Climate Measurement: A review of rainfall and temperature measurement standards in Guyana

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Presentation Outline

- How climate is measured?
- How climate change is measured?
- Why do we measure climate or climate change?
- Climate measurement in Guyana
- Existing standards for the measurement of climate
- Gaps in the implementation of climate measurement standards in Guyana
- Recommendations for addressing these gaps

What is climate?

- ***Climate*** is the average weather usually calculated over a 30-year time period for a particular region and time period (2015 Weather Wiz Kids).

- It is determined by patterns of temperature, precipitation (rain or snow), humidity, wind and seasons (Washington State Department of Ecology)

Measuring Climate

- The climate of a particular region is determined through analysis of Climatological variables in a region over a period of 30-years or greater

- The parameters measured include:
  - Temperature (maximum, minimum, lower ground and soil)
  - Wind speed
  - Relative humidity
  - Rainfall
  - Atmospheric pressure
  - Sunshine hours

How do we measure climate change?

- There are a number of key factors in measuring climate change, and they are broadly categorized below. The range of instrumentation used to observe and measure climate is truly amazing.

  Temperature When measuring climate change this is a primary and can be measured or reconstructed for the Earth's surface, and sea surface temperature (SST).

  Precipitation (rainfall, snowfall etc) offers another indicator of relative climate variation and may include humidity or water balance, and water quality.

  Biomass and vegetation patterns may be discerned in a variety of ways and provide evidence of how ecosystems change to adapt to climate change.

How do we measure climate change?

Sea Level measurements reflect changes in shoreline and usually relate to the degree of ice coverage in high latitudes and elevations.

Solar Activity can influence climate, primarily through changes in the intensity of solar radiation.

Volcanic Eruptions, like solar radiation, can alter climate due to the aerosols that are emitted into the atmosphere and alter climate patterns.

Chemical composition of air or water can be measured by tracking levels of greenhouse gases such as carbon dioxide and methane, and measuring ratios of oxygen isotopes. Research indicates a strong correlation between the percent of carbon dioxide in the atmosphere and the Earth's mean temperature.

Climatological parameters for measuring climate change

The primary parameters for measuring climate change are:

- Temperature - near ground temperature
- Precipitation - liquid

The discussions that follow are focused mainly on these two parameters.

Why Measure Climate and Climate Change?

Meteorological (climate) measurements are required, either jointly or independently and locally or globally for input to numerical weather models for hydrological and agricultural purposes an as indicators for climatic variability

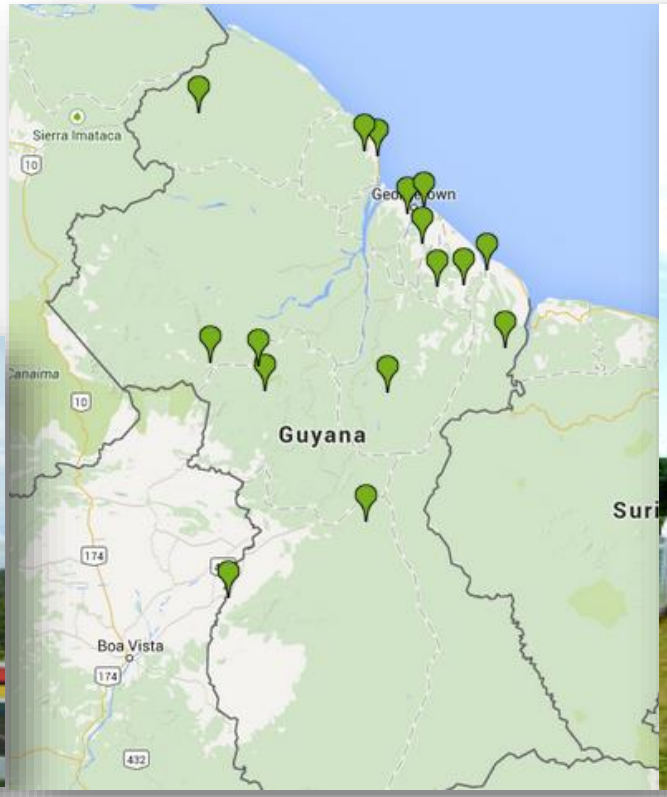
- We measure climate [change] to understand climate, climate variability and climatic changes at the local national and regional levels
- To better understand how climate [change] impacts our societies
- To better plan adaptation measures to combat the real and or potential impacts of climate change

Climate measurement in Guyana

- The **Hydrometeorological Service, Ministry of Agriculture** is the official provider of weather, water and climate information and related products and services for Guyana. The Department's general responsibility is to monitor and evaluate the weather and water resources in Guyana

