food supplies, destruction of property causing lack of shelter which might lead to increased exposure to disease-vectors.



### **Enhanced exposure to Cardio-Respiratory Problem**

Assuming current emission level continues there is high chances of deterioration of air quality in urban region as well increased exposure to ozone and other air pollutant including particulate matter projecting an increase in cardio- respiratory morbidity and mortality. Certain weather patterns enhance the development of urban heat island, the intensity of which is important for secondary chemical reaction within the urban atmosphere leading to elevated level of some pollutants.

The climate change may also alter the seasonal distribution of some allergenic pollen species leading to physiological problem.

### **Enhanced chances of Malnutrition and Food Security**

The lowering of yield of food crops due to climatic variability might diminish dietary diversity and reduces overall food consumption and may therefore lead to micronutrient deficiencies posing impact including death, malnutrition and/or micronutrient deficiencies especially among the vulnerable section of the population with lower economic stability. Food insecurity issue may also lead to

urban migration.

The action plan is strategized in order to reduce the impact of climate change related direct and indirect human health relevant exposure, combat the incidence of diseases and promotion of sustainable development. The strategy is framed on the basis of assessment of the scale of impact at regional level, determining the priority and scale of actions and strategising adaptation measures towards reducing vulnerability of climate change. Such strategy broadly includes enhancement of awareness and uptake of effective clinical and public health intervention in high need regions for reduction of impact.

### **Adaptation Pathway**

Adaptation measures are strategized in order to offset and reduce the negative impact of climate change and utilising the positive impacts towards enhancement of overall sustainable development. For working out the comprehensive strategy the socio economic driving forces are also linked those are indirectly impacted by the climate change but influence the overall health scenario which forms the fundamental and integral part of socio economic development.

Climate change Issues	Impact	Pathway
Surface temperature is projected to increase between 0.8-2.10C	Expected to face an increase incidence of malaria due to increase in temperature	Development of adaptation frame work towards reducing the incidence of malaria and enhancing the infrastructural facilities towards facilitating prompt and complete treatment of vector borne diseases
Decrease in winter Precipitation	1. Lower crop yield in winter	1. Management of Malnutrition and addressing food security issues
Increase in intensity of summer precipitation	2. Damage of crop due to higher precipitation	2. Loss of employment and adverse effect on health
Increase in night time temperature	3. Increased pest incidence	
	4. Increase runoff and landslide during summer precipitation	
	5. High night temperature reducing cereal yield	
Climate change Extremes like flood, landslide	1. Damage to agriculture leading to Increased Poverty and malnutrition, population displacement	1. Planning effective disaster management programme
	2. Population displacement adversely impacting social cohesion and health	2. Increased surveillance for evidence malnutrition including micronutrient deficiencies
		3. Addressing the specific needs of the community thereby preventing migration

### Key Priorities

- **Formulating Adaptation strategies to reduce the impact of climate change issues affecting human health**

The action for framing of adaptation strategies are conceptualised with an objective to reduce the vulnerability to the climate change that has already occurred and also to address the health risks projected

to occur over the coming decades. Vulnerability is partly a function of the programmes and measures in place to reduce burdens of climate-sensitive health determinants and outcomes, and the degree to which the adaptation programmes needs to be augmented. The strategic approaches identified are:

- **Upgradation of state health policy through incorporation of Health Impacts due to climate change**

Health impacts due to climate change are presently not included in the State Health Policy. The policy should include climate implication on human health such as occupational health and vector biology. Once the integration is done at the policy level, it will be easier to integrate those at the programmatic and other operating levels.

- **Research initiatives for changed patterns of diseases by region and by climate parameters**

There is high probability that Climate change might enhance the chances of newly emerging infectious diseases, re-emergence of diseases previously under control and redistribution of diseases in new areas/diseases free area. Current levels of vulnerability are due to non performance of traditional public-health activities, including providing access to safe

water and improved sanitation to reduce water borne diseases, and implementing surveillance programmes to identify and respond to outbreaks of malaria and other infectious diseases. Weak public-health systems and limited access to primary health care contribute to high levels of vulnerability and low adaptive capacity amongst the people.

Since the overall health condition is vital element in determining the adaptive capacity there is a high chance that the burden of disease and disability are likely to be more severe than otherwise in light of change in climatic conditions. The degree of emergence of diseases and climate change related vulnerability in the future, will depend not only on the extent of socio-economic change, but also on how evenly the benefits and costs are distributed, and the manner in which change occurs (McKee and Suhrcke, 2005).

Given the importance of these types of assessments, further research is proposed under the state climate change action plan.

In order to reduce the burdens of climate-sensitive health, determinants and outcomes may need to be revised, reoriented and in some regions expanded to address the additional pressures of climate change. To this context an assessment is required to be carried out to determine the degree to which

the existing health programmes is need to be augmented depending on factors such as the current burden of climate-sensitive health outcomes, the effectiveness of current interventions, projections of where, when and how the burden could change with changes in climate and climate variability, access to the human and financial resources needed to implement activities, stressors that could increase or decrease resilience to impacts, and the social, economic and political context within which interventions are implemented. Given the importance of these types of assessments, further research is proposed under the state climate change action plan. The assessment will also include the cost of adaptation.

### **Health impacts due to drinking water contamination and temperature variation**

#### **Identification of vector borne diseases and development of strategies to combat the impact**

Under the Dept. Of Health and family welfare a network has to be established for the control of vector borne diseases. Due to climate change, incidents of vector borne diseases are likely to increase and so is the spread. Therefore the present set up is required to be strengthened with better surveillance, better diagnosis and control of vector with a particular focus on vulnerable group.

- **Identify extrinsic and intrinsic drivers of malaria and identifying immunity intervention measures towards control of incidence of malaria.**

Tripura is a hardcore malarious area with around 10-12 months of open transmission window. The weather condition in the region is conducive for both mosquito proliferation and active malaria transmission. Most pockets in forest, forest-fringe and foothill villages located along inter country/ interstate border are vulnerable to occasional outbreaks. Many of the interventions like indoor residual spray are not operationally feasible as the human settlements are scattered and are also not accepted among the community.

The quantum of transmission in the region is governed by two entomological indices i.e. vectoral capacity and Entomological Inoculation Rates (EIR) per person/night. These indices are directly affected by the density of vectors in relation to number of humans in a given local situation, daily survival rate, feeding rate of vector mosquitoes and the duration of the sporogonic cycle which are sensitive to environmental conditions.

Although the environmental and eco-climatic factors are assisting in enhancing the breeding of mosquitoes but such parameters cannot be varied. It is therefore highly essential to identify the other extrinsic and intrinsic factor based on the local conditions through detailed entomological investigation in malaria endemic pocket.

The studies can include identification of vectors and parasite prevalence region wise, their breeding time and places, bionomics concerning their breeding, in addition to other parameters like geographic distribution, seasonal prevalence and host feeding preference and other related issues.

Based on the identified extrinsic and intrinsic factor the immunity intervention measures towards control of incidence of malaria will be strategized including variety of options like distribution of LLIN, Insecticide treated bed nets, antimalarial drug, introduction of larvivorous fishes in stagnant water, introduction of residual spray, clinical cure and awareness creation through training programme.

- **Evidence based assessment of biophysical determinants of malaria and development of framework for adaptation measures for malaria control.**

To frame up the adaptation measures it is essential to undertake multi-disciplinary, multi- institutional and multi-location study to generate evidence for impact of climate change on malaria. Such study is essential for developing a framework for adaptation measures for addressing the adverse impacts of climate change on malaria. Such study should include field survey in vector and parasite prevalence pockets, surveillance of entomological indices and malaria.

The adaptation measures towards control and outbreak of vector borne diseases includes both proactive initiatives towards reducing the incidence of diseases and reactive measures including preparedness for undertaking prompt and complete treatment.

Development of proactive framework includes

- Enhanced surveillance of suspected fever cases which is the cardinal symptom of malaria

- Supply of LLIN to population at higher risk of malarial incidence
- Supply of Insecticide treated bed nets
- Residual spray
- Chemoprophylaxis - Chemoprophylaxis is recommended for travellers, migrant labourers and military personnel exposed to malaria in highly endemic areas. Use of personal protection measures like insecticide-treated bed nets should be encouraged for pregnant women and other vulnerable populations.
- Assessment of malaria related knowledge, practices and behaviour of the community in malaria endemic areas to develop behavioural change for developing strategy towards prevention and control of malaria
- Increased awareness level and enhancing community participation in control of malaria
- Monitoring and supervision of activities to ensure carrying out of Malaria Control Programme in effective and judicious manner which is most often jeopardized due to lack of funding and lack of adequate professional support.

Development of reactive framework includes

- Early diagnosis followed by Prompt, effective and complete treatment
- Development of adequate infrastructure towards diagnosis of severe malaria cases negative on microscopy
- Strengthening of present health care set-up
- Development of adequate infrastructure for management of complications for management of severe malaria
- **Study and documentation of diseases caused by water (water borne) and development of institutional mechanism to reduce the incidence/outbreaks of such diseases along with awareness generation**

Climate-change-related alterations in rainfall (enhancement of precipitation-flood situation), surface water availability and water quality (increased contamination) could affect the burden of water related diseases. Extreme summer and lower rainfall is envisaged to enhance the pathogen loading whereas extreme rainfall and runoff events may increase the total microbial load in water courses

and drinking water reservoirs. So it is vital that a research study being is carried out to find out the possibility of outbreak.

Institutional development involves strengthening the surveillance with an integrated approach for management of water borne diseases including water source contamination and determining possibility of outbreaks of water borne diseases including developing of infrastructure towards facilitating prompt treatment of the diseases.

- **Development of institutional framework and infrastructural facilities for early detection of vector borne diseases, including managing outbreaks**

Vector-borne diseases such as malaria enhance the morbidity and mortality leading to social disruptions within the community. Besides ecological parameters which influence the disease incidence other local factors such as socioeconomic, socio-cultural and behaviour patterns of the community play a major role in disease transmission. This objective of early detection and managing outbreaks can be accomplished by compilation of generated dataset and its integration within spatial infrastructure (SI)

and introducing a geographical information system (GIS) for analysis and management of diseases outbreaks.

As a part of GIS infrastructure development thematic layers including PHC/CHC locations, geomorphological parameters, land use, soil type, water bodies, drainage network, forest cover and settlement is to be considered to form the basis of analysis towards describing the primary risk factor within the PHC/CHC's. Thematic maps of ecological parameter when overlaid on Malarial API map can guide towards information on malarial epidemiology including early detection and framing up strategy towards managing outbreaks.

### **Establishment/Upgradation of pathological laboratories for disease identification caused due to climate variations**

Climate change is expected to enhance burden on the existing health care system and specifically the diseases detection centre in the far off, remote and inaccessible areas or even in malaria endemic pockets where microscopy cannot be conducted within 24 hrs of sample collection or does not have RDT facilities or facilities of storing of RDT under recommended conditions. Such areas call for increase in the test centre for early detection of malaria.

Moreover some patient may not respond to treatment due to drug resistance or treatment failure or happened to be the case of severe malaria where microscopic evidence may examine to be negative. In such cases there is a requirement of well equipped lab.

Judging the necessity on the basis of above scenario well equipped labs are proposed in the state at malaria endemic pocket and also at remote areas that are not well connected to the main part of the state having well equipped laboratory.

Initiatives outlined above are planned as a key priority under state climate change action plan.

### **Human health infrastructure development and capacity building for climate change adaptation**

#### **Capacity Building**

Climate change interrelationship in health sector is a new area. Since the degree, dynamics and intensity of the vector and water borne diseases are changing with changing of time it is highly essential that training should be imparted to the existing man power on the treatment procedures. This calls for an urgent requirement to develop capacity within the sectoral institution as the implication of climate change on health is expected to be widespread; strengthening awareness, knowledge and skills

at all levels across the states will be required. Capacity building is strategized to work towards the goal. The training is to be carried out among the different categories of health care service provider after understanding the training requirement, development of module in consultation with state health department, undertaking training of local trainers and imparting of training among the community through the identified and trained trainers.

From The point of view of capacity building advocacy and sensitisation of policy makers, massive general awareness campaigns, sensitizations of the health service providers (ANMs, ASHA, Doctors, AWW) strengthening the curriculum of ANMS, Health workers and Paramedic staff, recognizing gender issues, promoting health insurance for vulnerable groups, strengthening community resilience and enhancing psychological aid to disaster victims would be a part of the exercise.

#### ***The detailed actions framed are as follows:***

1. Capacity building and training for mental and physical health treatment during and after emergency preparedness during extreme climate events & Capacity building and training for health workers for sensitization of climate

- variation and health impacts
- a. State Technicians (2 Batches of 20 Each)
  - b. Health Workers (15 Batches of 40 Each)
  - c. ASHA (100 Batches of 40 Each)

### Infrastructure Development

Climate Change poses' high risk of extreme climate events like enhanced precipitation leading to flooding, drought and landslide. A disaster management plan and emergency preparedness measures needs to be facilitated in order to reduce the impact of climate change extreme events. The infrastructural facilities need to be strengthened including strengthening of the current health care facilities to respond during natural disaster. Actions such as community resilience, disaster preparedness, extending psychological aid to victims, retrofitting of vulnerable infrastructure, strengthening surveillance including traditional knowledge and cultural plan is proposed under the initiatives.

***The detailed actions framed are as follows:***

- Public health infrastructure

development (Support and Logistics for extreme climate risks) Medicine, Vaccines (Meningococcal Meninztis), Lab Consumer able

- Mobility Support
  - a. One time expenditure for up-gradation of Agartala Medical College Lab and South Tripura District Lab)
  - b. IEC Materials

### Assessment of health impacts due to malnutrition

Climate change variations are expected to lead to consequential decline in agriculture and increased malnutrition and food security. Given the importance of these types of assessments, further research is proposed under the state climate change action plan to assess the increased impact due to climate change and develop nutritional status of vulnerable population.

