



Near 40-year drought trend during 1981-2019 earth warming and food security

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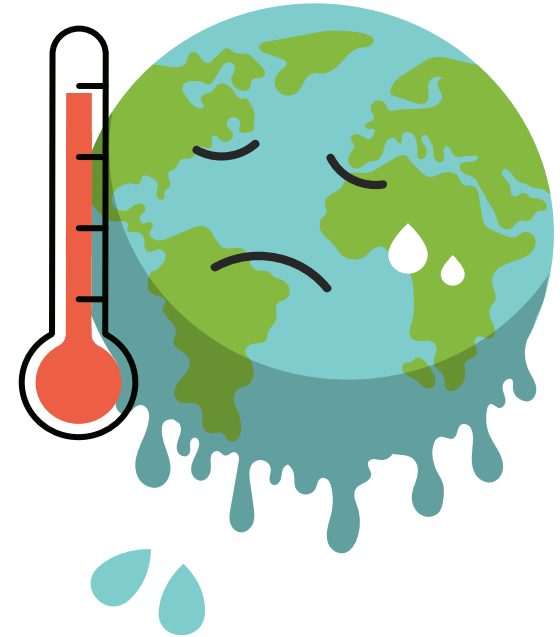
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OUR OBSERVATIONS

Global Warming

- **Global Warming** is the *phenomenon of increasing average air temperatures near the surface of Earth over the past one to two years*
- This process particularly intensified towards the end of the 20th century, in fact the global temperature anomaly increased up to 0.6°C
- This increase in temperature caused different environmental, economic and social events, and it has reported to speed up ice melting in the northern pole and sea level rise, affect changes in biological systems and increase water scarcity and deteriorate drought
- Continuation of climate warming, would further intensify and expand droughts leading to a stronger reduction of crop production, especially in developing countries, further deterioration of food security, leading to more intensive population malnutrition and hunger (FAO 2017; WMO 2017; UNESCO 2018)



What is Drought?

Description of the problem

Drought is defined by the National Integrated Drought Information System (NIDIS) as “A deficiency of precipitation over an extended period of time (usually a season or more), resulting in a water shortage.”

Nevertheless, it is difficult to give a proper definition since drought can be defined both in a conceptual and operational way:

- **Conceptual** definitions offer a general idea of drought and can be important for establishing drought policy
- **Operational** definitions help define the onset, severity, and end of droughts, how a drought functions or operates



HYDROLOGICAL

When low water supply becomes evident



METEOROLOGICAL

Dominance of dry weather patterns in an area



AGRICULTURAL

When crops become affected by drought



ECOLOGICAL

When natural ecosystems are affected by drought



SOCIOECONOMIC

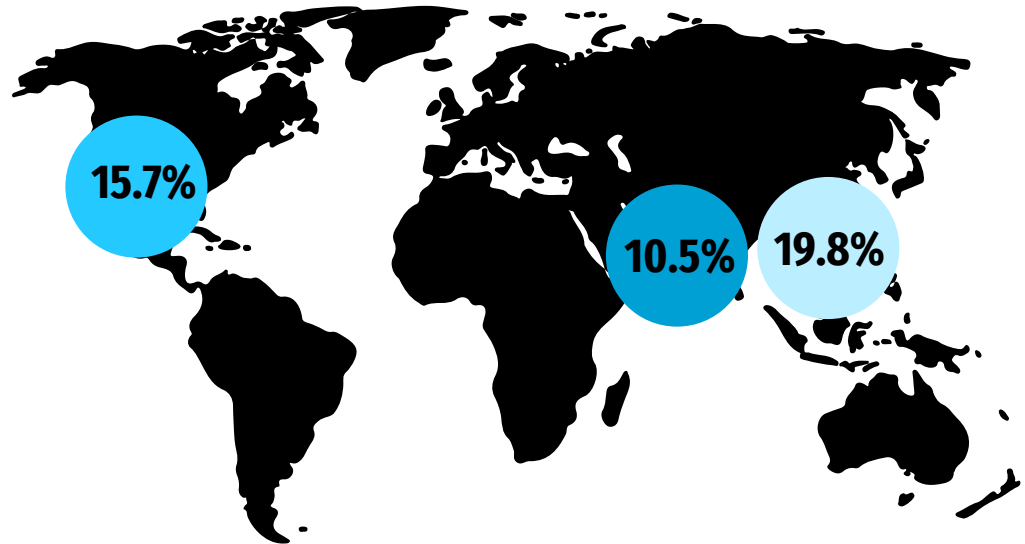
When supply and demand of commodities is affected by drought

