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Essential Tools To Establish A Comprehensive Drought Management Plan: Konya Closed Basin as a Case Study

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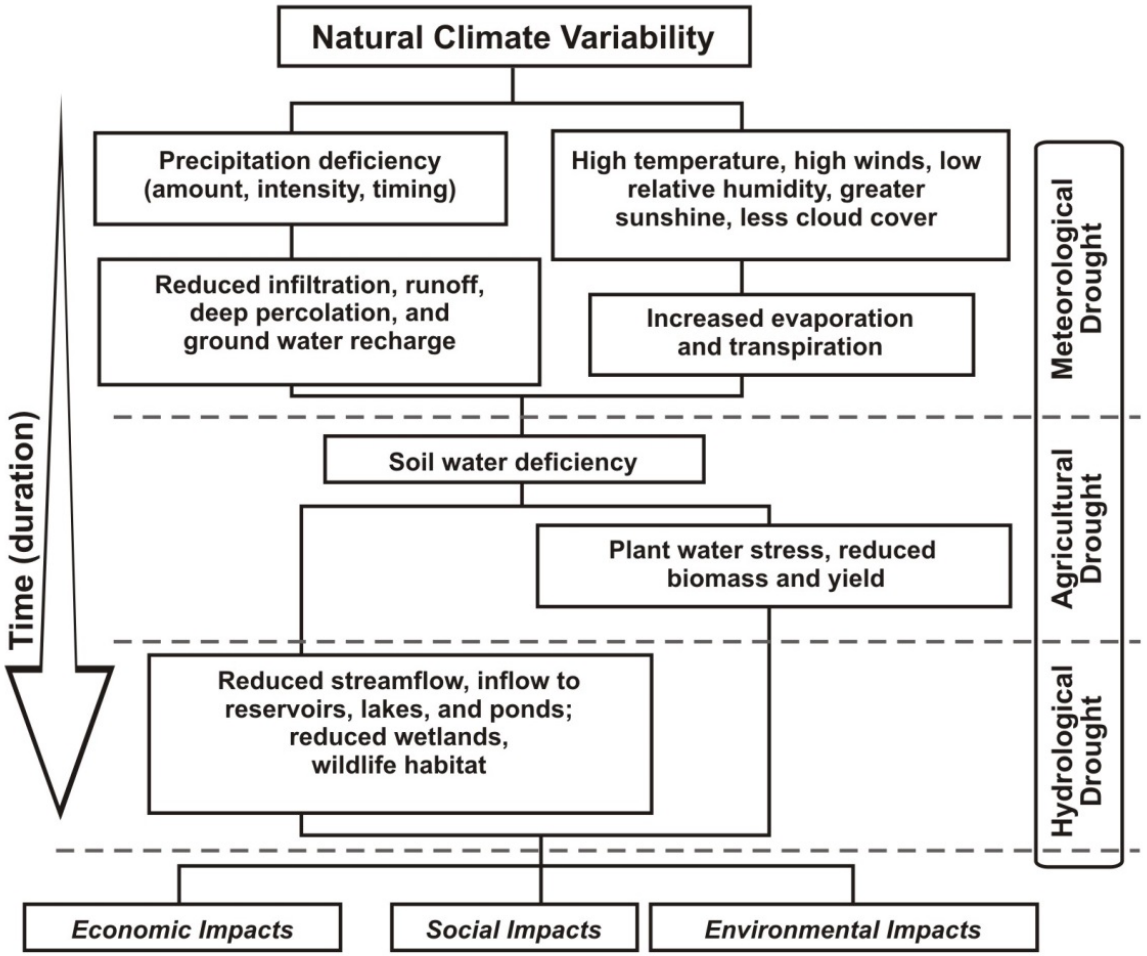
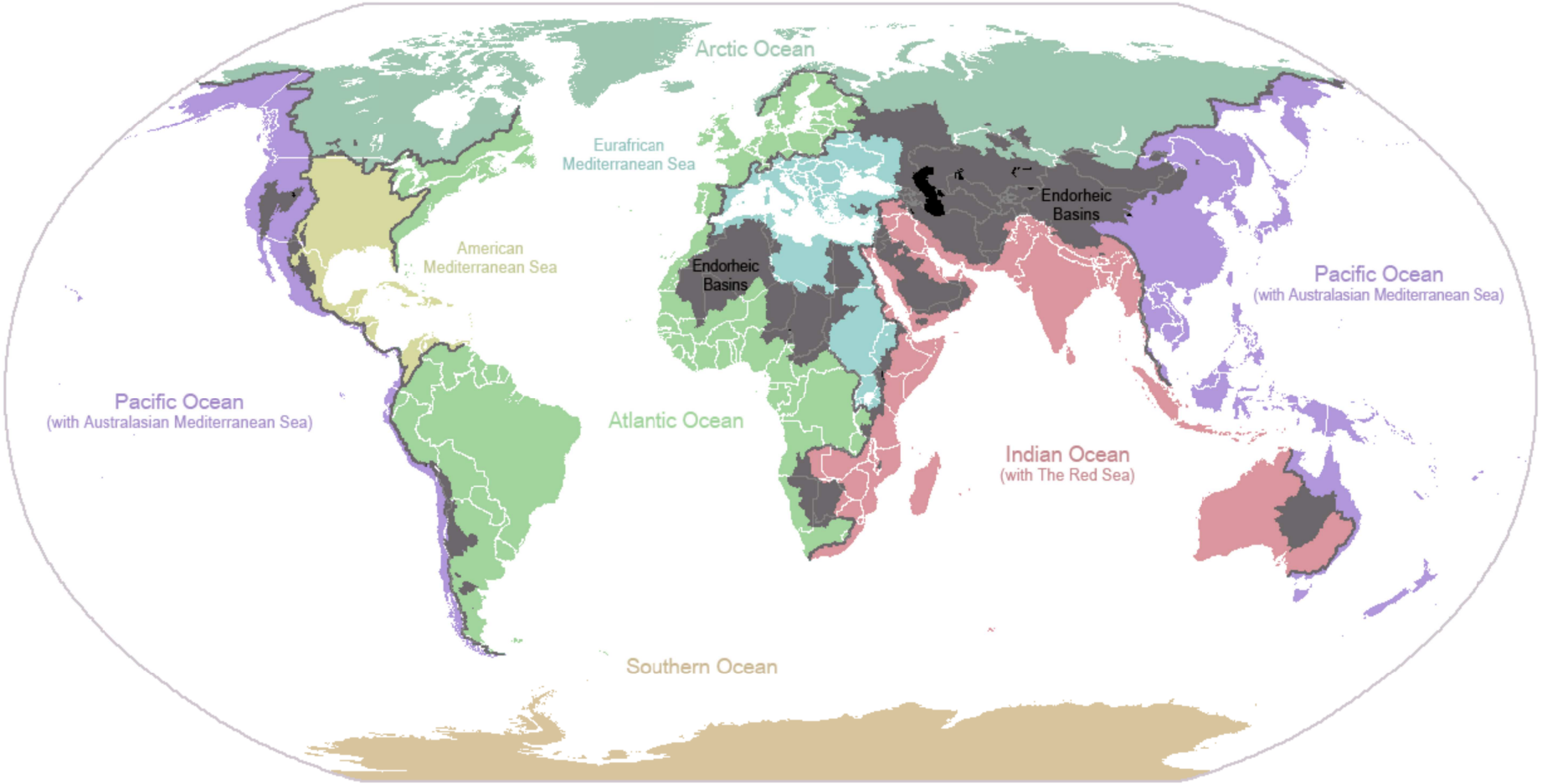
Outline

