

SURVEY OF THE DROUGHT INDICES IN AGROMETEOROLOGY

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DROUGHT (WMO 1992 N°182):

- (1) Prolonged absence or marked deficiency of precipitation
- (2) Period of abnormally dry weather sufficiently prolonged for the lack of precipitation to cause a serious hydrological imbalance

DRY SEASONS

Period of year characterized by almost complete absence of rainfall. The term is mainly used for low latitude regions.

DRY SPELL

Period of abnormally dry weather. Use of them should be confined to conditions less severe those of a *drought*.



ATMOSPHERIC DROUGHT

“too high saturation deficit”

METEOROLOGICAL DROUGHT

“a longer period of time with considerably less than average precipitation amounts”

AGRICULTURAL DROUGHT

“available soil moisture is inadequate” yield is considerably less than the average because of water shortage”

HYDROLOGICAL DROUGHT

“refers to a period of below-normal stream-flow”

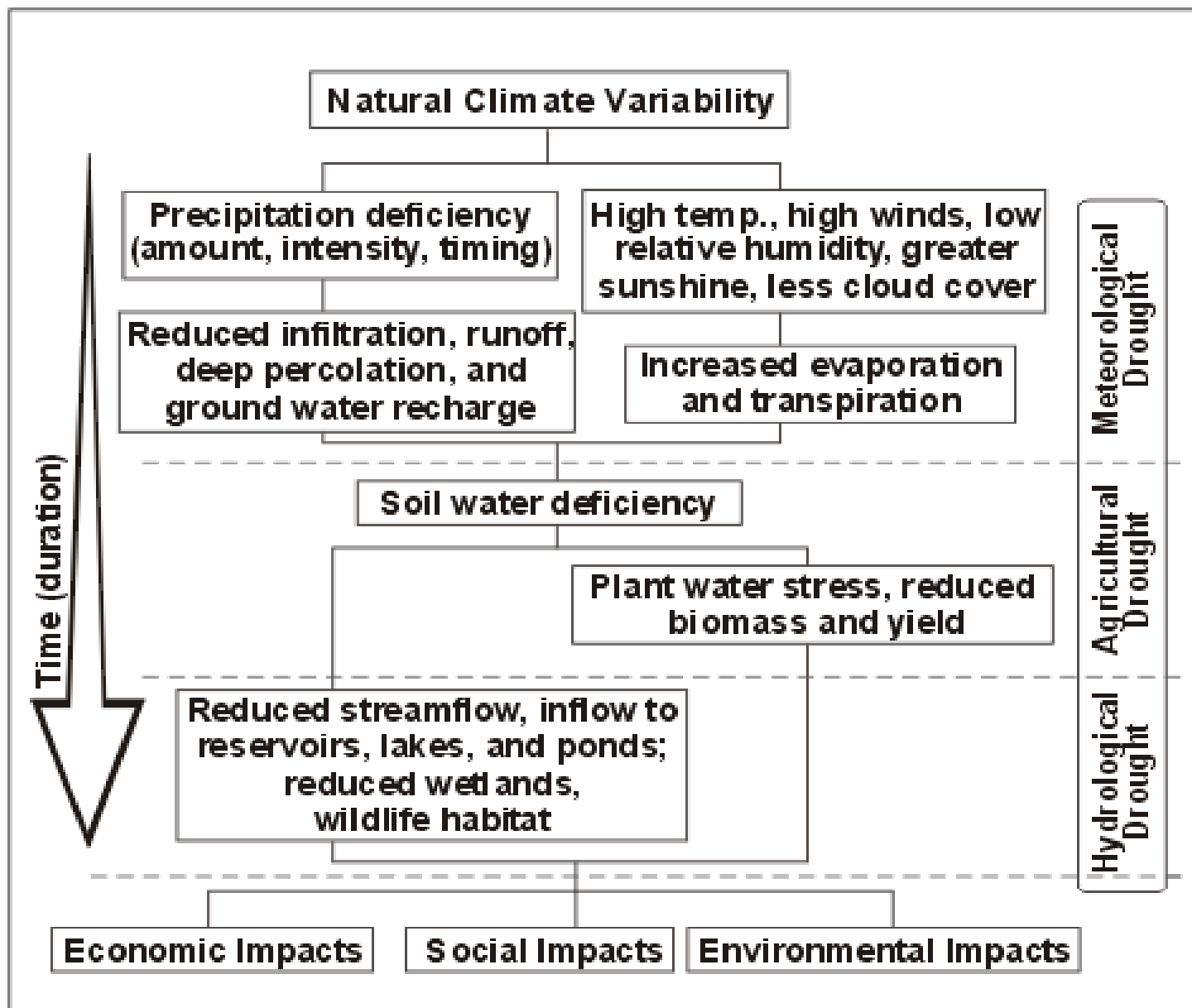
PHYSIOLOGICAL DROUGHT

“plant is unable to take up water in spite of the present sufficient soil moisture”

SOCIOECONOMIC DROUGHT

supply and demand of some economic good with elements of met, hydrological, and agricultural drought





Source: <http://drought.unl.edu>



Symposium on Climate Change and Variability - Agro Meteorological Monitoring and Coping Strategies for Agriculture, Oscarsborg, Norway, 4-6 June 2008



Drought index „an index which is related to some of the cumulative effects of a prolonged and abnormal moisture deficit“

- (1) Precipitation anomaly**
- (2) Atmospheric drought**
- (3) Aridity** „aridity - characteristic of climate relating to insufficiency of inadequacy of precipitation to maintain vegetation“
- (4) Soil moisture**
- (5) Combined or recursive**
- (6) Remotely sensed information**



(1) Precipitation anomaly indices

Precipitation index

$$\Delta P = P - m(P)$$

Relative precipitation sum