How the authors faced it

This paper was written by Felix Kogan, Wei Guo and Wenze Yang coming from the Center for Satellite Applications and Research, National Oceanic and Atmospheric Administration, National Environmental Satellite Data and Information Services, College Park, USA and the IMISG, College Park, USA

The authors addressed the problem of drought during a period of 38 year, dividing it in two parts (the first from 1981 to 2014 and the second from 2015 to 2019) by taking into considerations both **vegetation health** and **global warming**, and concentrating the analysis for the main grain producing countries, which were *China* , *USA* and *India*, considered to have produced almost 50% of global grain in 2014. They also related the issue of drought to the possible negative consequences with **food security**, especially regarding developing countries.

Grain production contribution to the world total



Vegetation Health

Analysis on drought was carried out by the National Oceanic and Atmospheric Administration (NOAA) operational polar-orbiting satellites by measuring weekly vegetation health in response to moisture-thermal variation.

Vegetation Health (or VH) is the state of vegetation in response to the environmental conditions

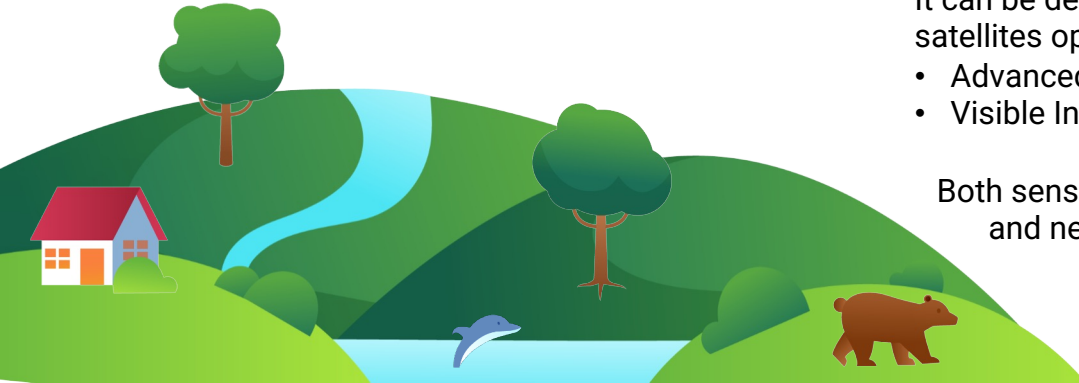
- ❖ It is healthy if it is Intensively green and distributed uniformly
- ❖ It is stressed if it is yellow, wilting and not uniform

How can we determine Vegetation Health?

It can be determined from **satellite data**, especially from NOAA satellites operation using two sensors:

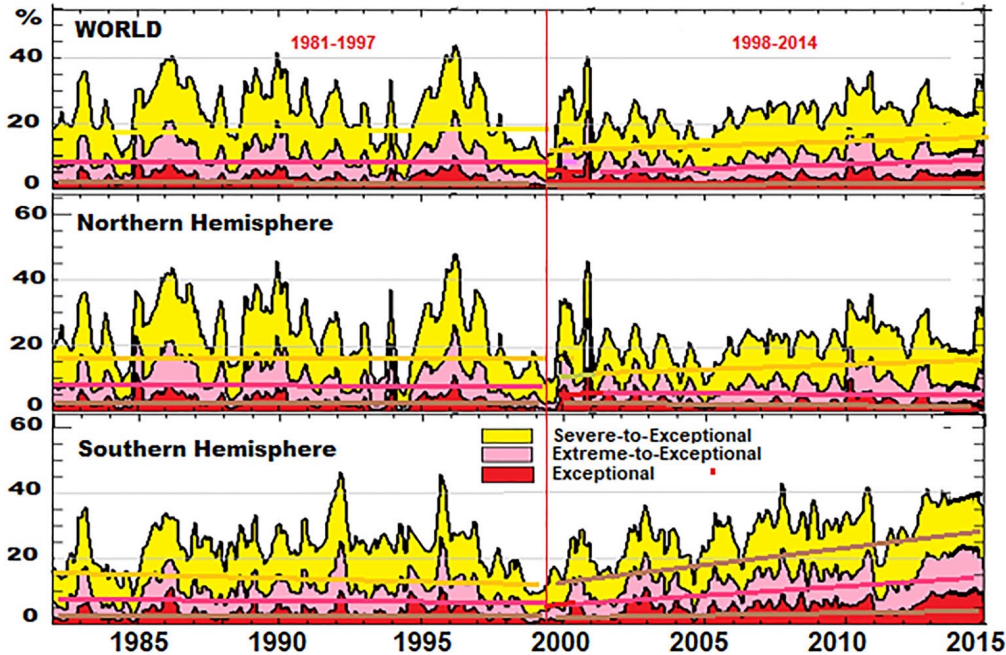
- Advanced Very High Resolution Radiometer (1981-2012)
- Visible Infrared Radiometer Suite (2013-2019)

Both sensors measured reflected solar radiation in the visible (VIS) and near infrared (NIR) and emitted radiation in infrared (IR) wavelength



Results

Mean global and hemispheric multi-year weekly VHI-based drought time series and trends



They indicate that during 1981-2014, **global drought has not intensified and has not expanded** following strong global mean TA (Temperature Anomaly) increase as was indicated by many climate publications. In spite of intensive global warming, the 1981-1997 global drought trends were stably flat for all intensities compared to a very strong global TA increase. Oppositely, during the next 17-year (1998-2014), upward drought area and intensity trends appeared, while global TA had quite stable (flat) trend during the entire 1998-2014 period.

Northern Hemisphere's drought trends for the three intensities were quite similar to the VHI (Vegetation Health Index)-based world's drought tendencies. In Southern Hemisphere droughts intensified and area increased from 1998 through 2014 almost 80-95%, mismatching with global TA flat trend.

Conclusion



Climate publications emphasized intensive Earth Warming after the second half of the 19th century which increased drought intensity



But recent 20-year climate-change scientific publication regarding drought dynamics are based on less than two decades of low-resolution weather station data



In reality, for the entire 38 year (1981-2018), the increased global earth warming has not changed drought area and intensity. **Therefore it is possible to state firmly that global and main grain countries' drought area and intensity trends have not been following global climate warming since 1980's.**

Little change in global drought over the past 60 years

The traditional metric of drought based on historical meteorological observations is applied – the **Palmer Drought Severity Index (PDSI)**. Many studies claim an increase in global drought.

The PDSI was developed originally as an agricultural monitoring tool in the United States in the 1960s that helped in allocating aid to shocked farmers. This index shows a decrease in humidity worldwide since the 1970s.

The simplicity of the PDSI, which is calculated from a simple water-balance model forced by monthly precipitation and temperature data, makes it an attractive tool in large-scale drought assessments, but may give biased results in the context of climate change.



