Monitoring Drought Conditions in the Navajo Nation Using NASA Earth Observations

NASA DEVELOP Climate project
The Navajo Nation

12 EPA lvl. IV Ecoregions

Semi-arid highlands

Forested Mountains

Drought in the Navajo Nation
Decreasing Precipitation

70,000+ residents without water

Increasing Temperatures

Drought in the Navajo Nation

Utah

New Mexico

Arizona
### Objectives

**Issues in Drought Monitoring**

- NASA DEVELOP & Navajo Nation
- Five Agencies
- Utah
- Arizona
- New Mexico
- Three Climate Divisions

**Spatially inaccurate climate data**

**Inadequate rain gauge coverage**

- Decreasing Precipitation
- Increasing Temperatures
- 70,000+ residents without water

**Standardized Precipitation Index**

\[ \text{SPI} = \frac{X_i - X}{\sigma} \]

- \( X_i \): accumulated precipitation over the months of interest
- \( X \): historical avg. accumulated precipitation over the months of interest
- \( \sigma \): standard deviation

**NASA DEVELOP & Navajo Nation**

Term 1

**Five Agencies**

**Three Climate Divisions**
Tool Data: Accumulated Monthly Precipitation

NASA DEVELOP & Navajo Nation

Historical Geodatabase

SPI Methods

Tool

1901 Produces an average SPI over an user specified area

Compare drought intensity over time 2014
Tool Data: Accumulated Monthly Precipitation

PRISM
Parameter-elevation Relationships on Independent Slopes Model

TRMM
Tropical Rainfall Measuring Mission

GPM
Global Precipitation Measurement

1901

2014
Tool Data: Accumulated Monthly Precipitation

Precipitation Rasters

PRISM

TRMM

SPI Algorithm

Precipitation Pixels

SPI Pixels

SPI Rasters

2014
Drought Severity Assessment
Decision Support Tool

User’s Manual

NASA DEVELOP Program
The NASA DEVELOP Climate Team at the Ames Research Center created this tool during the summer of 2015. The five group members are Cheryl (Team Leader), Michael, Anton, Vickie, Sophia. We are all pretty cool.

Tools
This project was the conclusion of a two-term project focusing on water resources in the NN and the role of NASA Earth Observations data in water management and drought mitigation. This term focused on creating an SPI tool in the statistical program R to allow the NN to generate SPI values specific to chosen boundaries within the Nation.

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Results of Tool
by Classification
Results of Tool by Agency

Jan 2014 Agency SPI Values:
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet

Feb 2014 Agency SPI Values:
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet

March 2014 Agency SPI Values:
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet
Results of Tool
by Chapter

Dec 2014
Chapter SPI Values
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet

Jan 2014
Chapter SPI Values
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet

Feb 2014
Chapter SPI Values
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet

March 2014
Chapter SPI Values
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet
Recap

Using data from 3 different sources
Benefits of Research

- Calculate SPI-specific to the Navajo Nation
- Produce monthly drought reports with current and historical data
- Allocate drought dollars in most impacted areas
Future Work

- **Continue** building partnerships with Navajo Nation

- **Applications** to other tribal and rural communities

- **Understanding drought regime changes**
Acknowledgements

Advisors
Dr. Jay W. Skiles, NASA Ames
Dr. Venkat Lakshmi, University of South Carolina
Dr. Juan Torres-Peres, NASA Ames

Partners
Navajo Nation Department of Water Resources: Water Management Branch
   Teresa Showa :: Robert Kirk :: Maurice Upshaw
   Crystal Lynn Tulley-Cordova :: Carl McLennan

Navajo Technical University
   Ramsey Seweingyawna

DEVELOP Staff
NASA DEVELOP National Program
   Clayton Sodergren :: Amber Brooks :: Chippie Kislik :: Andrew Nguyen

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Thank you!
Results of Tool by Agency

April 2014 Agency SPI Values
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet

May 2014 Agency SPI Values
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet

June 2014 Agency SPI Values
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet

July 2014 Agency SPI Values
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet
Results of Tool by Chapter

April 2014
Chapter SPI Values
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet

May 2014
Chapter SPI Values
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet

June 2014
Chapter SPI Values
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet

July 2014
Chapter SPI Values
- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet
Results of Tool by Classification

April 2014
SPI Value
- < -1.99
- -1.99 to -1.50
- -1.49 to -0.99
- -0.99 to 0.99
- 1.0 to 1.49
- 1.50 to 1.99
- > 1.99

May 2014
SPI Value
- < -1.99
- -1.99 to -1.50
- -1.49 to -0.99
- -0.99 to 0.99
- 1.0 to 1.49
- 1.50 to 1.99
- > 1.99

June 2014
SPI Value
- < -1.99
- -1.99 to -1.50
- -1.49 to -0.99
- -0.99 to 0.99
- 1.0 to 1.49
- 1.50 to 1.99
- > 1.99

July 2014
SPI Value
- < -1.99
- -1.99 to -1.50
- -1.49 to -0.99
- -0.99 to 0.99
- 1.0 to 1.49
- 1.50 to 1.99
- > 1.99
Navajo Nation Drought Monitoring Tool workshop

Introducing RAINN

Vickie Ly
Agenda

Introductions

Tool -- Installation
- Data
- Backend
- Frontend

Tool - Testing
- Troubleshooting
- Bugs
- Feedback
Index of /pub/org/chg/products/CHIRPS-2.0/global_monthly/

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Methodology workflow to calculate SPI rasters
RAINN

dRought Assessment Index for monitoring precipitation
Let’s try it!

- Make sure R 3.2.4 is installed
- Download file and save onto C drive
- Open Rstudio
- Open manual
Installation

> setwd("C:/developnn")
> require(shiny)
> runApp()
Test and Run
Troubleshooting

- Questions?
- Bugs?
- Feedback?
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