



**Assessment of the Impacts of and Adaptations to Climate
Change in the Plantation Sector, with particular reference to
Coconut and Tea, in Sri Lanka.**

Project No. AS-12

**Progress Report for the period
January 01 to June 30, 2002**

submitted to

**Third World Academy of Sciences
Trieste, Italy**

and

**AIACC Project Office
START Secretariat
Washington, USA**

by

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15 July 2002

1. Project Summary

1.1 Title

Assessment of the Impacts of and Adaptations to Climate Change in the Plantation Sector, with particular reference to Coconut and Tea, in Sri Lanka.

1.2 Principal Investigator

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1.3 Administering Institution

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Mr G A Gunasekera
Senior Administrative Officer

1.5 Participating Scientists

Name	Designation	Institute
Tea Sub-sector		
Dr. A. Anadacoomaraswamy	Senior Plant Physiologist	Tea Research Institute, Talawakele www.nsf.ac.lk/tri
Ms Asoka Jayakody	Agricultural Economist	-do-
Dr M A Wijeratne	Senior Agronomist	Tea Research Institute, Ratnapura
Coconut Sub-sector		
Dr Sanathanie Ranasinghe	Senior Plant Physiologist	Coconut Research Institute, Lunuwila www.nsf.ac.lk/cri
Dr Sarath G Peiris	Principal Biometrician	-do-
Dr Neil Fernando	Agricultural Economist	-do-
Climate Change		
Dr Lareef Zubair	Application Scientist	International Research Institute for Climate Prediction, U/Columbia & Nat. Res. Mgmt. Services Ltd.
Dr Senaka Basnayake	Meteorologist	Meteorology Department Colombo

PROGRESS REPORT

A. Brief Summary

The first few months were spent on preliminaries such as finalizing the work plan and the budget, having discussions among the participating scientists who are from different disciplines and institutions, and arranging for an Inception Workshop for stake-holders, which held on 9th April.

The Meteorology Department collected from their database the baseline data on rainfall, temperature (maximum & minimum), humidity and pan evaporation, covering about 193 rainfall stations for baseline (1961-1990) data. Trend analyses and significance tests were carried out for the monthly data of minimum, maximum and mean temperatures and rainfall during the period of 1900-2000 for the selected main ten meteorological stations.

In the coconut sector, data on annual coconut yield and socio-economic data in five estates in different Agro Ecological Regions, as well as national level data on coconut production, domestic consumption, export volumes of coconut products such as coconut oil, desiccated coconut, fresh nuts, mattress fibre, bristle fibre, coir yarn, twisted fibre and coir twine were collected for the period 1971-2001. In the tea sector, historical data on monthly yield, extent, clone and bush stand are being extracted from high, medium and low yielding estates representing different elevations and climatic conditions.

B. Tasks performed and Outputs

1. General

1.1 Review Meetings

The study teams met five times on January 31, March 01, April 09, May 13 and June 25, in order to:

- Review the progress in the previous month and plan the work for the ensuing month,
- Brief by the participating members to non-participating members on the knowledge and information gathered at the 3 AIACC meetings,
- Organize the Inception Workshop held on April 09th at SLAAS.
- Coordinate the data collection and analysis exercise to be carried out by the 4 participating institutes.
- Prepare specifications, identify vendors and consider the quotations received for the purchase of equipment and select suitable items.

The first four meetings were held in Colombo at SLAAS Headquarters, while the June meeting was held at TRI, Ratnapura.

1.2 Inception Workshop

This workshop was held to brief the stakeholders from the plantation estates, trade and commercial organizations and decision makers in the Ministries, Departments and Research Institutes as well as to concerned scientists, and to receive a feedback. The following presentations were made:

- Introduction to the AIACC project in Sri Lanka, and its importance.
Dr Janaka Ratnasiri,
- Development of Climate Scenario for Sri Lanka,
Dr Senaka Basnayake
- Possible impact of climate change in the tea sector and adaptation measures available,
Dr A Anandacoomaraswamy
- Socio-economic considerations in introducing adaptation measures in the tea sector,
Ms Asoka Jayakody
- Climate change impacts and adaptation measures in the coconut sector and socio-economic considerations,
Dr Sanathanie Ranasinghe

The presentations were followed by a lively discussion during which several useful ideas and suggestions were made by members in the audience.

