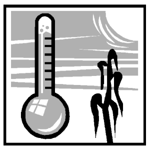
Droughts

UNIVERSITY OF FLORIDA
Cooperative Extension Service
Institute of Food and Agricultural Sciences

Chapter 16: Extreme Heat and Drought



What is Drought?

Drought is a normal, recurrent feature of climate, although many erroneously consider it a rare and random event. It occurs in virtually all areas, whatever their normal climate may be, and the characteristics of a drought may be very different from one region to another. Technically, drought is a “temporary” condition, even though it may last for long periods of time.

Drought is an insidious hazard of nature. Unlike many disasters which are sudden, droughts result when there is less than normal precipitation over an extended period of time, usually a season or more. The decreased water input results in a water shortage for some activity, group, or environmental sector. Drought can also occur when the temperature is higher than normal for a sustained period of time; this causes more water to be drawn off by evaporation. Other possible causes are delays in the start of the rainy season or timing of rains in relation to principal crop growth stages (rain at the “wrong” time). High winds and low relative humidity can make matters much worse.

Drought is not a disaster for nature itself, the disaster occurs when we consider the demand people place on their water supply. Human beings often increase the impact of drought because of high use of water which cannot be supported when the natural supply decreases. Droughts occur in both developing and developed countries and can result in economic and environmental impacts and personal hardships. All societies are vulnerable to this "natural" hazard.

Meteorological Drought

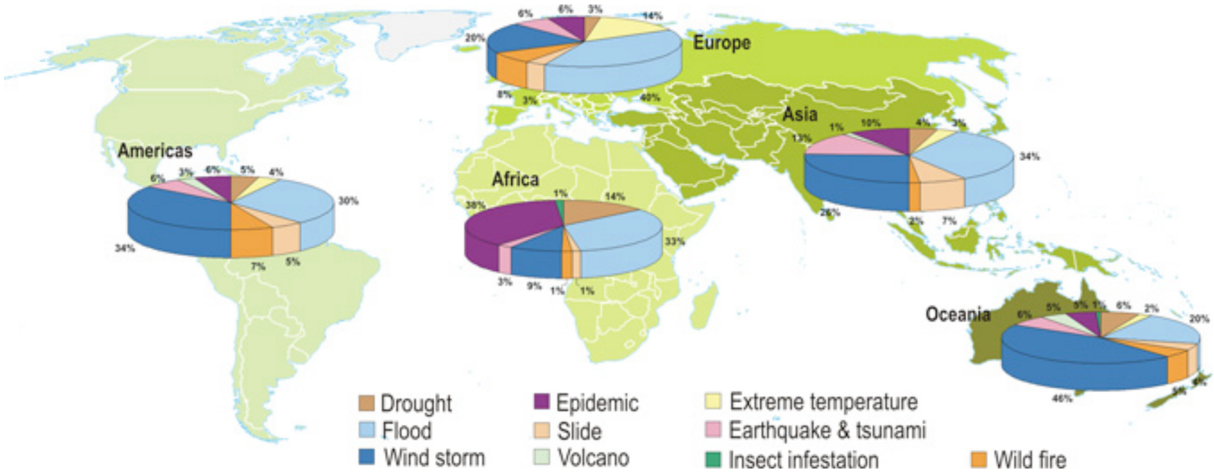
Meteorological drought is usually measured by how far from normal the precipitation has been over some period of time. These definitions are usually region-specific, and presumably based on a thorough understanding of regional climates. The following examples of "meteorologic droughts" from different countries at different times show why it is a poor idea to apply a definition of drought developed in one part of the world to another:

- United States (1942): less than one tenth inch of rainfall in 48 hours
- Great Britain (1936): fifteen consecutive days with daily precipitation totals of less than one hundredth of an inch
- Libya (1964): when annual rainfall is less than 7 inches
- India (1960): actual seasonal rainfall is deficient by more than twice the mean deviation
- Bali (1964): a period of six days without rain.

Under any circumstances, meteorological measurements are the first indicators of drought.

Socioeconomic Drought

Socioeconomic drought is what happens when physical water shortage starts to affect people, individually and collectively. Or, in more abstract terms, most socioeconomic definitions of drought associate it with the supply and demand of an economic good.



Regional distribution of disasters by type [1991 - 2005]

Predicting Droughts With Greater Certainty - ScienceDaily (June 3, 2009)

Using new data and reconstructions of the "Dust Bowl" drought in America during the 1930s, climatologists have shown for the first time a three-dimensional picture of the atmospheric circulation that led to the drought. This will enable climate models to be evaluated and further improved. The scientists hope this work will make it possible to predict future periods of drought more accurately.

In the 1930s, a drought that lasted almost ten years wrought havoc on the Midwest region of North America. The enormous dust storms accompanying it gave the "Dust Bowl" drought its name. This drought had devastating socio-economic consequences for America. The legendary "Route 66", along which the farmers fled towards California, was made famous in part by the Dust Bowl.

