FUTURE DROUGHTS IN SOUTHERN UKRAINE – REASONS AND POSSIBLE CONSEQUENCES FOR WATER RESOURCES AND AGRICULTURE

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Outlines:

1. Climatic background

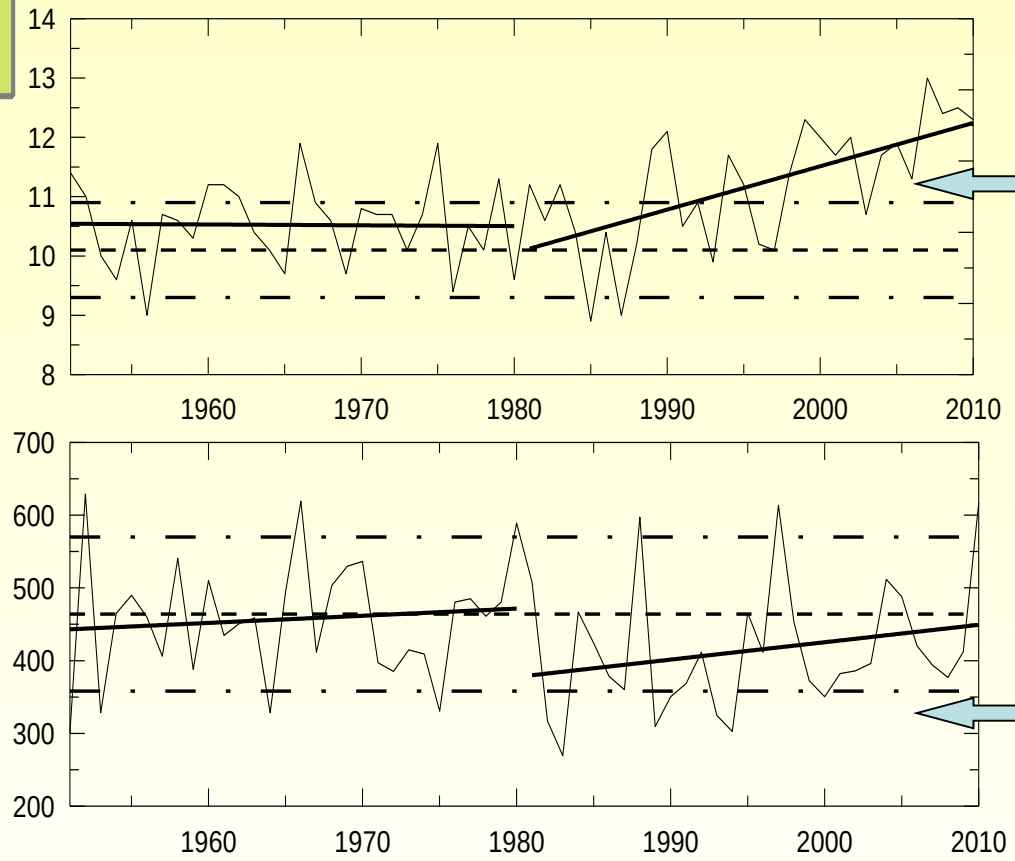
2. Methodology

3. Future temperature, precipitation and droughts

5. Consequences for: water resources

agriculture

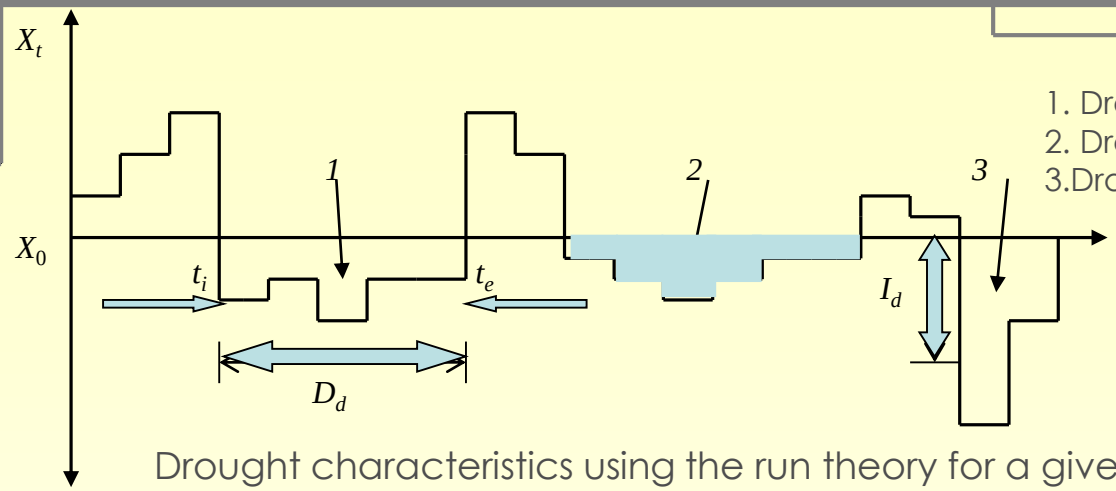
Climatic background



abrupt temperature growth started from 1980s

more frequent drier years from 1980s

Annual mean temperature (°C) and total precipitation (mm/y) in Odessa (Southern Ukraine) for 1951-2010. Climatic norms (1961-90) together with ±σ are shown by dash-and-dot lines. Straight lines are linear trends.