$$\frac{P}{m(P)}$$

Relative anomaly

$$\frac{P - m(P)}{m(P)}$$

Standardized
anomaly index, SAI

$$SAI = \frac{P - m(P)}{d(P)}$$

Average standard anomaly

$$\frac{\sum_1^K \frac{\Delta P_K}{dP_K}}{K}$$



(2) Atmospheric drought

„saturation deficit“

$$d = E - e$$



(3) Aridity index

$$\frac{\text{precipitation}}{\text{potential evaporation}}$$

Lang's rainfall index

$$\frac{P}{T}$$

De Martonne aridity index

$$\frac{12P}{T+10} \quad \frac{P}{T+10}$$

Ped's Drought index [PDI1]

$$\frac{\Delta T}{d(T)} - \frac{\Delta P}{d(P)}$$



Selyaninov's hydrothermal coefficient

$$HTK = \frac{P}{\sum_{T>10} \frac{T}{10}}$$

0.4 - 0.7	very dry
0.7 - 1.0	dry
1.0 - 1.3	insufficiently wet
> 1.3	wet

Thornthwaite Index

$$1.65 \left[\frac{P}{T + 12.2} \right]^{\frac{10}{9}}$$



Potential water deficit

$$PE - P$$

Potential evaporation ratio
reciprocal of aridity index

$$\frac{PE}{P}$$

Aridity index,
moisture availability index

$$\frac{P}{PE}$$

Relative evaporation

$$\frac{ET}{PE}$$

(Surface energy balance $R_n = \mu A + H + L.E$)

Bowen ratio

$$\beta = \frac{H}{L.E}$$



(4) Soil moisture index

Relative soil moisture index

$$\frac{W}{AWC}$$

Ped's Drought index [PDI2]

$$\frac{\Delta T}{d(T)} - \frac{\Delta P}{d(P)} - \frac{\Delta W}{d(W)}$$



(5) Combined or recursive

Fooley anomaly index (FAI)

$$FAI_1 = \Delta P_1$$

$$FAI_k = FAI_{k-1} + \Delta P_k$$

Bhalme-Mooley
drought index (BMDI)

$$i_0 = 0$$

$$i_k = C_1 i_{k-1} + \frac{SAI_k}{C_2}$$

$$BMDI = \frac{1}{K} \sum_{k=1}^K i_k$$



Palmer Drought Severity Index, PDSI

$$PDSI_k = \frac{Z^k}{3} + 0.897 PDSI_{k-1}$$

Categories extremely wet	$4,0 < PDSI$
very wet	$3,0 < PDSI < 4,0$
moderately	$2,0 < PDSI < 3,0$
slightly wet	$1,0 < PDSI < 2,0$
wet spell	$0,5 < PDSI < 1,0$
normal	$-0,5 < PDSI < 0,5$
slightly dry	$-1 < PDSI < -0,5$
mild drought	$-2 < PDSI < -1$
moderate drought	$-3 < PDSI < -2$
severe drought	$-4 < PDSI < -3$
extreme drought	$PDSI < -4$



