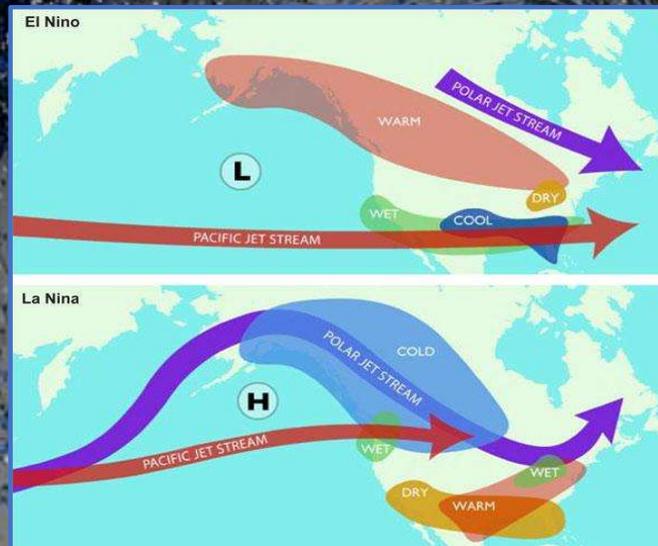


# U.S. Climatological Drought: "A persistent upper-level ridge over the region"

Mid-tropospheric warming; Adiabatic warming Low-level divergence



El Niño

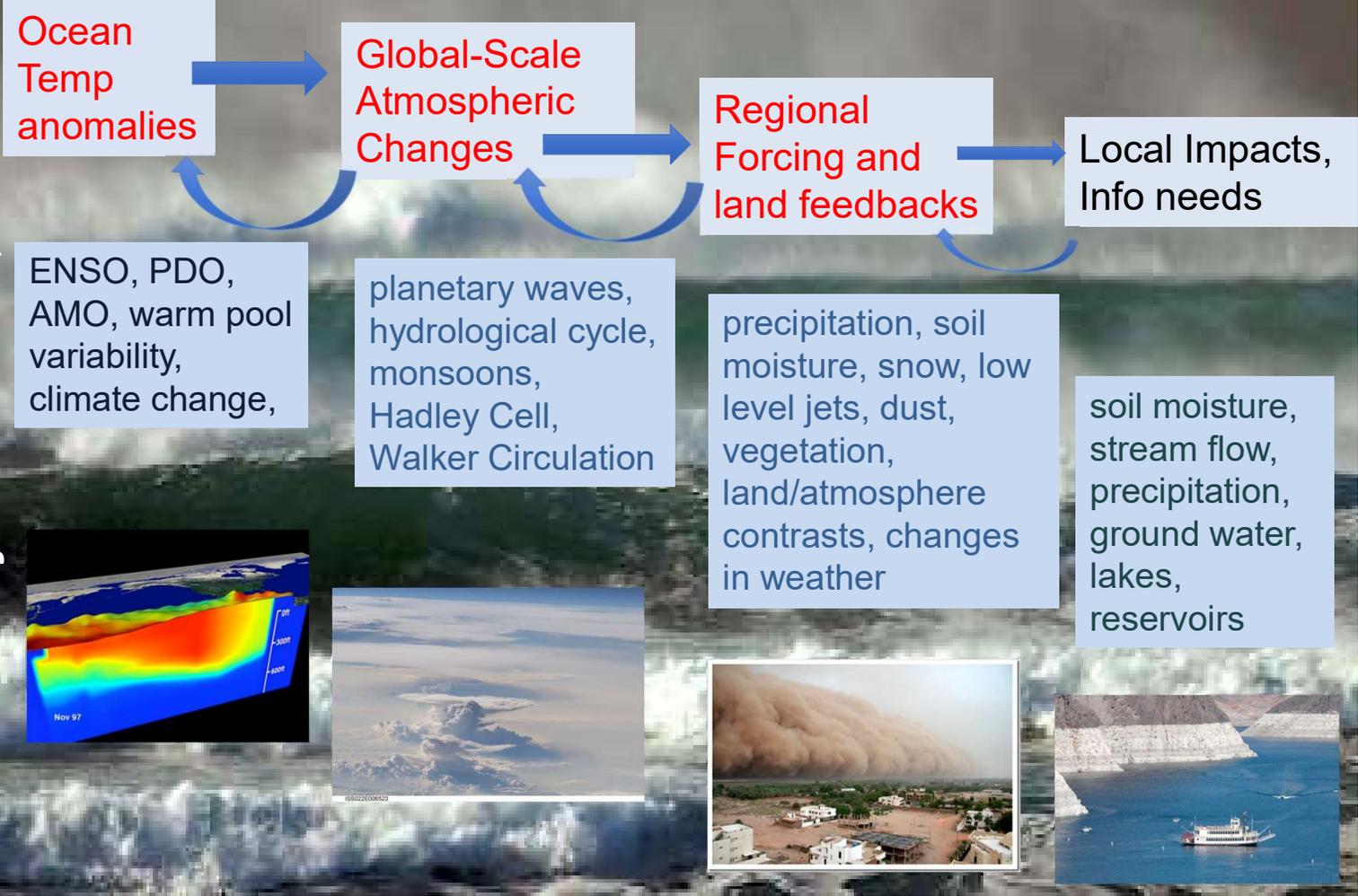