- Drought Hazard
- Drought Hazard in Closed Basins
- Drought Monitoring & Assessment
- Drought Hazards & Climate Change
- Drought Decision Support System
- Drought Impact Assessment
- Drought Vulnerability Assessment
- Case Study: Konya Basin

Drought Hazard



Drought Hazard in Closed Basins

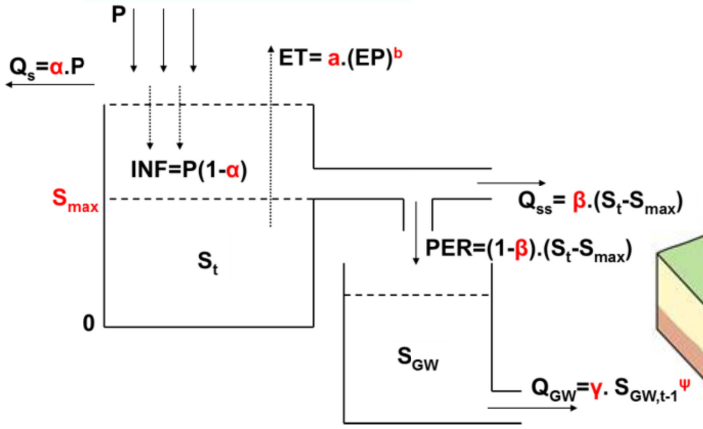


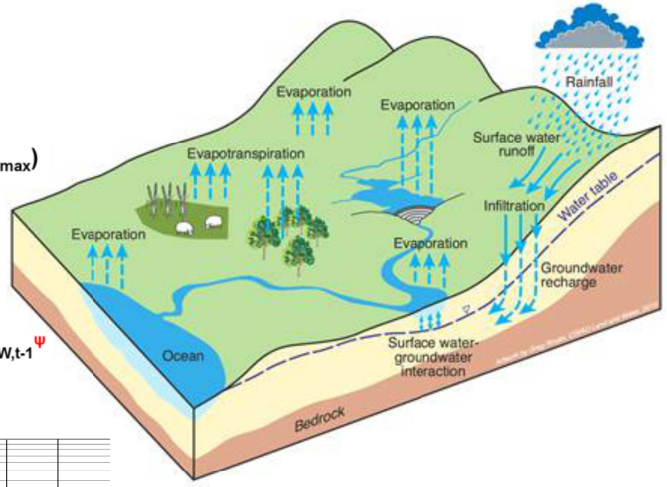
Drought Monitoring & Assessment

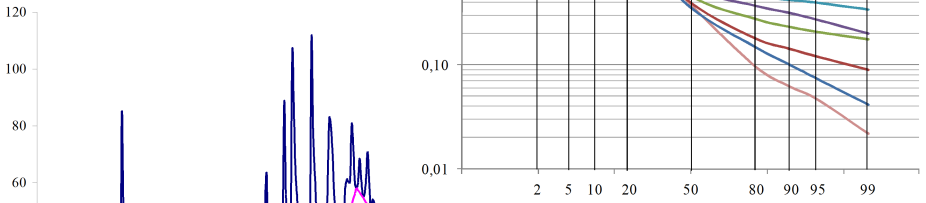
DROUGHT INDICES	Meteorological	Agricultural	Hydrological	Climatological	Agro-hydrological	Climate Change	Historical Evaluation	Risk Assessment	Monitoring & Forecasting
Percent of Normal Precipitation Index (PNI)	x	x							
Standardized Precipitation Index (SPI)	x		x						x
Palmer Drought Severity Index (PDSI)	x	x					x	x	
Palmer Hydrological Drought Index (PDHI)			x						x
Palmer Z-Index (ZNDX)					x				
Water Exploitation Index (WEI)			x						
Aridity Index (AI)	x	x		x		x			x

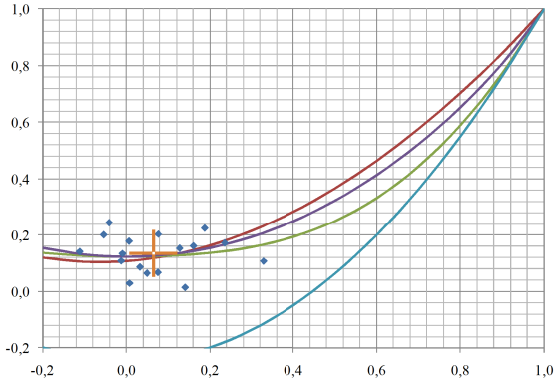
Hydrological Drought Assessment

- Deterministic Approaches
  - Rainfall-Runoff Model
- Statistical Approaches
  - Flow-Duration,
  - Flow-Frequency,
  - Recession Curve



