Introduction/Background

- A reliable drought monitoring system allows to identify regions affected by these phenomena so that early response measures can be implemented (Wilhite, 2000).
- Drought monitoring systems around the world have taken advantage of global hydrometeorological datasets derived from remote sensing tools (Hao et al., 2014; Sepulcre-Canto et al., 2012; Sheffield et al., 2014; Svoboda et al., 2002). However, its use in Mexico for drought assessment is still incipient (e.g., de Jesús, 2016).
- Mexico has the Mexico’s Drought Monitor (MDM), derived from the North American Drought Monitor (NADM), since 2014. Although it has inherited several strengths from the NADM, its main limitation is the scarcity of ground-based data, as well as the subjective criteria to represent the spatial extent of droughts.
- MDM has failed to detect some past events.

Objectives

Provide an operational framework for drought monitoring in Mexico, based on univariate and multivariate nonparametric standardized indexes.

Data

Atmospheric reanalysis Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA-2; Rienecker et al., 2011).

Methodology

PRECOTOTLAND: Total precipitation in land BASEFLOW: Baseflow flux RUNOFF: Overland runoff RZMC: Water in the root zone

SPI, SRI, SSI and MSDI: nonparametric standardized drought indices (SI) for precipitation, runoff and soil moisture, and multiple variables (Hao and AghaKouchak, 2013; Farahmand and AghaKouchak, 2015; McKee et al., 1993; Shukla and Wood, 2008).

\[ p(x) = \frac{i}{\pi + 0.12} \]

where \( p(x) \) denotes the empirical probability; \( i \) is the rank of non-zero data in ascending order; \( n \) is the sample size; \( \phi \) is the standard normal distribution function.

MSDI has been extended to three variables associated to droughts (precipitation, runoff and soil moisture) in order to detect the whole dry spell across the hydrological continuum.

Drought maps and time series

Results

Sample event: Michoacán 2015-present

Sample del Lago de Cuitzeo por causas naturales: Cienega de la Flor, La Sepultura y Cañada Honda, Michoacán 2015

Drought intensity time series (MSDI)

Drought intensity map

Drought magnitude map

Conclusions

- The applied framework succeed in detecting observed drought events.
- Maps of magnitude are helpful for identifying areas with drought persistence, which can help to define priority regions for aid relief.
- While MSDI offer insight on the whole dry spell across the hydrological continuum, the analysis of univariate SI allows to track its propagation.
- Further work shall aim at correcting MSDI-2 output with ground-based data in order to improve the results.

References

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Graphical abstract

Climatic variability in Mexico, with special emphasis in the Michoacán State, has been assessed using ground-based and remote sensing data to develop drought monitoring system. The study area is characterized by climatic conditions that are strongly influenced by the background of the Sierra Madre Occidental and the Sierra Madre Oriental. The results show that drought severity and spatial extent have increased along the past decades, with a remarkable increase in the last 5 years.