La Niña

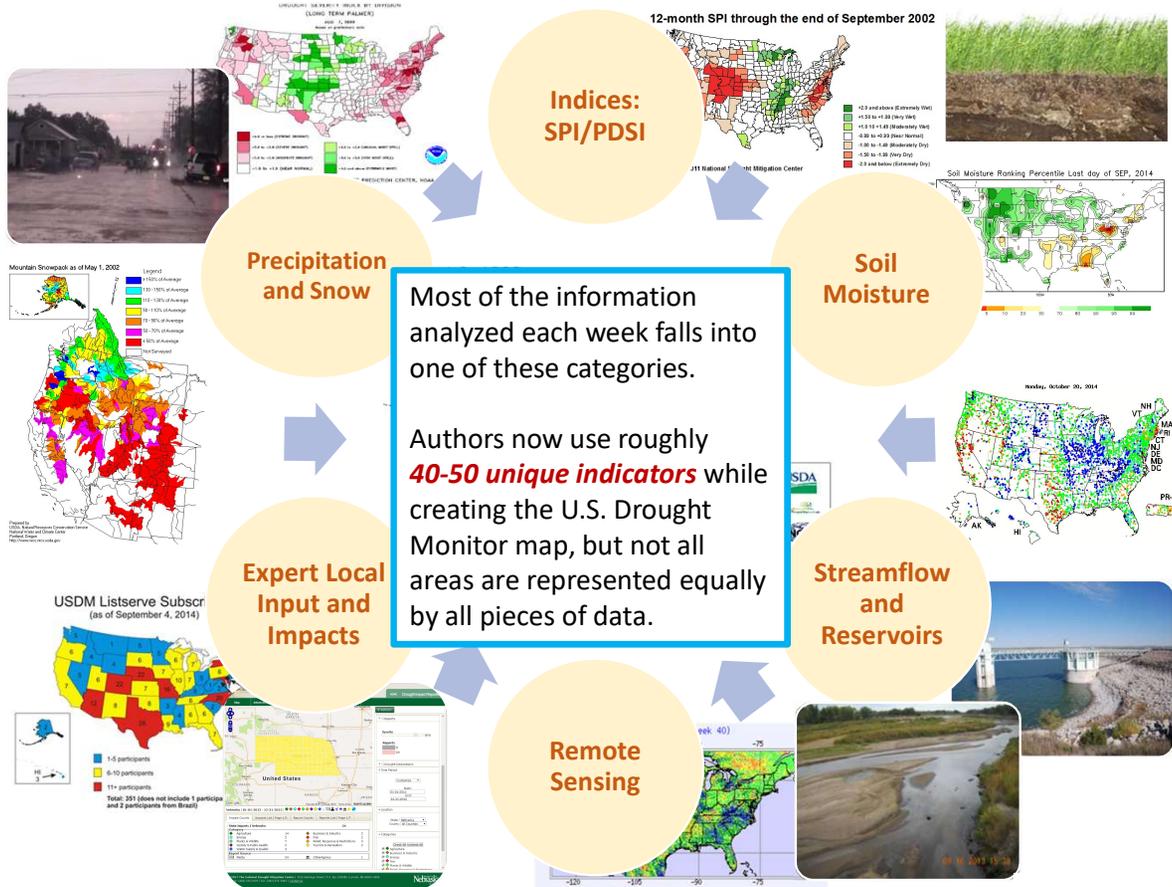


<http://earthobservatory.nasa.gov/IOTD/view.php?id=46145&sr=6>

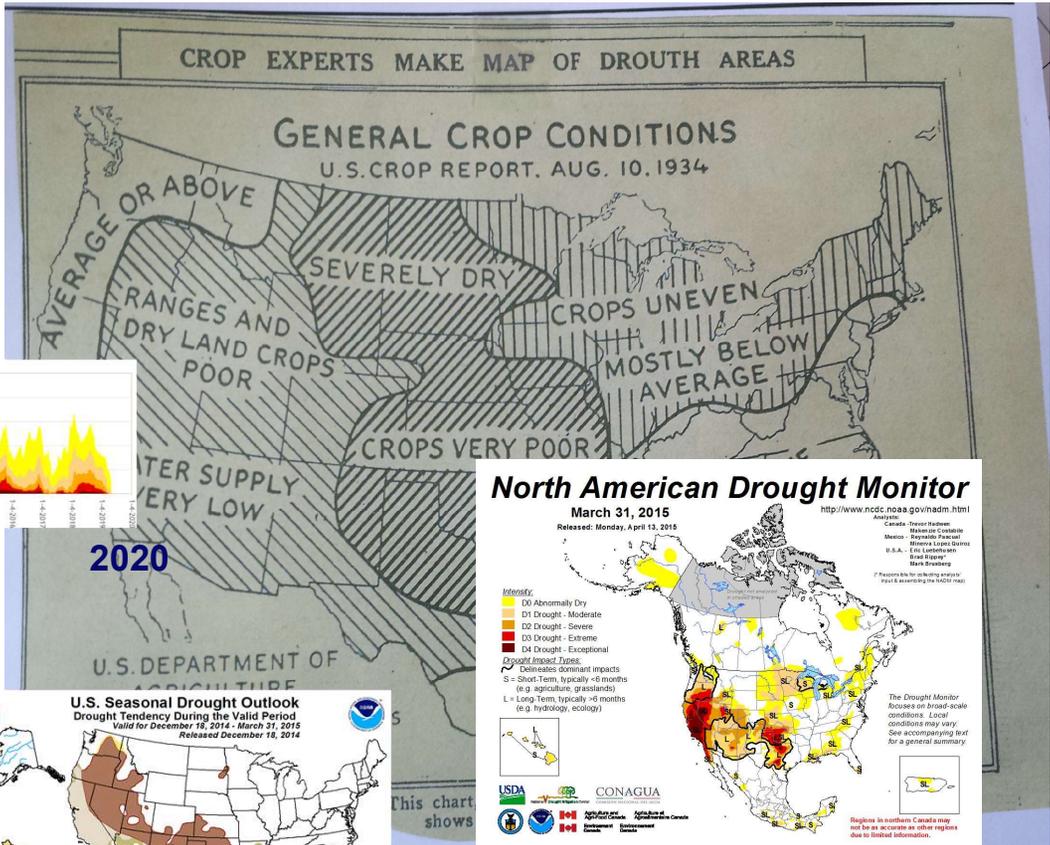
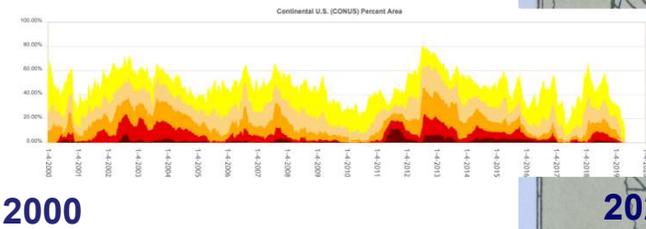
# Pathways to Drought Monitoring and Predictability

