Gridded Aquifer Recharge Estimates for the Puerto Rico South Coast Aquifer

Eric W. Harmsen

Research Assistant Natalia López Adames

Research Assistant Niwde Rivera Maldonada

Department of Agricultural and Biosystems Engineering

UPR-Mayagüez

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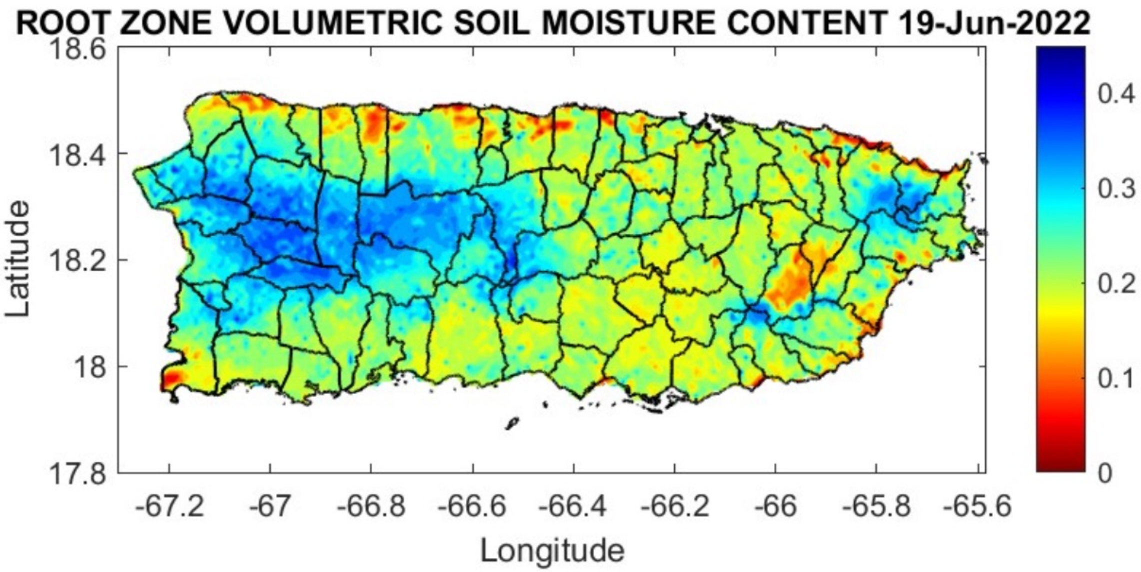
Objectives

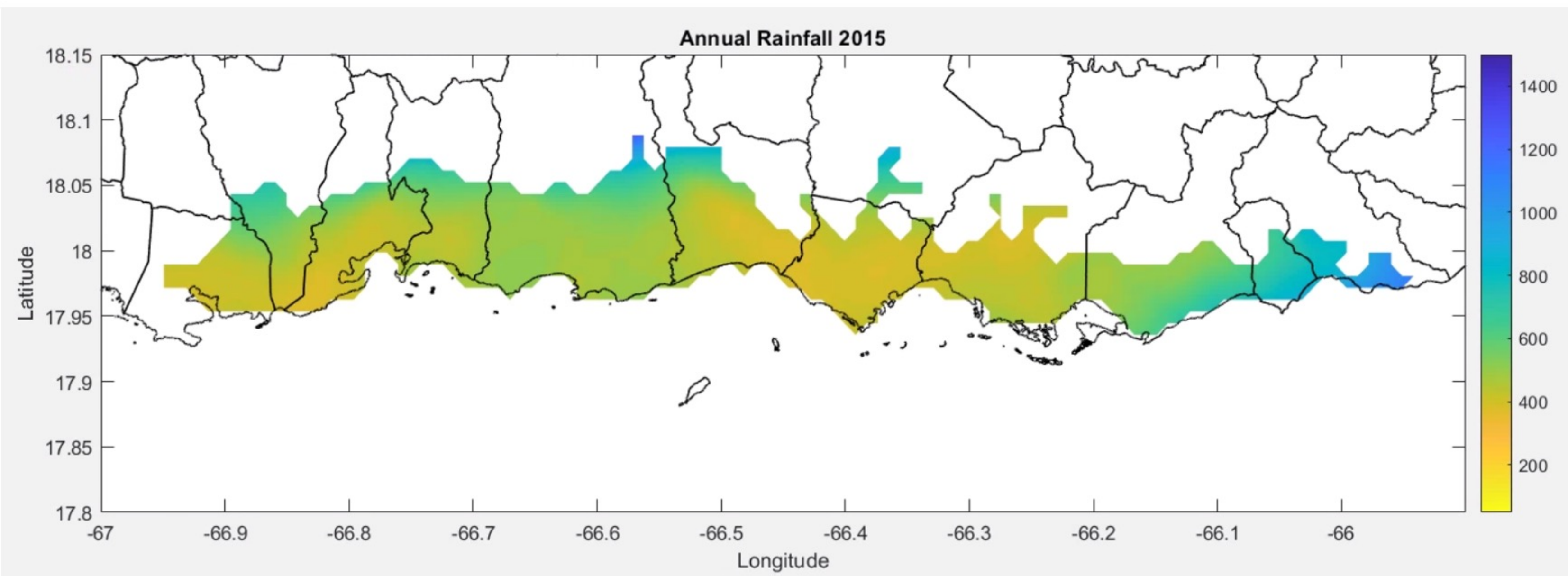
1. Describe a methodology for estimating the historical, current and future rainfall recharge in the South Coast Aquifer (SCA) Area
2. Present results of an operational model that has been producing recharge estimates in the SCA area since 2009.
3. Present results of an analysis of high-resolution downscaled GCM data to estimate historical and future rainfall recharge in the SCA area.
4. Discuss implications and Recommendations