1. Drought with the highest severity;
2. Drought with the longest duration;
3.Drought with the highest intensity

Drought characteristics using the run theory for a given threshold level

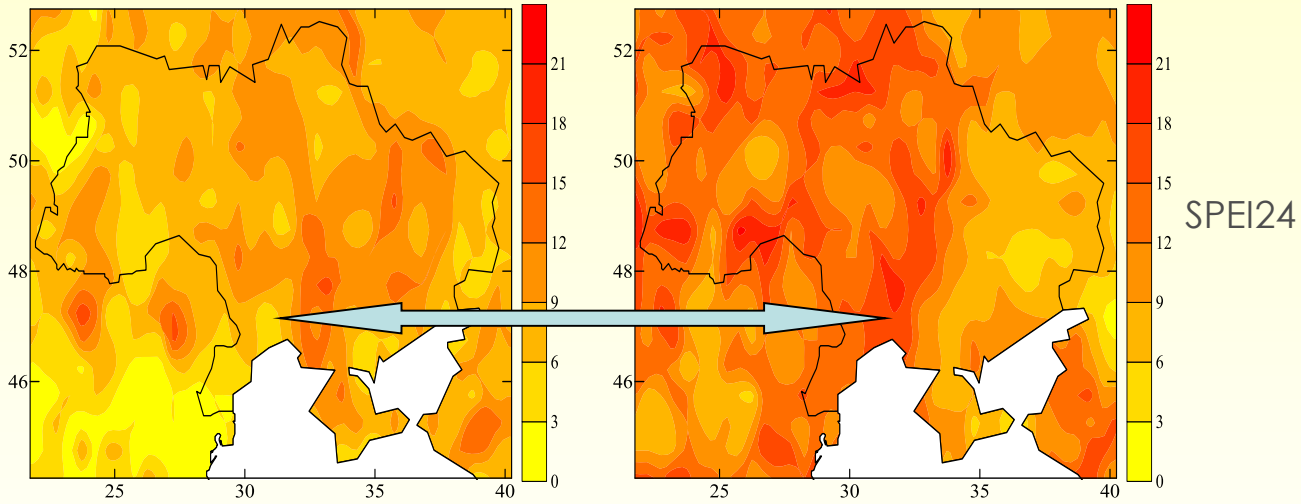
– Drought duration: it's expressed in years/months/weeks, etc., during which a drought parameter is continuously below the critical level. In other words, it is the time period between the initiation and termination of a drought;

– Drought severity: it indicates a cumulative deficiency of a drought parameter below the critical level;

– Drought intensity: it's the average value of a drought parameter below the critical level.