Monitoring and managing migration and psychological impacts of food security on the vulnerable rural poor is also planned as a part of the study.



## Cross Cutting and Implementation Level Issues in Climate Change

### Multi-stakeholder platform

Managing climate change requires multi-sectoral coordination and commitment of multiple stakeholders. Key stakeholders have to consider the vulnerability, priorities and inter-sectoral coordination and indicators for tracking climate change and its impact as well impact of their action at all levels. Although not new, collaboration across the sectors—private, public and civil society—has traditionally been defined by a single issue or geography. ‘Convergence’ is a more complex form of collaboration involving multi-stakeholder coalitions, seeking to affect systemic change on wide-ranging issues, focused on outcomes rather than inputs to deliver scalable and sustainable change.

While looking at the environmental effectiveness in choosing a key priority one has to see whether the cost is localised (area specific, state-wide, national or global). In this context if we take the example

of a coal-fired power plant. Then the environment cost is localised but it helps in electrification in the North-Eastern Region. The state can even earn revenue through open access by exporting power to other regions of the country. However, if it has to opt for a clean technology like a combined cycle plant or capture the carbon and store it or to have a supercritical boiler, then the costs have to be considered and additional investment need to be negotiated from non-local stakeholders. This will tie up with the other arguments like equity, flexibility in approach not to obstruct anything or everything that has an environmental cost. The state also has to address the issue of complementarity to avoid duplication of efforts or resource deployment. It has to negotiate with multiple players and based on the development priority of the state decide on the implementation agenda.

The priority actions where such dilemma exists have been deliberated keeping these criteria in mind and treated as a cross-sectoral issue.

The table below gives some idea about cross-sectoral relevance of the some contemplated actions.

<b>Cross-sectoral challenge</b>	<b>Sectors-Involved</b>	<b>Actions</b>	<b>Typology of action</b>	<b>Anticipated conflict</b>
Containing Damage to the housing and storage infrastructure in flood prone areas	Agriculture, Water, Housing	Change in crop storage structure and raised plinth	Adaptation	Medium
Containing Food				
Insecurity during extreme weather conditions	Agriculture, Horticulture, Rural Development	Food preservation, seed bank, homestead garden	Adaptation	Low
Management of water scarcity	Agriculture, Rural Development, Water, PHED, Health	Raising the plinth of tube-wells	Adaptation	Medium
Alternate livelihood during flooding conditions	Agriculture, Animal Husbandry, Fishery	Duck rearing, seed storage, Banana cultivation	Adaptation	Low
Basin/ Flood Plain Management	Water, Agriculture, Industry, Energy	Integrated water resource management at basin level should determine the apportionment of water different sectors	Adaptation	High
Promoting sustainable agricultural practices	Agriculture, Rural Development, Forestry	Prevention of slash and burn type shifting cultivation and moving to better agro-sylvicultural pattern	Adaptation	High

Preserving the bio-diversity	Forest, Fishery, District autonomous councils	Requires a holistic action to preserve the flora as well as the fauna including the aquatic ones of a specific area	Adaptation	Medium
Institution-alising Energy use efficiency	Energy, Industry, Works, Agriculture	A multi-layered approach to change the mindsets, methods and appliances to improve end-use efficiency and process efficiency	Mitigation	Medium
Promoting green infrastructure	Energy, Works, Urban, Transport	Green topped road, promotion of renewable and energy saving measures in the housing sector	Mitigation	Medium

### Planning Process

Under the climate change programme, there will be sectoral programs and under sectoral programs there would be projects (around key priorities) and individual “sub-projects” which will be delivered in two distinctive delivery modes. The projects/sub-projects are categorised into (a) investment projects that need to be elaborated in a participatory manner. Involving community, non-village based stakeholders such as line departments, NGOs, academia or other groups. However, where permissible as so called “stand-alone” projects, these interventions should eventually be

integrated at district level planning processes and should be used as entry level activities to kick-start climate change adaptation measures at the village levels. A multi-stakeholder process at the planning stage (including private industries and policy makers) is highly recommended. (b) Regular Operational and Maintenance: efforts should be made to identify the O & M budget in the existing projects and how these can be made climate resilient (e.g. if the recharge areas can be improved in watershed or de-silting of ponds can help in de-risking crops due to higher recharge and residual moisture availability) (c) Policy research: This kind of actions should be very

targeted and carefully chosen with a simple criteria that it should have short to medium term effect as well in the line of least resistance and fully targeted and tied to a specific climate linked result. (d) Training & Capacity Building type of projects shall include: Sponsorship for training needs (GIS, accounting, micro planning, CCA issues), Carbon monitoring training, Climate modelling), Beneficiaries: Exposure visits & extension

Enhancement of capacity building and skill development in cross cutting areas are also needed: A green growth would also require green jobs and green entrepreneurs. The state has to plan for an institutional framework for green entrepreneurship development, eco-system governance. It can even develop capacity building plans

around the adaptation pathways defined elsewhere in this report and pool in capacity building budgets from different projects to enhance.

### **Common Cross-cutting needs and capabilities**

The following are the common cross-cutting needs and capabilities that have emerged from the working group deliberations. Government of Meghalaya understands the common needs that emerge across sectors and has proposed several institutional mechanisms to move forward. This includes the apex council, building capacity of the district councils, an institution of Governance, looking at program monitoring and impact assessment, an entrepreneurship development institute to promote skill building in general with a special emphasis on the green skills.



<b>Geography Strategies</b>	<b>Local</b>	<b>State level</b>	<b>Linkages to national programmes/missions</b>
Awareness	Creating local level awareness is a first step, e.g. barefoot workers, farmer field schools may promote descaled climate change concerns	Building awareness of legislators, policy makers on socio-economic and socio-political cost of climate change	Participation in national networks, interface with the national knowledge network and research systems
Capacity	Monitoring, observation Awareness/assessment at state/ district/ community levels	Scientific assessment, measurement, models, with state level technical institutions like SPCB, Watershed Mission, Regional Centres of National Institution, Universities	Special regional modeling and assessments, best practices study and resource leveraging from various missions and mission resource centres and technical secretariates
Generation of Knowledge/Information	Locale specific databases, scenarios and assessment, local monitoring networks, rapid assessment for input to state inventory	Research networks, Compilation of state level GHG inventory and input to National databases(e.g. NATCOM), scientific and policy models, statewide and area specific scenarios, technology inventory	Interface with IPCC assessments, interfacing with regional/global databases, scenarios and assessments, technology inventory database
Institutions/Partnerships	Community initiatives, Early warning networks, Disaster management teams	Stakeholders networks, public/private programs	Standardised Climate impacts assessment both academic as well more applied ones for result based management and programming

Policy/ Instruments	Local specific adaptation plans, community based adaptation programs	Science-policy linkage, mainstreaming climate change agenda in sectoral policies of the state (agriculture, mining, industry, energy, water, forestry, etc.) economic instruments (e.g. insurance, R&D funds), integration with national development/ planning process	Adaptation funds, Interface with private sector participants for fund under market mechanisms like CDM, REDD+
Technology	Locale specific technology adaptation	Targeted R&D, Technology transfer protocols, demonstration/ pilot projects	Scientific exchange, technology transfer

### **Knowledge management and skill development**

Future actions need to focus on widening the awareness and understanding of the issue of climate change in the state, including their contribution to biodiversity protection and supporting sustainable development, and especially their value to indigenous peoples and local communities. The apex council shall act as the inter-sectoral coordinating body for the state to take the process forward.

#### **Some of the processes that will be undertaken in the first step:**

#### **Mainstreaming the agenda of climate change into the sectoral policies and practices:**

This will involve building in climate

change related triggers/indicators in the planning, monitoring and evaluation processes. For example if there is a sectoral programme like soil water conservation, in the micro-planning process itself the indicators shall be built in and actions have to be prioritised.

#### **Knowledge management**

Climate change related knowledge is very limited at the state level. The localised indicators, investments in generating local dataset for modelling, forecasting and tracking will be essential. The data base will be needed to construct baseline for several sectors to assess the cost and benefit of specific adaptation action. Baseline data would also be necessary for the co-benefit to be harnessed from market mechanism like Clean Development Mechanism,

Payment against ecosystem services, perform achieve and trade, etc. Particular emphasis will be placed on web-based communication and interaction and websites will be integrated as part of the state level climate change Knowledge Management System. These websites will be designed as part of the programme to serve the needs of the key officials and would also reach out to the wider community.

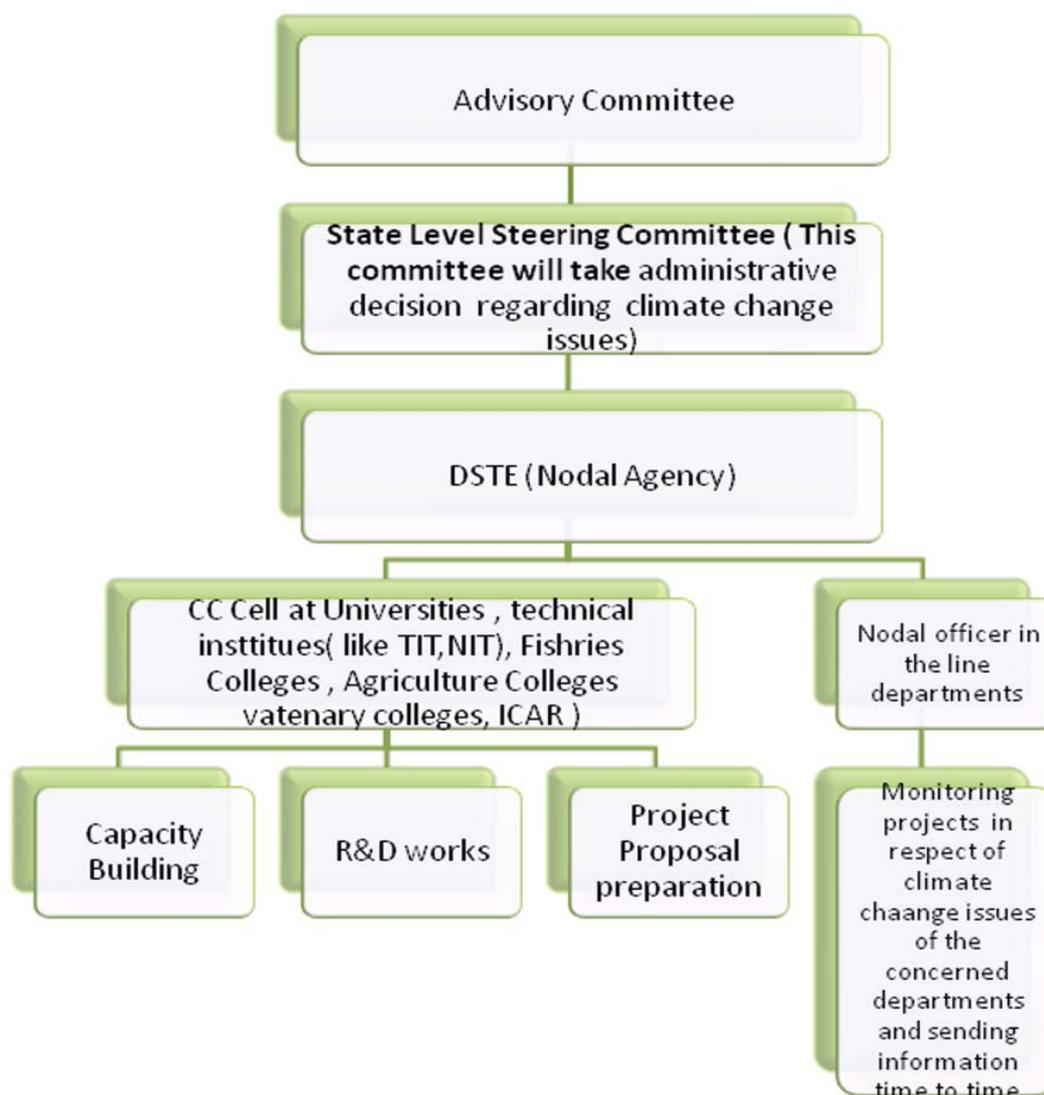
### Climate Change and Media

Popularized publications on the values of bio-diversity, issue based

features on climate change at the state level, through targeted Opinion Editorial Pieces and other media forms will be pursued. A concerted communication effort focused on the value of sustainable development reduction of GHG emission and low carbon lifestyle will be of special interest. Local media persons will be involved in this process.

### Implementation arrangement

The state has prepared a detailed mechanism for climate governance illustrated in the diagram below:



The nodal agency will be housed in DSTE department. The agency will have an advisory, supervisory and coordinating role in climate change issues. The agency will be single window facilitation centre to coordinate with GoI, state departments and external funding agencies. It will have its own websites (it can be managed by outsourced providers having experience in climate change knowledge management). The success of the implementation will be based on the quantum of flexibility and autonomy the agency has. It should have access to good quality staff some from open market and some on deputation as well as if support is available from any external agency.

**The office shall be responsible for:**

- Preparing working documents (manual for design and

implementation of sub-projects, base-line establishment, O&M concepts, monitoring of sub-projects, performance based reward schemes);

- Preparation of decision making (pre-screen of sub-project applications; screening criteria; sanctioning of sub-projects, etc.);
- Project management (activity schedule, indicators in a participative manner with stakeholders and implementing agencies) & administration.

**M & E Framework**

Without tracking the outcome of the climate change adaptation and mitigation actions, this elaborate exercise will be counterproductive. The following schema is proposed to monitor each priority action and the efforts made.

Sectors	Key Vulnerability/ Impacts to monitor	Key Programmes	Key Targets	Remark

There are some critical areas that would need consideration under this framework. These are listed below.

