Characterization of meteorological droughts in continental Ecuador during the period 1902-2017

Ronnie Araneda-Cabrera[1*], María Bermúdez[2], Jerónimo Puertas[1,2]

[1,3]*University A Coruña, A Coruña, Spain;* [2]*University of Granada, Granada, Spain*

*Correspondence YP: ronnie.aranedac@udc.es

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Abstract

The Droughts in Ecuador are related to precipitation and temperature, varying their characteristics considerably across the country. Using the Standardized Precipitation and Evapotranspiration Index (SPEI), we have divided the country into three homogeneous drought regions that are similar to the country's geographical divisions. In these homogeneous drought regions, a characterization of the droughts during the periods 1906-1961 and 1962-2017 was performed. All three regions showed an increase in the frequency of droughts for all the temporal aggregations of SPEI. In the Coastal and Andean regions, the duration, intensity and severity also increased in the second period. The results point to increased pressure on water resources in recent years.

Keywords: Drought, regionalization, SPEI, climate change, drought maps, Ecuador.

Methods

- The Standardized Precipitation and Evapotranspiration Index (SPEI) proposed by Vicente-Serrano, Beguería, & López-Moreno, 2010 were calculated on a grid of 0.5° over the whole Ecuadorian territory (106 cells).
- Six SPEI time scales were used: -3, -6, -12, -24, -36, -48 months for a time span from 1906 to 2017.
- We defined drought homogenous regions applying the k-means clustering method and the silhouette method (to find the optimal cluster number).
- In each region we used the run-theory (Yevjevich, 1969) method to characterize drought events during the period 1906-1961 and 1962-2017. We defined drought as SPEI lower than -1 for at least 2 consecutive months.
- Drought characteristic maps were plotted.

Table 1: Average drought characteristics for the three drought regions of Ecuador using the SPEI-12.

SPEI ≤ -1.00	Coast		Andean		Amazon	
	a	b	a	b	a	b
Frequency [%]	1.04	2.23	1.34	2.38	2.08	1.79
Duration [N° months]	5.57	8.73	4.67	7.81	5.79	8.17
Intensity	-1.31	-1.56	-1.34	-1.48	-1.36	-1.45
Severity	-6.88	-12.9	-5.87	-10.8	-7.26	-11

" a " period 1906-1961; " b " period 1962-2017

Results

- Three homogeneous drought regions were identified in Ecuador (Coast, Andean and Amazon).
- The SPEI time series revealed more important drought events in the second analysis period in the three drought regions (Table 1).
- In the Coastal and Andean regions, the higher the temporal aggregation of the SPEI, the higher the rate of change of the average characteristics between the first and second period.

Conclusions

i) The SPEI drought index detects as homogeneous drought regions the usual geographical regions of Ecuador, with contrasting climate regimes.

ii) The second half of the study period generally showed an increase in the frequency, duration, intensity and severity of drought in the three regions.

iii) The events tended to last longer and showed a higher intensity and severity, especially the long-term indices, suggesting that the main effects of droughts could be felt in river flows and groundwater.

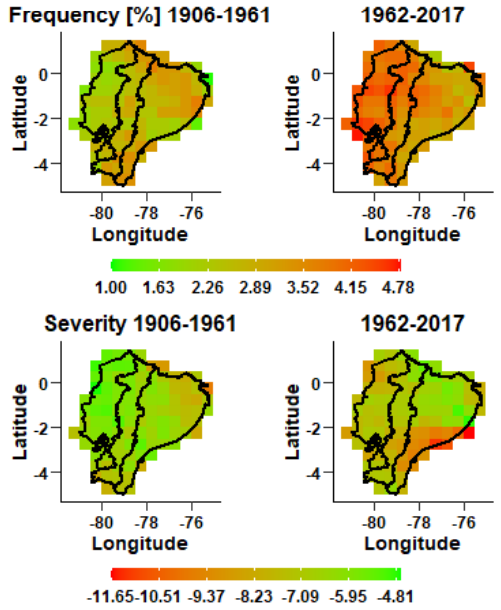

Figure 1: Drought frequency and severity maps for the two periods in the Coast (left), Andean (center) and Amazon (right) regions.

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