The Current Situation

CURRENT DROUGHT MONITOR, JUNE 14, 2022



SOUTH COAST AQUIFER (SCA) AREA



Methods

- A gridded water and energy balance model (GOES-PRWEB) was used to evaluate two downscaled global circulation models (GCMs) for the SCA area.
- GCMs include:
  - French National Center for Meteorological Research (CNRM)
  - Climate Earth System Model (CESM)
- Downscaling to a 2 km spatial resolution was accomplished using the Weather Research Forecast (WRF) Model (Bowden, et al., 2020)
- Downscaling was performed for 1986-2005 and 2041-2060.

Methods – cont.

- The downscaled monthly rainfall data was bias corrected using monthly rainfall obtained from NOAA's Advanced Hydrologic Prediction Service for the period 2009-2020.
- Irrigation was included at the location of farms that use irrigation.
  - Irrigation was simulated by assuming that the soil water was maintained at 85% of the Total Available Water (TAW) within the root zone.

Water Balance Model GOES-PRWEB

$$SM_2 = Precip - ET_a - RO - DP + SM_1$$

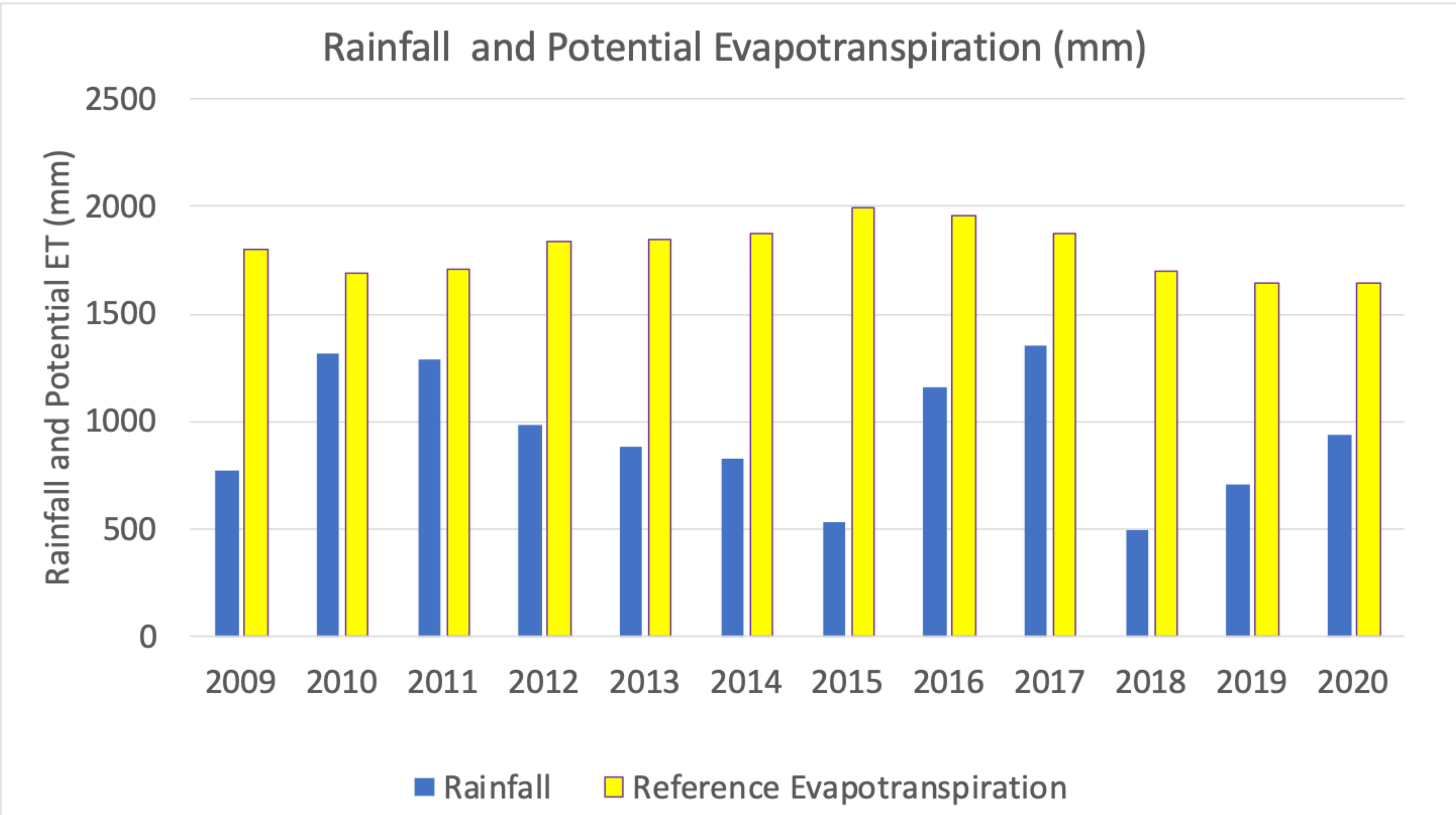
Precip =precipitation
ETa = actual evapotranspiration
RO = surface runoff
DP = deep percolation or aquifer recharge
SM = soil moisture content
1 and 2 represent time 1 and time 2