Key Phenomena, variables

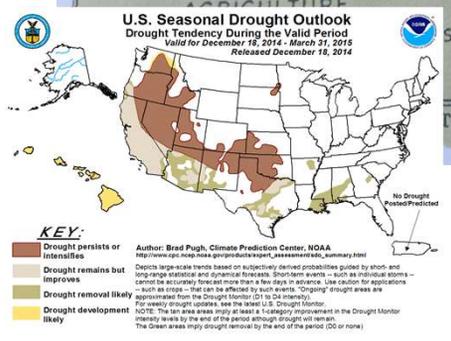
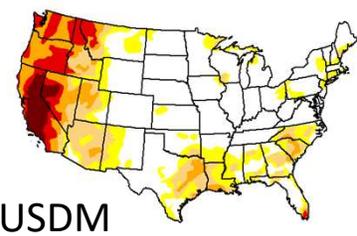




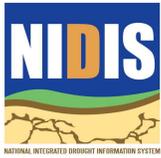
We've come a long way!



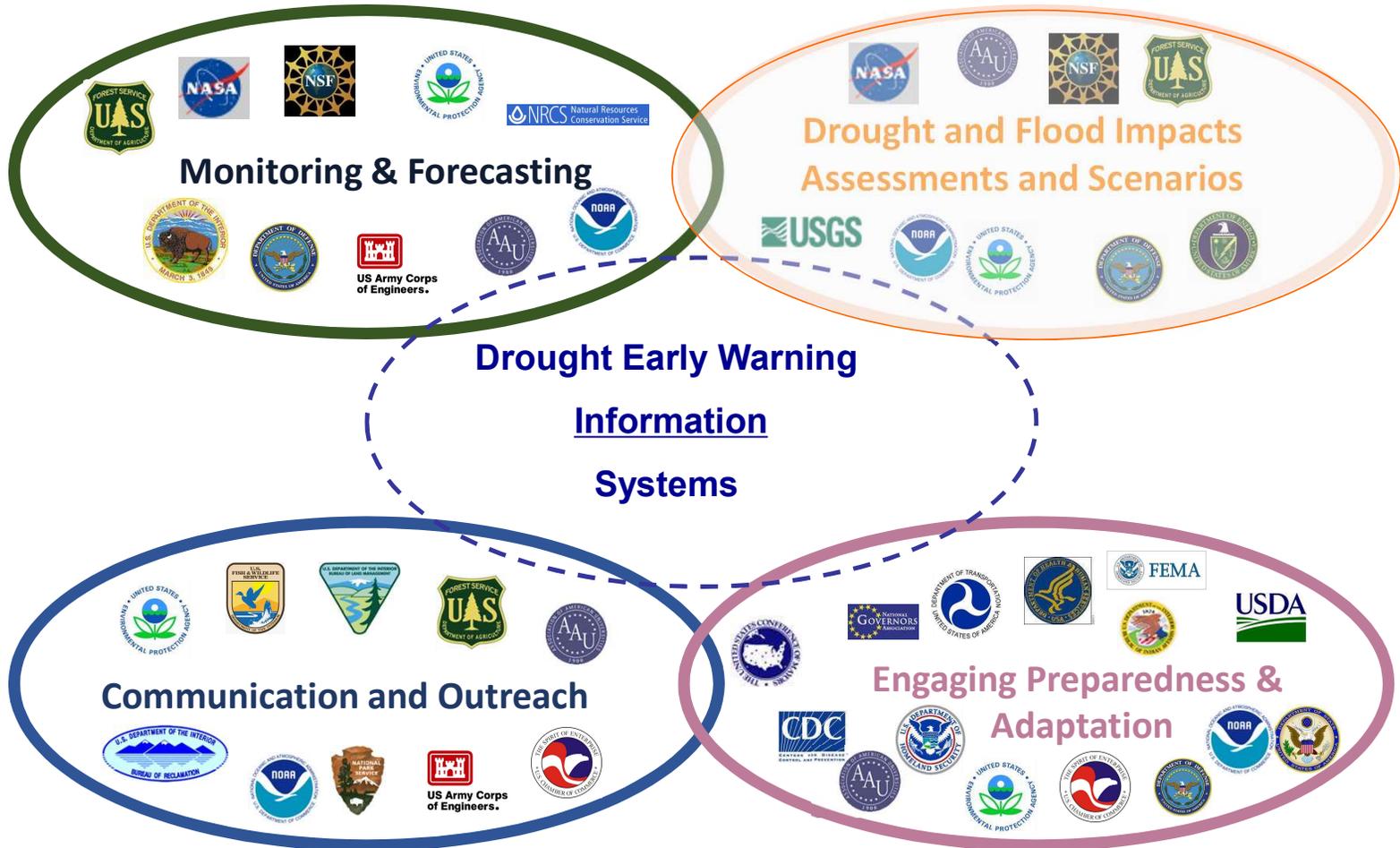
March 2015



Seasonal Drought Outlook



# National Integrated Drought Information System (Federal, States, Tribes, Private sector)





Meteorol



Agricultu



Hydrolo

Socio-eco

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## NIDIS Drought Early Warning Systems