Climate Stations Network - Guyana

There are 20 Automatic Weather stations installed in Guyana

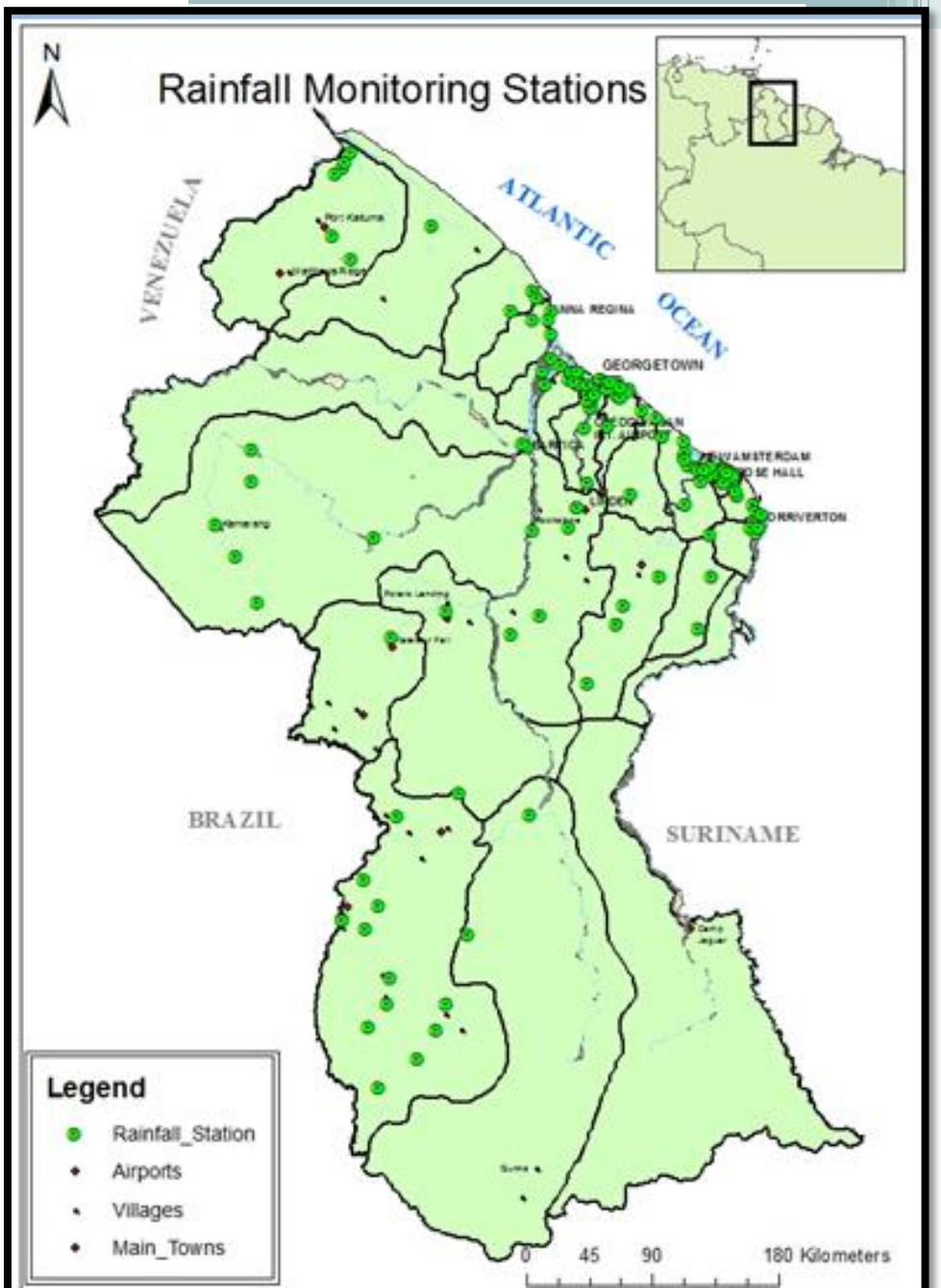


In addition to these there are six (6) additional stations that are already installed and functioning

Synoptic Weather Station

There are Nine (9) synoptic weather stations in Guyana

Hydromet operates and maintains in excess of 150 rainfall stations. This figure shows the spatial distribution of the stations within the rainfall monitoring network.



Climate measurement network in Guyana

- This manual network of rainfall station is sustained by the Hydromet Service with the support from the public across Guyana, who provides near real-time updates wherever possible.

- The data collected throughout this Network are archived and housed within the Department and used for further analysis and research both nationally and internationally.

Standards for Climate measurement in Guyana

- Climate measurements in Guyana are guided by the World Meteorological Organisation's (2010) Guide for Meteorological Instruments and Methods of Observations.

