Monitoring Drought Conditions in the Navajo Nation Using NASA Earth Observations

NASA DEVELOP Climate project

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The Navajo Nation

- 12 EPA lvl. IV Ecoregions
- Semi-arid highlands
- Forested Mountains
Drought in the Navajo Nation

- Decreasing Precipitation
- Increasing Temperatures
- 70,000+ residents without water
Issues in Drought Monitoring

Standardized Precipitation Index $\left( \frac{X_i - X}{\sigma} \right)$

- $X_i$ = accumulated precipitation over months of interest
- $X$ = historical avg. accumulated precipitation over months of interest
- $\sigma$ = standard deviation

Utah

Arizona

New Mexico

Five Agencies

NASA DEVELOP & Navajo Nation

Inadequate rain gauge coverage

Spatially- inaccurate climate data

Decreasing Precipitation

70,000+ residents without water

Increasing Temperatures

Objectives

Three Climate Divisions

Term 1

Inadequate

Spatially

Inaccurate

Climate Data

Decreasing

Precipitation

70,000+ residents

Without Water

Increasing

Temperatures

Inadequate

Rain Gauge

Coverage

Objectives
Tool Data: Accumulated Monthly Precipitation

NASA DEVELOP & Navajo Nation

Historical Geodatabase

SPI Methods

Tool

1901
Produces an average SPI over an user specified area

2014
Compare drought intensity over time

Term 1

Term 2
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

PRISM

TRMM

SPI Algorithm

Precipitation Rasters

Precipitation Pixels

SPI Rasters

SPI Pixels

1901

2014
Drought Severity Assessment
Decision Support Tool

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.

Acknowledgements
Thanks to Ramsey Sewinggawma of the Navajo Technical University for communication and coordination of incoming Navajo Technical University students, to Maurice Upshaw, Robert Kirk, Teresa Showa and Jason John of the Navajo Department of Water Resources: Water Management Branch for providing project guidance and Navajo Nation in-situ GIS data.
Results of Tool by Classification

Dec 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

Jan 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

Feb 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

March 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
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

This material is based upon work supported by NASA through contract NNL11AA00B and cooperative agreement NNX14AB60A.
Thank you!
Results of Tool
by Agency

April 2104
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 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
Methodology workflow to calculate SPI rasters.
RAINN

dRought AAssessment IIndex 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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