Calculating the PDSI

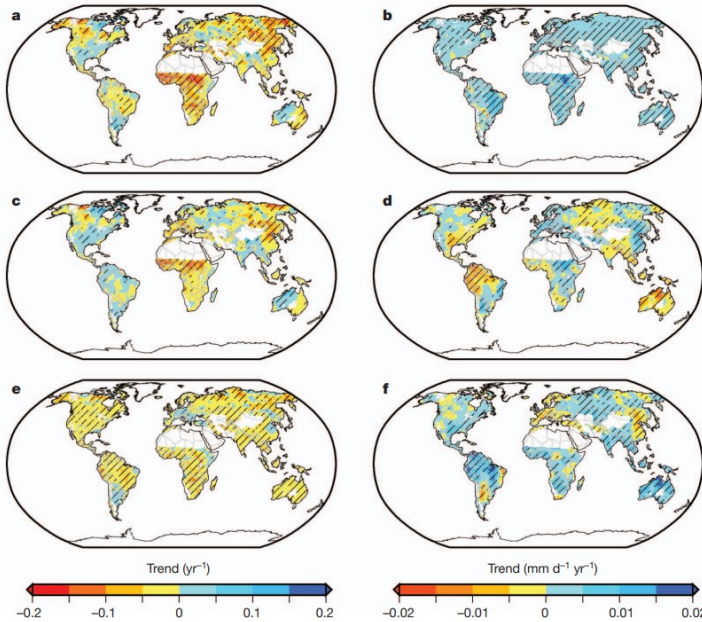


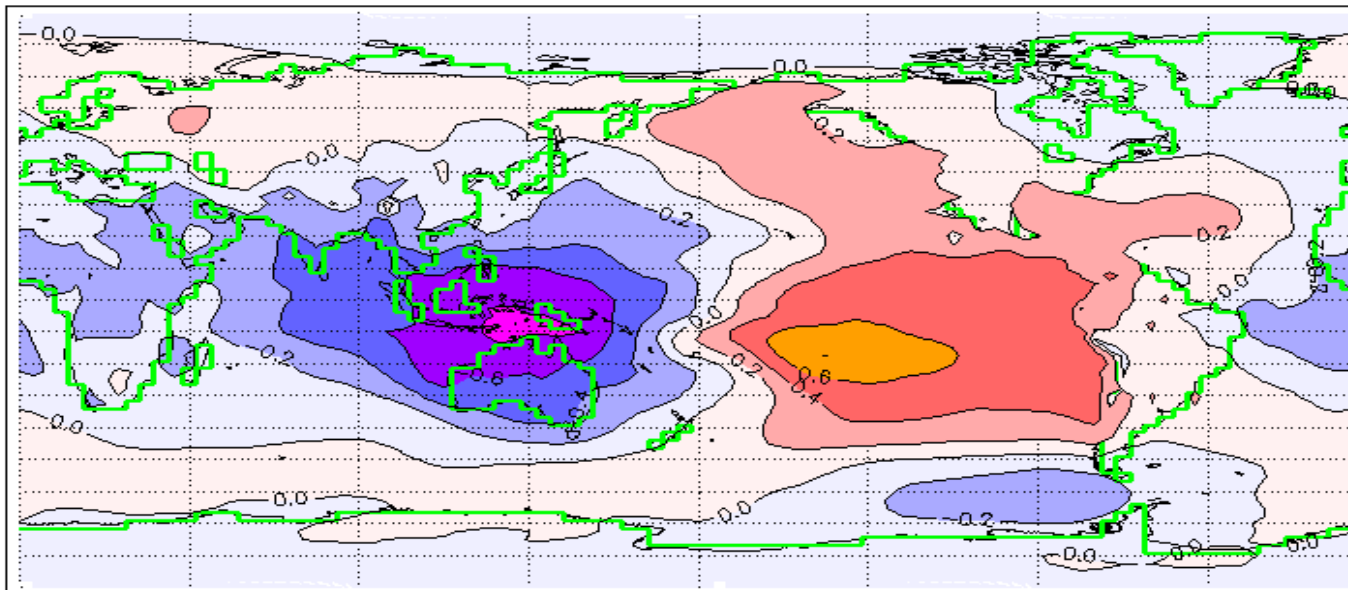
Figure 2 | Trends in the PDSI and PE. a, c, e, Non-parametric trends for 1950–2008 in annual average PDSI (averaged over the results using the four precipitation data sets and, for the PDSI_PM, also over the two net radiation data sets) from the PDSI_Th (a) and the PDSI_PM (c), and their difference (e). b, d, f, Non-parametric trends for 1950–2008 in annual average PE from the Thornthwaite equation

(b) and the PM equations (d), and their difference (f). Values are not shown for Greenland, Antarctica and desert regions with a mean annual precipitation of less than 0.5 mm d^{-1} . Statistically significant trends at the 95% level are indicated by hatching. The difference in trends in e and f and its statistical significance are calculated from the time series of differences between the two data sets.