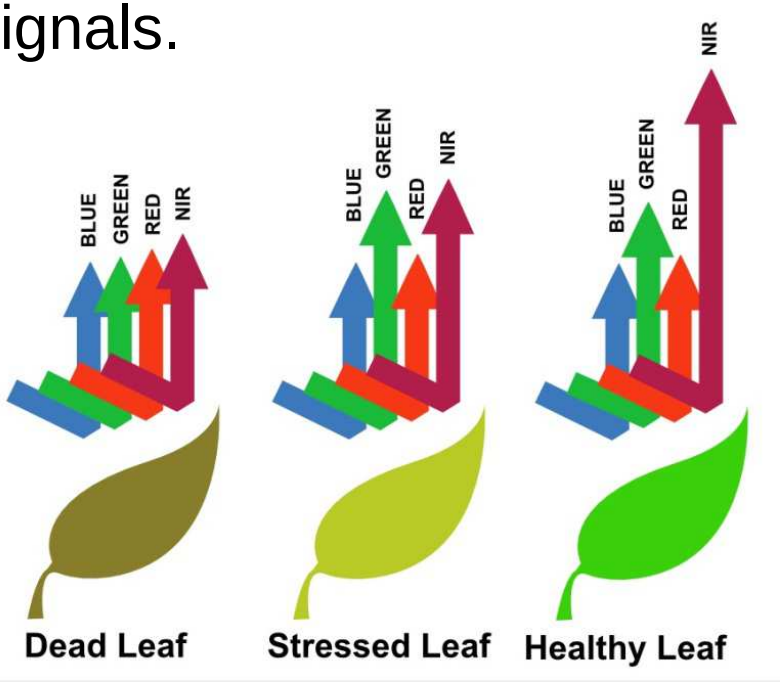


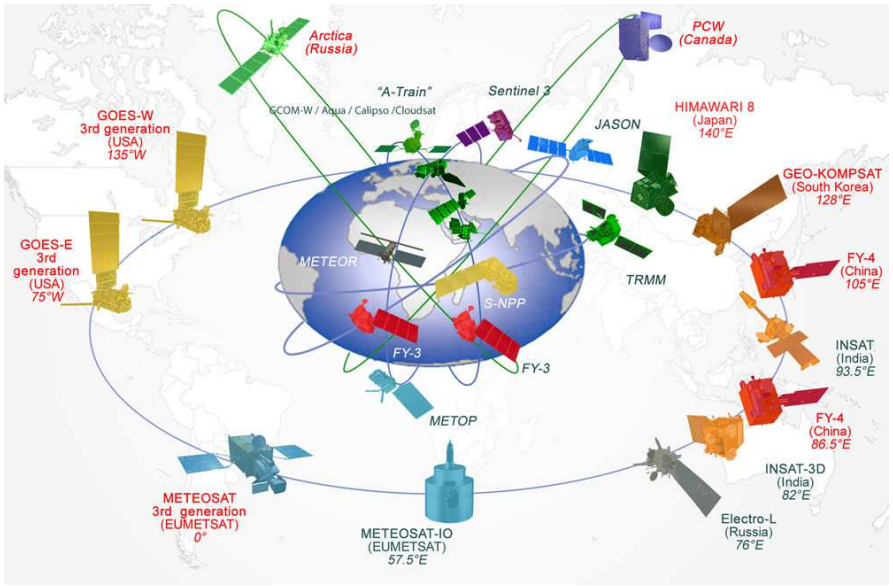


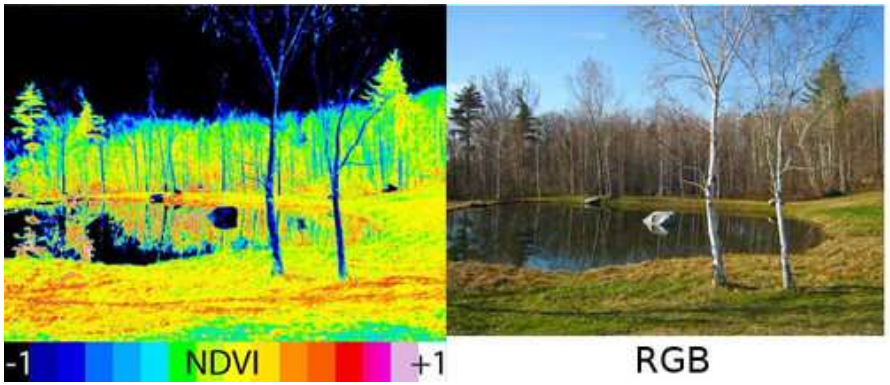


Remote Sensing Techniques in Drought Assessment

- Various indices have been developed to monitor vegetation change by processing satellite signals.