- (a) Baseline data: there has to be attempt to generate baseline data sector wise
- (b) A set of suitable indicators to be developed for an effective M&E system will have to use improved mechanisms of joint monitoring, social audits and third party evaluations.
- (c) However, uncertainty surrounding climate change

impacts and their long-term repercussions will make impact assessment difficult.

- (d) Indirect effects of climate change on health and social situations can equally affect the achievements and need due consideration.
- (e) Project impacts on reducing vulnerability to unpredictable weather and extreme events may be difficult to monitor if such events don't happen during the project period.





# Analysis and Synthesis

## Introduction

This chapter outlines the findings from the analysis and synthesis of the previous chapters. The analysis in each sector provided a set of key priorities. Certain cross cutting areas were also identified. These were synthesized to arrive at findings, which describe what the Climate Change Action Plan will achieve. The case is made for new institutional arrangements that will be required in the context of the proposed initiatives. This is introduced and described. The independent monitoring and evaluation required to ensure effective implementation is then described. Finally, the chapter concludes with the financial budget for the Climate Change Action Plan.

## Findings

### Changes in policies, organizations and practices:

Analyzing the key priorities revealed that climate change orientation needs to be provided at policy, organizational and practice

levels in different sectors. Policies need to integrate climate change considerations. At an organizational level, awareness, skills and capacity has to be built.

Strategic bodies like Tripura Institute of Strategic Knowledge for Climate Change (TISKCC) have to be established. At a practice level, line department's implementation initiatives will be required to shift towards a more climate- friendly development path. There are significant actions – Marginal/ incremental actions will not suffice and there are significant actions required at all these levels to move on a climate-friendly development path.

### Awareness generation and capacity building :

Considering that climate change is a relatively new challenge, the focus of this Climate Change Action Plan will be on generating awareness and building capacity. This will be done across all levels of the Government of Tripura and external stakeholders involved in the different sectors.

This strong drive towards building capacity will result in empowering people and organizations to be able to address, manage and respond to climate change concerns.

### **Action implemented across the economy:**

Given the all-pervading nature of climate change, action will be taken across the state economy. The interconnectedness of issues pertaining to climate change necessitates this approach. Selecting and initiating work only in some of the sectors will undermine the effectiveness in an overall sense. Therefore, progress will be made across all the identified sectors in a parallel and simultaneous manner.

### **Climate-intrinsic sectors distinguished:**

Broadly, the different sectors can be classified as climate-intrinsic and climate add-on sectors. Climate-intrinsic are sectors that are so heavily associated with climate change that every action within these sectors have a strong bearing or related to climate change. These include forest, water, agriculture and Energy. Climate add-on sectors are those wherein the climate dimension is additional, e.g. fisheries, health and urban. While the key priorities across all these sectors will be met, Government of Tripura will recognize that every activity particularly any new policies, organizations and initiatives - in the

climate-intrinsic sectors will have a strong association with climate change.

### **Integrated perspective imperative:**

To be effective in implementing initiatives pertaining to the key priorities, it is vitally important to have an integrated outlook and not work in isolation. This will be required to ensure maximum returns to the efforts being made.

### **Carbon-conscious development:**

The various mitigation initiatives being planned under the proposed Missions will ensure that Tripura proceeds on a carbon-conscious development path.

### **Biodiversity in addressing livelihoods:**

The key adoptive strategy being envisaged in the climate change action plan will facilitate conservation of biodiversity including restoration and rehabilitation which will help vulnerable people, mostly the tribal communities and economically most backward strata, to cope with climate change. Biodiversity plays a central role in ensuring livelihoods especially amongst rural populations and indigenous communities. The climate change adaptation so planned will aim at integrated management of biodiversity, thus immensely facilitating the poverty reduction

and food security planning in the state.

### **Building climate resilience:**

The different adaptation initiatives being planned will ensure better preparedness to climate-induced changes, including extreme events. For a climate sensitive state such as Tripura, climate change adaptation is an integral part of good development.

### **Institutional Arrangements**

.In initiating the preparation of the Climate Change Action Plan the state Planning Board in its meeting on 31-05-2010 had constituted a committee of State Action Plan on Climate Change under the Chairmanship of Minister , Science, Technology&Environment. This committee has delegated the responsibility of Climate Change Action Plan preparation to 4 subcommittees from line departments to bring greater focus on different sectors. These deliberations revealed that implementation also requires strong inter-sectoral and inter-department coordination.

To meet this need, a State Level Steering Committee on Climate Change will be put in place during the first year of implementation. This will have an advisory, supervisory and coordinating role on climate change issues. This Committee will

formulate a Nodal Agency which will be a single-window contact for dealing with the GoI and other external funding agencies in issues pertaining to climate change. However, the Agency's role will include and involve all sectors and all departments. It is envisaged that this Agency will function in an independent and autonomous manner so that it can execute its various roles, responsibilities and duties in a smooth, quick and effective manner. The Agency will be equipped with appropriate quality manpower, resources and infrastructure that are commensurate with the requirements and challenges faced. The Agency's functioning style will be collaborative and inclusive, not only within Departments of the Government but also with the different external stakeholders.

### **Financial budgets**

Each working group has put together a budget for the initiatives proposed to meet the key priorities in each sector. There are a number of ongoing initiatives, which are also relevant to climate change, these budgets have also been included in determining the overall budget for the CAP. The additional resources required in each sector has also been estimated and resources for these will be sourced from the GoI or external funding agencies. The following table provides the rough budget estimate for the first CAP.

### *Budget for CAP, 2010-15*

S. No.	Particulars	Approx. Amount (Cr)
1	Sustainable Himalayan Mission	94.70
2	Sustainable Habitat Mission	1196.5
3	Sustainable Agriculture Mission	795.80
4	Green Tripura Mission	591.70
5	Strategic Knowledge Mission	31.00
6	Solar Mission	1085.11
7	Mission on Energy Efficiency	828.35
8	Mission on Water	8005.93
9	Mission on Health	30.48
	<b>Total</b>	<b>12659.57</b>

## Conclusions

This chapter draws the conclusions from the different key priorities, their analysis and synthesis. This chapter also includes recommendations for preparing future Climate Change Action Plans.

The Climate Change Action Plan will lead Tripura to move towards a carbon-conscious, climate resilient development path. The following are the key conclusions of this Climate Change Action Plan:

### **Significance of climate change:**

The nature, scale and magnitude of the climate change impacts are likely to be high on the state's. In addition, Climate Change impacts on Bangladesh can magnify the migrations to the Tripura. Therefore, Tripura will be a focus of both national and international attention in the context of climate change.

### **Addressing both adaptation and mitigation:**

The state Climate Change Action

Plan will address both mitigation and adaptation issues in a holistic manner by implementing all the activities in the action plan. It has been recognised that adaptation is of much greater significance.

### **Information on climate change implications:**

In terms of assessing the climate change implications for the state, Government of Tripura will adopt a dual approach, i.e. top-down approach through the downscaling of global models as well as a bottom-up approach through collecting empirical evidences of climate change at a grassroots level to develop sector specific models.

### **Awareness and capacity-building:**

Awareness and capacity building to face this new challenge will be the primary focus; this will be undertaken across the different sectors and the state economy as a whole

### **Overall approach:**

A multidisciplinary, integrated and co-ordinated approach is required and to be adopted in implementing this Climate Change Action Plan. Government of Tripura will adopt a proactive, preventive and preparedness-oriented approach rather than a reactive approach.

Different sectors have different key priorities to be addressed through different initiatives over different timeframe. Each sector will implement its initiatives relevant to their key priorities within themselves and in close integration with different departments and stakeholders involved.

During this Climate Change Action Plan implementation, Government of Tripura will demonstrate, promote and encourage different initiatives through policy changes and implementation actions as a response to climate change.

### **Involve stakeholders:**

Government of Tripura will involve stakeholders, particularly community, in a more proactive way in the Climate Change Action Plan implementation. This involvement will relate to (i) promoting much greater climate change awareness within community, (ii) identifying problematic issues relevant to climate change, (iii) support in monitoring of climate-induced problems and (iv) ensuring greater

accountability to the people on climate change issues. Stakeholder involvement will be an effective tool with stakeholders, who play an important part in bringing out the solutions. If stakeholder involvement as described here is not initiated, then stakeholders are bound to look at Government of Tripura as an adversary and not as a partner.

### **Tripura Climate Change Agency:**

To ensure the effective implementation of the above approach, a State Level Steering Committee will be put in place to provide advisory, supervisory and co-ordination services to the state. This Committee will facilitate dealing with the Government of India and the various external funding agencies in the context of climate change.

Once the Tripura Climate Change Steering Committee is established, Government of Tripura will ensure transparency by sharing information on all its climate change related activities on a public website.

### **Going beyond environmental & climate change professionals:**

From the range of issues / concerns, it is quite clear that even though climate change is an environmental challenge, the response requires non-environmental professionals. Resolving climate change issues

cannot be done in isolation by the environmental or climate change fraternity alone. The issues/problems are so fundamental and deep in the sectoral context that the respective sector professionals would have to address these problems.

Policy-makers, economists, planners, engineers, scientists, development program specialists and others have to be encouraged to contribute towards resolving climate change problems in a structured way.

#### **Dynamic document:**

Approaches to responding to climate change are fast changing based on research being done across the world. Given this situation, this 5-year Climate Change Action Plan should be seen as a dynamic document rather than a fixed in time or static one. The key priorities provide the guidance and direction that Government of Tripura wishes to take. Keeping these key priorities, flexibility will have to be exercised in implementing the proposed initiatives so that these are in line with the latest and up to date developments in this fast-changing discipline.

#### **Integrate climate change in new initiatives:**

This CAP was prepared taking into account the current development activities and how climate

change considerations need to be integrated in all those. As there will be new development activities in each of these sectors, it will also be ensured that climate change considerations are integrated with these sectors as well.

#### **Monitoring of CAP:**

Climate change is relevant to most sectors and departments within the Government of Tripura. As activities across all sectors and departments are identified and planned through state planning processes, the monitoring and evaluation of this CAP will be done in close coordination with the monitoring of the state planning activities. Over a period

1-2 years, the process of monitoring the CAP will be streamlined with the monitoring of activities under the state planning framework with half yearly monitoring of priority actions in respective sector. Those would be compiled and reported to the highest levels of Government.

#### **Budget:**

Any estimation for implementation of Climate Change Action Plan will only be a rough estimate. However the budget for climate change response actions has been estimated to be Rs. 12659.57 Crore for a 5-year period between 2012 and 2017. This estimate includes both existing / already earmarked resources and additional resources

required to shift Tripura towards a carbon-conscious, climate-resilient development path. Energy, forests, Health agriculture, water resources and urban are the sectors that constitute about 80 percent of the overall budget. Parts of the Action Plan can be implemented with the available resources of the departments and additional funds may have to be provided for certain activities. As the implementation proceeds, the picture will be clearer.

### **Recommendations for future CAPs**

The preparation of this CAP was undertaken from the commencement of the climate change scoping study. From the experience of preparing this CAP, the following are the recommendations for preparing future CAPs in the state:

- Following the implementation of this first CAP, awareness and knowledge on climate change issues / concerns would have developed across the state. Therefore, the overall capacity of both Government staff across all levels as well as those of the external stakeholders will be considerably higher. Once built, this capacity should be collectively and gainfully used in a consultative, participatory and inclusive manner in determining the focus areas of attention in the next version of

the CAP.

- As was done in the first CAP, a set of sector working groups were established - should be created within the Government of Tripura to prepare subsequent CAPs as well. The ownership and commitment of the Government of Tripura in implementing this CAP gets a substantive boost if there is an active involvement and engagement of the Government of Tripura staff in preparing these plans. A similar multi-sector and integrated approach should therefore be adopted for future CAP preparations.
- While all sectors were directly or indirectly covered in preparing the first CAP, there were some departments of the Government of Tripura that were not actively engaged, e.g. Education, Disaster Management departments. The overall focus on capacity building addresses an educational goal / target but this is not implemented through the formal systems of the Education department. In the next version of the Climate Change Action Plan, those Government of Tripura departments that have not been directly engaged should be encouraged to be involved so that new perspectives and approaches emerge.

- As climate change has an all-pervading influence, it is relevant to most sectors and departments within the Government. Activities across all sectors and departments are identified through state planning processes and budgets are prepared on an annual basis. With the implementation of this first Climate Change Action Plan, the move towards climate-friendly sectoral development will be achieved. Subsequent

Climate Change Action Plan should aim to identify only the additional activities and budgets required to further move the sector development plans towards being more climate-responsible. There should be a monitoring and advisory group comprising Chief Secretary as its chair, representatives of line departments, 2 experts from the state and 2 NGO representatives. They should meet at least twice in a year and take stock.