## Regional

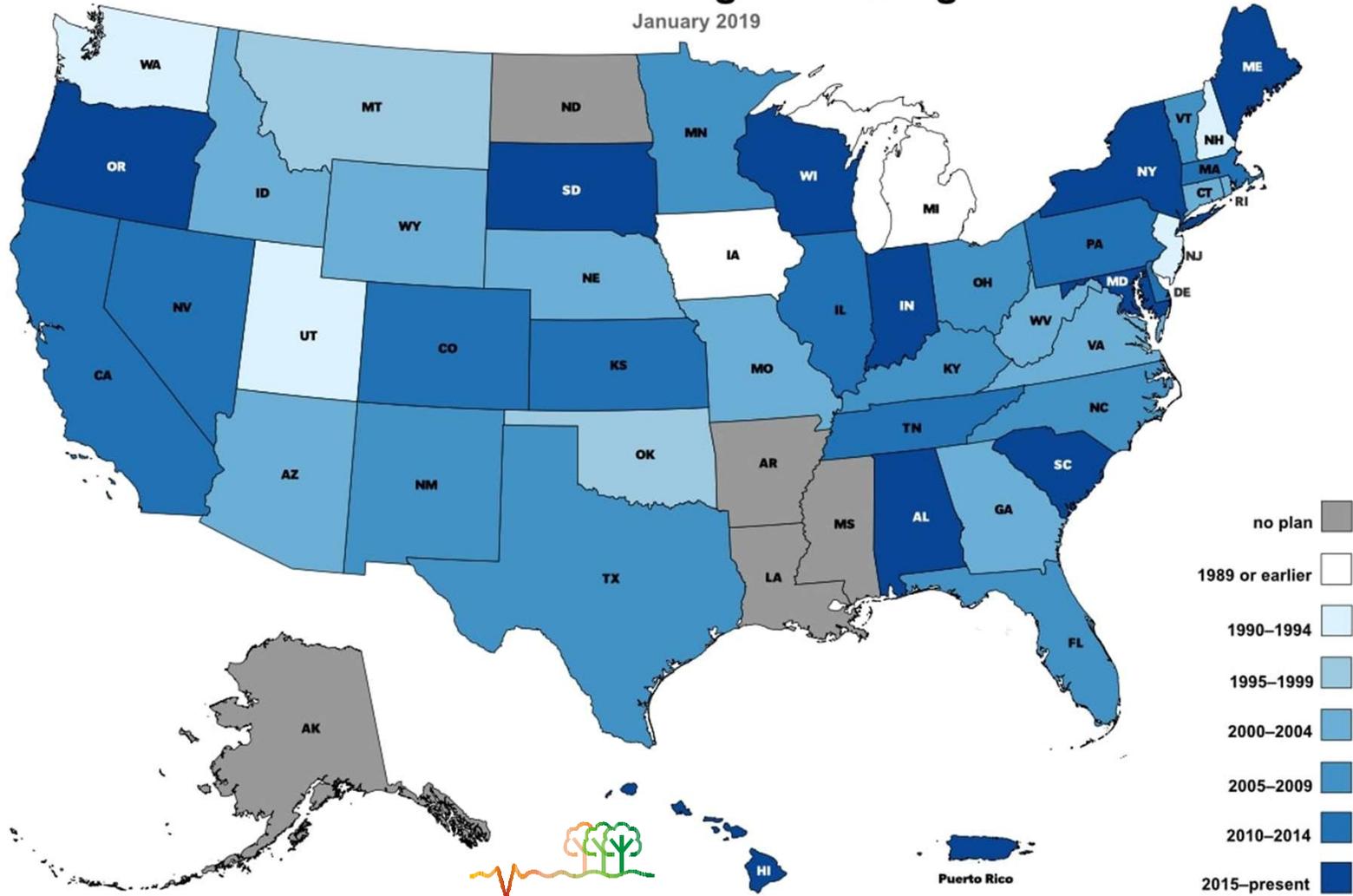
### Research and Stakeholder Collaborative network: Colorado Basin Early Warning Information System example

- Colorado Division of Water Resources (CDWR)
- Colorado State Climatologist
- Colorado River Water Conservation District (CRWCD)
- Colorado Water Conservation Board (CWCB)
- CU – Western Water Assessment, CIRES, and CADSWES
- Denver Water Board
- Northern Colorado Water Conservancy District (NCWCD)
- Wyoming State Engineer
- Wyoming State Climatologist
- Utah State Climatologist
- Western Regional Climate Center
- Mexico CNA
- National Center for Atmospheric Research (NCAR)
- National Drought Mitigation Center (NDMC)
- USDA: Natural Resources Conservation Service
- USFS: Region 2
- USBR: Eastern Colorado Area Office, Great Plains Region, Office of Policy and Programs, Research and Development
- USGS: Colorado Water Science Center, Central Region, Grand Canyon Monitoring and Research Center
- NOAA: Earth System Research Laboratory, National Centers for Environmental Prediction, National Climatic Data Center, National Weather Service

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# Status of Drought Planning

January 2019



NDMC University of Nebraska



## National Drought-Resilience Partnership Goals

**Goal 1:** Data Collection and Integration –key data platforms, modeling and prediction

**Goal 2:** Communicating Drought Risk on Critical Infrastructure

**Goal 3:** Drought Planning and Capacity Building

**Goal 4:** Coordination of Federal Drought Activity

**Goal 5:** Market-Based Approaches for Infrastructure and Efficiency

**Goal 6:** Innovative Water Use, Efficiency, and Technology



# CRITICAL INFRASTRUCTURE SECTOR IMPACTS DUE TO DROUGHT HAZARD

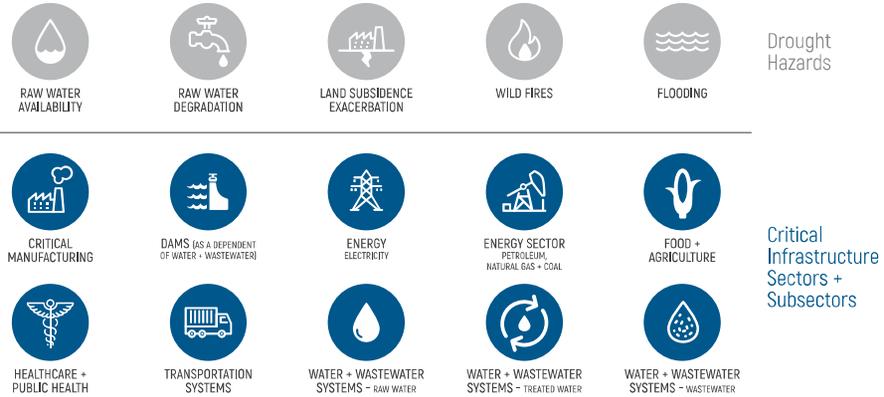
National Protection and Programs Directorate Infrastructure Development and Recovery (IDR) | February 2018



## SCOPE

### Critical Infrastructure Sector Impacts Due to Drought Hazard

Existing resources from NIDIS, EPA, USDA, DOI, DHS, FEMA, HHS-CDC, and other sources were compiled to create a risk analysis of drought hazard impacts to critical infrastructure sectors. The analysis reflects summaries of identified vulnerabilities of critical infrastructure sectors to direct exposure of drought hazards, operational impacts to each sector that contributes to slow down or stoppage of essential goods and services to meet demand needs, and indirect/cumulative impacts of dependent sectors and communities when supply needs cannot be met. Ten critical infrastructure sectors and subsectors were investigated in the context of five drought hazards.