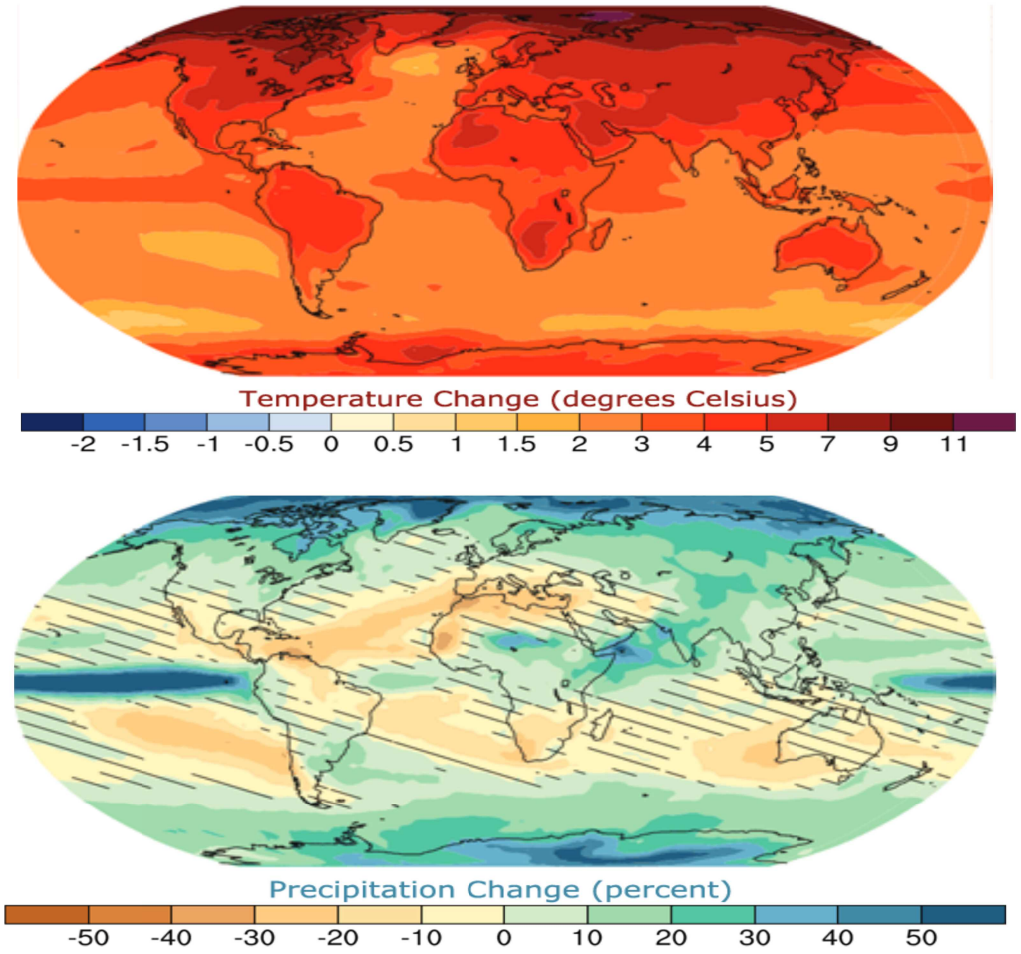






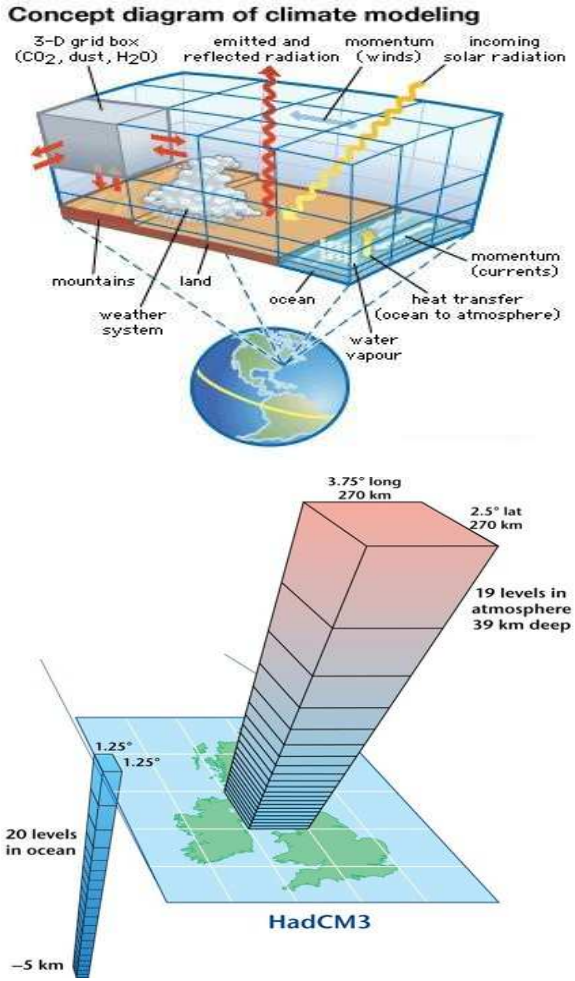
Climate Change & Droughts

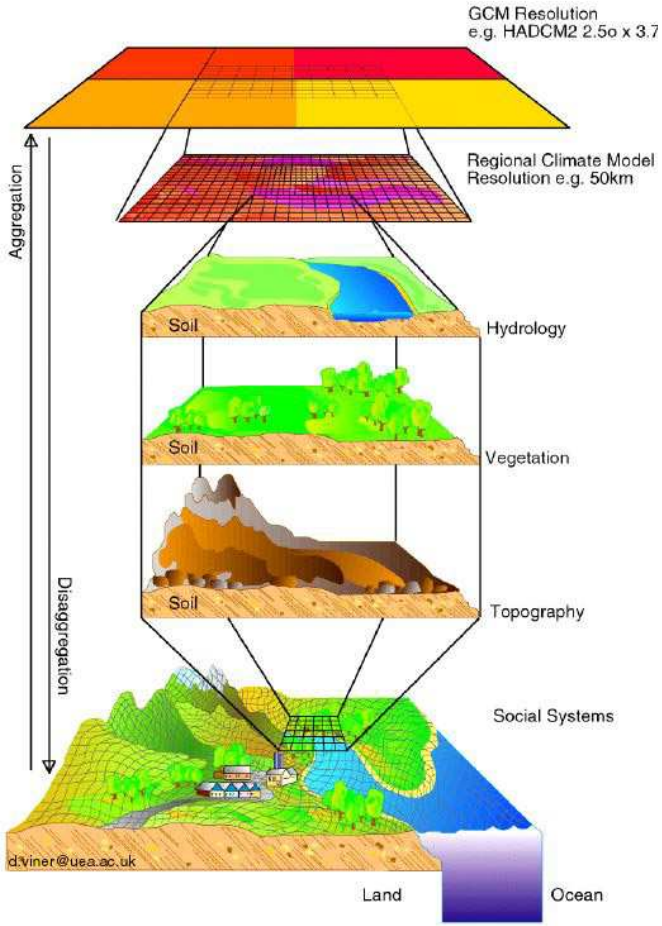
- GHG and emissions from human activities are estimated to keep accumulating to the compelling levels in the atmosphere by 2100.
- These accumulations are likely to emerge as changes in precipitation and air temperature.
- Climate change as a consequence of global warming unbalance the existing conditions in hydrological systems and processes.