## Key Priorities

### 1. Solar Mission & Non-Conventional Energy

Primary Department: TREDA

Sl. No.	Action Points	Total Budget (Rs. In Crore)	Source of Funding
1	<b>Promotion of grid interactive power generation from Solar and other Renewable Energy sources through declaration of State Energy Policy.</b>	0.00	
1.1	Formulation & Declaration of state energy policy for power generation through renewable energy sources.		
1.2	Declaration of Tariff Policy by Tripura Electricity Regulatory Commission for Solar and other renewable power purchase.		
1.3	Facilitating private sector participation in solar power generation under JNNSM and/or other schemes of Govt. of India through selection of private investors and other support activities through Single window clearance process.		
2	<b>Promotion and facilitation of Off-grid or decentralized renewable energy generation for electrification, cooking and other thermal energy requirement.</b>		
2.1	Facilitating deployment of stand alone off-grid solar power plant within 100 kW for fulfilling the power demand in dispersed locations under National Solar Mission with following target - a) Up to 2016-17 is 10 MW b) 2017-18 to 2021-22 is 10 MW c) 2022-23 to 2026-27 is 10 MW	900.00	Govt. of India, Govt. of Tripura, External Agencies

2.2	Facilitating deployment of 1000 No. Biogas plant (using cattle waste, household waste as well as water hyacinth) annually in 12th plan period and setting up of bottling unit at community level to use the biogas in agro based/ rural industries across the state under the Govt. of India programme.	<b>157.50</b>	Govt. of India, Govt. of Tripura, Beneficiary/ User
<b>3</b>	<b>Promotion &amp; Facilitation setting up of Solar Water Heater (SWH) systems in all Govt. establishments under National Solar Mission.</b>	<b>12.11</b>	Govt. of India, Govt. of Tripura, User or Beneficiary Department or Organization, External Agencies
3.1	Declaration of targeted actions by the State Govt. through policy mechanism.		
3.2	Project Implementation in Public Health Centre's - 86 Hospital - 22 Nos. Govt. Higher Secondary School - 248 University, College & Engineering College - 26 Nos.		
<b>4</b>	<b>Harnessing renewable energy potential scenario of the state for power generation through</b>		
4.1	Assessment of Biomass potential and availability for energy generation in the state and demarcation of biomass potential sites in the map.	<b>0.20</b>	Govt. of Tripura
4.2	Assessment of Solar irradiation, temperature, wind speed at district level across the state for solar mapping.	<b>0.30</b>	Govt. of Tripura
<b>5</b>	<b>State Govt. by amendment of building bye-laws suitable to state condition will promote and mandate use of solar energy based water heating and/or lighting in all commercial buildings and in private houses costs more than Rs. 20.00 lakhs or as may be decided by the competent authority on time to time.</b>	<b>5.00</b>	Govt. of Tripura
5.1	Amendment of building bye-law considering state demographic profile.		

5.2	Enforcement of incentives /rebate on property tax for use of solar water heaters in buildings.		
<b>6</b>	<b>Strengthening of technical capability of existing renewable energy technology service providers and develop new service providers as per the international standard by introducing training course in all ITI's in the state.</b>	<b>10.00</b>	Govt. of Tripura, Govt. of India
<b>Total Budget In Rs. Crores</b>		<b>1085.11</b>	

## 2. Mission on Energy Efficiency

**Primary Department/Departments: TSECL**

Sl. No.	Activities	Total Budget (Rs. In Crore)	Source of Funding
1	Conversion of open cycle gas based thermal power plant to combined cycle systems.	455.25	Govt. of Tripura, Govt. of India, External source of funding from Multilateral agencies
2	T & D Loss reduction	341.5	Govt. of Tripura, Govt. of India, External source of funding from Multilateral agencies
3	Development of policy for mandatory use of efficient light particularly for commercial organizations in the state.	0.2	Govt. of Tripura, Govt. of India, External source of funding from Multilateral agencies
4	Conversion of conventional street lights to solar LED/CFL street lights.	10.5	Govt. of Tripura, Govt. of India, External source of funding from Multilateral agencies
5	Encourage use of Solar Gadgets in Industries	0.1	Govt. of Tripura, Govt. of India, External source of funding from Multilateral agencies
6	Policy development for mandatory Energy Audit in Govt. Building;	0.3	Govt. of Tripura, Govt. of India, External source of funding from Multilateral agencies
7	Research study to assess the potential of energy conservation across all sectors and designated consumers and designing of resource estimation and institutional structure required to address the energy efficiency	0.1	Govt. of Tripura, Govt. of India, External source of funding from Multilateral agencies

	issues.		
<b>8</b>	Awareness and implementation for use of CFL and replacing incandescent lamp under Bachat Lamp Yojana, and Umbrella program of BEE.	20	Govt. of Tripura, Govt. of India, External source of funding from Multilateral agencies
<b>9</b>	Development of policy to mandate ECBC adoption in state.	0.15	Govt. of Tripura, Govt. of India, External source of funding from Multilateral agencies
<b>10</b>	Formulation of DSM project for TSECL	0.25	Govt. of Tripura, Govt. of India, External source of funding from Multilateral agencies
Total Budget In Rs. Crore		828.35	

### 3. Sustainable Habitat

**Primary Department-** Urban Development & Municipal Councils , PWD and Transport

#### Key Priorities for Sustainable Habitat

Sl. No.	Activity	Other Budget Rs. In Millions	Source of Funding
<b>Primary Department- Urban Development &amp; Municipal Councils</b>			
1	Capacity building and research initiative through improvement of knowledge base for climate change adaptation <ul style="list-style-type: none"> <li>• Awareness generation and capacity building in climate change impacts and preparedness</li> <li>• Capacity building for departments on advance solid waste management</li> <li>• Capacity building on Water management and efficient distribution of supply and delivery</li> <li>• Capacity building on Urban Management</li> </ul>	100 100 75 50	Govt. Of India, External Agencies
2	Water usage management through improved urban drainage, sanitation management and drinking water quality to reduce Climate change impacts <ul style="list-style-type: none"> <li>• Liquid waste management through improved sewage design for addressing climate change impacts</li> <li>• Improvement of Water Use Efficiency and conservation through leak reduction in Urban Areas</li> <li>• Developing models of urban storm water flows and capacities of existing drainage system</li> </ul>	100 50 50	Govt. Of India, Govt. Of Tripura, External Agencies
3	Development of climate friendly Solid Waste management systems to mitigate GHG emissions		Govt. Of India, Govt.

	<ul style="list-style-type: none"> <li>Developing a climate friendly waste management system</li> <li>Composting and treatment of Municipal Solid Waste in Agartala Town and other district towns is very important in regard to control of methane emission</li> <li>Waste management through Sanitary landfill and aerobic composting facilities for reduction of GHG</li> <li>Reduction of vector borne diseases from unmanaged dumping grounds</li> <li>Improvement of collection efficiency and segregation at source</li> </ul>	100 100 100 50 200	Of Tripura, External Agencies
4	<p>Disaster risk reduction through from adverse climate change impacts</p> <ul style="list-style-type: none"> <li>Formulation of building guidelines with provision of promoting traditional houses for different agro-climatic zone, floodplains and in consideration of the seismic vulnerability of the state</li> <li>Urban poor Mapping to Identify vulnerable urban population</li> <li>Developing climate- responsible master plans for selected city/towns (CDP)</li> <li>Reformulation land tenure policy to enable sustainable urban development</li> <li>Disaster risk reduction in Urban sector</li> </ul>	1000 100 50 50 50	Govt. Of India, Govt. Of Tripura, External Agencies
5	Promote and facilitate setting up green building for upcoming commercial buildings in the state through policy and regulation measures	300	Govt. Of Tripura, BEE, External Agencies
<b>Primary Department- PWD</b>			
6	<p>Promotion of eco-friendly road construction methods and capacity building of stakeholders</p> <ul style="list-style-type: none"> <li>Capacity Building on Climate Change Impacts on Construction of Road, Bridge and Building to private Engineers, Contracts and Architects and Bitumen fuel usage</li> <li>Promoting eco friendly methods of road construction (Like Using Bitumen without burning)</li> <li>Recycling and Reuse of the Building and road construction materials</li> </ul>	125 200 500 500 500	Govt. Of India, Govt. Of Tripura, NHAI, External Agencies

	<ul style="list-style-type: none"> <li>• Pilot project on Rubberized Bitumen usage in Road Construction</li> <li>• Constructing Pilot water proof Road (Heavy rain fall, water logging, average Ground water level is only 10 mt)</li> </ul>		
<b>Primary Department- Transport</b>			
<b>7</b>	<p>Reduction of direct or indirect GHG emission transport management and vehicular pollution control</p> <ul style="list-style-type: none"> <li>• Switching to liquid fuel based vehicle to CNG based Vehicle</li> <li>• Promotion of low emission vehicles, electric vehicles</li> <li>• Introduction to concept of mass rapid transit</li> <li>• Introduction of more public transport</li> <li>• Quantitative assessment of the impact of climate change</li> <li>• GHG Emissions foot printing for all urban bodies including upcoming satellite townships</li> <li>• Promotion of Bio-fuel</li> </ul>	<p>3000</p> <p>15</p> <p>1000</p> <p>3000</p> <p>200</p> <p>300</p>	<p>Govt. Of India, Govt. Of Tripura, External Agencies</p>
	<b>Total Budget</b>	1196.5	

## 4. Mission on Water

**Primary Department:** Water Resource Department, PWD(DWS)

Sl.No	Activities	Total budget (Rs. In Crore)	Source of Funding
1.	Creation of new minor storage/irrigation tanks-400	4000	Government of India and others
2.	Protection and Conservation of large wetlands/waterbodies (like RudraSagar )	1000	Government of India and others
3.	Embankment raising in preventing high flood	500	Government of India and others
4.	Development of GIS supported Data-base/status maps for all the existing water sources	1	Government of India and others
5.	Information on status of runoff, water level, sedimentation during different seasons	0.5	Government of India and others
6.	Extensive Awareness Generation Programme about water resource mgt	0.2	Government of India and others
7.	River conservation measures and river health monitoring-sewerage Mgt	500	Government of India and others
8.	Establish of Basin Authority for river conservation and Mgt	7.5	Government of India and others
9.	Anthropogenic activities vs climate change and their impact on landslide, soil erosion and decaying river courses of the major rivers & other major water bodies of Tripura	1	Government of India and others
10.	Formation of Ecological monitoring and research cell in WR to coordinate with other research organization for feedback	7.5	Government of India and others
11.	Installation of STW/DTW for irrigation	1000	Government of India

			and others
12.	Ground water recharge-position/ scenario for the last 30 years in Tripura and ground water modeling	0.5	Government of India and others
13.	Impact of recent climatic change on groundwater condition in Tripura: Monitoring and geo- electrical mapping for sustainable agriculture development	0.5	Government of India and others
14.	Setting up Iron removal plants to remove excessive presence of iron in water	141	Government of India and State Government
15.	Setting up Surface Water Treatment Plant for supplying of Quality Water	168	Government of India and State Government
16.	Proper management of rural Solid Wastes and liquid wastes	325.28	Government of India and State Government
17.	Assessment of arsenic contaminated water areas /bodies/ground water sources	0.385	Government of India and others
18.	Installation of SBTW/DTW /Spot Sources (like OHP,Mark-II, Ring well etc) for drinking Water.	316.54	Government of India and State Government
19.	Extensive Awareness Generation Programme about Safe use of drinking water & sanitation.	8.6	Government of India and others
20.	Setting up of Block level water testing laboratory for drinking water parameters	9.63	Government of India and others
21.	Setting up of Scientific Research Laboratory for drinking water& waste water parameters	17.8	Government of India and others
	<b>Total budget</b>	<b>8005.935</b>	

## 5. Sustainable Himalayan Ecosystem

### Primary Department: Forest Department

Sl.NO.	Activities	Total Budget (Lakhs)	Source of Fund
1.	Protection of existing forest lands from encroachment and illegal land use	100	Govt of India, Govt of Tripura and External Agencies
2.	Protection of forests and forest land from soil erosion	2000	Govt of India, Govt of Tripura and External Agencies
3.	Encourage the cultivation of traditional varieties of crops and horticulture by promotion of organic farming, enabling farmers to realize a price premium.	1000	Govt of India, Govt of Tripura and External Agencies
4.	Conservation and Management of two major Wetlands RudraSagar and Gumiti Reserve	2000	Govt of India, Govt of Tripura and External Agencies
5.	Grazing Policy on domestic bovine population	130	Govt of India, Govt of Tripura and External Agencies
6.	Undertaking studies on indigenous (at least five) tree species to assess their vulnerability to climate change	50	Govt of India, Govt of Tripura and External Agencies

7.	Knowledge Management on climate change and policy developments	40	Govt of India, Govt of Tripura and External Agencies
8.	Studies to assess the impact of climate change on the endangered and vulnerable wildlife species in the state	50	Govt of India, Govt of Tripura and External Agencies
9.	Monitoring of carbon stock and biodiversity at regular intervals	50	Govt of India, Govt of Tripura and External Agencies
10.	Awareness creation on biodiversity conservation and its relation with the climate change to the Policy makers	100	Govt of India, Govt of Tripura and External Agencies
11.	Establishing observational and monitoring network to assess ecosystem health including freshwater systems.	150	Govt of India, Govt of Tripura and External Agencies
12.	Strengthening regional cooperation through established mechanisms for exchanging information with countries to share the Himalayan ecology.	100	Govt of India, Govt of Tripura and External Agencies
13.	Documentation of the People's Biodiversity Registers and Biodiversity Conservation	500	Govt of India, Govt of Tripura and External Agencies
14.	Undertaking studies and investment promotion of NTFP and indigenous forest resources for adaptation of climate change	500	Govt of India, Govt of Tripura and External Agencies
15.	Ecotourism promotion for biodiversity protection and sustainable livelihood	500	Govt of India, Govt of Tripura and External Agencies

			Agencies
16.	Take measures to regulate tourist inflows into mountain regions to ensure that these remain within the carrying capacity of the mountain ecology	2000	Govt of India, Govt of Tripura and External Agencies
17.	Documentation of Medicinal Plant resources in Tripura	200	Govt of India, Govt of Tripura and External Agencies
Total		Rs 9470 Lakhs ~ Rs 94.70 Crore	