Guide for Meteorological Instruments and Methods of Observations

This guide sets out guidelines for:

- Instruments
- Unit and scale of measurement
- Frequency of measurement
- Measurement methods
- Documenting circumstances in which measurements are taken
- Siting and exposure of instruments
- Systematic and random errors and corrections
- Calibration and maintenance of instruments
- Storage of instruments

Standard for temperature Measurement - Guyana

- *Parameter – Near Ground Temperature*
- Instruments –
  - Thermometers (Ordinary (dry and wet bulb), Maximum and Minimum)
  - Usually mercury-in-glass type
  - Automatic Weather System

Standard for Measuring temperature -Accuracy Requirement

- Thermometer characteristic requirement
  - All temperature measuring instruments should be issued with a certificate confirming compliance with the appropriate uncertainty or performance specification, or a calibration certificate that gives the corrections that must be applied to meet the required uncertainty
  - Thermometers are required to be recalibrated at least two years following the first calibration
  - The only recognised calibration center for meteorological instruments available regionally is located at the Caribbean Institute for Meteorology and Hydrology (CIMH) in Barbados.

Standard for Measuring temperature- Procedure for Measurement

- **Procedure for Measurement** - Readings are made to the nearest tenth of a degree

- Corrections for scale errors, should be applied to the readings

- Maximum and Minimum thermometers are read once daily. Max at 00 UTC (20:00 hours) and min in the morning about 10 UTC (06:00 hours)

Standard for Measuring temperature -Thermometer Siting and Exposure

- **Siting and Exposure -** Thermometers are always exposed in a thermometer screen placed on a support
- The extreme thermometers are mounted horizontally on suitable supports
- Thermometers are mounted 1.2m above ground level
- Screens are usually mounted on levelled surfaces.

Rainfall Measurement Standard - Instrument

- Instrument – Manual rain gauges, transmitting rainfall gauges and Automatic Weather Stations
- The orifice diameter and corresponding cylinder for manual rainfall gauges in Guyana is 5 inches and 8 inches for automatic weather stations.
- Manual gauges are imported as well as manufactured locally to the specification

Rainfall Measurement Standard - Instrument

- The height of gauges in Guyana 39 inches to avoid splashing from the ground

- The surface surrounding the precipitation gauge is covered with short grass or sand. Hard, flat surfaces, such as concrete are avoided to prevent excessive in-splashing.

Rainfall Measurement Standard - measurements

- Precipitation is a measure of linear dept usually in mm (volume/area)
- In Guyana rainfall measurements are recorded daily at rainfall stations and six hourly at synoptic stations in Guyana
- Automatic weather stations provide continuous rainfall measurements

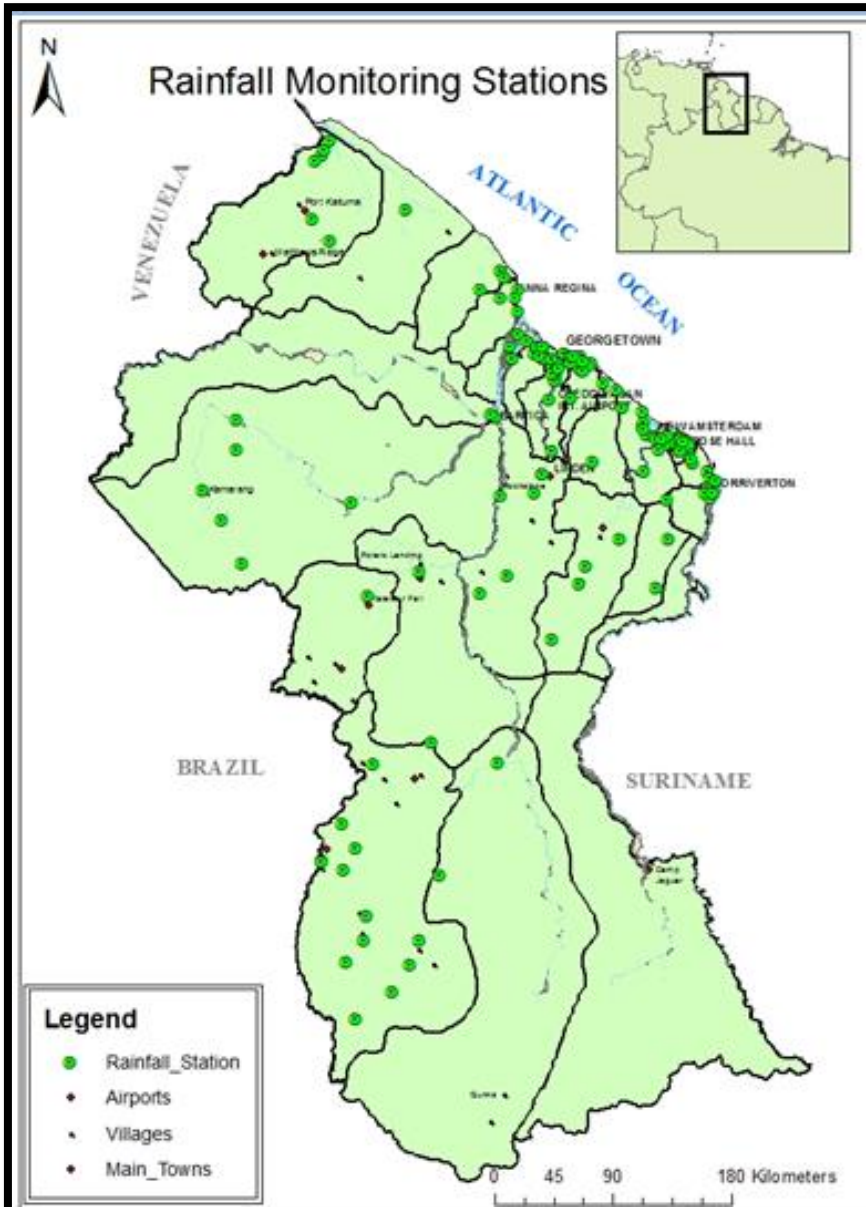
Rainfall Measurement Standard – recording measurements