Gridded results – 1 km spatial resolution

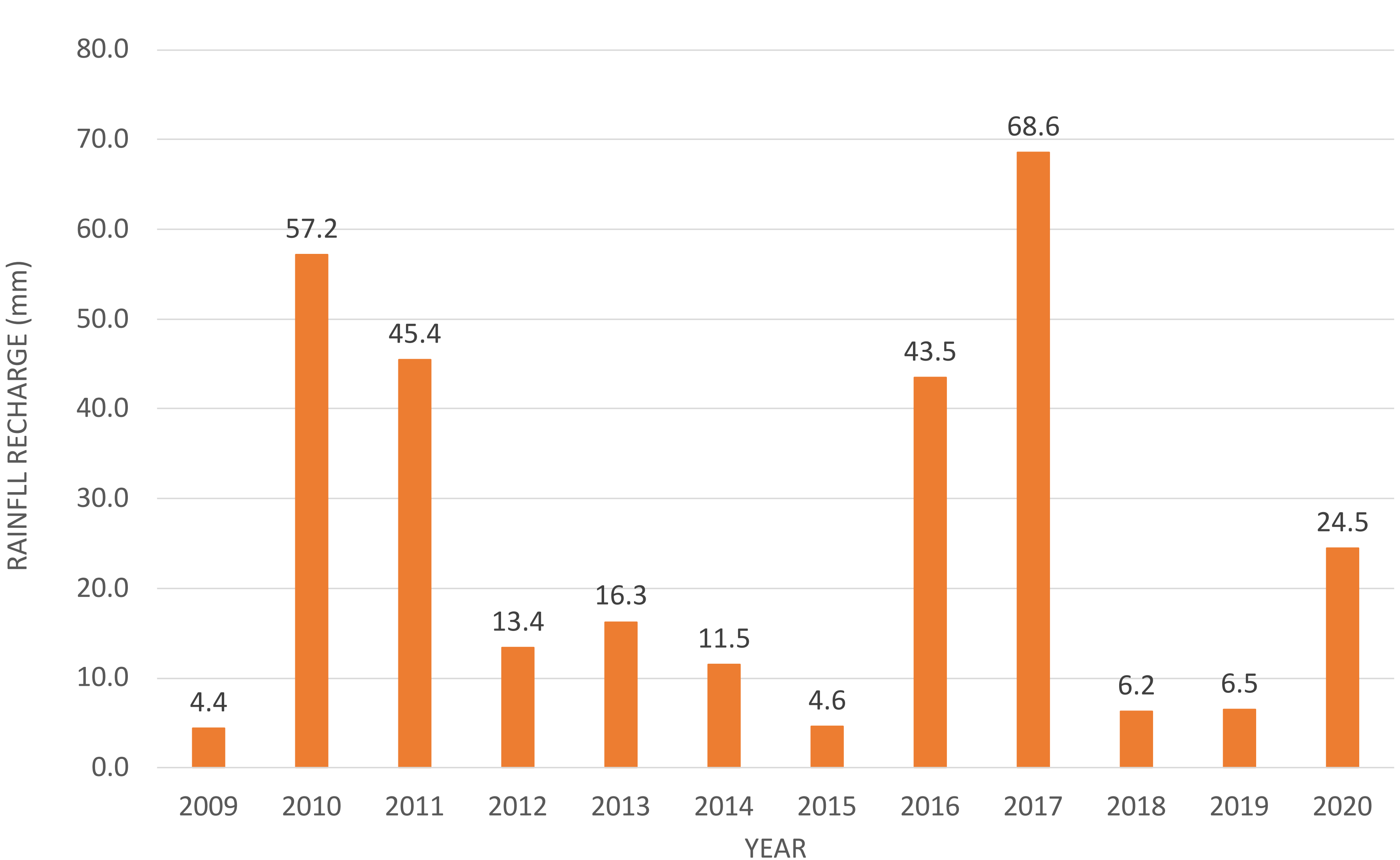
Results for 2009-2020

Operational GOES-PRWEB

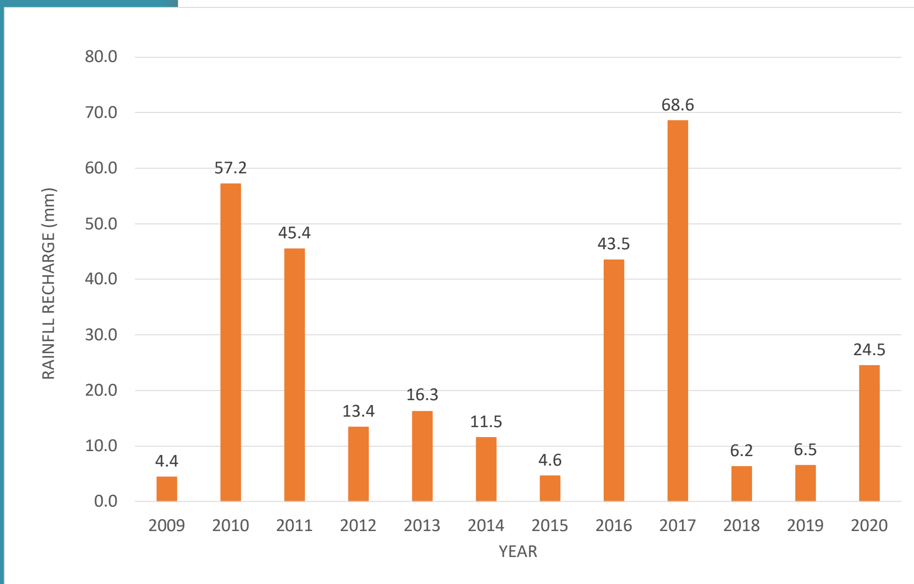
Rainfall and Potential Evapotranspiration 2009-2020