Computation of the PDSI

step 1 hydrological accounting

soil moisture,

potential evaporation (PE),

Available water capacity (AWC)

step 2 climate coefficient

$\alpha = ET/PE$, $\beta = \text{actual/potential recharge}$, $\gamma = \text{actual/pot runoff}$, $\delta = \text{loss}$

step 3 CAFEC values

I , amount of precipitation ~ normal weather

CAFEC = Climatically Appropriate for Existing Conditions

step 4 moisture anomaly index

$D = P - I$, $Z = K(j)/D$

step 5 drought severity

$X_j = 0,897 X_{j-1} + Z_j/3$



The other indices form the PDSI index family

Standardized Precipitation Index, SPI

Surface Water Supply Index, SWSI

Reclamation Drought Index, RDI

Palmer Drought Index, PDI

Palmer Crop Moisture Index, CMI

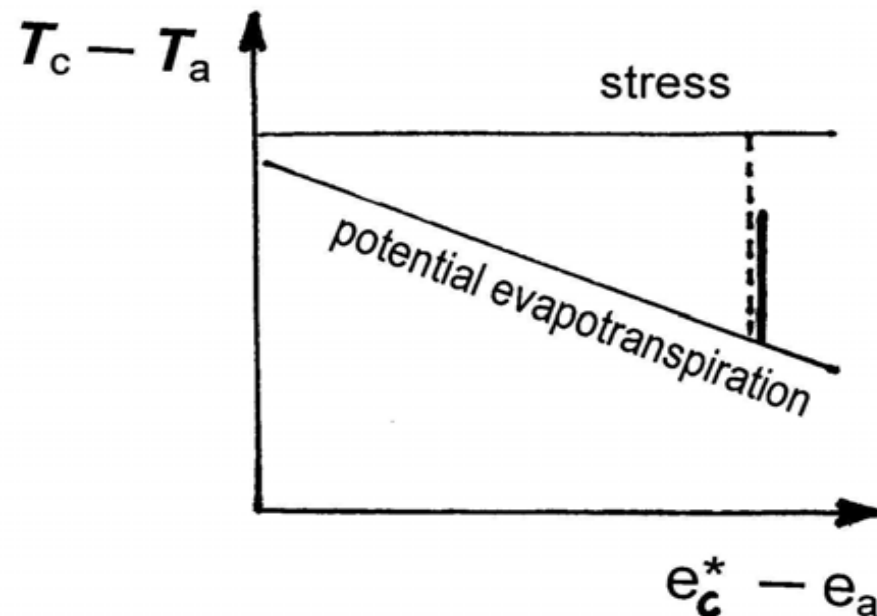
Keetch-Byram Drought Index, KBDI



(6) Remotely sensed information

crop water stress index, theoretically

$$CWSI = \frac{PE - ET}{PE} = 1 - \frac{ET}{PE}$$



(6) Remotely sensed information

Vegetation index

$$\frac{\text{NIR}}{\text{VIS}}$$

Normalised Difference Vegetation Index

$$\text{NDVI} = \frac{\text{NIR} - \text{VIS}}{\text{NIR} + \text{VIS}}$$

Stress degree day

$$\Sigma \text{ET}_D = \Sigma R_N + a - b \Sigma (T_C - T_A)$$



THANK YOU

- *FOR YOUR ATTENTION!*
- *FOR THE ORGANISATION!*
- *TO BE HERE!*



The logo for COST (European Cooperation in Science and Technology), featuring a stylized blue 'C' followed by the word 'cost' in a bold, blue, sans-serif font.



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