Scientists have been studying the Dust Bowl phenomenon for decades, and until now the mechanisms that caused this exceptionally long period of drought have not been fully understood, as little information has been available on the atmospheric circulation. At the time of the drought, wind and temperature readings were already being taken using balloons and aircraft, initially at altitudes of three to eight kilometres, and later at much higher altitudes. These data have now been digitalised as part of a US project and a project undertaken by the Swiss National Science Foundation. Based on these data, statistical methods were used to reconstruct the upper air circulation at an altitude of up to 15 kilometres.

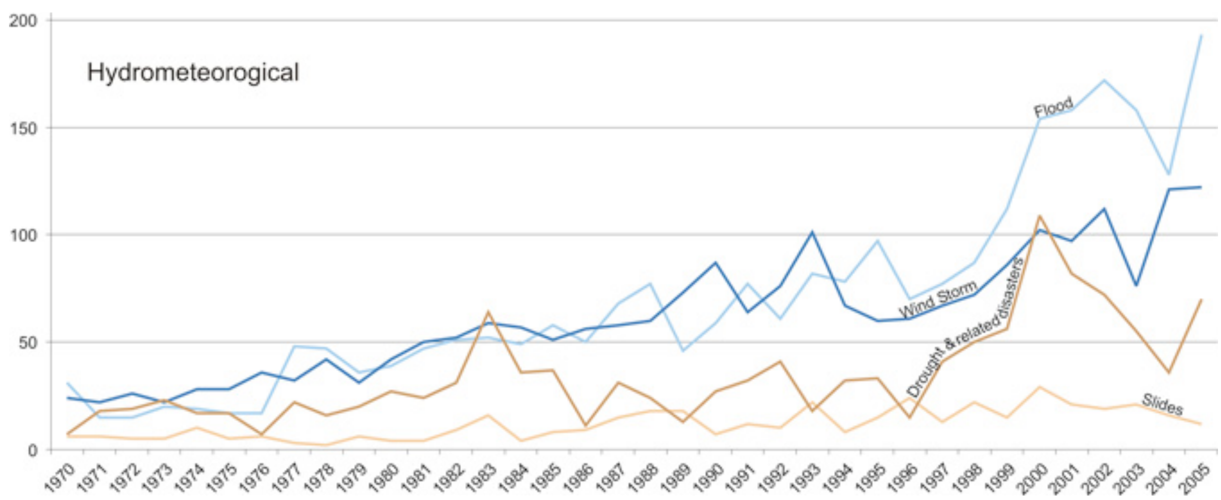
Based on computer models, researchers have up to now conjectured that unusual sea surface temperatures in the Pacific and Atlantic Oceans would have altered the wind systems, thereby triggering the drought. At the same time, the dying vegetation, the parched soil and the dust created by these conditions could have further intensified the drought.

In their study, the scientists focused on three known circulation patterns which characterise the basic wind conditions of the region and the wider area. Using the new data, they were able to show that a specific wind flow, the Great Plains Low-Level Jet, was shallower at the time of the Dust Bowl. This air current usually carries moist air from the tropical Atlantic far into the region, which covers approximately two million square kilometres. In addition, the Jet did not penetrate as far north as usual, as it was deflected too early towards the east.

The researchers believe this was caused by a high-pressure system that built up over the Plains and was associated with an abnormal upper air flow extending from the Pacific across North America to the Atlantic. "Overall, these features are clearly consistent with the flow conditions that climate models predict as the effect of a cold Pacific coinciding with a warm Atlantic". Because the temperatures of the tropical oceans can to a certain degree be predicted, the scientists see here the possibility of predicting periods of drought as well. However, the study also shows up some remaining shortcomings in the models: for the most part, they would not correctly depict the spatial shift of the Low-Level Jet, and in many models the drought is located too far to the south.