## KEY FINDINGS

### Direct Impacts to Critical Infrastructure from Drought Hazards

SERVICE PROVIDER CRITICAL INFRASTRUCTURE SECTOR	DROUGHT HAZARDS, DIRECT IMPACTS					
	Raw Water Availability	Raw Water Quality Degradation	Dust Storms	Flooding	Land Subsidence Exacerbation	Wild Fires
Critical Manufacturing	●	●		●*	●*	●
Dams						
Energy - Electricity	●	●	●	●		●
Energy - Petroleum, Natural Gas + Coal	●	●		●		●
Food + Agriculture	●	●		●	●*	●
Healthcare + Public Health		●		●*		●
Transportation Systems	●	●		●	●	●
Water + Wastewater Systems - Raw Water		●	●	●	●	●
Water + Wastewater Systems - Treated Water	●	●	●	●	●	●
Water + Wastewater Systems - Wastewater		●	●	●	●	●

### Critical Infrastructure Dependencies + Interdependencies

SERVICE PROVIDER CRITICAL INFRASTRUCTURE SECTOR	SERVICE RECEIVER (DEPENDENT) CRITICAL INFRASTRUCTURE SECTOR										
	Crit. Manf.	Dams	Energy - Elect.	Energy - Petro, NG, Coal	Food + Ag.	HC + Public Health	Trans	RW	TW	WW	
Critical Manufacturing	●	●*	●	●	●		●	●	●	●	
Dams	●*	-	●	●	●		●	●	●	●	
Energy - Electricity	●	●	-	●	●	●	●	●	●	●	
Energy - Petroleum, Natural Gas + Coal	●	●	●	-	●	●	●	●	●	●	
Food + Agriculture	●	●*		●	-	●	●	●	●	●	
Healthcare + Public Health	●	●	●	●	●	-	●	●	●	●	
Transportation Systems	●	●	●	●	●		●	●	●	●	
Water + Wastewater Systems - Raw Water	●	●	●	●	●		●	-	●	●*	
Water + Wastewater Systems - Treated Water	●		●	●		●	●		-		
Water + Wastewater Systems - Wastewater	●	●	●	●	●	●	●	●		-	

\* Dependency understood but not identified specifically by reference

This example is generally based on products provided by the Office of Cyber and Infrastructure Analysis, NPPD, list document.

## Caribbean drought: impacts of the regional drought of 2013-2016

- **Rainfall:** 2014/2015 driest on record in 7 territories;
- **Food & Agriculture:** reduced agricultural production in 13 countries; destructive bush fires in several countries;
- **Water:** water shortages (forcing rationing) in 8 countries;
- **Tourism:** St. Kitts & Nevis curtailed water delivery to cruise ships.



Increased food prices and food shortages in Haïti Credit: LatinAmerican Post



Destructive bush fires in Jamaica Credit: Daily Observer

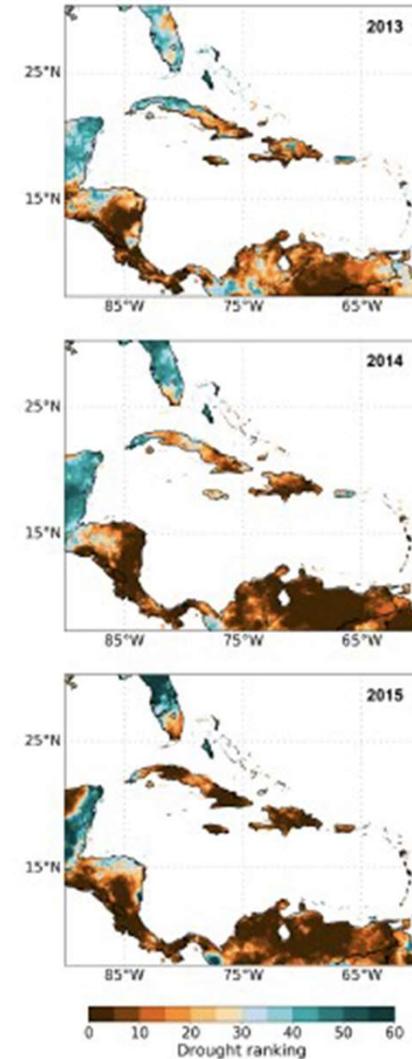
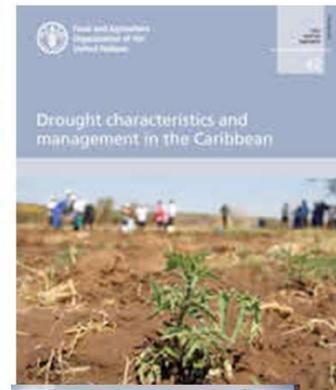
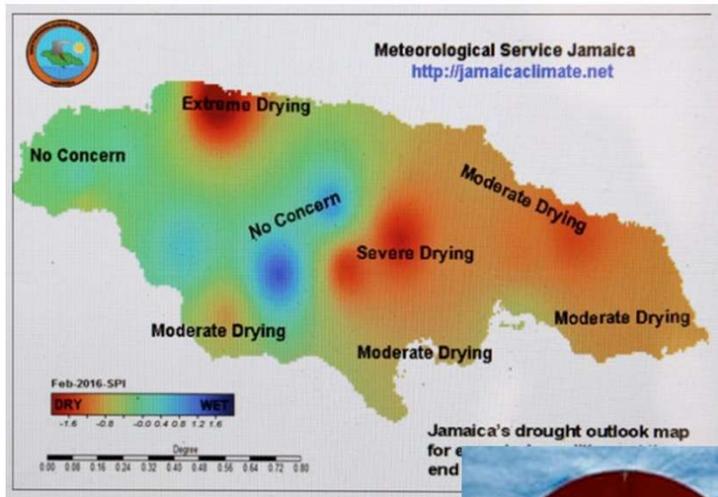


FIG. 17. Annual drought rankings between 2013 and 2015. Drought conditions in 2014 ranked as the most severe since 1950 in a greater area than in 2015. However, in the Caribbean, 2015 ranks as the driest year during the 2013-16 drought.