Total number of moderate droughts during two 30-year periods

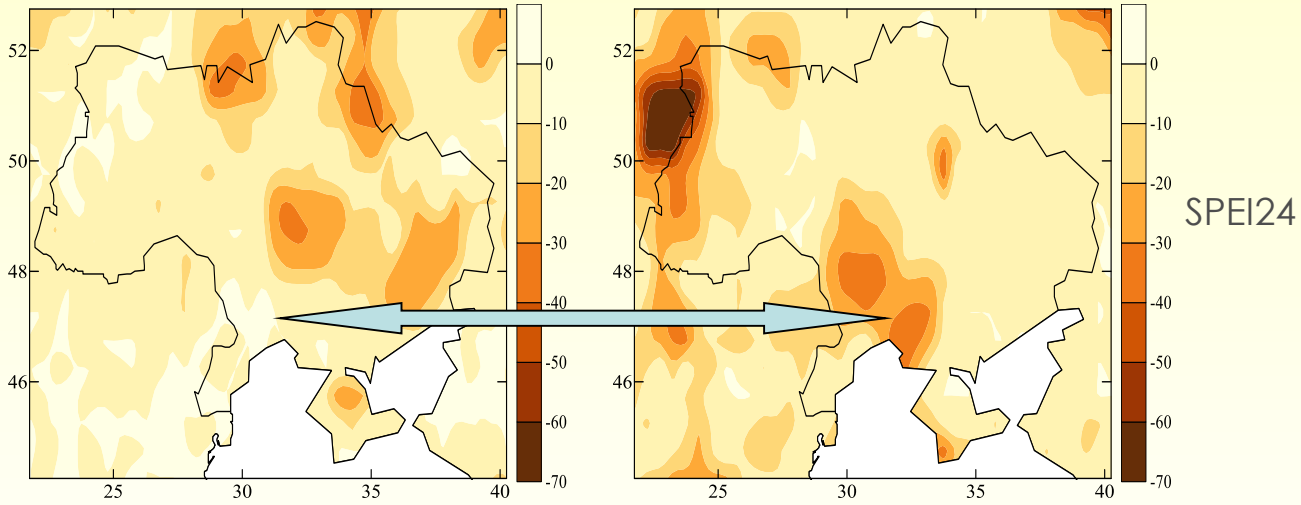
1951-1980 1981-2010



Increasing number of moderate droughts – from 5 to 20

Severity of drought (SPEI < -1) during two 30-year periods

1951-1980 1981-2010



Increasing severity up to –30

SPEI – standardized precipitation and evapotranspiration index takes into account both precipitation and potential evapotranspiration (Vicente-Serrano et al., 2010).