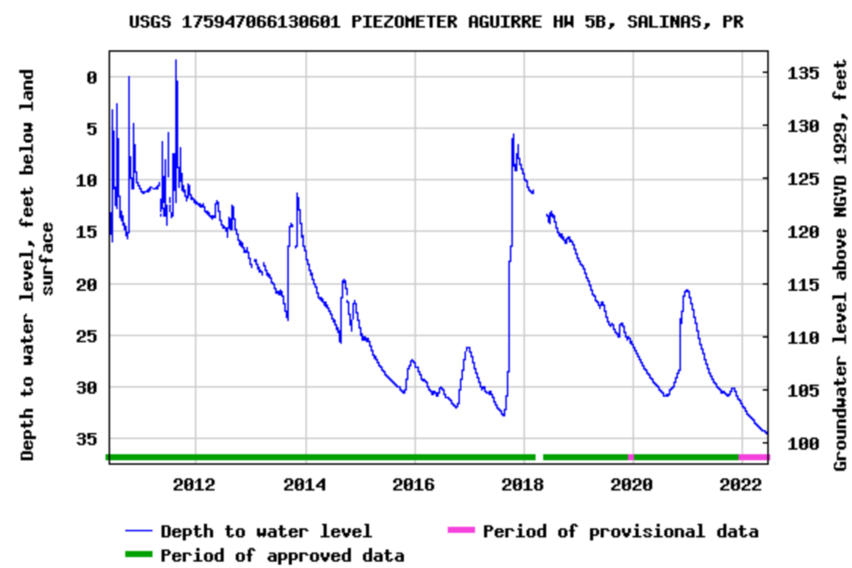


Average Annual Rainfall Recharge (mm)



Comparison of Rainfall Recharge Estimates with Measured Groundwater