IMPROVING LIVES THROUGH AGRICULTURAL RESEARCH

CARDI

FACTSHEET

AGRICULTURE AND CLIMATE

I. Understanding and differentiating climate variability and climate change

By:
Clyde W. Fraisse, University of Florida, USA
J. W. Jones. University of Florida, USA
Leslie Anthony Simpson, CARDI, Jamaica

INTRODUCTION

To facilitate a better understanding of the relationship between climate and agriculture, it is first necessary to understand important parameters of the climate. This factsheet defines weather and climate and then goes on to clarify the differentiation of climate variability and climate change. It should be considered a prerequisite to an understanding of how agriculture can affect and is affected by climate

WEATHER AND CLIMATE

Weather describes conditions in the atmosphere that are happening today or over a short period of time. Decisions made by farmers based on weather forecasting are tactical decisions such as applying agro-chemicals, and planting or harvesting a crop.

Climate describes the long-term weather patterns for a specific area and time of the year. The average amount of annual or monthly rainfall or average temperature during winter or summer months, are examples of climatological information for a given location. Climatology includes both average conditions and frequencies of extreme events such as heavy rainfall or hurricanes. The latitude of a location has an important impact on its climate that can also be affected by other factors such as elevation and proximity or not to coastal areas.

CLIMATE VARIABILITY

The Earth's climate is dynamic and naturally varies on seasonal, decadal, centennial, and longer timescales (NOAA 2011). This variability can occur in the form of warmer or colder, wetter or drier conditions as compared to long-term averages for a given location. Seasonal climate variability is a major source of production risks in agriculture. The majority of crop failures are associated with either a lack of or excess rainfall in time and space. Climate variability is also associated with other sources of production risks such as pest and disease incidence. Weather patterns, including high temperature and humidity, and the potential for daily rainfall, can create a near-perfect environment for the outbreak of fungal diseases (Fraisse et al. 2006).

The El Niño Southern Oscillation (ENSO) phenomenon is the strongest driver of inter-annual climate variability around the world (Ropelewski and Halpert 1996; McPhaden et al. 2006) and affects crop production in many regions. ENSO phases are characterised by sea surface temperature (SST) anomalies in the eastern equatorial Pacific Ocean. When SST is higher than normal the phenomenon is referred to as El Niño or warm events. Associated with the warmer surface temperatures is an increase in convective activity, and at a certain stage, a persistent reduction of the normally westward flowing winds (Cane 2001). When the SST is lower than normal, the phenomenon is referred to as La Niña or cold events. During La Niña events, the equatorial trade winds strengthen, resulting in colder water being brought up from the ocean’s floor, especially over the western coast of South America.

Neutral is the term for when neither El Niño nor La Niña are present in the Pacific. Under neutral conditions, trade winds blow from east to west near the Equator in the Pacific Ocean (Fraisse et al. 2008). Hastenrath (1976) studied the driest and wettest summers in the Caribbean using rainfall records from 1911 to 1972 to find a correlation between elevated sea-surface temperatures (SSTs) in the equatorial Pacific with a drier season in the Caribbean. Chen and Taylor (2002) showed that El Niño events result in reduced Caribbean late season rainfall and an increase in early season rainfall in the year following the onset of the El Niño.

CLIMATE CHANGE

Natural, long-term climate change occurs in responses to fluctuations in the amount of solar energy reaching the Earth, changing ocean currents, formation or loss of ice sheets, and many other causes. In addition to these natural causes of climate variability, human activities have been shown to influence climate in many ways. Land use changes like the irrigation of historically semi-arid areas for farmland, the paving and development of sprawling urban areas, the draining of wetlands and increased aerosols in our atmosphere are all anthropogenic factors (which are termed forcings) to our climate system (Fraisse et al. 2009). Perhaps the most significant human influence today is the increasing concentrations of greenhouse gases (GHG) in the atmosphere, mainly carbon dioxide (CO2) and methane (CH4), which have modified the Earth-atmosphere energy balance leading to a warming of the system (IPCC 2007). Society is now starting to demand actions from governments and the private sector to reduce the emissions of GHG across all sectors of the economy. The latest science indicates that a large-scale reduction of greenhouse gas emissions will be required across its many sources in our economy, including the agricultural sector, to reduce the anticipated increases in global temperatures.