## 6. Green Tripura Mission

### Primary Department: Forest Department

Sl.NO.	Activities	Total Budget in crore	Source of Funding
1	Enabling adaptation of forest dependent local communities In the face of climatic variability providing basic needs of the community	3.4	Govt of India, Govt of Tripura and External Agencies
2	Promoting Urban Forestry (1000 Hectors Area will be taken under planting and after-care)	5	Govt of India, Govt of Tripura and External Agencies
3	Agro Forestry and Social Forestry Promotion ( 3500 Ha will be taken under Agro/Social forestry to enhance Carbon Sinks )	15	Govt of India, Govt of Tripura and External Agencies
4	Rehabilitation of shifting cultivators and the restoration of shifting cultivated areas (1 Lakh Ha will be restored to representative ecosystems through plantation of bio-diverse species mix to supplement natural regeneration )	300	Govt of India, Govt of Tripura and External Agencies
5	To support Conservation and promotion of Scared Groves Tripura (Killa, Jampui, Teliamuraetc with an area of 100 acres)	2	Govt of India, Govt of Tripura and External Agencies
6	Valuation of existing forest wealth of Tripura	10	Govt of India, Govt of Tripura and External Agencies
7	Tree Canopy covering improving by enrichment plantations with aim of optimum utility in degraded forest areas over 2 lakhs hectors	150	Govt of India, Govt of Tripura and External Agencies
8	Promoting rural households to adopt fuel wood efficiency and alternative RE device like improved Chulas , Biogas Etc ( Intervention in 20000 HH )	6	Govt of India, Govt of Tripura and External Agencies

9	Strengthening of Forest Department (Infrastructure , Capacity Building)	40	Govt of India, Govt of Tripura and External Agencies
10	GIS based Monitoring and Evaluation of the program	6	Govt of India, Govt of Tripura and External Agencies
11	Forest Fire management	10	Govt of India, Govt of Tripura and External Agencies
12	Strengthening local level institutions about Forest Management Climate Change Adaptation including community forests for 1000 hamlets @ 15000 INR	15	Govt of India, Govt of Tripura and External Agencies
13	Livelihood improvement Activities	7	Govt of India, Govt of Tripura and External Agencies
14	Increasing plantation activities on outside forest land ( Plantation Activities and Supporting natural Regeneration in 5000 Ha)	6	Govt of India, Govt of Tripura and External Agencies
15	Establishment of Mission Directorate	15	Govt of India, Govt of Tripura and External Agencies
16	Sustainability of afforestation activities through income generation from CDM and Voluntary Markets	0.7	Govt of India, Govt of Tripura and External Agencies
17	Certification of Rubber wood coming from Sustainably Managed Forests	0.5	Govt of India, Govt of Tripura and External Agencies
18	Energy Conservation within Rubber Processing federation of TFDPC	0.1	Govt of India, Govt of Tripura and External Agencies
	Total	591.7	

## 7. Sustainable Agriculture

**Primary Responsibility: Agricultural, Horticultural, ARDD & Fisheries Department**

Sl. No.	Activity	Other Budget Rs. In Lakhs	Source of Funding
Primary Responsibility: Agricultural and Horticultural Department			
1.	Rapid screening and strategy assessment of State agriculture policy	35	Govt. Of India, Govt. Of Tripura, External Agencies
2.	Climate Change Impact studies on Coconut and Orange Production	35	Govt. Of India, Govt. Of Tripura, External Agencies
3.	Undertaking capacity-building	2500	Govt. Of India, Govt. Of Tripura, External Agencies
4.	Risk management in agriculture and allied sectors Disease forecasting Trans boundary Disease Problems Yield Studies Meteorological Data Moisture Measurement Bench Marking Weather Based Insurance Crop Insurance DRR	15000	Govt. Of India, Govt. Of Tripura, External Agencies
5.	Breeding studies on major crops for tolerance/resistance (Adaptive Research-Breeding and Validation through multi location testing)	1000	Govt. Of India, Govt. Of Tripura, External Agencies
6.	Establishing an effective institutional delivery mechanism to promote best practices on climate change 1. Identification Nodal farmers 2. Demonstration plot	3600	Govt. Of India, Govt. Of Tripura, External Agencies

7.	Utilization of Bio-resources (Organic wastes, plant wastes, leaf fall droppings etc) towards preparation of organic manure	5550	Govt. Of India, Govt. Of Tripura, External Agencies
8.	Developing livelihood – focused, people- centric integrated watershed development in rain-fed areas:	21600	Govt. Of India, Govt. Of Tripura, External Agencies
9.	Development of water use-efficient micro irrigation methods and individual/community farm ponds	3150	Govt. Of India, Govt. Of Tripura, External Agencies
10.	Developing sustainable soil, water and crop management practices: (4000 Ha drip irrigation & Demonstration)	1250	Govt. Of India, Govt. Of Tripura, External Agencies
11.	Increasing Cropping Intensity in Traditional Conventional Land (To achieve 300% Cropping Intensity)	12500	Govt. Of India, Govt. Of Tripura, External Agencies
12.	Improving monitoring and surveillance techniques including cropping cutting measures (Electronic communication System, GPS and CB 40 Training Personnel)	200	Govt. Of India, Govt. Of Tripura, External Agencies
Primary Responsibility : ARDD			
13.	Research study on the Climate Change Impacts on the Reproduction of Cattle, worm infestation, milk Production and vector borne diseases for domestic animals	330	Govt. Of India, Govt. Of Tripura, External Agencies
14.	Adaptability good milch breed of cattle such as Sahiwal, Gir and Red Sindhi, Jursey and Holstein cross, rearing and bio gas production with milk chilling plant	1250	Govt. Of India, Govt. Of Tripura, External Agencies
15.	Study on Performance of Broiler Production in High temperatures	25	Govt. Of India, Govt. Of Tripura, External Agencies
16.	Integrated watershed management for Fodder and nutritional security	1000	Govt. Of India, Govt. Of Tripura, External Agencies

17.	Research study on supply of animal feedstock and feasibility of rubber seed cake as feedstock in drought seasons	30	Govt. Of India, Govt. Of Tripura, External Agencies
18.	Adaptability of low input technology like Kuroialer, Gramapriya and Kalinga Brown	25	Govt. Of India, Govt. Of Tripura, External Agencies
19.	Capacity Building and training of farmers	100	Govt. Of India, Govt. Of Tripura, External Agencies
Primary Responsibility : Department of Fisheries			
20.	Capacity building and welfare activities of fishing communities	300	Govt. Of India, Govt. Of Tripura, External Agencies
21.	Impact assessment of climate change on fishery	50	Govt. Of India, Govt. Of Tripura, External Agencies
22.	Study of impact of Climate Change on the indigenous fauna of aquatic ecosystem and open waters	50	Govt. Of India, Govt. Of Tripura, External Agencies
23.	Mono crop Plantation Impacts on Fisheries	50	Govt. Of India, Govt. Of Tripura, External Agencies
Primary Responsibility: ICAR with Department of Biotechnology			
24.	Contingency Crop planning <ul style="list-style-type: none"> <li>• Land use planning in 40 Blocks of Tripura for Sustainable Agricultural Development</li> <li>• Preparation of Agro-climatic atlas (Block wise )</li> <li>• Assessment of Seasonal Soil Moisture</li> <li>• Block wise crop calendar</li> <li>• Farm Health Card</li> </ul>	300 200 150 100 200	Govt. Of India, Govt. Of Tripura, External Agencies

25.	Agro-meteorological data Acquisition & management <ul style="list-style-type: none"> <li>• Microclimatological Laboratory</li> <li>• Crop simulation model</li> <li>• weather based Agro Advisory at Panchayat Level</li> <li>• Setting up of new agro-met observatory at block level and Centralized meteorological data assembling system</li> </ul>	400 150 100 200	Govt. Of India, Govt. Of Tripura, External Agencies
26.	Approach to increase cropping intensity with diversification options under variable climatic condition <ul style="list-style-type: none"> <li>• Crop diversification with options of Intercrops</li> <li>• Collection and documentation of local Crops and their Adaptability</li> <li>• Development of Suitable Land use systems involving various cropping options in Accordance with Land Topography</li> <li>• Research in Cropping System in Accordance with climatic Variability</li> </ul>	450 200 5000 500	Govt. Of India, Govt. Of Tripura, External Agencies
27.	Supply of plant nutrients in an eco-friendly way <ul style="list-style-type: none"> <li>• Studies of Micro-bial Diversity and Formulation of Effective Bio-fertilizer to Increase the Crop Productivity Under Variable Climatic Scenario</li> <li>• Establishment of Bio control Unit to Study the Efficacy of Various Bio Control Agent for Ecofriendly Plant Protection Measures</li> </ul>	1000 1000	Govt. Of India, Govt. Of Tripura, External Agencies
<b>Total Budget</b>		<b>79580Lakhs ~ 795.80 Crs</b>	

## 8. Strategic Knowledge Mission

**Primary Department:** Department of Science Technology & Environment

Sl.NO.	Activities	Total Budget (Rs in crore)	Source of Funding
1	<p>Development of Knowledge Management on Climate Change and facilitating its operation for initial period</p> <ol style="list-style-type: none"> <li>1. Formulation of Tripura Institute of Strategic Knowledge for Climate Change (TISKCC)</li> <li>2. Establishment of Centre of Monitoring and Assessment of Climate Change (CMACC)</li> <li>3. Compile a data base of past weather related information and damage caused by extreme weather related episodes and facilitating study to identify the possible weather variability and associated vulnerability</li> <li>4. Setting up of weather monitoring stations (AWS)</li> </ol>	10.00	Government of India, Government of Tripura and External Agencies
2	<p>Capacity Building on Climate Change</p> <ul style="list-style-type: none"> <li>• Capacity building of personnel in the service department</li> <li>• Exposure visit for capacity building</li> </ul>	3.00	Government of India, Government of Tripura and External Agencies
3	To build GHG inventory and identify the dominant GHG/CO <sub>2</sub> emitting sectors, industries, districts, municipalities in order to enable selection of mitigation opportunities.	1.00	Government of India, Government of Tripura and External Agencies
4	Identifying and inventorizing all kinds of water sources existing in the state (include generation of database for ponds, tanks, dighis, lakes and big water-bodies) with focus on water quality.	1.00	Government of India, Government of Tripura and External Agencies

<b>6</b>	Generation of Basin level data for all the rivers for the entire state	2.00	Government of India, Government of Tripura and External Agencies
<b>7</b>	Conservation of River Aquatic Resources	0.50	Government of India, Government of Tripura and External Agencies
<b>8</b>	Development and implementation of Biomass based initiatives for adaptation to climate change including horticulture	5.00	Government of India, Government of Tripura and External Agencies
<b>9</b>	Study on Biotechnology intervention for increasing the production of milk	5.00	Government of India, Government of Tripura and External Agencies
<b>10</b>	Studies on ways on means to reduce dependency of people on Natural Resources	2.50	Government of India, Government of Tripura and External Agencies
<b>11</b>	Studies on impact of Urban Migration on the resilience of the Urban ecosystem	1.00	Government of India, Government of Tripura and External Agencies
<b>Total</b>		<b>Rs 31.00 Crore</b>	

## 9. Mission on Health

### Primary Department: Health Department

Sl. No.	Action Points	Total Budget (Rs in Crore)	Source of funding
1.	Formulating Adaptation strategies to reduce the impact of climate change issues affecting human health		Government of India, Govt of Tripura, External Aid, External Funding agency
1.1	Upgradation of state health policy through incorporation of Health Impacts due to climate change	0.15	
1.2	Research initiatives for changed patterns of diseases by region and by climate parameters	0.30	
2.	Health impacts due to drinking water contamination and temperature variation		
2.1	Identification of vector borne diseases like malaria, kala-azar, dengue, filarial, encephalitis etc.	0.09	
2.1	Establishment/Upgradation of pathological laboratories for disease identification caused due to climate variations	1.50	
3.	Human health infrastructure development and capacity building for climate change adaptation		
3.1	Capacity building and training for mental and physical health treatment during and after emergency preparedness during extreme climate events & Capacity building and training for health workers for sensitization of climate variation and health impacts 1. State Technicians (2 Batches of 20 Each) 2. Health Workers (15 Batch of 40 Each) 3. ASHA (100 Batch of 40 Each)	0.88	
3.2	Public health infrastructure development (Support and Logistics for extreme climate risks) Medicine ,Vaccines(Meningococcal Meninzitis), Lab Consumerable	25.50	
3.3	Mobility Support 1. One time expenditure for up-gradation of Agartala Medical College Lab and South Tripura District Lab) 2. IEC Materials	1.76	
4.	Assessment of health impacts due to malnutrition- Research study on	0.30	Government of

	malnutrition of vulnerable groups due to food insecurity caused by climatic variations		India, Govt of Tripura, External Aid, External Funding agency
<b>Total</b>		Rs. 30.48 Crore	

## Comprehensive list of Actions Solar Mission & Non-Conventional Energy

Primary Department

TREDA

Sl. No.	Action Point	Important	Constraint	Priority	Type	Scale	Nature	Time Frame
1	<p><b>Promotion of grid interactive power generation from Solar and other Renewable Energy sources through declaration of State Energy Policy.</b></p> <p>1.1 Formulation &amp; Declaration of state energy policy for power generation through renewable energy sources.</p> <p>1.2 Declaration of Tariff Policy by Tripura Electricity Regulatory Commission for Solar and other renewable power purchase.</p> <p>1.3 Facilitating private sector participation in solar power generation under JNNSM and/or other schemes of Govt. of India through selection of private investors and other support activities through Single window clearance process.</p>	H	Nil	H	MI & AD	S	PA, CB	ST
2	<p><b>Promotion and facilitation of Off-grid or decentralized renewable energy generation for electrification, cooking and other thermal energy requirement.</b></p>	H	Low	H	MI	S	PA	ST

2.1	Facilitating deployment of standalone off-grid solar power plant within 100 kW for fulfilling the power demand in dispersed locations under National Solar Mission with following target - a) Up to 2016-17 is 10 MW b) 2017-18 to 2021-22 is 10 MW c) 2022-23 to 2026-27 is 10 MW	H	Low	H	MI	A	PA, PS, IP, CB	MT
2.2	Facilitating deployment of 1000 No. Biogas plant (using cattle waste, household waste as well as water hyacinth) annually in 12th plan period and setting up of bottling unit at community level to use the biogas in agro based/ rural industries across the state under the Govt. of India programme.	H	Minimal	H	MI	S	PS, IP, CB	MT
<b>3</b>	<b>Promotion &amp; Facilitation setting up of Solar Water Heater (SWH) systems in all Govt. establishments under National Solar Mission.</b>	<b>H</b>	<b>Low</b>	H	MI	A	PA, PS, IP	MT
3.1								
3.2	Declaration of targeted actions by the State Govt. through policy mechanism. Project Implementation in Public Health Centre's - 86 Hospital - 22 Nos. Govt. Higher Secondary School - 248 University, College & Engineering College - 26 Nos.							