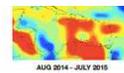
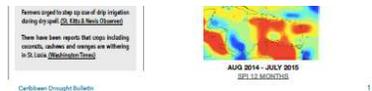
# Caribbean Drought

2013-2016



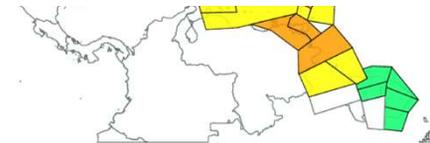
The 2013–16 Caribbean multiyear drought was most severe and extensive period of dry conditions in the Caribbean/Central American Region since at least 1950.

Appears to be related not only to El Niño–driven precipitation deficits, but also to temperature- driven increases in potential evapotranspiration



Records have shown that there has been less rainfall over successive years. This year Saint Lucia is starting with a water deficit... The conversion of water to evaporation... The water that we produce must be used sparingly... It's up to us... The water that we produce must be used sparingly... It's up to us... The water that we produce must be used sparingly... It's up to us...

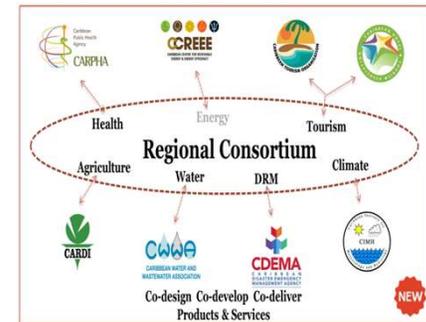
Mexico to help



# Building Awareness and Capacity of the Partner Community

## Supports interpretation and application of products and services

- Webinars with health and tourism communities in collaboration with Consortium and international partners
- CariCOF Stakeholder Forum - Dry Season (agriculture and water); Wet Hurricane Season (DRM); 2014 drought; 2015 extreme wet spells, coral reef threat;
- 2016 strong health focus, 2017 Heat products; 2018 sub-seasonal forecasts (IRI, Columbia University; NOAA)
- Drought monitoring, management and planning (NDMC, NOAA, OECS, CDEMA)
- Media – Dry Season CariCOF 2015; Special media event February 2016; Wet Season CariCOF 2017 (WMO, CLIMADATA).
- Support from EWISACTs Consortium



# CARIBBEAN DROUGHT BULLETIN

May 2019 | Volume V | ISSUE 12

## Announcement

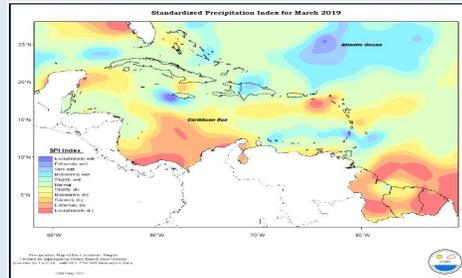
For short term drought that can impact agriculture, and flow in small rivers and streams, there is concern for most of the Caribbean except in the northwest in the vicinity of Cuba, The Bahamas, Jamaica and Cayman islands. For longer term drought that can impact groundwater, and large Reservoirs and rivers, concerns also extend to Jamaica and Cayman Islands. Most of the Caribbean should therefore closely monitor water resources and try to conserve as much as possible, at least until June/July.

## Month at a Glance

Conditions were mixed in the eastern Caribbean for the month of March. Trinidad, Tobago, Grenada, Saint Lucia, Antigua and St. Thomas were all normal or predominantly so; Barbados normal to slightly wet; St. Vincent very to extremely wet; Martinique slight to moderately dry; Dominica moderately dry; Guadeloupe slightly dry St. Kitts moderate to severely dry; St. Maarten severely dry; and St. Croix severe to extremely dry. Conditions in the Guiana's ranged from exceptionally dry in parts of southern Guyana and much of French Guiana to normal in northeastern Guyana. Aruba was slightly dry, but Curacao slight to moderately wet. Puerto Rico was normal to slightly dry, but Hispaniola ranged from normal in the west, south and east to very wet in north-western Dominican Republic. Jamaica was predominantly normal, with above normal rainfall in the southern and western extremities, and below normal in the northern extremities, but Grand Cayman was normal. Northern Bahamas was normal to moderately dry, while Belize was predominantly normal apart from the extreme north that was slightly dry and the extreme south that was slightly wet.

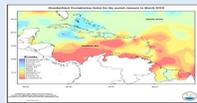
## Latest News

Drought affecting businesses in Guyana Region 9; Read more: <https://guyanatimesgy.com/region-9-drought-affecting-businesses-minister/>

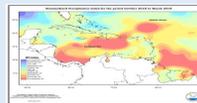


## January-February-March

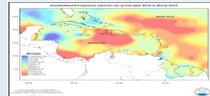
For the three month period, normal to below normal rainfall was experienced in the islands of the Caribbean. Trinidad was slight to severely dry; Tobago and Antigua moderately dry; Grenada slightly dry; Barbados severe to extremely dry; St. Vincent and Guadeloupe normal to slightly dry; St. Lucia and St. Kitts moderate to severely dry; Martin que extreme to exceptionally dry; St. Maarten severely dry; St. Croix severe to extremely dry; and St. Thomas normal. Conditions in the Guiana's ranged from exceptionally dry in northern Guyana and much of French Guiana to normal in northeastern and southern Guyana and western Suriname. Aruba was exceptionally dry, but Curacao moderately dry. Puerto was moderately dry to normal from northwest to southeast, but Hispaniola from slightly wet in the north to severely dry in eastern Dominican Republic and to slightly dry in southwest Haiti. Conditions in Jamaica ranged from moderately wet in the west to slightly dry in the north, but Grand Cayman very wet. Northern Bahamas was normal to moderately wet and Belize from severely dry in the east to normal to the north and south.