Projections of future climate are based on climate models, complex computer programmes that attempt to describe how the atmosphere will behave through time in response to the forces that act upon it. According to the IPCC (2007) report, the best estimates from these models indicate that the global average surface temperature will rise between 1.8 °C to 4 °C by the year 2099 depending on how much the concentrations of CO2 and other greenhouse gases increase. This would be a significant increase in temperatures when compared to warming observed over previous centuries. An important question for agriculture is if a changing climate will also affect the occurrence of extreme events. Will droughts, floods, heat waves, freezes and storms become more or less frequent? It has been theorised that a warmer planet would lead to more severe extremes, though not necessarily more frequent, but limitations in computer models keep us from answering that question conclusively.

Under El Nino conditions warmer waters and enhanced rainfall is experienced over the eastern Pacific (coloured red), but depressed (reduced) rainfall over the Caribbean.

Source: http://buford67.glogster.com/el-nino/

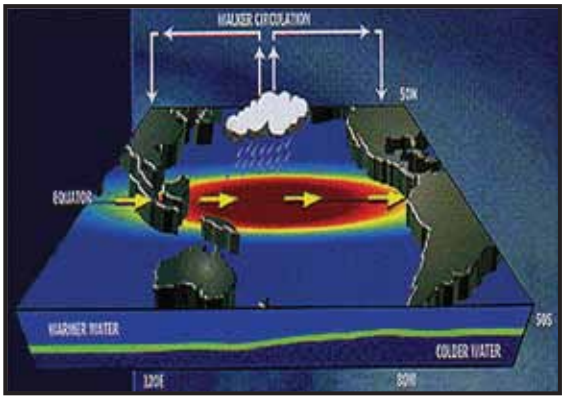

Figure 1: A diagrammatical representation of the El Nino Southern Oscillation (ENSO) considered the strongest driver of inter-annual climate

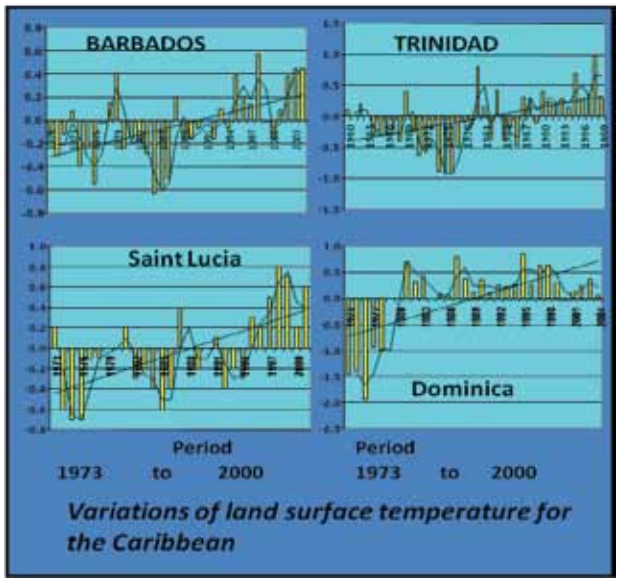

Figure 2: Land surface temperature variations for four Caribbean territories over the period 1973 - 2000

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Caribbean Agricultural Research and Development Institute

HEADQUARTERS CONTACT INFORMATION
P.O. Bag 212
University of the West Indies
St. Augustine Campus
St. Augustine
Trinidad and Tobago

Email: infocentre@cardi.org
Website: www.cardi.org
Fax: 1.868.645.1208
Tel: 1.868.645.1205/8120

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