<b>4</b>	<b>Harnessing renewable energy potential scenario of the state for power generation through</b>	<b>H</b>	<b>Nil</b>	H	AD	S	RS	ST
4.1	Assessment of Biomass potential and availability for energy generation in the state and demarcation of biomass potential sites in the map	H	Nil	H	AD	S	RS	ST
4.2	Assessment of Solar irradiation, temperature, wind speed at district level across the state for solar mapping.	H	Nil	H	AD	S	RS	ST
<b>5</b>	<b>State Govt. by amendment of building bye-laws suitable to state condition will promote and mandate use of solar energy based water heating and/or lighting in all commercial buildings and in private houses costs more than Rs. 20.00 lakhs or as may be decided by the competent authority on time to time.</b>	H	Low	H	MI	S	PA, CB	ST
5.1	Amendment of building bye-law considering state demographic profile.							
5.2	Enforcement of incentives /rebate on property tax for use of solar water heaters in buildings.							
<b>6</b>	<b>Strengthening of technical competency of the existing solar and other renewable energy technology service providers and develop new service providers of international standard by introducing training course for technicians on RE system</b>	H	Minimal	H	AD	A	CB	MT

	<b>installation, O&amp;M, etc. in all ITI's of the state.</b>							
<b>7</b>	<b>Maximizing use of solar energy application for meeting up the community energy requirement and supplementing grid power demand by</b>	<b>H</b>	<b>Large</b>	M	MI	S	PA, IP, CB	LT
7.1	Installation of grid connected Rooftop and small solar plant under National Solar Mission across the state - a) Up to 2016-17 is 5 MW b) 2017-18 to 2021-22 is 10 MW c) 2022-23 to 2026-27 is 10 MW	H	Large	M	MI	S	IP, CB	LT
7.2	Installation of grid connected solar power plant of capacity above 2 MW under National Solar Mission - a) Up to 2016-17 is 5 MW b) 2017-18 to 2021-22 is 20 MW c) 2022-23 to 2026-27 is 25 MW	H	Large	M	MI	S	IP, CB	LT
7.3	Promotion of community based solar cooker system use for 200 people at schools/education centers through policy mechanism and demonstration project implementation.	M	Low	M	MI	A	PA, PS, DP	MT
<b>8</b>	<b>Creating solar energy technology supply chain by incorporation of Mini Solar Park or Solar Valley for production of Solar PV and thermal devices etc. in a SEZ mode by the Government of Tripura.</b> a) Land identification, development and allocation for solar park.	<b>H</b>	<b>Large</b>	M	AD	A	PA, PS, IP	MT

	<p>b) Development of solar park as a PPP initiative.</p> <p>c) Allocation of area to solar manufacturers under SEZ scheme.</p>							
<b>9</b>	<p><b>Promotion and facilitation for setting up of large scale biomass based power plants of capacity 3 MW and above through single window procedure.</b></p> <p>a) Preparation of Bankable Detailed Project Report</p> <p>b) Arrangement &amp; management of project implementation fund</p> <p>c) Single window clearance for setting up biomass power plant</p> <p>d) Dedicated plantation activity for biomass generation</p> <p>e) Implementation of a pilot power project</p>	<b>M</b>	<b>Large</b>	M	MI	S	PS, IP	MT
<b>10</b>	<p><b>Establishment and introduction of Solar Energy Resource Institute in the state under National Solar Mission for R&amp;D programmes in solar energy</b></p>	<b>H</b>	<b>Large</b>	M	<b>AD</b>	<b>A</b>	<b>RS, IP</b>	<b>MT</b>
<b>11</b>	<p><b>Introducing course on Renewable energy technology and Energy management at under -graduate level engineering courses to achieve target of National Solar mission by increasing technically qualified manpower.</b></p>	<b>H</b>	<b>Large</b>	M	<b>AD</b>	<b>A</b>	<b>CB, IP</b>	<b>MT</b>
12	<p><b>Deployment of Improved chulha in</b></p>	M	Low	M	MI	S	PS, IP	MT

<b>rural households for efficient energy consumption and promotion in the state through enabling policy and subsidy framework</b>							
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**Priority** H – High, M – Medium, L – Low;  
**Type** MI - Mitigation, AD – Adaptation;  
**Scale** S – State-wide, A – Particular / Focused Area  
**Nature** RS - Research Study, PA - Policy Action, PS - Pre-investment Study, DP - Demonstration Project, IP - Investment Project, CB - Capacity Building, OM - Regular Operation & Maintenance;  
**Timeframe** ST – Short-term, MT - Medium Term, LT – Long term  
**Constraint** Nil, Low, Minimal, Large



## Comprehensive list of Actions Mission on Energy Efficiency

Primary Department/Departments: TSECL

Sl.No.	Action points	Importance	Constraint	Priority	Type	Scale	Nature	Time frame
1	Conversion of open cycle gas based thermal power plant to combined cycle systems.	High	Nil	High	MI	A	IP	MT
2	T & D Loss reduction	High	Minimal	High	AD	S	PS,IP	MT
3	Development of policy for mandatory use of efficient light particularly for commercial organizations in the state.	High	Minimal	High	MI	S	PA	ST
4	Conversion of conventional street lights to solar LED/CFL street lights.	High	Minimal	High	MI	S	DP	ST
5	Encourage use of Solar Gadgets in Industries	High	Minimal	High	AD	S	PA	ST
6	Policy development for mandatory Energy Audit in Govt. Building;	High	Minimal	High	MI	S	PA, DP	ST

<b>7</b>	Research study to assess the potential of energy conservation across all sectors and designated consumers and designing of resource estimation and institutional structure required to address the energy efficiency issues.	High	Minimal	High	MI	S	RS	MT
<b>8</b>	Awareness and implementation for use of CFL and replacing incandescent lamp under Bachat Lamp Yojana, and Umbrella program of BEE.	High	Minimal	High	MI	S	IP	MT
<b>9</b>	Development of policy to mandate ECBC adoption in state.	High	Minimal	High	MI	S	PA	ST
<b>10</b>	Formulation of DSM project for TSECL	High	Minimal	High	MI	S	IP	MT
<b>11</b>	Development of comprehensive scheme for promotion of energy efficient pumps in agriculture sector.	Medium	Large	Medium	MI	S	PA, DP	MT
<b>12</b>	Encouragement for Decentralized generation of power to reduce the T&D Losses by introducing schemes and policy	Medium	Large	Medium	AD	S	RS, PA	LT

13	Promoting efficient brick manufacturing process leading to fossil fuel conservation, preventing denudation of top soil and GHG emission reduction by mandatory use of efficient brick heating/burning.	Medium	Large	Medium	MI	S	PA, CB	ST
14	Promotion of use of star rated domestic appliances may be encouraged. The shops selling TV, Refrigerators or Washing Machines, Fans etc. may be asked to keep only star rated products.	Medium	Large	Medium	MI	S	PA, CB	MT

**Priority** H – High, M – Medium, L – Low;  
**Type** MI - Mitigation, AD – Adaptation;  
**Scale** S – State-wide, A – Particular / Focused Area  
**Nature** RS - Research Study, PA - Policy Action, PS - Pre-investment Study, DP - Demonstration Project, IP - Investment Project, CB - Capacity Building, OM - Regular Operation & Maintenance  
**Timeframe** ST – Short-term, MT - Medium Term, LT – Long term  
**Constraint** Nil, Low, Minimal, Large



## Comprehensive list of Actions Sustainable Habitat

**Primary Department-** Urban Development & Municipal Councils , PWD and Trasport

Sl. No.	Activity	Importance	Criteria for Prioritisation	Priority	Type	Scale	Nature	Time Frame
1	Awareness generation and capacity building in climate change impacts and preparedness	H	Ease of implementation	H	AD	S	CB	LT
2	Capacity building for departments on advance solid waste management	H	Ease of implementation	H	AD	S	CB	LT
3	Capacity building on Water management and efficient distribution of supply and delivery	H	Ease of implementation, Cost effective	H	AD	S	CB	LT
4	Capacity building on Urban Management	H	Ease of implementation	H	AD	S	CB	LT
5	Liquid waste management through improved sewage design for addressing climate change impacts	H	Cost benefit	H	AD/MI	S	PA, CB, OM	MT
6	Developing models of urban storm water flows and capacities of existing drainage system	H	Ease of implementation	H	AD	S	RS	ST
7	Developing a climate friendly waste management system	H	Cost benefit	H	AD/MI	A	RS, PA	LT
8	Composting and treatment of Municipal Solid Waste in Agartala Town and other district towns is	H	Cost benefit	H	M	R	PIS	MT

	very important in regard to control of methane emission							
<b>9</b>	Waste management through Sanitary landfill and aerobic composting facilities for reduction of GHG	H	Cost benefit	H	MI	A	RS, IP	LT
<b>10</b>	Reduction of vector borne diseases from unmanaged dumping grounds	H	Incremental vs transformative change	H	AD	A	CB	MT
<b>11</b>	Improvement of collection efficiency and segregation at source	H	Cost effectiveness, cost benefit, ease of implementation	H	AD/MI	A	IP, ROM	LT
<b>12</b>	Formulation of building guidelines with provision of promoting traditional houses for different agro-climatic zone, floodplains and in consideration of the seismic vulnerability of the state	H	Ease of implementation	H	AD	A	IP	LT
<b>13</b>	Developing climate- responsible master plans for selected city/towns (CDP)	H	Ease of implementation	H	AD	A	PA	MT
<b>14</b>	Reformulation land tenure policy to enable sustainable urban development	H	Ease of implementation, cost benefit	H	AD	S	PA	LT
<b>15</b>	Disaster risk reduction in Urban sector	H	Cost benefit, Ease of implementation		AD	S	CB	ST

<b>16</b>	Declaration of incentives / rebate on property tax for use of solar water heaters in buildings	H	Cost benefit	H	MT	S	PA	MT
<b>17</b>	Capacity Building on Climate Change Impacts on Construction of Road, Bridge and Building to private Engineers , Contracts and Architects and Bitumen fuel usage	H	Cost benefit	H	AD	S	CB	MT
<b>18</b>	Promoting eco friendly methods of road construction ( Like Using Bitumen without burning )	H	Cost benefit	H	MT	S	RS/IP	ST
<b>19</b>	Recycling and Reuse of the Building and road construction materials	H	Cost benefit	H	MT	S	RS/IP	ST
<b>20</b>	Pilot project on Rubberized Bitumen usage in Road Construction	H	Cost benefit	H	MT	S	RS/IP	ST
<b>21</b>	Constructing Pilot water proof Road (Heavy rain fall , water logging, average Ground water level is only 10 mt)	H	Cost benefit	H	AD	S	IP	ST
<b>22</b>	Conversion of grid power street lights to solar lamps in important State Highways and National highways	H	Cost benefit	H	MT	S	IP	LT
<b>23</b>	Automatic boards to be installed and Solar traffic Signal Powers (Shifting grid power to solar power)	H	Cost benefit	H	MT	S	IP	LT
<b>24</b>	Switching to liquid fuel based vehicle to CNG based Vehicle	H	Cost benefit	H	M	R	IP	MT
<b>25</b>	Promotion of low emission vehicles, electric vehicles	H	Cost benefit	H	M	S	PA	MT

<b>26</b>	Introduction to concept of mass rapid transit	H	Cost benefit, Incremental vs transformative change	H	M	R	PIS	LT
<b>27</b>	Introduction of more public transport	H	Cost benefit, Incremental vs transformative change	H	M	S	IP	LT
<b>28</b>	Quantitative assessment of the impact of climate change	H	Ease of implementation	H	AD	S	RS	LT
<b>29</b>	Promotion of Bio-fuel	H	Cost effectiveness, Cost benefit	H	M	S	PA/IP	MT
<b>30</b>	Urban poor Mapping to Identify vulnerable urban population	H	Ease of implementation	H	AD	S	RS	LT
<b>31</b>	Promote green building concept aggressively through policy and regulation measures	H	Cost effectiveness, Cost benefit	H	MT	S	PA	ST
<b>32</b>	Improvement of Water Use Efficiency and conservation through leak reduction in Urban Areas	M	Implementation will be difficult	M	AD	S	PS, OM	LT
<b>33</b>	Improvement of Pumping energy efficiency in Water supply system	M	Less cost effective	M	MT	A	IP	MT
<b>34</b>	Roof top rain water harvesting Structures in Buildings	M	Less cost effective	M	AD	R	PA	MT
<b>35</b>	Growing Vegetation in Urban Areas and Roadside Plantations	M	Implementation not easy, lack of land	M	MT	S	IP	LT

<b>36</b>	GHG Emissions foot printing for all urban bodies including upcoming satellite townships	M	Implementation not easy and time taking	M	AD/MI	A	RS	MT
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**Priority**

H – High, M – Medium, L – Low;

**Type**

MI - Mitigation, AD – Adaptation;

**Scale**

S – State-wide, A – Particular / Focused Area

**Nature**

RS - Research Study, PA - Policy Action, PS - Pre-investment Study, DP - Demonstration Project, IP - Investment Project, CB - Capacity Building, OM - Regular Operation & Maintenance