Levels USGS Aguirre Well 5B, Salinas, PR





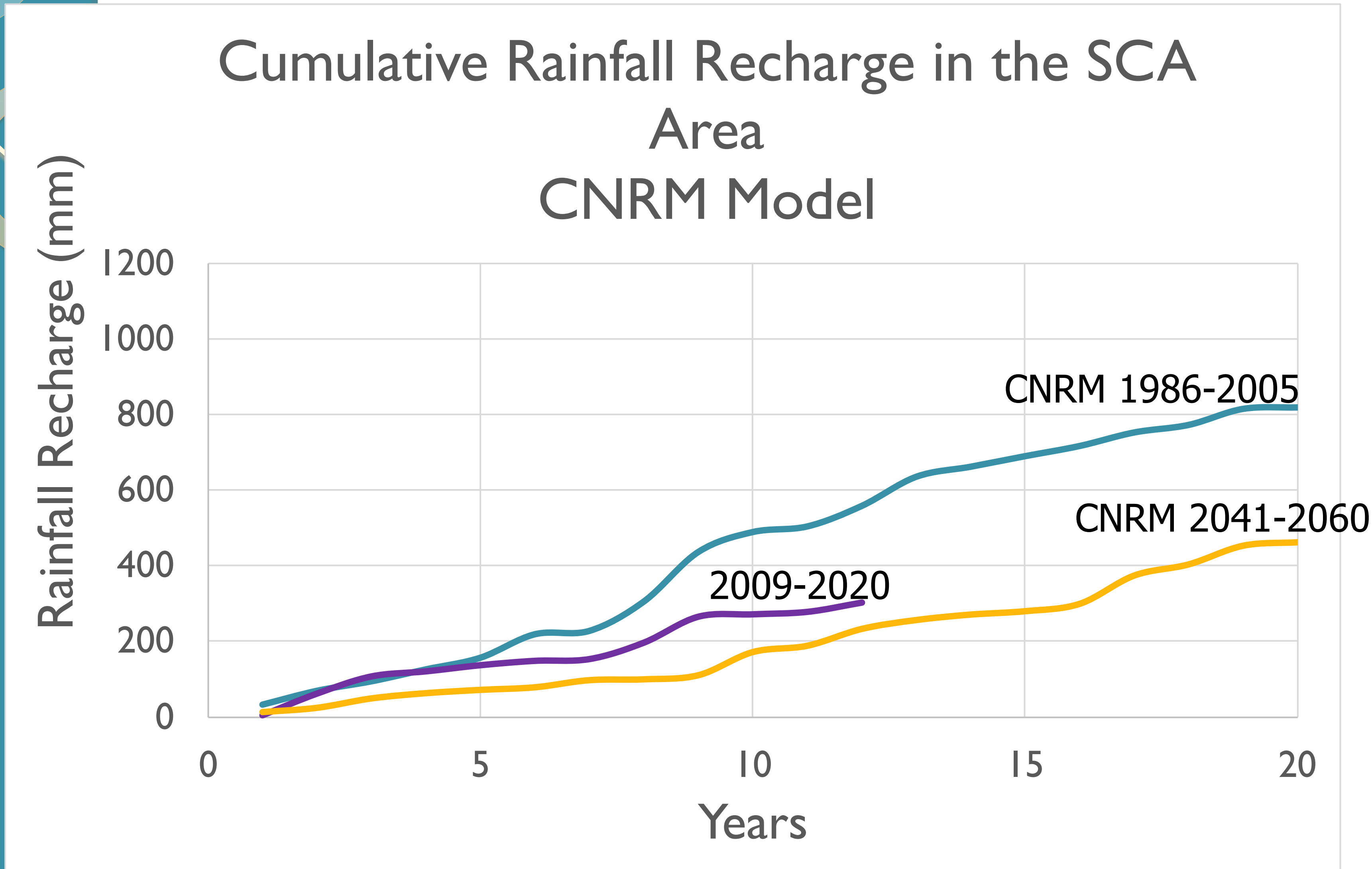
Selected Results of the Downscaled Climate Modeling in the SCA Area