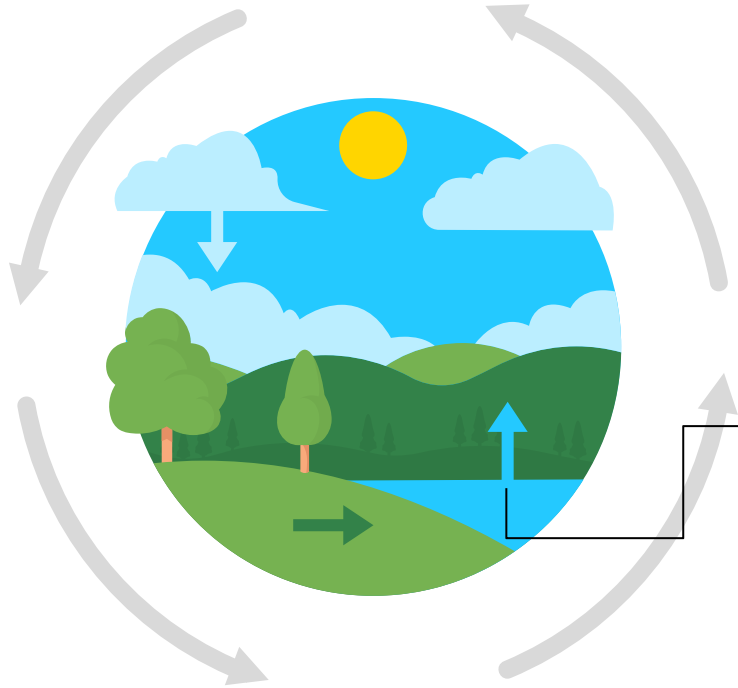
- The study shows that an increase in global drought is overestimated
- Alternative is to calculate the PDSI via the Penman–Monteith (PM) equation that incorporates the effects of wind and humidity, plus solar and longwave radiation
- **The picture a** – the traditional method of calculation of the PDSI, **the picture c** – the modified one. The first picture has more arid areas than the second one. Period is 1950 - 2008.

Something is missing

Omission of the ENSO (**El Niño/Southern Oscillation**) influence. The most common source of episodic droughts around the world. During El Niño events there are major droughts over Australia, Indonesia, southeast Asia, parts of Africa and the northeast of Brazil. Thus ENSO is the primary source of variability in the tropical and global precipitation record and therefore variations in ENSO affect perceptions about changes in drought and their possible links to climate change.



Results



There has been **little change in drought over the past 60 years**. It is more plausible that evaporation actually decreases during drought because of less precipitation, and that drought drives increases in temperatures because there is less evaporative cooling and thus a higher sensible heat flux warming the air.

- Nevertheless, the regions of decreasing PE (*potential evaporation*) trends estimated with the PM model are generally in agreement with the abundance of evidence of decreasing pan evaporation for many regions.

Our observations...

In conclusion, with the first paper we analysed, we were able to see that drought is a major problem all around the world. It is commonly believed that the increasing issue of global warming in the last decades has worsened the situation of water scarcity and food security, but according to the tools/indexes used by the authors of the first paper, there hasn't really been an increasing in drought and the situation was considered to be stable.



Nevertheless, many studies have been done over the issue of drought and the relation with global warming. As we have seen, different studies have shown that according to the period of time analysed and the tools/indexes used by the authors of the different papers, the conclusions can be different and the correlation between drought and global warming and the increasing of drought can actually be a serious issue to control for the future years.

Overall, it is possible to say that choosing the methods for calculation indexes is extremely important, every method has its own drawbacks. Moreover, it is important to take wisely data and period of research taking into account diverse natural events.

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Thanks

Do you have any questions ?

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