IMTA
INSTITUTO MEXICANO DE TECNOLOGÍA DEL AGUA

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Model Implementation of a Drought Persistance Monitor for Water and Agriculture Sectors

Internal Workshop of the WG-CLIMATE of ICID

Agricultural water management under the climate change

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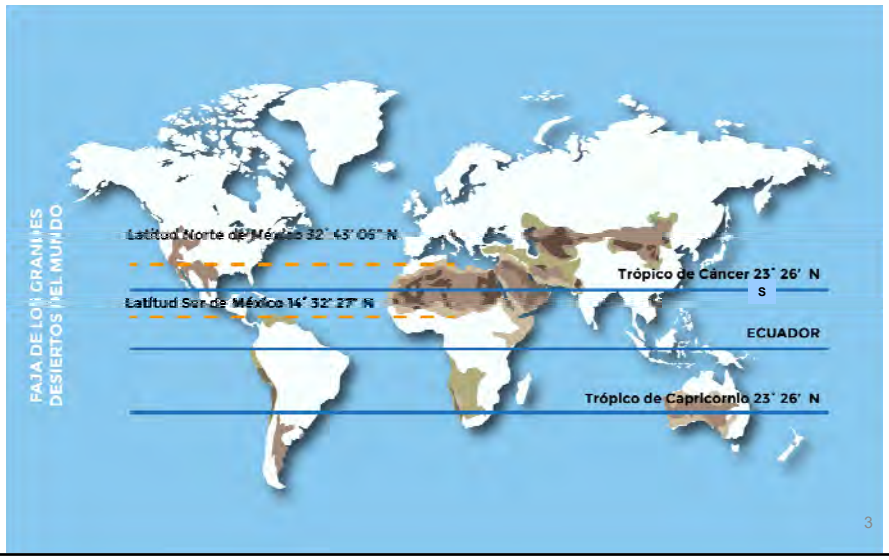
"A drought is defined as a sustained period of below normal precipitation such that the available water in the reservoirs, streamflows, aquifers and external sources are not enough to fulfill the user needs"

Fick et al, 1900

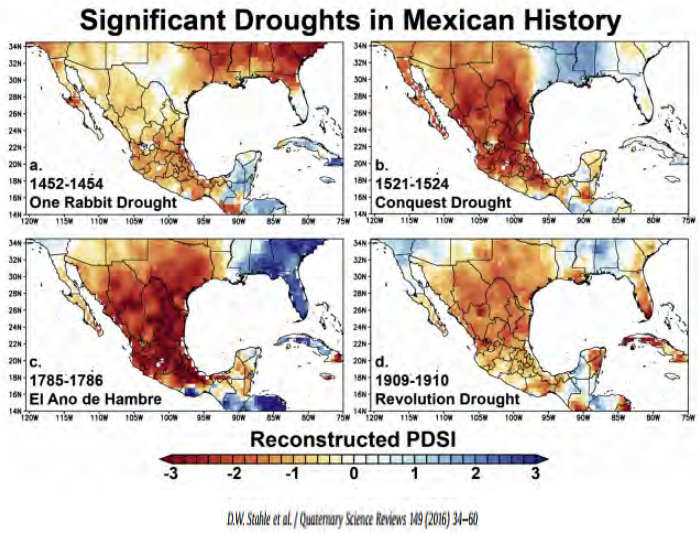
Due to its geographical location Mexico is vulnerable to climate impacts



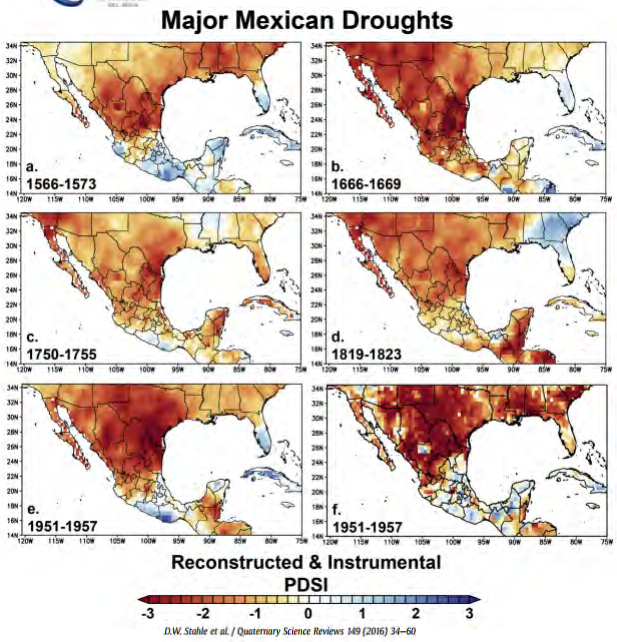
Droughts in Mexican History

- Drought is a recurrent and persistent natural phenomenon.
- Some theories favor the disappearence and migration of the Mayan and Teotihuacan cultures due to droughts.
- During the Colony (1521-1821) several food crises occurred due to droughts.
- Drought was one of the main causes of historical events like The Independence in 1810, and the Mexican Revolution in 1910.