**Timeframe**

ST – Short-term, MT - Medium Term, LT – Long term

**Constraint**

Nil, Low, Minimal, Large



## Comprehensive list of Actions Mission on Water

**Primary Department:** Water Resource Department, PWD(DWS)

SL No	Activities	Importance	Constraint	Priority	Type	Scale	Nature	Time frame
1.	Creation of new minor storage/irrigation tanks-400	H	None	H	A	State	Investment	long
2.	Protection and Conservation of large wetlands/waterbodies (like Rudra Sagar )	H	None	H	A	state	Investment	Long
3.	Embankment raising in preventing high flood	H	None	H	A	state	Investment	Long
4.	Development of GIS supported Data-base/status maps for all the existing water sources	H	None	H	A	State	Pre- Investment	short
5.	Information on status of runoff, water level, sedimentation during different seasons	H	None	H	A	state	Pre-invest	Short
6.	Extensive Awareness Generation Programme about water resource mgt	H	None	H	A	District	Capacity building	Long
7.	River conservation measures and river health monitoring-sewerage Mgt	H	None	H	A	State	Pre-invest	Long
8.	Establishment of Basin Authority for	H	None	H	A	State	Policy action	Short

	river conservation and Mgt							
9.	Formation of Ecological monitoring and research cell in WR to coordinate with other research organization for feedback	H	None	H	A	state	Research study	Long
10	Installation of STW/DTW for irrigation	H	None	H	A	state	Invest	
11	Impact of recent climatic change on groundwater condition in Tripura: Monitoring and geo- electrical mapping for sustainable agriculture development	H	None	H	A	State	Research study	Short
12	Setting up Iron removal plants to remove excessive presence of iron in water	H	None	H	A	GP	Investment	Long
13	Setting up Surface Water Treatment Plant for supplying of Quality Water	H	None	H	A	block	Investment	LONG
14	Proper management of rural Solid Wastes and liquid wastes	H	None	H	A	Dist	investment	Long
15	Assessment of arsenic contaminated water areas /bodies/ground water sources	H	None	H	A	State	Research study	Short
16	Installation of SBTW/DTW /Spot	H	None	H	A	District	Capacity building	Long

	Sources (like OHP, Mark-II, Ring well etc) for drinking Water.							
17	Extensive Awareness Generation Programme about Safe use of drinking water & sanitation.	H	Minimal	H	A	state	Invest	short
18	Setting up of Block level water testing laboratory for drinking water parameters	H	Minimal	H	A	District	Capacity building	Long
19	Setting up of Scientific Research Laboratory for drinking water & waste water parameters	H	Minimal	H	A	Block	Investment/Research	Long

**Priority**

H – High, M – Medium, L – Low;

**Type**

MI - Mitigation, AD – Adaptation;

**Scale**

S – State-wide, A – Particular / Focused Area

**Nature**

RS - Research Study, PA - Policy Action, PS - Pre-investment Study, DP - Demonstration Project, IP - Investment Project, CB - Capacity Building, OM - Regular Operation & Maintenance

**Timeframe**

ST – Short-term, MT - Medium Term, LT – Long term

**Constraint**

Nil, Low, Minimal, Large

## Comprehensive list of Actions Sustainable Himalayan Ecosystem

### Primary Department: Forest Department

Sl. No	Activities	Importance	Constraint	Priority	Type	Scale	Nature	Time frame
1	Protection of existing forest lands from encroachment and illegal land use	H	None	H	AD/M	S	PA	LT
2	Protection of forests and forest land from soil erosion (900 Km )	H	None	H	AD	S	PA	LT
3	Encourage cultivation of traditional varieties of crops and horticulture by promotion of organic farming, enabling farmers to realize a price premium.	H	None	H	AD	S	PA/ IP	LT
4	Conservation and Management of two major Wetlands RudraSagar and Guniti Reserve	H	None	H	AD	S	RS/IP	LT
5	Grazing Policy on domestic bovine population	H	None	H	AD	S	PA	ST
6	Undertaking studies on indigenous (at least five) tree species to assess their vulnerability to climate change	H	None	H	AD	S	RS	MT
7	Knowledge Management on climate change science and policy developments	H	Nil	H	AD	S	RS	ST
8	Studies to assess the impact of climate change on the endangered and vulnerable wildlife species in the state	H	Nil	H	AD	S	RS	ST

<b>9</b>	Monitoring of carbon stock and biodiversity at regular intervals	H	M	H	AD	S	ROM	MT
<b>10</b>	Awareness creation on biodiversity conservation and its relation with the climate change to the Policy makers	H	None	H	AD	S	CB	LT
<b>11</b>	Establishing observational and monitoring network to assess ecosystem health including freshwater systems.	H	None	H	AD	S	IP	LT
<b>12</b>	Strengthening regional cooperation through established mechanisms for exchanging information with countries to share the Himalayan ecology.	H	None	H	AD	R	CB	LT
<b>13</b>	Documentation of the People's Biodiversity Registers	H	None	H	AD	S	RS	ST
<b>14</b>	Undertaking studies and investment promotion of NTFP and indigenous forest resources for adaptation of climate change	H	None	H	AD	S	RS	ST
<b>15</b>	Ecotourism promotion for biodiversity protection and sustainable livelihood	H	None	H	AD	S	IP	LT
<b>16</b>	Take measures to regulate tourist inflows into mountain regions to ensure that these remain within the carrying capacity of the mountain ecology	H	None	H	AD	S	PA	LT

<b>17</b>	Documentation of Medicinal Plant resources in Tripura	H	None	H	AD	S	RS	ST
<b>18</b>	Adopt appropriate land-use planning and watershed management practices for sustainable development of mountain ecosystem.	H	None	M	AD	S	IP	LT
<b>19</b>	Consider unique mountain spaces as entities with “Incomparable Values”, in developing strategies for their protection	L	None	M	M	S	PA	LT
<b>20</b>	Assessing threats to biodiversity and wildlife	L	None	M	AD	S	RS/PA	LT
<b>21</b>	Creation and management of community and conservation reserves for economic welfare of local communities and conservation of biodiversity.	M	None	M	AD	S	IP	LT
<b>22</b>	Capacity building of JFM committees and Panchayati Raj Institutions to adapt to climate change	M	None	M	AD	R	CB	ST
<b>23</b>	Assessment and quantification of the changes in the Himalayan eco system attributable to the climate change as a result of global emissions and human activities in the region and model for future projections	M	None	M	AD	S	RS	LT

<b>24</b>	Exploration of linking of traditional and formal knowledge systems through strategic mechanism of formalization for mutual benefit and value for the sustainability of the Himalayan ecosystem	M	None	M	AD	S	CB	LT
<b>25</b>	Adaptive species identification for effective plantation through establishment of Permanent Nursery	M	None	M	AD	S	RS	ST
<b>26</b>	Sequestering carbon through avenue plantations	L	None	M	M	S	IP	ST
<b>27</b>	Study on dependence of ecosystem people on forestry resources.	L	High	M	AD	S	RS	ST
<b>28</b>	Awareness about climate change and its impact through 27 Eco-parks	L	High	M	AD	S	IP	ST
<b>29</b>	Promoting community-based management through developing mechanisms for incentives for protection and enhancement of forested lands.	L	High	M	AD	S	PA/IP	ST
<b>30</b>	Building human and institutional capacities in the different existing / new Institutions in the Himalayan region.	L	High	L	AD	S	PA/IP	LT
<b>31</b>	Identification of most-desirable Adaptation Policies to Improve Regional Sustainability.	L	High	L	AD	S	RS/PA	LT

<b>Priority</b>	H – High, M – Medium, L – Low;
<b>Type</b>	MI - Mitigation, AD – Adaptation;
<b>Scale</b>	S – State-wide, A – Particular / Focused Area
<b>Nature</b>	RS - Research Study, PA - Policy Action, PS - Pre-investment Study, DP - Demonstration Project, IP - Investment Project, CB - Capacity Building, OM - Regular Operation & Maintenance
<b>Timeframe</b>	ST – Short-term, MT - Medium Term, LT – Long term
<b>Constraint</b>	Nil, Low, Minimal, Large

## Comprehensive list of Actions Green Tripura Mission

**Primary Department: Forest Department**

Sl. No.	Activities	Importance	Constraints	Priority	Type	Scale	Nature	Time frame
1	Provisioning services from forests, particularly fuel wood, fodder/grass/grazing; timber, cane/bamboo, NTFPs through creating community reserves	H	None	H	AD/MI	S	IP	LT
2	Enabling adaptation of forest dependent local communities In the face of climatic variability	H	None	H	AD	S	CB	LT
3	Promoting Urban Forestry (1000 Hectors Area will be taken under planting and after-care)	H	None	H	AD/MI	S	IP	LT
4	Agro Forestry and Social Forestry Promotion ( 1500 Ha will be taken under Agro/Social forestry to enhance Carbon Sinks )	H	None	H	AD/MI	S	IP	LT
5	Rehabilitation of shifting cultivations (1 Lakh Ha will be restored to representative ecosystems through plantation of bio-diverse species mix to supplement natural	H	None	H	MI	S	IP	LT
6	To support Conservation and promotion of Scared Groves Tripura	H	None	H	AD	S	IP	LT
7	Valuation of existing forest wealth of Tripura	H	None	H	AD	S	RS	LT
8	Tree Canopy covering improving by enrichment plantations with aim of optimum utility in degraded forest areas over 2 lakhs	H	None	H	MI	S	IP	LT
9	Promoting rural households to adopt fuel wood efficiency and alternative RE device like improved Chulas, Biogas etc (Intervention in 20000 HH )	H	None	H	MI	S	IP	LT

10	Strengthening of Forest Department (Infrastructure & Capacity Building)	H	None	H	AD	S	CB	LT
11	GIS based Monitoring and Evaluation of the program	H	None	H		S	IP	LT
12	Assessing Fire management Strategies	H	None	H	AD/MI	S	IP	LT
13	Strengthening local level institutions about Forest Management Climate Change	H	None	H	MI	S	IP	LT
14	Livelihood improvement Activities	H	None	H	AD	S	CB	LT
15	Increasing plantation activities on outside forest land (Plantation Activities and Supporting natural Regeneration in 5000 Ha)	H	None	H	AD/MI	S	IP	LT
16	Establishment of Mission Directorate	H	None	H	MI/AD	S	IP	LT
17	Sustainability of afforestation activities through income generation from CDM and Voluntary Markets	H	None	H	MI	A	IP	LT
18	Certification of Rubber wood coming from Sustainably Managed Forests	H	None	H	AD	A	IP	ST
19	Energy Conservation within Rubber Processing federation of TFDPC	H	None	H	MI	A	IP	ST
20	Enhancing the Resilience and Ability of vulnerable Species /ecosystems to adapt to climate change	M	High	M	AD	S	RS	ST
21	Enabling adaptation of forest dependent local communities In the face of climatic variability	M	High	M	AD	S	RS	ST

**Priority**

H – High, M – Medium, L – Low;

**Type**

MI - Mitigation, AD – Adaptation;

**Scale**

S – State-wide, A – Particular / Focused Area

**Nature**

RS - Research Study, PA - Policy Action, PS - Pre-investment Study, DP - Demonstration Project, IP - Investment Project, CB - Capacity Building, OM - Regular Operation & Maintenance

**Timeframe**

ST – Short-term, MT - Medium Term, LT – Long term

**Constraint**

Nil, Low, Minimal, Large

## Comprehensive list of Actions Sustainable Agriculture

**Primary Responsibility: Agricultural, Horticultural, ARDD & Fisheries Department**

Sl. No.	Activity	Importance	Constraints	Priority	Type	Scale	Nature	Time Frame
1	Rapid screening and strategy assessment of State agriculture policy	H	None	H	AD	S	RS	ST
2	Climate Change Impact studies on Coconut and Orange Production	H	None	H	AD	S	RS	MT
3	Undertaking capacity-building	H	None	H	AD	S	CB	LT
4	Risk management <ul style="list-style-type: none"> <li>• Disease forecasting</li> <li>• Trans boundary</li> <li>• Disease Problems</li> <li>• Yield Studies</li> <li>• Meteorological Data</li> <li>• Moisture Measurement</li> <li>• Bench Marking</li> <li>• Weather Based</li> <li>• Insurance</li> <li>• Crop Insurance</li> <li>• DRR</li> </ul>	H	Minimal	H	AD	S	IP	MT
5	Breeding studies on major crops for tolerance/resistance (Adaptive Research-Breeding)	H	Minimal	H	AD	R	RS	S

	and Validation through multi location testing)							
<b>6</b>	Establishing an effective institutional delivery mechanism to promote best practices on climate change 1. Identification Nodal farmers 2. Demonstration plot	H	None	H	AD	S	IP	LT
<b>7</b>	Utilization of Bio-resources (Organic wastes, plant wastes, leaf fall droppings etc) towards preparation of organic manure	H	None	H	AD	S	IP	LT
<b>8</b>	Developing livelihood – focused, people- centric integrated watershed development in rain-fed areas	H	None	H	AD	S	IP	MT
<b>9</b>	Development of water use-efficient micro irrigation methods and individual/community farm ponds	H	None	H	Mi	S	IP	MT
<b>10</b>	Developing sustainable soil, water and crop management practices: (4000 Ha drip irrigation & Demonstration)	H	None	H	AD	S	PA	MT
<b>11</b>	Increasing Cropping Intensity in Traditional Conventional Land (To achieve 300% Cropping	H	Minimal	H	AD	S	IP	LT

	Intensity)							
<b>12</b>	Improving monitoring and surveillance techniques including cropping cutting measures (Electronic communication System, GPS and CB 40 Training Personnel)	H	None	H	AD	S	PA, IP	LT
<b>13</b>	Research study on the Climate Change Impacts on the Reproduction of Cattle, Vector borne diseases for domestic animals and Climate Change Impacts on the Worm infestation, Milk Production	H	None	H	AD	S	RS	LT
<b>14</b>	Adaptability good milch breed of cattle such as Sahiwal, Gir and Red Sindhi, Jursey and Holstein cross, rearing and bio gas production with milk chilling plant	H	Minimal	H	AD	S	IP	LT
<b>15</b>	Study on Performance of Broiler Production in High temperatures	H	Minimal	H	AD	S	RS	ST
<b>16</b>	Assessment of non descript cattle of Tripura to identify high milk production ability	H	None	H	AD	S	PA	MT