JAN2019- MAR2019  
SPI 3 MONTHS



OCT2018- MAR 2019  
SPI 6 MONTHS



APR2018- MAR2019  
SPI 12 MONTHS

## The Caribbean Drought & Precipitation Monitoring Network

The Caribbean Drought and Precipitation Monitoring Network is led by the Caribbean Institute for Meteorology and Hydrology (CIMH), the World Meteorological Organization's Regional Climate Centre (RCC) for the Caribbean. The Network was launched in January 2009 under the Caribbean Water Initiative (CARWIN) to support equitable and sustainable Integrated Water Resources Management.

The concept was born out of the need to mitigate and respond to the creeping phenomenon, drought. Drought and the general precipitation status is monitored at the regional scale. Efforts are being made to enhance drought monitoring at the national level.

## The Caribbean Climate Outlook Forum (CariCOF)

The CariCOF brings together climate experts and meteorological services in the Caribbean region on an operational basis to produce a monthly climate outlook. CariCOF interacts with sectoral users to assess the likely implications of the outlooks on the most pertinent socio-economic sectors. The Caribbean Institute for Meteorology and Hydrology (CIMH), in its role as WMO Regional Climate Centre, coordinates the CariCOF process. [Read more...](#)

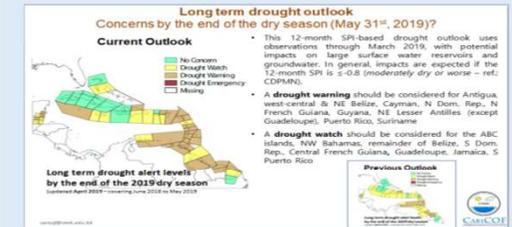
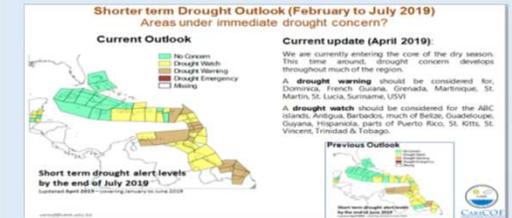
### For more information contact:

Mr. Adrian Trotman:  
[atrotman@cimh.edu.bb](mailto:atrotman@cimh.edu.bb)

Mrs. Lisa Kirton-Reed  
[lkreed@cimh.edu.bb](mailto:lkreed@cimh.edu.bb)

Website: [CDPMN Drought Monitor](#)

## Drought Outlook for the End of July CariCOF's Drought Alert Map



## Current Drought Situation

- Current drought situation (up to the end of March 2019):**
  - Barbados, Martinique, St. Lucia, USVI have seen long term drought developing.
  - Shorter term drought is seen in northern St. Kitts.
- Shorter term drought situation (by end of July 2019):**
  - Shorter term drought is evolving in Dominica, French Guiana, Grenada, Martinique, St. Martin, St. Lucia, Suriname, USVI.
  - Shorter term drought might possibly develop in the ABC islands, Antigua, Barbados, Much of Belize, Guadeloupe, Guyana, Hispaniola, parts of Puerto Rico, St. Kitts, St. Vincent, Trinidad and Tobago.
- Long term drought situation (by end of May 2019):**
  - A weak El Nino is expected to contribute to reduced rainfall up until May.
  - Long term drought is evolving in Antigua, west-central and NE Belize, Cayman, N Dom Rep, N French Guiana, Guyana, NE Lesser Antilles (except Guadeloupe), Puerto Rico, Suriname.
  - Long term drought might possibly develop in the ABC islands, NW Bahamas, remainder of Belize, S Dom Rep, central French Guiana, Guadeloupe, Jamaica, S Puerto Rico.

We advise all stakeholders to keep monitoring drought and look for our monthly updates.

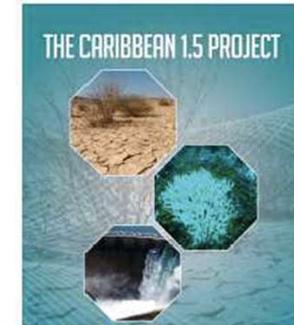
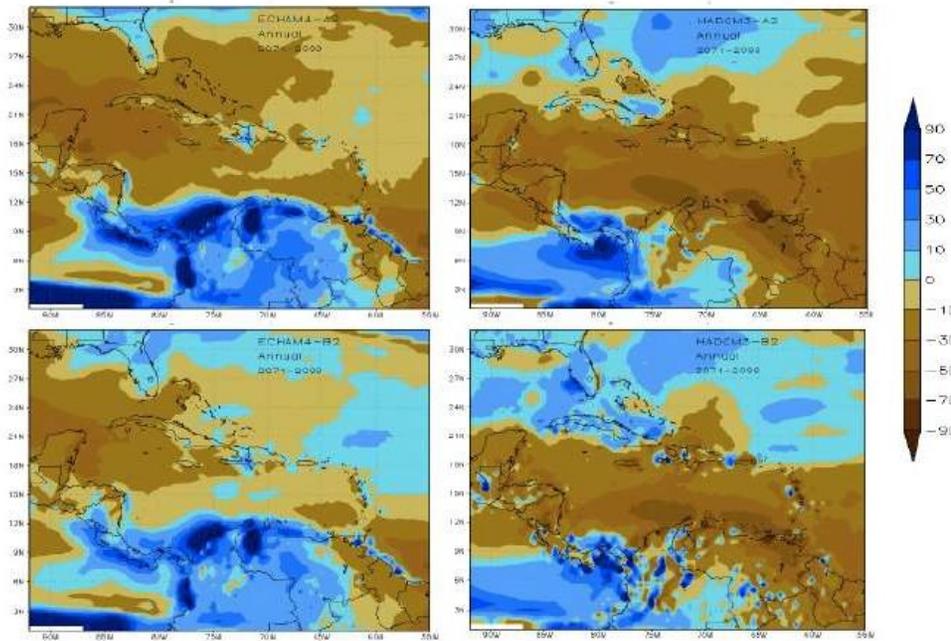
Drought outlook available for download [here](#)