The reconstructed Palmer Drought Severity Index (PDSI) with tree ring input data describes important historical events associated to the presence of droughts.



Intense Droughts in Mexico



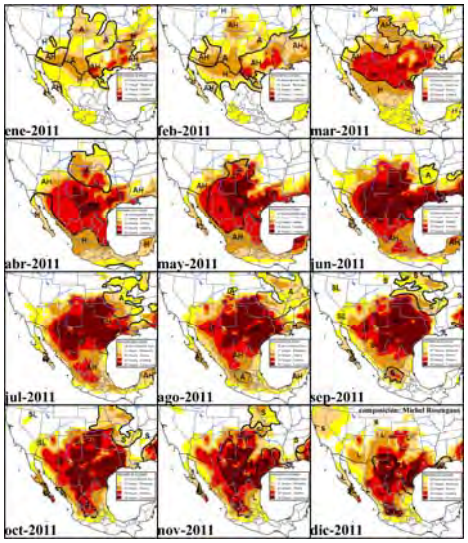
The most severe event according with tree ring data and direct observations occurred around 1950 and was concentred in northern Mexico.

D.W. Stahle et al. / Quaternary Science Reviews 149 (2016) 34–60

Drought in 2011

86% of the national territory was affected by some degree of drought

2011 was the 3th driest year from the last 70 years.



Ways to measure drought

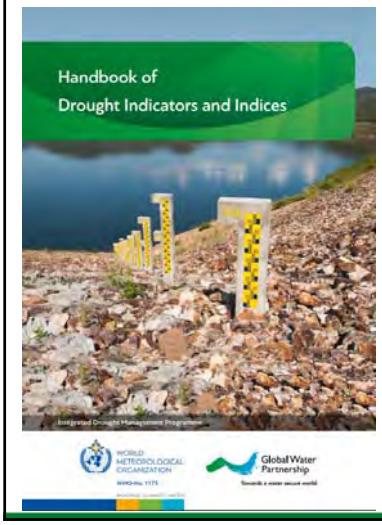
Drought indices are essentially tools for the characterization and monitoring of droughts. Basically use climatic functions and allow the estimation of climatic anomalies as well as severity, frequency and duration.

Its usefulness allows to communicate to a wider audience (non specialized) with a comprehensive information which considers the severity of drought episodes.

(Tsakiris et al., 2007a).

Handbook of Drought Indicators and Índices

Integrated Drought Management Programme



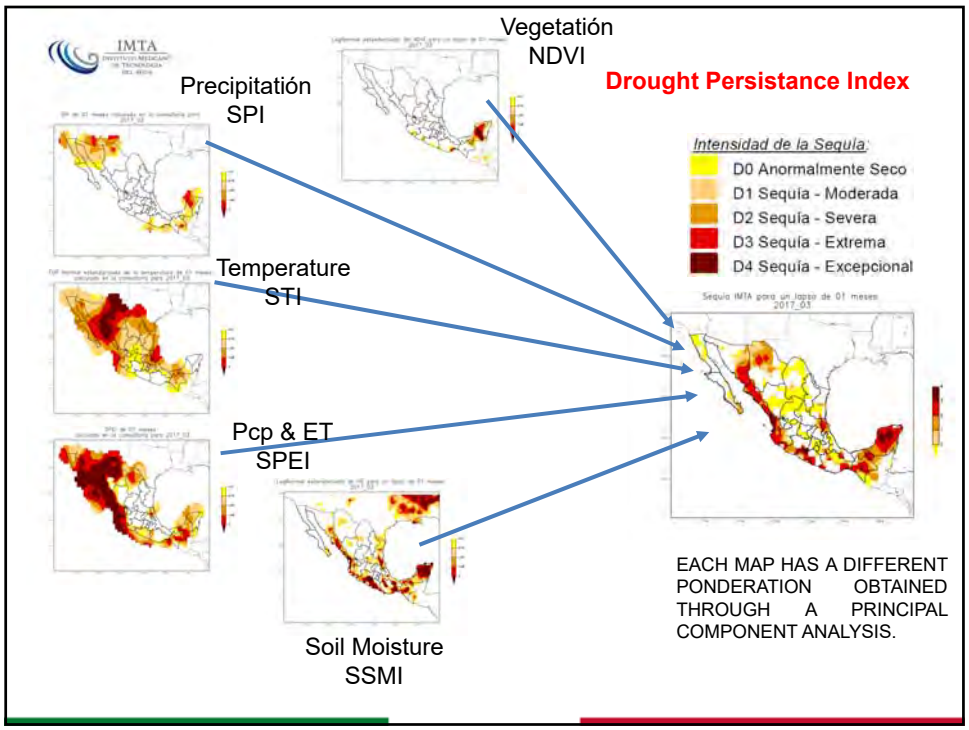
Describes índices that classify type and use, grouped as:

a) Meteorology (23)
b) Soil Moisture (4)
c) Hidrology (8)
d) Remote sensing (10)
e) Combined/Modeled (5)

IMTA recently developed the "Drought Persistance Index" using as input:

1) **Standardized Precipitation Index**
2) **Standardized Temperature Index**
3) **Standardized Soil Moisture Index**
4) **Standardized Vegetation Index**
5) **Standadized Precipitation-Evapotranspiration Index**

Each one is computed for different time periods and represents the cummulative probability for that given period, as well as the duration, intensity and magnitude of dry spells.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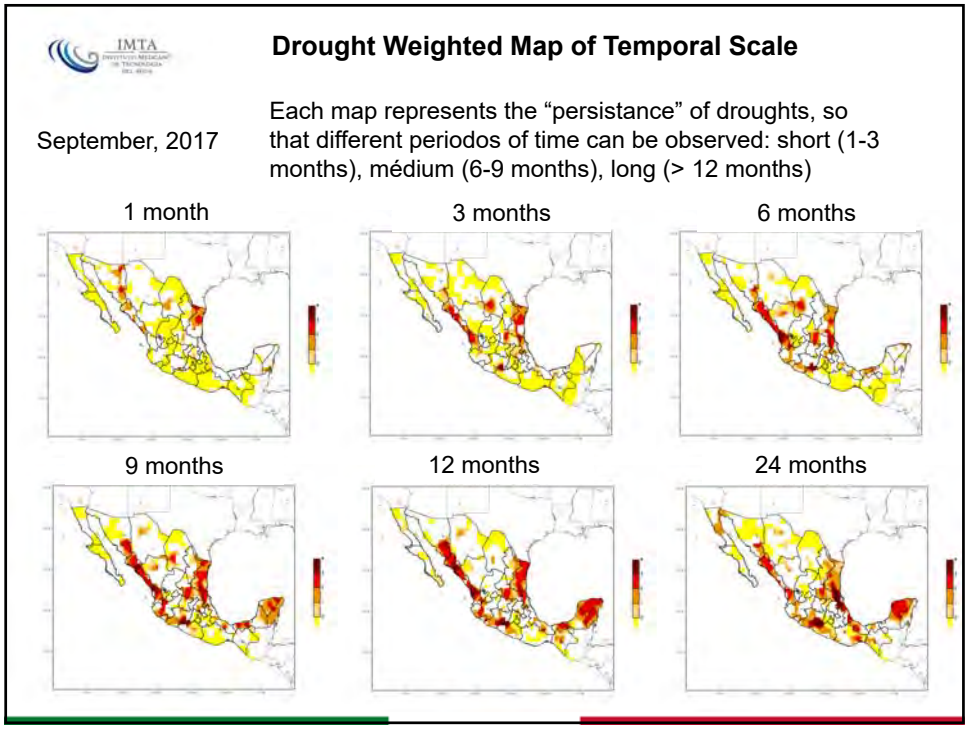
Vegetatión
NDVI
Precipitatión
SPI
Drought Persistance Index
Intensidad de la Sequía
D0 Anormalmente Seco
D1 Sequía - Moderada
D2 Sequía - Severa
D3 Sequía - Extrema
D4 Sequía - Excepcional
Temperature
STI
Pcp & ET
SPEI
Soil Moisture
SSMI
EACH MAP HAS A DIFFERENT PONDERATION OBTAINED THROUGH A PRINCIPAL COMPONENT ANALYSIS.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Drought Weighted Map of Temporal Scale
September, 2017
Each map represents the “persistance” of droughts, so that different periodos of time can be observed: short (1-3 months), médium (6-9 months), long (> 12 months)
1 month
3 months
6 months
9 months
12 months
24 months

Improvement process to the system

To enhance both the spatial and time resolution, is is being incorporating data from satellite platforms.