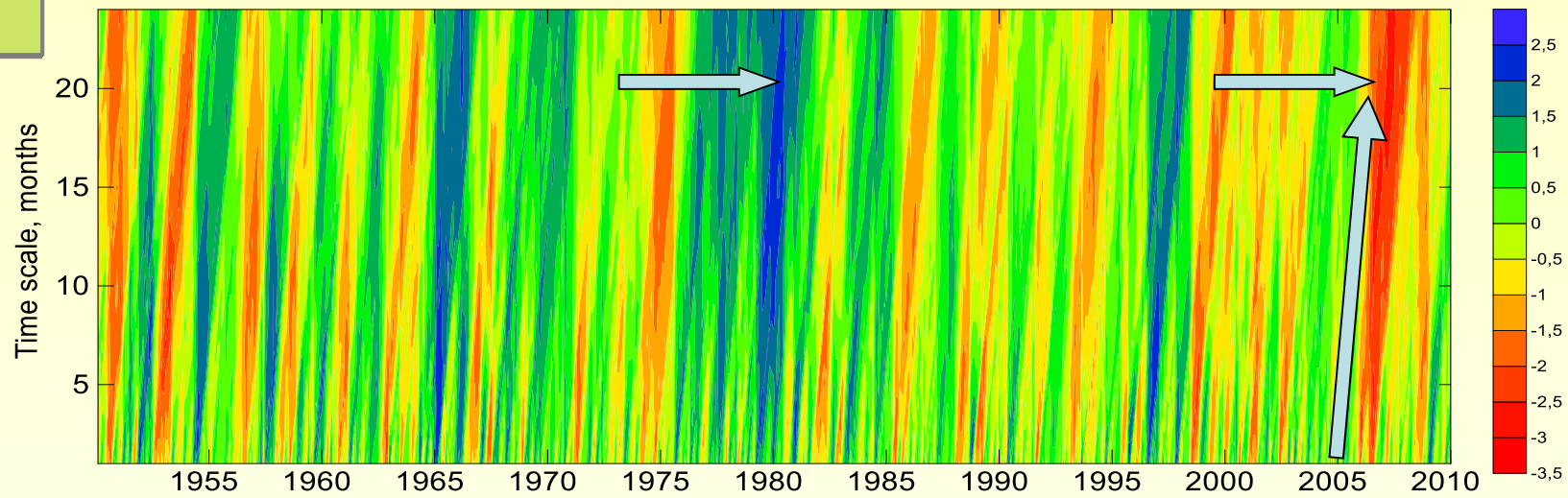
The index can be compared with similar values in other areas during different time periods.

– meteorological droughts: on the 1–2 months time scale;
– agricultural droughts: on the 3–12 months time scale;
– hydrological droughts: on the 13–24 months time scale

Drought categories

Values	Drought category
−0,99 ≤ SPEI < 0	**mild drought**
−1,49 ≤ SPEI < −1	**moderate drought**