	Hydrometeorological disasters							Geological disasters			Biological disasters			
	Drought	Extreme Temperature	Flood	Slide	Wild Fire	Wind Storm	**Total**	Earthquake & Tsunami	Volcano	**Total**	Epidemic	Insect Infestation	**Total**	**Total**
Africa														
Eastern Africa	87		132	7	2	46	**274**	11	3	**14**	146	3	**149**	**437**
Middle Africa	8		37	2	2	1	**50**	1	1	**2**	50	2	**52**	**104**
Northern Africa	9	6	56	2	2	9	**84**	12		**12**	19	2	**21**	**117**
Southern Africa	23	1	24	1	7	17	**73**	2		**2**	12		**12**	**87**
Western Africa	18	2	87	2	2	15	**126**		1	**1**	151	8	**159**	**286**
Sub-total	**145**	**9**	**336**	**14**	**15**	**88**	**607**	**26**	**5**	**31**	**378**	**15**	**393**	**1 031**
Americas														
Carribean	6		44	2	2	95	**149**	5	4	**9**	6		**6**	**164**
Central America	20	13	82	12	7	76	**210**	31	19	**50**	30		**30**	**290**
North America	8	11	90	1	56	236	**402**	10	1	**11**	9		**9**	**422**
South America	23	21	165	46	20	36	**311**	34	10	**44**	28	3	**31**	**386**
Sub-total	**57**	**45**	**381**	**61**	**85**	**443**	**1 072**	**80**	**34**	**114**	**73**	**3**	**76**	**1 262**
Asia														
Eastern Asia	31	8	132	34	8	219	**432**	81	5	**86**	17	1	**18**	**536**
South Central Asia	22	47	285	63	7	137	**561**	95		**95**	103	4	**107**	**763**
South East Asia	25		198	47	13	140	**423**	56	23	**79**	61	1	**62**	**564**
Western Asia	13	11	57	7	5	23	**116**	38		**38**	12		**12**	**166**
Sub-total	**91**	**66**	**672**	**151**	**33**	**519**	**1 532**	**270**	**28**	**298**	**193**	**6**	**199**	**2 029**
Europe														
Eastern Europe	7	46	108	10	23	47	**241**	12		**12**	19	1	**20**	**273**
Northern Europe	2	12	22	2		27	**65**	2	1	**3**	6		**6**	**74**
Southern Europe	9	19	70	5	25	20	**148**	22	2	**24**	10		**10**	**182**
Western Europe	1	19	60	6	3	38	**127**	5		**5**	6		**6**	**138**
Sub-total	**19**	**96**	**260**	**23**	**51**	**132**	**581**	**41**	**3**	**44**	**41**	**1**	**42**	**667**
Oceania														
Australia	6	5	36	2	11	49	**109**	1	1	**2**	2	2	**4**	**115**
Melanasia	5		9	5	1	24	**44**	11	9	**20**	5		**5**	**69**
Micronesia	2					10	**12**	1		**1**	2		**2**	**15**
Polynesia	1			2		16	**19**	1		**1**	2		**2**	**22**
Sub-total	**14**	**5**	**45**	**9**	**12**	**99**	**184**	**14**	**10**	**24**	**11**	**2**	**13**	**221**
Total	**326**	**221**	**1 694**	**258**	**196**	**1 281**	**3 976**	**431**	**80**	**511**	**696**	**27**	**723**	**5 210**

Number of natural disasters by type: regional distribution [1991-2005]



Number of natural disasters by type [1991-2005]

Magnitude - Drought Indices

Percent of Normal

Overview: The percent of normal is a simple calculation well suited to the needs of TV weathercasters and general audiences.

Pros: Quite effective for comparing a single region or season.
Cons: Easily misunderstood.

The percent of normal precipitation is one of the simplest measurements of rainfall for a location. Analyses using the percent of normal are very effective when used for a single region or a single season. Percent of normal is also easily misunderstood and gives different indications of conditions, depending on the location and season. It is calculated by dividing actual precipitation by normal precipitation—typically considered to be a 30-year mean—and multiplying by 100%. This can be calculated for a variety of time scales. Usually these time scales range from a single month to a group of months representing a particular season, to an annual or water year. Normal precipitation for a specific location is considered to be 100%.

One of the disadvantages of using the percent of normal precipitation is that the mean, or average, precipitation is often not the same as the median precipitation, which is the value exceeded by 50% of the precipitation occurrences in a long-term climate record. The reason for this is that precipitation on monthly or seasonal scales does not have a normal distribution. Use of the percent of normal comparison implies a normal distribution where the mean and median are considered to be the same.

Palmer Drought Severity Index

Overview: The Palmer is a soil moisture algorithm calibrated for relatively homogeneous regions.
Who uses it: Many U.S. government agencies and states rely on the Palmer to trigger drought relief programs.
Pros: The first comprehensive drought index developed in the United States.
Cons: Palmer values may lag emerging droughts by several months.

Palmer based his index on the supply-and-demand concept of the water balance equation, taking into account more than just the precipitation deficit at specific locations. The objective of the Palmer Drought Severity Index (PDSI), as this index is now called, was to provide measurements of moisture conditions that were standardized so that comparisons using the index could be made between locations and between months.

The PDSI is a meteorological drought index, and it responds to weather conditions that have been abnormally dry or abnormally wet. The PDSI is calculated based on precipitation and temperature data, as well as the local Available Water Content (AWC) of the soil.

The Palmer Index is popular and has been widely used for a variety of applications across the United States. It is most effective measuring impacts sensitive to soil moisture conditions, such as agriculture. It has also been useful as a drought monitoring tool and has been used to trigger actions associated with drought contingency plans