Drought Assessment under Climate Change

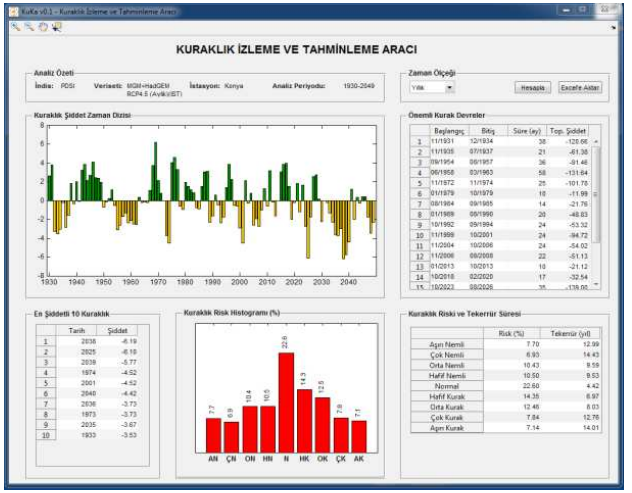
- Climate change projections are performed by climate modeling.
- RCM simulations provide valuable insight into drought studies.
- These outputs can be used to project future streamflow, low flow behavior of surface waters, and drought conditions.

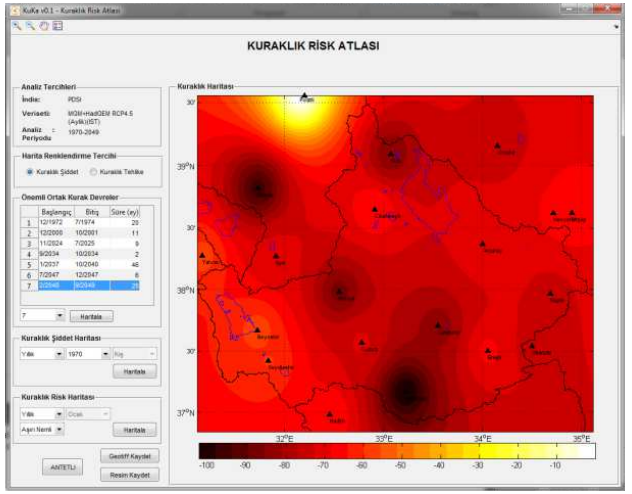




Drought Decision Support System

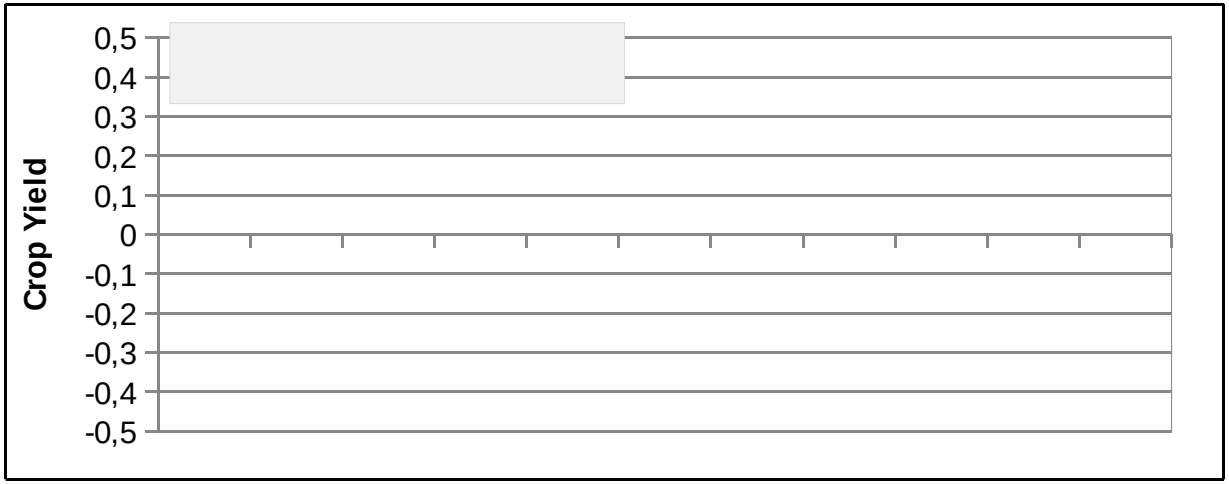
- A toolbox associated with a geographical database is required to compile all available datasets –such as meteorological, hydrological, agricultural, administrational, economic and social– and monitor, forecast and assess historical and prospective drought risks.