1.3 Participation in Meetings

- Three members in the team, Dr A Anandacoomaraswamy, Dr Neil Fernando and Dr Senaka Basnayake attended the “Kick-Off” meeting, which was held at the UNEP Headquarters, Nairobi, Kenya in February 2002, for the purpose of discussing individual project objectives, assisting in project designs, getting feedback on training needs and encouraging inter-project networks, sharing of skills and administrative matters.
- Dr Senaka Basnayake attended the workshop on “Development of Future Climate Scenarios”, which was held at University of East Anglia, UK in April 2002. It was basically a technical session where the participants were exposed to many scenario development models such as MAGICC/SENGEN, SDSM, RCM etc.
- Dr M A Wijeratne, Dr Sanathanie Ranasinghe and Ms Asoka Jayakody participated in the AIACC Project development workshop on “Climate Change Vulnerability and Adaptation” held in Trieste, Italy during 3-14 June 2002. It filled the gaps in knowledge on development of climate change scenarios, vulnerability assessment, biological and socio-economic impact assessment, and evaluation of adaptation / mitigation measures to climate change.

- Dr Sarath Pieris visited the Climate Research Unit (CRU), University of East Anglia, Norwich, during 15 – 16 June, 2002. This two-day visit was useful to understand how a weather generator works and to enhance knowledge on the analysis of long-term climate variability and predicting the relationship of seasonal rainfall in a tropical climate.

2. Climate Studies

2.1 Climate Data Collection

- Meteorological data were collected and a database was developed in consultation with the TRI and CRI. Baseline data during 1961-1990 on rainfall were collected from 183 stations other than the stations, which are maintained by the Department of Meteorology. Temperature (maximum, minimum) and humidity were collected from 10 stations maintained by the Department of Meteorology and pan evaporation data were collected from 3 stations.
- Stations in the Agro-ecological zones were identified by overlapping of Agro-ecological zone map with rainfall station map by using Surfer and Adobe PhotoShop. Data were collected from the rainfall stations and meteorological stations in the districts of Anuradapura, Badulla, Colombo, Galle, Kandy, Kurunagala, Nuwara-Eliya, Puttalam, Ratnapura and Trincomalee
- Monthly Mean temperature data for 16 stations for the Department of Meteorology stations extending to 130 years have been compiled and that of 20 stations from the Department of Agriculture for the last 30 years have been obtained. This data has been digitized and checked.
- Monthly Rainfall data for 20 Dept of Meteorology stations for the last 130 years have been obtained and data for 20 stations from Department of Agriculture have been obtained.
- Quality control of the temperature data has been carried out in a systematic manner for 16 stations. Stations that were moved were identified. Outliers were identified and consistency among stations was checked. A complete set of data was constructed after the quality control

2.2 Data Analysis

- Trend analyses and significance tests have been carried out for the monthly data of minimum, maximum and mean temperatures and rainfall during the period of 1900-2000 for the selected main ten meteorological station (which are covered from above-mentioned districts).
- It was revealed that the temperatures have shown increasing trend in most of the selected stations and the rainfall has not shown any significant trend within the considered period of 1900-2000.

2.3 Scenario Development

- Several attempts were made to familiarise with the *MAGICC/SCENGEN* (Model for the Assessment of Greenhouse gas Induced Climate Change/Global and regional SCENario GENERator) softwares. However, problems arose because of the incompatibility of versions, as the new version of MAGICC/SCENGEN Version 3.0 should be used to generate future climate scenario in this project (because version 2.4 was used in preparation of SAR, Second Assessment Report and version 3.0 has been used in preparation of TAR, Third Assessment Report).
- Time was spent on training on *SDSM* (Statistical Down Scaling Method) software, since this has an ability to develop climate scenarios at a single-site. Several communications (through e-mails) were also made with Dr. Xian Fu (Tyndall Centre, Norwich) to clarify some difficulties encountered.

3. Crop and Socio-economic Data

3.1 Coconut Sector Data

The following data for the 30 year period of 1971-2001 was collected.

- Annual coconut yield in five coconut Estates, under different land suitability classes in different Agro Ecological Regions.
- Daily rainfall and monthly temperature (minimum and maximum) of the same estates.
- Socio-economic data (number of labourers, wage rate, number of estate officers, selling price of coconut) within the above five estates.
- National level socio-economic data on:
 - Annual coconut production
 - Annual export volumes of coconut products (coconut oil, Desiccated coconut. Fresh nuts, mattress fibre, bristle fibre, coir yarn, twisted fibre and coir twine).
 - Annual export revenue of above products
 - Annual domestic consumption

Collection of daily rainfall data in five Agro-ecological regions of coconut growing areas for past 100 years, and other climate variables such as temperature, sunshine hours etc. (depending on the availability) is in progress.