- In Guyana rainfall below 0.1 mm but more than 0 mm is referred to as trace rainfall.

- Weekly or monthly measurement are read to the nearest 1 mm (at least).

Rainfall Measurement Standard - Siting and exposure

- Guyana's coastland which occupies 5% of the country's area contains 70% of the rainfall stations. The number and location of gauge may impact the how well the measurements represent the actual amount of precipitation falling in the area.
- The difficulties in accessing inland areas and low population density in these areas have made it difficulties in establishing rainfall stations
- The increase in number of AWS and transmitting rainfall stations has helped to reduce this issue



Rainfall Measurement Standard - Maintenance Ctd.

- Hydromet Service carries out maintenance checks on rain gauges 4 times annually along the coastland and once yearly for inland stations.

- Maintenance includes:
  - Painting, levelling, other physical checks on gauge and support.
  - Training staff who read and record data.
  - Ensure that measuring cylinder is correct and in working order.
  - A report on visits and maintenance is kept for each station

Certification of the Hydrometeorological Service - QMS

- The Hydrometeorological Service in Guyana is currently working to address a number of management areas to improve the quality system in compliance with the ISO 9001 standard

Quality management system (QMS) is a means of standardizing the process of data collecting, collating or assembling, editing, formatting, storing, publishing and distributing of aeronautical (climate) information

Certification of the Hydrometeorological Service – QMS

An aeronautical data management standard is required in order to:

a) ensure compliance of the data quality reported to national administrations, as specified in the standard;

b) ensure that the data management processes are carried out such that the integrity of the data is not jeopardized at any point in the process;

c) design the data collection and handling processes such that due regard is paid to the risk of error;

d) operate multi-layer data integrity management tools that enable the detection of discrepancies against known and tested logic and the appropriate rules;

e) ensure that data management tools are developed and managed in a controlled manner to ensure the integrity of the overall process;

f) provide for the development of appropriate metadata to ensure that complete audit trails are available at all times.

Areas to be addressed to improve the implementation of the standards

- **Some of these areas include, but are not limited to:**
- Availability of instruments – lack of adequate instruments
- Ensuring that instruments used for measurement met the required standard. For instance the WMO (2010) standard require that thermometers used for meteorological measure should have a lag coefficient (the time required by the thermometer to register 63.2 per cent of a step change in air temperature) of 20 seconds.
- Lack of a national calibration center for instruments – the need for this will increase given the increase in the use of electronic weather instruments. The only recognised regional center for calibration of instruments is located at the Caribbean Institute of Meteorology and Hydrology
- Density of network – need for increasing density of network particularly in inland areas to ensure greater areal representation
- Errors in reading and recording of data by part-time observers

Areas to be addressed to improve the implementation of the standards

- Construction or vegetation near rain gauges on private property may affect accurate reading
- Need for maintenance of calibration record for each instrument by the Service - currently the calibration log is only needed for the thermometers and other electronic systems since the rain gauges do not really need calibrating.
- Vandalism of Automatic Weather Stations
- Updated training of staff in monitoring and instrumentation
  - Observers and instrumentation staff

Conclusion

- Guyana remains committed to the provision of accurate weather and climate information to aid in the long term goal of adapting to climate change.
- There are several areas that Guyana is required to address to improve the standard for meteorological / climate measurement
- Addressing these gaps are important for achieving the ISO 9001 QMS certification and also for improving the quality of data, the analysis of which assists in informing local decisions and policies.

Thank you!

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