	<b>Trend</b>	<b>Implication</b>	<b>Feature</b>
<b>Present Climate</b>	High temperatures Variable Rain More intense storms Rising sea levels	Emergence of a new climate regime	<b>Unfamiliarity</b>
<b>Future Climate</b>	Higher temperatures Drying trend Intense extremes Higher sea levels	Entrenchment of the new climate regime	<b>Unprecedented</b>

## **Critical Transitions**

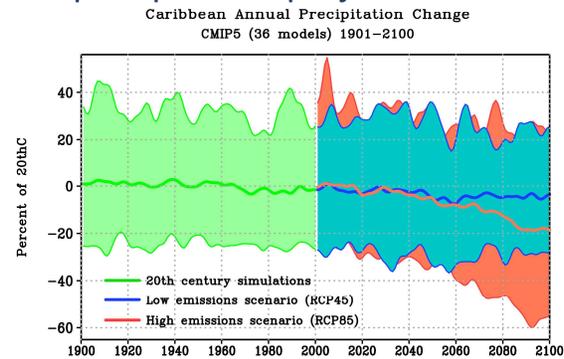
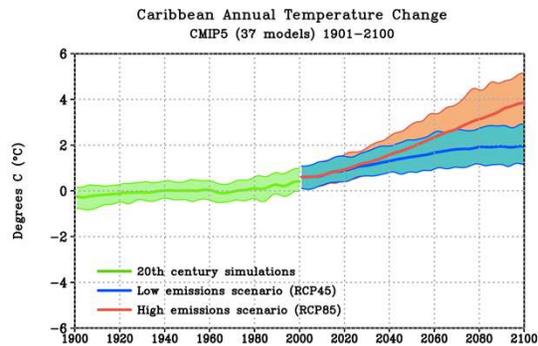
The 2018 Caribbean 1.5 project reported that 2.0 degrees will result in even further significant changes (over 1.5) in regional climate which take the region closer to climates it has not experienced to date

**Net Drying trend**



Mean changes in the annual rainfall for 2070-2100 with respect to 1961-1989 as simulated by regional climate models. 15-20%

### Caribbean annual temperature and precipitation projections CMIP5



# Climate Services Information System (CSIS) and User Interface Platform (UIP) Mechanisms

## -critical to advancing climate services

- “...to promote effective decision-making with respect to climate considerations by making sure that the right information, at the right time and in the right amount, is delivered, understood, and used”

Engaging...

- Users can make their voices heard through these mechanisms and make sure climate services are relevant to their needs.



Means for communication, awareness building, education, and feedback.



Stakeholder meetings bring meteorologists and climatologists and the user-community together to discuss climate forecasts and other information; and provide feedback. Builds trust and understanding

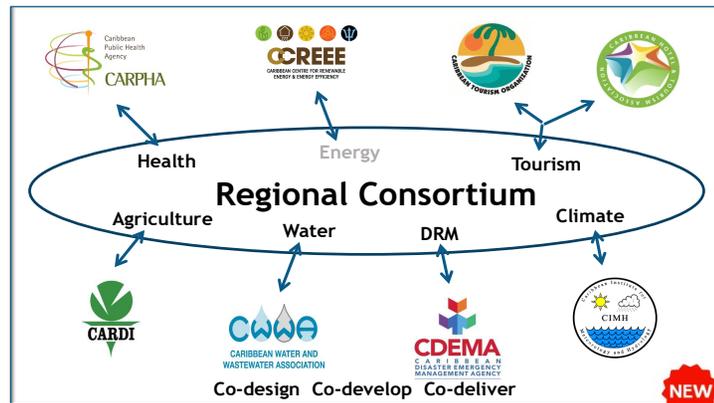
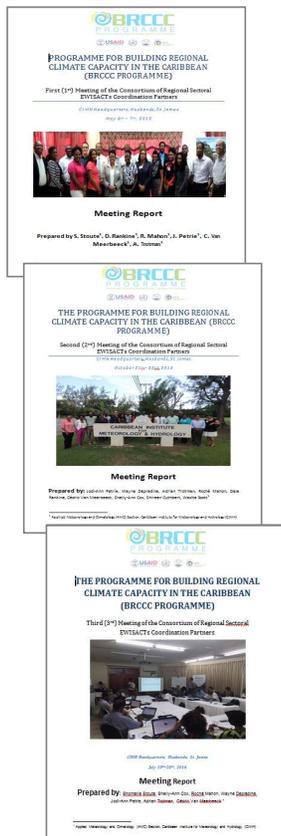
Forums for individual or multiple sectors- Regional and National  
**CariCOF** – Wet/Hurricane and Dry Season  
 NCOFs in – Guyana, Trinidad and Tobago, Belize, Suriname

ICT – portals, help desks  
 Portal of CariSAM - CARDI

# Early Warning Information Systems Across Climate Timescales

## EWISACTs

The Consortium is a key regional mechanism to champion the design, development and delivery of tailored climate products and services in the agriculture and food security, disaster risk management, energy, health, tourism and water sectors.



### Co-development of sector-specific climate indices

- Facilitates broader dialogue and sustained engagement with regional and national stakeholders;
- Facilitates the identification and sharing of textual and georeferenced sectoral datasets;
- Facilitates the identification and sharing climate-related impact data;
- Supports research that examines associations between climate and relevant sectoral productivity outcomes; and
- Promotes the dissemination of climate information.



CTO and CHTA sign the LoA, September 16th, 2016



CWWA signs the LoA, October 26th, 2016



CARDI and CDEMA sign the LoA, December 6th, 2016



CARPHA and CIMH sign the LoA, April 26th, 2017

# Caribbean Public Health Agency



## CARPHA Partners



Established in 2013: Integrating 5 regional agencies