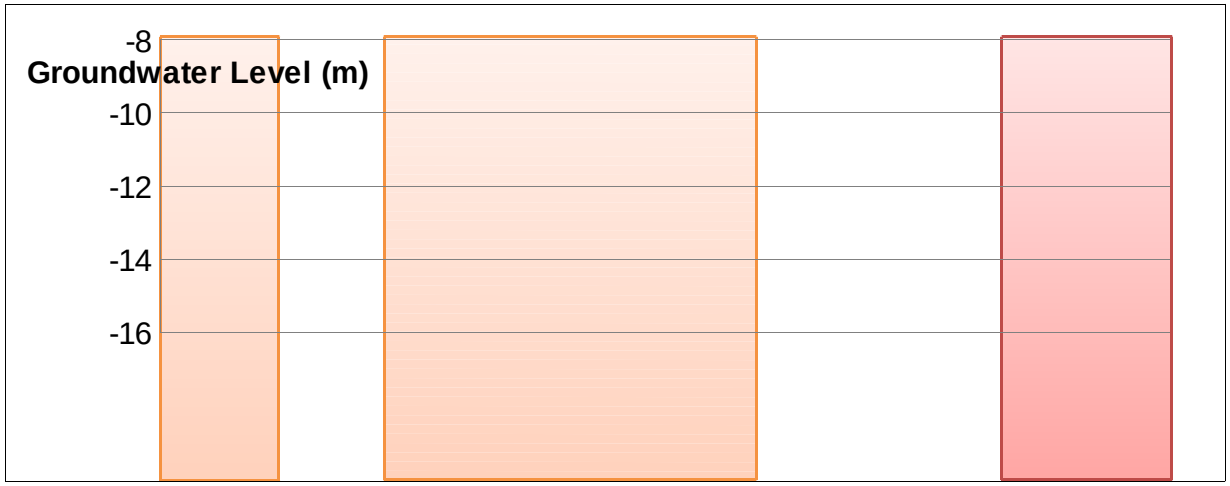




Drought Impact Assessment

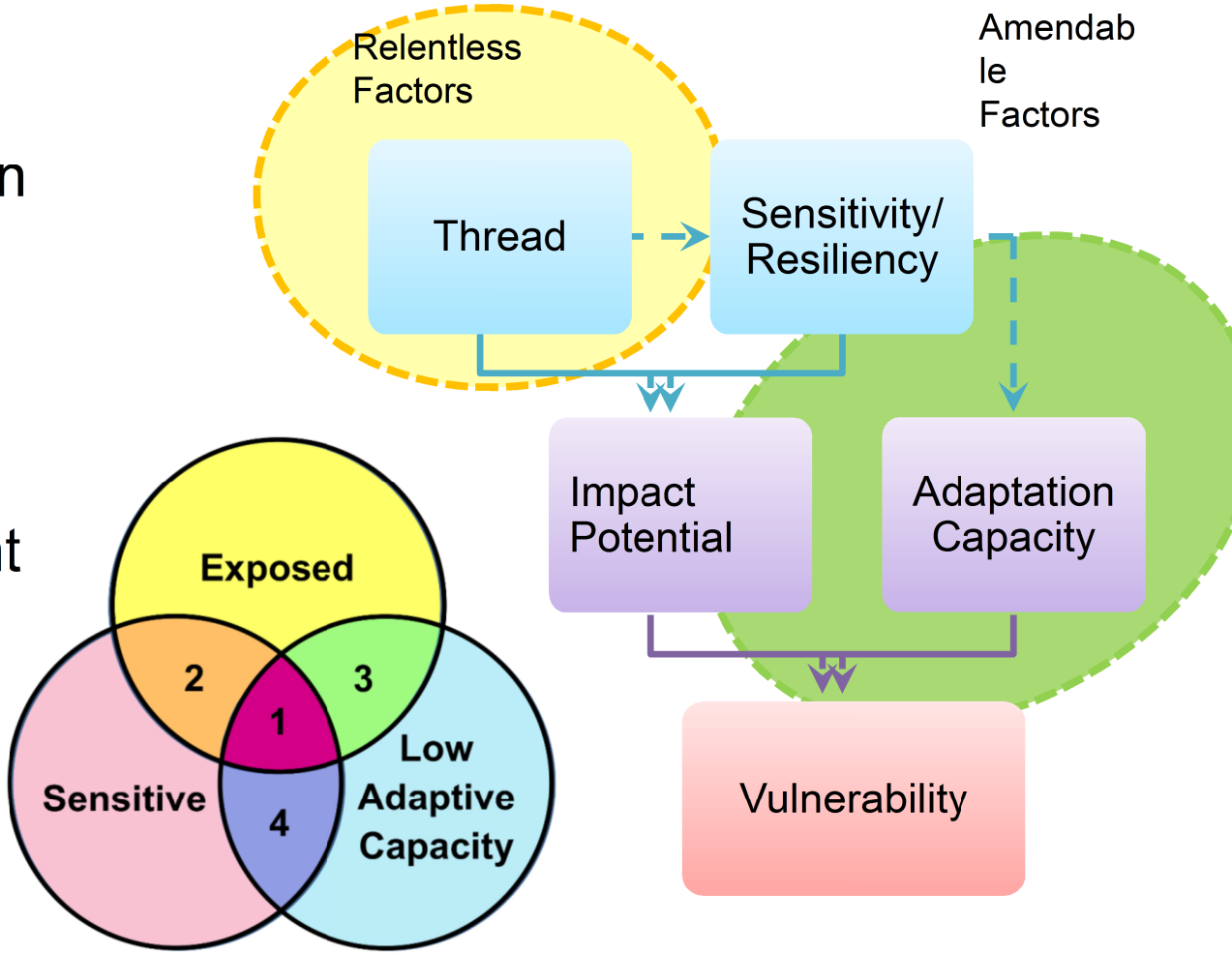
- Severity-duration-impact relationship of drought hazards should be assessed.
- However, impacts of historical droughts are usually not well-reported or quantitatively assessed.
- Therefore drought impact data needed to be generated.