3.2 Tea Sector Data

- Fifteen estates representing Low country (0-600 m amsl) wet zone, Low country intermediate zone and Mid country (600-1200m amsl) wet zone were selected for data collection covering a minimum period of 25 years. Data on crop productivity were recorded from three different fields (high yielding, moderately yielding and low yielding) of each of 8 estates. The data consisted of monthly yield, extent, clone and

bush stand. Data were also collected from two estates from different agro-ecological regions in the high elevation (>1200m amsl).

- Literature survey was partly done to gather information on the relationship between climate (temperature, CO₂, rainfall) and crop productivity, drought effects on tea production in the low and mid grown tea and cultural practices mitigating drought effects and minimizing heat stress. Copies of research papers were taken from local as well as international journals.
- Discussions were held with the scientists, expertise and tea growers to gather information relating to various adaptation measures that could be useful in mitigating drought effects, heat stress etc. on tea.
- A brief field study was commenced to evaluate the impact of increasing CO₂ on productivity of both low and high grown tea, as a gap-filling study. The relationship between crop productivity and CO₂ level is an important input for conducting modeling exercises and this has to be obtained under local conditions.
- Macro and sector specific socio-economic data were collected:
 - Contribution to the National economy in terms of GDP and Foreign Exchange Earnings since 1975/80.
 - National Tea Area, Production and Exports since 1934
 - Direct employment and Material input use by the sector (mainly fertilizer) since 1980
 - Cost of production and Tea Prices (FOB and NSA) since 1975
 - Elevation wise tea Area and Production (Up country, Mid Country and Low country since 1975/1980
 - Tea Area, Production and Exports by Kenya and India (since 1960)
 - Major importers of Sri Lankan tea since 1960

C. Difficulties Encountered

- Difficulties were encountered in the process of gathering historical data from a large number of stations as most of the stations do not have computerized data. Almost all Agro-Meteorological stations commenced after 1975. Therefore they do not possess 30-year baseline data. In some stations there are breaks in data, some times with 10-year gaps. Also, most of the stations do not possess 100-year records.
- There were discontinuities in socio-economic data at estate level. The need for extra assistants was also identified for collecting field data and analysis.
- There was difficulty in accessing literature on previous work done as the journals covering the subject are not available in the country. We are ordering one journal but with their high cost, are unable to order several. Perhaps, AIACC could arrange to send content pages of more important journals devoted to climate change.

A. Tasks within the next 8 months**1. Climate Data Analysis**

The following tasks are expected to be carried out:

- Complete the trend analyses for all of the stations and for all parameters on monthly, seasonally, decadal basis.
- Obtain further training on SDSM and MAGIC/SCENGEN softwares, which are to be used in scenario development.
- Commence scenario development by
 - Using baseline data collected and analyzed
 - Downloading of NCEP reanalysis data and GCM outputs
 - Downscaling GCM output to the Station level or to fine grid
- Perform quality control analysis on variables such as minimum and maximum temperature, humidity, rainfall data.
- Undertake estimation of regional climate change, its seasonal, decadal and possible diurnal variability.
- Arrange for the overseas training of one climate scientist in climate scenario development.

3 Coconut Sector Data Analysis

The following tasks are expected to be carried out:

- Completion of collection of data on yield, climate and socio-economic factors.
- Analysis of long-term climate data applicable to coconut growing areas.
- Development of climate change scenarios for coconut growing areas jointly with climate scientists.
- Development and application of crop models to determine the relationship between yield and climate factors.
- Identification of socio-economic impact indicators sensitive to climate change.
- Arrange for the overseas training of one coconut scientist in crop modeling.

3. Tea Sector Data Analysis

The following tasks are expected to be carried out:

- Continue the collection of historical data on productivity from selected tea estates in different agro-climatic zones
- Continue the literature survey on relationship between climate and tea productivity and crop models.
- Continue the CO₂ enrichment experiments and obtain other bio-physical parameters such as chlorophyll content, leaf area and photosynthesis rate, to feed the data into crop models.
- Analysis of data collected from low high and mid-country estates and obtain regression equations for yield and climate parameters.
- Analysis of data and establishment of relationships between environmental factors and productivity of tea using data collected from field experiments.
- Run the two crop models, ECOSYS and CROPSYS to forecast productivity changes due to changes in climate parameters under different agro-ecological zones.
- Arrange for the overseas training of one tea scientist in crop modeling.
- Collect following information from 50 tea estates in all 3 elevations (including the low country sample) minimum of 4 estates from each Agro-Ecological Regions (AER), to cover 12 tea growing AERs.
 - Annual tea production & productivity and land use from 2 estates in 2 AER since 1960.
 - Total green leaf harvested, Total Made tea produced, Mixture of different tea grades produced, Cost of Production, Net Sales Averages, were collected on monthly basis, from 12 estates since 1980 in 6 AER Regions.
- Undertake a stakeholder survey to identify social vulnerability and adaptive capacities of different stakeholder groups. Questionnaires have been prepared and yet to be pre-tested.

E. Anticipated Difficulties

The main difficulty anticipated is in identifying sources of Integrated Assessment Models applicable to agricultural sector, which is an important component of the study. We are still awaiting a positive response from those who may have this information.

We also plan to send three scientists to India to familiarize themselves in climate scenario development (one) and in crop model development (two). In view of the need to obtain the clearance from Indian higher authorities for such activities, we could foresee some difficulties. It is pertinent to mention that the requested host government endorsement for the proposed training programme planned earlier to be conducted at the Indian Institute of Management at Ahmadabad never came.

B. Presentations

The presentations made by Dr S Basnayake at the Norwich Meeting is given is given in Annex I.

The presentation made by Dr S Ranasinghe at the Trieste meeting is given in Annex II.

Annex I

Assessment of the impacts of and adaptations to climate change in the plantation sector, with particular reference to coconut and tea, in Sri Lanka.

AS-12

**Senaka Basnayake, Centre for Climate Change Studies,
Department of Meteorology, Colombo, Sri Lanka**

Overall objectives

- Collection of baseline data
- Project the climate change scenarios in the coconut and tea growing areas based on the global circulation model results relevant to South Asia.
- Assess the impact of climate change on productivity of tea and coconut and socio- economic status of the people within the plantation sector.
- Identify adaptation options and assess their feasibility of implementation.
- Build capacity of natural and social scientists engaged in plantation research for undertaking assessment studies incorporating impacts, vulnerability and adaptation.
- Train scientists to prepare proposals for seeking funds in meeting costs of adaptation to adverse effects of climate change as provided in Article 4 of the UN Framework Convention on Climate Change (UNFCCC, 1992).

Required climate data are

Temperature (minimum, Maximum and mean), rainfall and humidity data are needed in the annual, monthly and daily time scales and regional, national and farm level spatial resolutions.

Required non-climate data are

- ★ Productivity data on tea for different agro-climatological zones.
- ★ Nut production of coconut for different agro-climatological zones
- ★ Socio economic data (income, dependents, education and quality of life)
- ★ Trade statistics on tea and coconut and contribution to national income
- ★ Past experimental findings relating to productivity and the climate

The above-mentioned data are also needed in the same time scales and in the same spatial resolutions.

Methods/tools planning to use for developing climate scenarios

- ★ Global Circulation Model (GCM)

★ Regional Circulation Model (RCM)

Advantages of using these methods/tools

B. Conceptual advantages

1. Uses only large scale and therefore most reliable GCM information
2. Provides physically based estimates of climatic conditions.
3. High resolution synoptic weather systems that lack in GCM's and are important for severe weather phenomena are generated by photographic forcing or by non linier interactions due to more realistic land sea distribution and orthography (especially improved orographic precipitation).

Practical advantages

1. No transformation baseline climate series necessary if the regional model output is detailed enough as a scenario and the control simulation is satisfactory.
2. A consistent set of all required variables can be obtained from one single model

Limitations

1. There is only one way link between GCM and LAM, since the boundaries are time dependently driven by the course mesh GCM(no feedback)
2. A regional increase of resolution does not solve the problems of systematic errors in the large scale GCM circulation, since they are transmitted to errors in the large scale GCM circulation, since they are transmitted to the finer scale.
3. Still lack a realistic representation of variability and extremes at small spatial and temporal scales (inherent to any dynamical model)
4. Transformation causes that the historical temporal sequencing of events is retained (e.g. runoff is highly sensitive to changes in the timing of precipitation or storm inter-arrival times).

Practical disadvantages

1. Due to computational expenses only explored for short periods (<10 complete years) and selected seasons or months providing a limited range of scenarios.
2. Spatial resolution is often still too low to obtain the details required

Methods/tools are planning to use for developing non-climate scenarios

- ★ Crop models to understand the effects of changes in climate on crop productivity,
- ★ Socio-Economic models at farm or regional level that deal with effect of agricultural production on various issues such as profits, employment, and trade in general (Aggarwal and Karla, 1999).