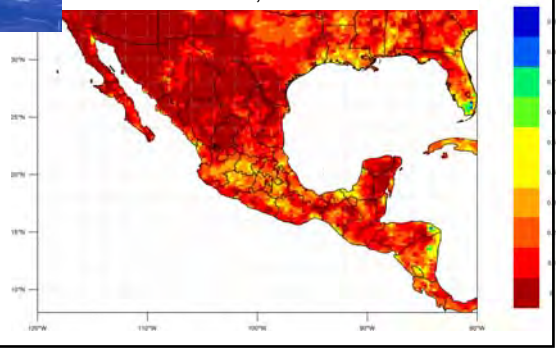
- ✓ Soil Moisture through the satellite Soil Moisture and Ocean Salinity (SMOS) from the European Spatial Agency.
- ✓ Precipitation through the Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS).
  - Rainfall estimation based on infrared band and ground corrected.
  - Spatial resolution: 0.05 deg (~ 5km)
  - Temporal resolution: daily
  - From 1981 to date
- ✓ Starting to obtain Surface Temperature from the new platform GOES-16.
- ✓ It is required a longer calibration process, so adequate weights can be adjusted.

NDVI obtained from MODIS satellite is already incorporated.

Soil Moisture Observing Satellite
SMOS

- From the European Spatial Agency.
- Soil Moisture and Oceanic Salintiy.
- SM data calibrated.
- Polar orbit – it covers the whole country in aprox. 72 hours.

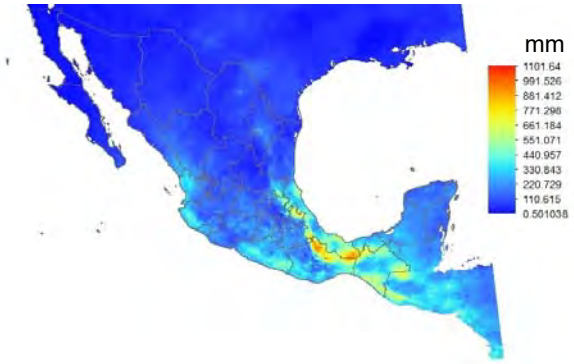
Junio, 2017



Climate Hazards Group with Stations
CHIRPS

Quasi-global data base 50°S-50°N (with all longitudes), starting in 1981 to date, CHIRPS satellite imagery with a spatial resolution of 0.05° (~ 5km) corrected with surface stations to create gridded rainfall data usefull for a number of purposes.

Accumulated rainfall for September, 2017



New Generation of Satellites

Geostationary Operational Environmental Satellite – R series

GOES-16

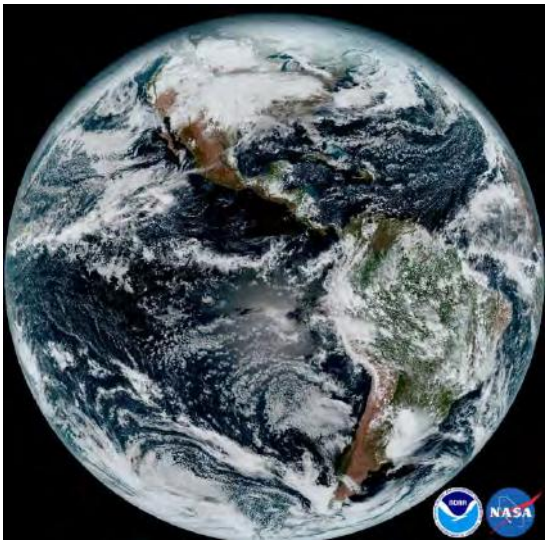
Almost ready to full operational

Sensor Advanced Baseline Imager (ABI)

16 spectral bands (compared with 5 on the previous sensor), three times more data available.

34 variables available, among those Surface Temperature.

31 Under process, among those NDVI.



Conclusiones

- **Due to the increasing lack of surface data, satellite information is the tool of the future for drought monitoring.**
- **The system applies for the water and agricultura sectors but can be adjusted to other users. Even in the context of climate change. It is not recommended to incorporate many variables to serve a wide range of different users.**
- **Asigned weigths to the 5 layers have different value obtained from the principant component analysis. Are the ones which requiere continous calibration.**
- **Working on a related scheme to forecast droughts. Coupled hydro-climate models may be a possible solution.**

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Gracias