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Working Group on Climate Change1

# Impact, vulnerability and adaptation of Indian tea to climate change

Most of the outcomes of global studies on climate change are at continental levels, while the details at regional and sub-regional levels which strongly influence the total economics are inadequate. Tea production systems are basically regional to sub-regional, hence there is a need for detailed studies. In its assessment reports of 2000, the Intergovernmental Panel on Climate Change (IPCC) categorically stated the need for more comprehensive studies to be carried out at the regional/sub-regional production system level as the climate is strongly influenced by local topography, location and proximity to sea and oceans. Studies by various agencies across the globe were taken up using various approaches to conceptualize the climate change in a specific region and its impacts on the various production systems and economic sectors in that region. Most of these studies, however, suggest the need for: (a) detailed analysis of long term weather and productivity information to quantify the specific changes in weather conditions that have occurred over the period; and (b) how the current and future weather are/would be affecting the productivity and economic activities/returns from that region.

# Objectives

**Long term**

* To develop a decision support system for contingency tea crop planning by using an interactive tea production specific methodology/ technique for systematic analysis of scaled (spatial/ temporal) and geo-referenced data/ information which will allow for the sustainability of logical niches based (area specific and broadly weather based) tea production system (garden level-cluster), independent of conditioning variables (policy, infrastructure, markets, ethno-demographics) and climate resilient.

**Short term**

* Development and analysis of a scaled and geo-referenced database of historical local (niche based) weather, soil, disease/pest incidence and tea yield in tea growing regions of Assam.
* Assessing future climate scenarios by downscaling global circulation models (GCMs) to regional level by using regional model PRECIS (*Providing Regional Climates for Impact Studies*).
* Integration of Satellite data with regional weather data and creation of a spatial gridded database (1 km resolution) and use of this information in ecosystem model to generate Operational Weather Forecasts (short and medium range).
* Development of decision support framework/toolkit for Contingency Crop Planning for efficient management of tea plantations and make them climate resilient.
* Dissemination of specific weather based advisories to individual tea plantations, through GCM network, using a *'Cluster Approach'*.

To achieve these objectives, databases need to be prepared using historical, current and simulated future data. Further, surface statistical/satellite and climate data need to be integrated with simulation models to plan for a climate resilient tea production system. However, the most important feature of the entire exercise will be the selection/use of appropriate models and accuracy of the analysis suiting to the tea growing region under study. Following can be the possible key elements of analysis:

* Trend detection and attribution
* Vulnerability indication
* Scenarios and scenario development
* Biophysical inputs projections
* Economic inputs projections
* Bifurcation of the impacts of climate change impacts on individual sectors
* Regional forecasts and nowcasts
* Development of decision support framework/toolkit and crop planning based on weather advisories

**Trend detection and attribution**

Trends detection projects the movement or change of a phenomenon/parameter from its normal course. Trends can be both positive and negative and may also remain static (neutral) over a period of time. The historical data collected over the years (minimum 20-30 years) will be subjected to analysis using normal and descriptive statistics. This will give us information on how different data parameters are behaving over the years.

**Vulnerability indication**

Vulnerability conveys the susceptibility of a system to a particular set of condition. The vulnerability analysis will be done region-wise and the extent (low, medium, high) to which a region is vulnerable will be determined. Appropriate analysis for quantifying vulnerability and the impact of climate change will be done. Further the vulnerability of different sub sectors (organized – large growers – and unorganized –small tea growers) will be analyzed.

**Scenario and scenario development**

In India PRECIS model (based on Hadley Centres regional climate modelling system) is widely used to generate high resolution climate change information for different regions. This model will be used to develop climate change scenarios for the tea growing regions. The output of PRECIS will be taken to appropriate tea crop model (e.g. CUPPA tea) or other crop models (e.g. Info crop model) to find out the outputs in terms of future production levels under different scenarios.

**Biophysical inputs projections**

Analysis of the changes occurring in the biophysical parameters over the years and the input projections for the future using the extrapolation of the change detected both temporally and spatially will be taken up.

**Economic inputs projections**

Based on appropriate analysis of socio-economic data and collection of the relevant information on tea from the country report(s) or international agencies with respect to climate change impacts on regional/country economy, future economic input projections will be made.

**Bifurcation of the impacts of climate change impacts on individual sectors**

Until recently, we are not very clear about the contribution of climate change on tea production and quality in different regions. Yield is not only the function of climate/weather but depends on various other parameters viz. soil, water, nutrient and pest/disease. Hence using appropriate analysis, it has to be deciphered that how much contribution climate change has on production and quality, through variations in these parameters using historical data. Further contribution of climate changes on various other factors e. g. the small growers and big growers need to be assessed quantitatively using historical data. Future projections can be made based on this analysis.

**Regional forecasts and nowcasts**

Weather forecast allows to at least take immediate management decisions at farm level. We intend to use appropriate observation and prediction system, which takes data from our databases directly and makes predictions at high resolution (1km grid). We intend to use NASA’s Terrestrial Observation and Prediction System (TOPS) for the purpose.

**Development of decision support framework/toolkit and crop planning**

Spatial data, observed/ simulated weather and agronomical data will be used to develop the Decision Support framework/toolkit. To develop this framework will use crop details, Soil Information, water bodies and other crops nearby, plant monitoring support via geo-tagged photos, agronomic information (plant growth, physiological parameters), ground weather observation, location specific forecast data (even hourly), historical data (appropriate short/long). Such data and details will be from surface as well as satellite and simulation runs. Once the prototype framework/toolkit is available, crop planning based on weather advisories can be made specific to a region based on the regional information. This approach will make it easy to adapt to the changing weather conditions and also will be able to cope with the extreme events, because this can be used as an early warning system.