<b>17</b>	Integrated watershed management for Fodder and nutritional security	H	None	H	AD	S	IP	LT
<b>18</b>	Research study on supply of animal feedstock and feasibility of rubber seed cake as feedstock in drought seasons	H	Minimal	H	AD	S	RS	MT
<b>19</b>	Adaptability of low input technology like Kuroialer, Gramapriya and Kalinga Brown	H	None	H	AD	R	PA	S
<b>20</b>	Capacity Building of farmers	H	Minimal	H	AD	R	CB	S
<b>21</b>	Capacity building and welfare activities of fishing communities	H	None	H	Mi	S	CB	LT
<b>22</b>	Impact assessment of climate change on fishery and development of watershed vulnerable to climate variations.	H	None	H	AD	S	RS	LT
<b>23</b>	Study of impact of Climate Change on the indigenous fauna of aquatic ecosystem and open waters	H	None	H	AD	S	RS	MT
<b>24</b>	Rubber Plantation Impacts on Fisheries	H	Minimal	H	AD	S	RS	MT
<b>25</b>	Contingency Crop planning	H	Minimal		AD	S	IP, RS	ST
<b>26</b>	Agro-met data Acquisition and Management	H	None	H	AD	S	PA,RS	ST

<b>27</b>	Approach to increase cropping intensity with diversification options under variable climatic condition	H	None	H	AD	S	PA, RS	ST
<b>28</b>	Supply of plant nutrients in an eco-friendly way	H	None	H	AD	S	IP, RS	ST
<b>29</b>	Water storage and providing proper diversion channels to the existing ponds for drainage of catchment runoff during sudden heavy rains (Pilot)	L	High	L	AD	S	PA	MT
<b>30</b>	Water bodies/Wetland conservation for fishery sector	L	High	L	AD	S	PA	MT

**Priority**

H – High, M – Medium, L – Low;

**Type**

MI - Mitigation, AD – Adaptation;

**Scale**

S – State-wide, A – Particular / Focused Area

**Nature**

RS - Research Study, PA - Policy Action, PS - Pre-investment Study, DP - Demonstration Project, IP - Investment Project, CB - Capacity Building, OM - Regular Operation & Maintenance

**Timeframe**

ST – Short-term, MT - Medium Term, LT – Long term

**Constraint**

Nil, Low, Minimal, Large



## Comprehensive list of Actions Strategic Knowledge Mission

**Primary Department:** Department of Science Technology & Environment

Sl.No.	Activities	Importance	Constraint	Priority	Type	Scale	Nature	Time frame
1	Knowledge Building on Climate Change 1. Formulation of Tripura Institute of Strategic Knowledge for Climate Change (TISKCC) 2. Establishment of Centre of Monitoring and Assessment of Climate Change (CMACC) 3. Compile a data base of past weather related information and damage caused by extreme weather related episodes 4. automatic weather stations (AWS)	H	NIL	H	AD	S	PA/CB	ST
2	To build GHG inventory and identify the dominant GHG/CO <sub>2</sub> emitting sectors, industries, districts, municipalities in order to enable selection of mitigation opportunities.	H	NIL	H	MT	S	RS	ST
3	Identifying and inventorizing all kinds of water sources existing in the state (include generation of database for ponds, tanks, dighis, lakes and big water-bodies) with focus on water quality.	H	NIL	H	AD	S	RS	ST
4	Generation of Basin level data for all the rivers for the entire state	H	NIL	H	AD	S	RS	ST
5	Studies on ways on means to reduce dependency of people on Natural Resources	H	NIL	H	AD	S	RS	LT
6	Conservation of River Aquatic Resources	H	NIL	H	AD	S	IP	ST
7	Development and implementation of Biomass based initiatives for adaptation to climate change including horticulture and biomass processing	H	NIL	H	M	S	IP	MT

	industries							
<b>8</b>	Capacity Building on Climate Change 1. Capacity building of personnel in the service department 2. Exposure visit for capacity building	H	NIL	H	AD	S	CB	LT
<b>9</b>	Studies on impact of Urban Migration on the resilience of the Urban ecosystem	H	NIL	H	AD	S	RS	LT
<b>10</b>	Preparation of ground water status map for the entire state.	M	HIGH	M	AD	S	RS	ST
<b>11</b>	Studies on nutrient application and crop uptake in different land situations, topography and varied soil classifications in order to understand and monitor the influence of edaphic and environmental interaction in relation to climate change.	H	NIL	M	AD	S	RS	ST
<b>12</b>	Study on impact of climate change on landslide, soil erosion and decaying river courses of the major rivers of Tripura	H	NIL	M	AD	S	RS/IP	LT
<b>13</b>	Targeted Monitoring of Air Pollution and Climate Change Impacts on Biodiversity	L	HIGH	M	AD	S	RS/IP	LT
<b>14</b>	Development of information system for the generation and dissemination of agro-meteorological knowledge	M	HIGH	M	AD	S	RS/CB	ST
<b>15</b>	Ethanobotany (medicinal and Aromatic ) plant cell	M	NIL	M	AD	S	RS	LT
<b>16</b>	Studies and establishment of institutional arrangement for Diseases Forecasting of Animal Health	M	HIGH	M	AD	S	RS/IP	LT
<b>17</b>	Introduction of Soil Health Card	M	NIL	M	AD	S	PA/IP	LT

<b>18</b>	Study on Biotechnology intervention for increasing the production of milk	H	NIL	M	AD	S	RS	LT
<b>19</b>	Research and development of implementation strategy to combat the impact of climate change on public health	M	NIL	M	AD	S	RS/PA	LT
<b>20</b>	Research on development of Climate Resilient Town planning, buildings and construction technology	M	HIGH	M	AD	S	RS/IP	LT
<b>21</b>	Development of Energy related technological innovations for mitigation of climate change (Biomass gasifiers, Chullahs, solar energy utilization)	M	HIGH	M	AD	S	IP	LT
<b>22</b>	Framing of E - governance related to climate change action Plan	M	HIGH	M	AD	S	RS/IP	LT
<b>23</b>	Technology watch, foresight & assessment, climate change response impact assessment extramural research, human capacity building, S&T international and regional cooperation and linkages,	L	NIL	L	AD	S	RS/IP	LT

**Priority**

H – High, M – Medium, L – Low;

**Type**

MI - Mitigation, AD – Adaptation;

**Scale**

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**Timeframe**

ST – Short-term, MT - Medium Term, LT – Long term

**Constraint**

Nil, Low, Minimal, Large

## Comprehensive list of Actions Mission on Health

**Primary Department:** Health Department

Sl. No.	Action Points	Importance	Constraint	Priority	Type	Scale	Nature	Time frame
1	Formulating Adaptation strategies to reduce the impact of climate change issues affecting human health							
	Upgradation of state health policy through incorporation of Health Impacts due to climate change	H	None	H	AD	S	PA	ST
	Research initiatives for changed patterns of diseases by region and by climate parameters	H	None	H	AD	S	RS	MT
2	Health impacts due to drinking water contamination and temperature variation							
	Identification of vector borne diseases like malaria, kala-azar, dengue, filarial, encephalitis etc.	H	Minimal	H	AD	S	RS	ST
	Establishment/Upgradation of pathological laboratories for disease identification caused due to climate variations	H	Minimal	H	AD	S	IP	MT
3	Human health infrastructure development and capacity building for climate change adaptation							
	Capacity building and training for mental and physical health treatment during and after emergency preparedness during extreme climate events & Capacity building and training for health workers for sensitization of climate variation and health impacts	H	Minimal	H	AD	S	CB	LT
	Public health infrastructure development	H	Minimal	H	AD	S	IP	MT
4	Assessment of health impacts due to malnutrition- Research study on	H	None	H	AD	S	RS	ST

	malnutrition of vulnerable groups due to food insecurity caused by climatic variations							
4	Identification and documentation of temperature related morbidity	M	M	M	AD	S	RS	ST
5	Study and documentation of diseases caused by drinking water contamination	M		M	AD	S	RS	ST

**Priority**

H – High, M – Medium, L – Low;

**Type**

MI - Mitigation, AD – Adaptation;

**Scale**

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**Constraint**

Nil, Low, Minimal, Large



## **Minutes Stakeholder consultation workshop – TCCAP**

The stakeholder's consultation meeting held on 2<sup>nd</sup> November 2011 was a second round meeting post to the first consultation programme on state climate change action plan and round of discussion had in between the working group members and CTRAN consulting to have the input on actions identified for each priority sectors with an objective to finalize the State Climate change Action Plan.

Post to the inaugural deliberation by Director DSTE on the background of the state climate change action plan the strategic initiative undertaken by the department and the way ahead.

Following are the inputs from different stakeholders on the priority action on the state action plan on climate change.

### **State Vulnerability issues**

1. The data used in the vulnerability analysis should be based on the current information of the state.
2. The data or information used to arrive at the population and food security issues should be update on the basis of 2010 data.
3. The chapter should be highlighted on the basis of scientific studies or observation with reference to the Tripura
4. The plan should be site specific/state specific
5. There are 15 Nagar Panchayats now instead of 12

### **Generic**

1. Mission & vision statement, outcome & process indicator to be included in the action plan report.
2. Mid-term review of each action points to be included in the report.
3. Picture and graphical representation should be included.

### **Forestry sector presentation – Principal Secretary commented on**

1. Though Himalayan Ecosystem concept is applicable to the NE region of India but, Tripura and Assam has lots of plane areas and already lots of people are staying in those areas. So, sustainable agriculture practice is most feasible and suitable option instead of sustainable forestry in those areas. Moreover 70% of population in Tripura is sustained by agricultural practices. Therefore, sustainable model for agriculture, horticulture and animal husbandry is required in the state.
2. Study should be conducted through premiere institution on the scope, prospect of agro forestry, shifting cultivation
3. The forestry sector should highlight on the scope of medicinal plantation
4. Study should be made to understand the impact of forestry in management of microclimatic conditions

### **ICAR representative commented on Agriculture sector –**

1. Action points related to Capacity building needs to be detailed up and budgeting also requires to be detailed. Capacity building of 4 Krishivigyan Kendra need to be incorporated under this action point with mentioning the centers names.
2. Budget for this action point is too high and so reduction is needed.
3. Dept. of bio-technology should be in Action point 5 -7.
4. To Identify impacts of climate change on Land use in cropping strategy
5. Land use planning in 40 Blocks of Tripura for Sustainable Agricultural Development
6. Preparation of Agro-climatic atlas (Block wise )
7. Assessment of Seasonal Soil Moisture
8. Preparation of Block wise crop calendar
9. Formulation of Farm Health Card
10. Technological Interventions to Address the Issues of Climatic Variability- Agro-met data Acquisition and Management
11. Facilitating Microclimatological Laboratory

12. Development of Crop simulation model
13. Facilitating weather based Agro Advisory at Panchayat Level
14. Setting up of new agro-met observatory at block level and Centralized meteorological data assembling system
15. Undertaking study to options for Crop diversification with options of Intercrops
16. Studies of Micro-bial Diversity and Formulation of Effective Bio-fertilizer to Increase the Crop Productivity Under Variable Climatic Scenario
17. Establishment of Bio control Unit to Study the Efficacy of Various Bio Control Agent for Ecofriendly Plant Protection Measures

#### **Energy Sector – Stakeholders consultation**

1. For modification of the thermal power plant, technology should be adopted to minimize the use of water for power generation
2. Rain water harvesting and water conservation technique should be promoted to minimize use of ground water
3. Air cooled condenser should be promoted

#### **Representative from Bio-technology department commented**

1. An action to be included for medicinal plants and hubs as Tripura has a well reserve of these plants which need to be promoted.

#### **Member Secretary of Pollution Control Board commented that**

2. Action point for river bank plantation needs to be re-drafted and considered as high priority as the state has seven rivers but none of them has capacity to hold a good quantity of water and soil erosion takes place in very high rate.

#### **Solar Mission –CEO & Director, TREDA has commented**

1. Renewable energy policy is already drafted and to be declared shortly should be highlighted in the report.
2. Data of un-electrified hamlets and villages as available from TREDA to be included in the report.
3. Generic tariff for renewable power is already drafted by TERC and to be declared shortly.
4. Solar Pump should be promoted in the uphill area

5. Promotion of micro hydel power plant
6. Study to be conducted to analyze solar radiation potential in the state

**Representative from transport department commented on Urban sector presentation –**

1. Incorporation of cycle track and footpath in urban areas to be considered as action point under transport sector.

**Water Sector**

1. The action points of the water sector related to the basin management should be redrafted as establishment of basin management authority to reduce the ambiguity.
2. Study related to rainfall and other meteorological condition should be made

**Director, DSTE commented that,**

1. Action point for inclusion of Vermi-composting technology should be included.

**Representative from Dept. of fisheries further commented that-**

1. ICAR and College of fisheries to be included in Point no. 24 -26.
2. Please delete Point no. 28 as it is already included in water sector.
3. Point no. 27 should not be linked with Dept. of fisheries.

**Principal Secretary commented on Strategic Knowledge Mission**

1. A specific cell for bio-resource monitoring should be incorporated.
2. Instead of 4 districts, it should be 8 districts as the state has 8 districts.
3. All over India 8 Doppler weather Radar is proposed and out of which 1 is already under implementation in Agartala near Airport. So, please re-draft the relevant action point accordingly.
4. A solar insolation radiation research station in Tripura will be set up very soon so, relevant action point should be omitted.