−1,99 ≤ SPEI < −1,5	**severe drought**
SPEI ≤ −2	**extreme drought**

Climatic background



1- to 24-month SPEI in Odessa (Southern Ukraine)

– 1980 was a turning point, maximally wet

– from 1980 to 2010 severity of the droughts increased

– drought of second half of 2010th was exceptionally severe and prolonged

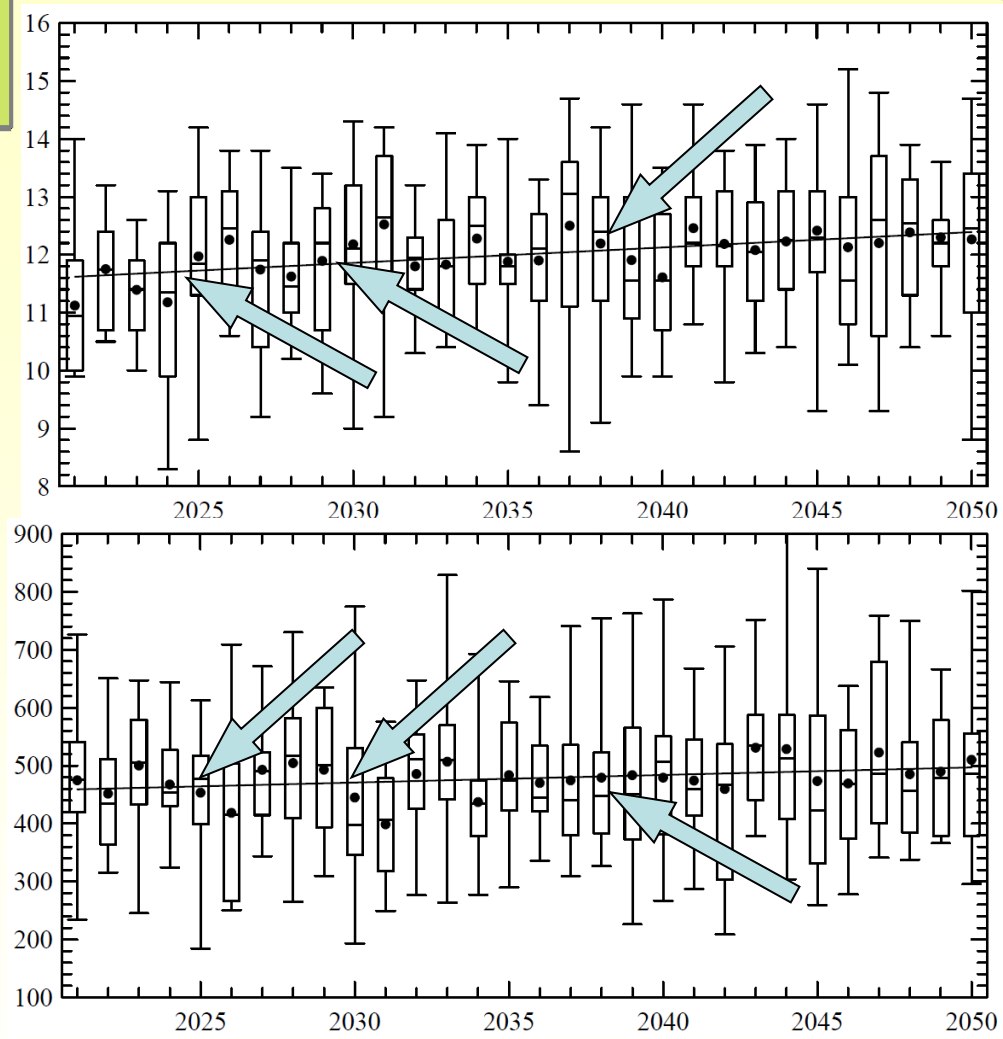
– duration of drought is increasing with time scale