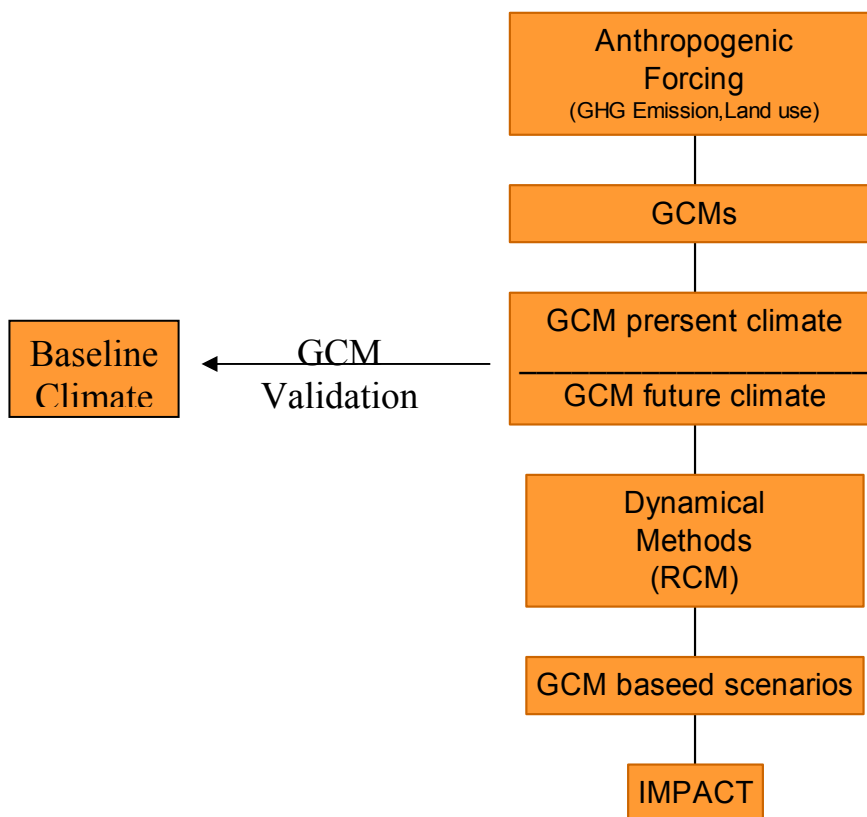
The following crop-weather models have been used by scientists at the Tea Research Institute, Sri Lanka to study the effect of weather on tea production.

- ★ Cuppa Tea Model
- ★ Tea Gro
- ★ Tea Cross

Plans to communicate and transfer the knowledge/skills to the rest of team members

- By conducting a training seminar on applicable models
- Distribution of handouts on applicable models, techniques etc

The following flow chart is used to develop future scenarios.

Scenario Development

Annex II

Summary of the Presentation made by Dr C S Ranasinghe at Trieste Meeting

The presentation was made on 13th June 2002. The main objectives of the presentation were to discuss the new things learnt during the workshop that can be included in our project framework and to highlight the expected outputs of the project to scientific community and relevant stakeholders.

The contribution to scientific community for advancing scientific knowledge would be the information on;

- a. climate and socio-economic scenarios for Sri Lanka and for different agro-ecological regions
- b. vulnerable areas of Sri Lanka to climate change (in particularly tea and coconut growing areas)
- c. crop models for tea and coconut, relating productivity and climate variables
- d. biological and socio-economic impacts of climate change on national, sectoral and stake holder levels
- e. adaptation and mitigation measures that can be practiced in tea and coconut growing areas, the cost and benefit analysis of feasible options
- f. integrated assessment models relating climate change, crop yield, and socio-economic impacts

These information will be submitted to IPCC reports and articles in peer reviewed journals.

The expected output for relevant stakeholders includes the intervention on policy decision making relevant to;

- (a) land use for tea and coconut plantations in Sri lanka (crop diversification in vulnerable areas and intensification in most suitable areas)
- (b) adaptation measures that should be practiced in vulnerable areas to climate change (eg. Frequent droughts)
- (c) import / export policy on tea and coconut related products
- (d) consumer protection measures during crop shortage periods
- (e) investments on industries related to value addition
- (f) future planning on producer and consumer protection programmes in vulnerable areas.