Average Annual Totals for Selected Water Balance Components for the Two Downscaled Models (mm)

	CNRM Model		CESM Model	
	1986-2005	2041-2060	1986-2005	2041-2060
Rainfall	1015	818	1079	858
Rainfall Recharge	**41**	**24**	**54**	**33**
Reference ET	1690	1795	1965	2066

Average Annual Totals for Selected Water Balance Components for the Two Downscaled Models (Values are in %)

2041-2060 minus 1986-2005		
	CNRM	CESM
Change in Rainfall	-13.0	-16.7
Change in Rainfall Recharge	**-41.3**	**-38.8**
Change in Reference ET	6.3	5.2


Cumulative Rainfall Recharge in the SCA Area
CNRM Model
Rainfall Recharge (mm)
1200
1000
800
600
400
200
0
0
5
10
15
20
Years
CNRM 1986-2005
CNRM 2041-2060
2009-2020

Implications and Recommendations

- According to projections, rainfall and rainfall recharge will decrease in the future. Irrigation requirements will increase, and cultivated land may increase in the future as a matter of food security.

- Currently, the majority of irrigation water comes from groundwater in the SCA area (56%). A larger share of irrigation water may have to come from surface water sources.

Implications and Recommendations

- There is surface water available, but the Puerto Rico water authority (AAA) depends on the excess water. Conflicts between domestic and irrigation water supply will increase in the future.

- Citizens should be encouraged to capture rainfall to reduce the demand for the AAA to pump from the SCA and to reduce its dependency on Irrigation District water.

Implications and Recommendations

- Pumping of water from the South Coast Aquifer during years with low recharge will result in lower groundwater water levels and increase the potential for saltwater intrusion.

- For this reason, groundwater pumping from the South Coast Aquifer needs to be managed carefully and projects that promote additional aquifer recharge, such the DRNA/FEMA and NRCS projects, should be encouraged.

Implications and Recommendations

- How can we use less water?
  - Farmers in the Irrigation Districts get water essentially for free.
  - How are they managing their irrigation water?
  - Should there be laws that require farmers to use water efficiently?

- Where can we get more water?
  - Groundwater from the interior of the island?
  - Groundwater from NW Puerto Rico?

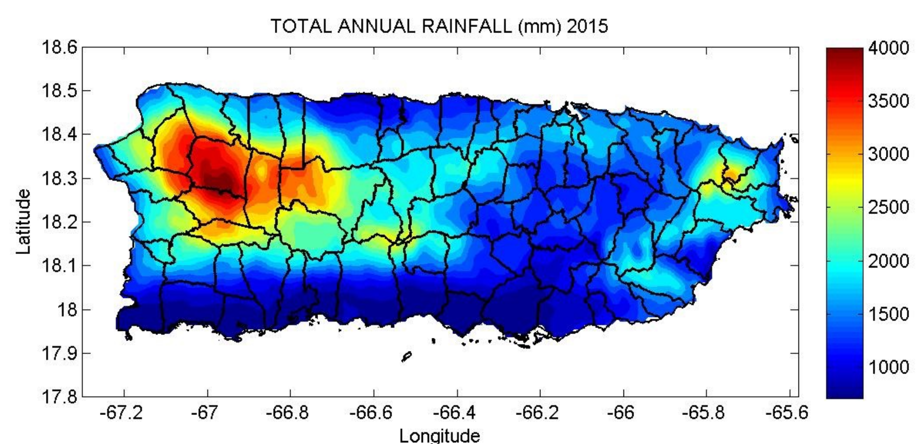
Comparisons of Rainfall in NW PR for drought and non-drought years

Weather Station	Avg. rain drought yrs.	Avg. rain non-drought yrs.
Coloso	72.88	77.48
Hacienda constanza	68.7	69.51
Maricao fish hatchery	81.92	98.62
Mayaguez city	62.31	67.44
Mayaguez airport	62.44	78.24
San sebastian 2 wnw	86.26	91.24

Compared average of:

17 Drought Years

94 Non-Drought Years



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