Two periods:
– nearest past (1981–2010)
– nearest future (2011–2040)

RCMs from CORDEX RCP4.5 runs

Institute	RCMs	GCMs
CLMcom	CCLM4-8-17	CNRM-CERFACS-CNRM-CM5 ICHEC-EC-EARTH MOHC-HadGEM2-ES MPI-M-MPI-ESM-LR
DMI	HIRHAM5	ICHEC-EC-EARTH
KNMI	RACMO22E	MOHC-HadGEM2-ES ICHEC-EC-EARTH
MPI	REMO2009	MPI-M-MPI-ESM-LR
SMHI	RCA4	CNRM-CERFACS-CNRM-CM5 ICHEC-EC-EARTH IPSL-IPSL-CM5A-MR MOHC-HadGEM2-ES MPI-M-MPI-ESM-LR

Future temperature and precipitation



Annual mean temperature (°C; upper panel) and total precipitation (mm; lower panel) in Odessa estimated using the outcomes from the CORDEX Project

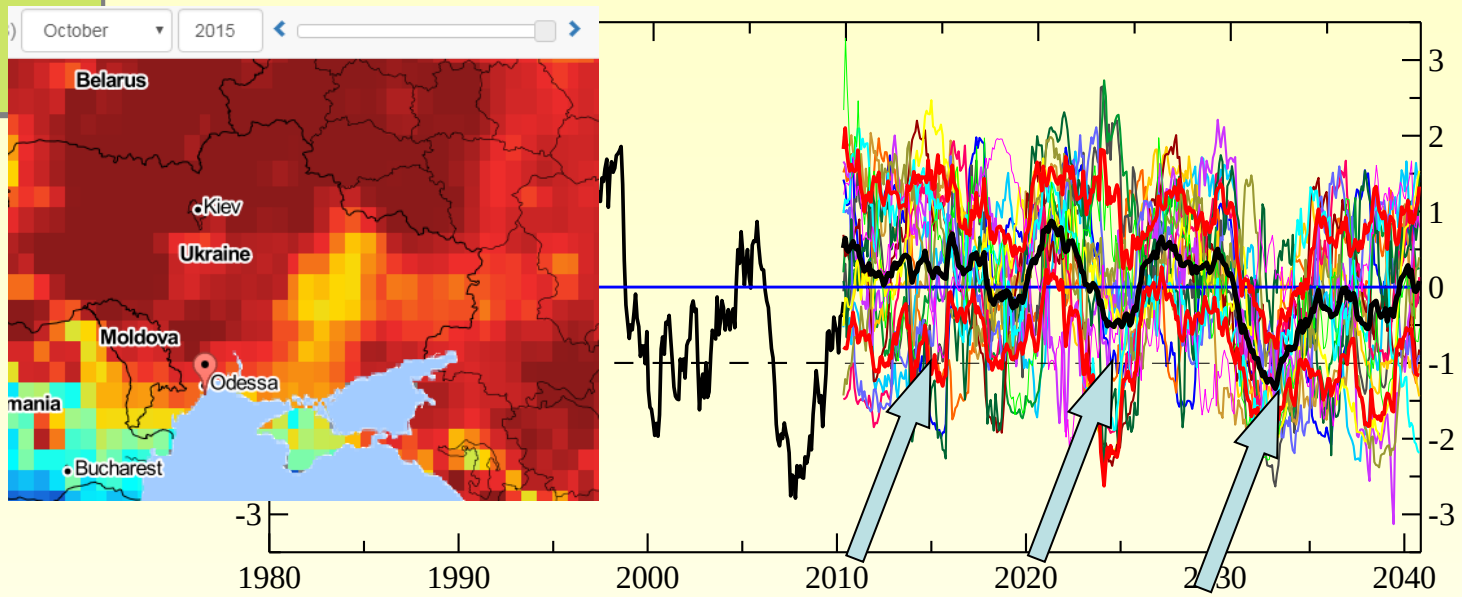
– rising (by linear trend) temperature (about 0.8 °C per 30 years) and precipitation (about 40 mm per 30 years)

– changeable increase of temperature and sharp decrease of precipitation during the 2023-26

– sharp increase of temperature following decrease of precipitation during the 2028-31

– sharp decrease of temperature against the steady precipitation background during the 2037-40

Future droughts



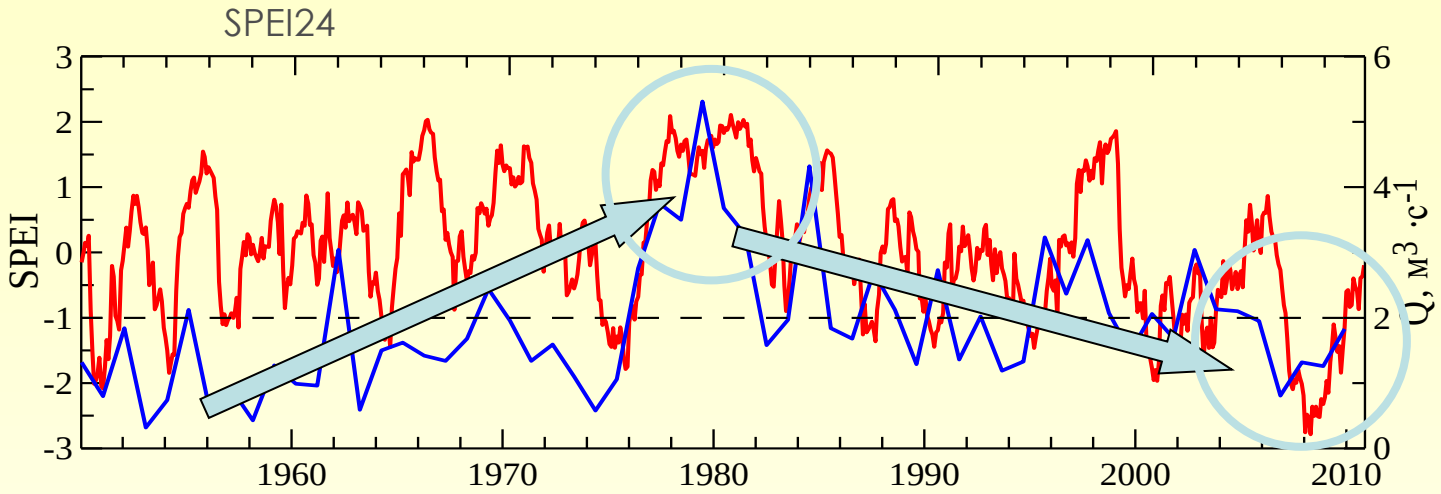
24-month SPEI in Odessa (Southern Ukraine) from 1980 to 2041

– next long and severe droughts can be registered about 2025 and after 2030

– the period 2031-2040 will be driest and duration of drought can be a few year

– it's rather surprising, the model ensemble reveals the drought in 2014–16 (real data from the Global Drought Monitor; Vicente-Serrano et al.)

Consequences for water resources



SPEI24 (red) and annual mean water discharge in middle course of Southern Buh River (blue)

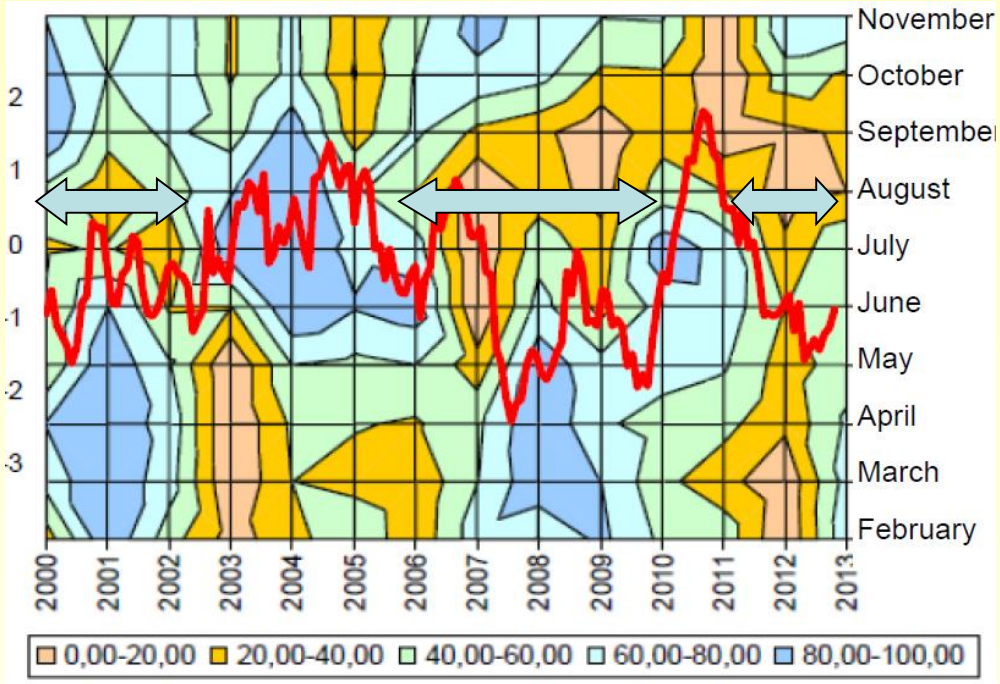
– strong positive trend up to the end of 1970s

– negative trend from 1980

– droughts not registered during five years resulting in the maximal water in 1980

– intensive water-management activities during last years

Consequences for agriculture



VCI = *f*(NDVI);

VCI < 50% - drier conditions

VCI (Vegetation Condition Index; %) in Southern Ukraine (Semenova, 2016) and SPEI12 (red)

– drier conditions in summer are well correlated with the SPEI12

Short conclusions:

– a vulnerability of different community in Southern Ukraine to the droughts in the nearest future will be rather high

– droughts can impact both the water-management and agricultural sector

– future droughts together with undeveloped irrigation will result in negative effect on the cereals

Thanks a lot for your attention !