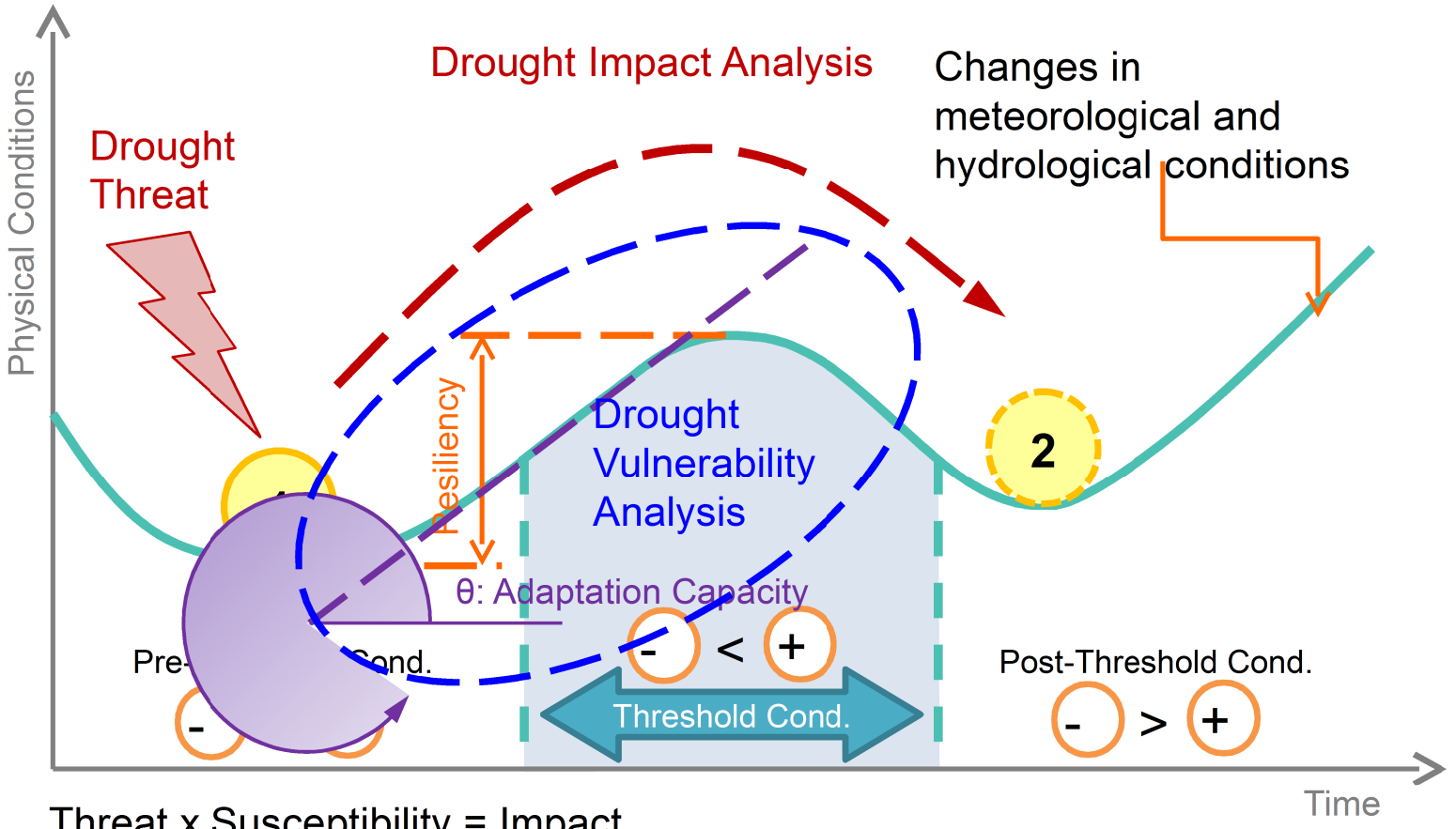


Drought Vulnerability Assessment

- This approach incorporates all drought-related information along with temporal and spatial characteristics, severity, frequency and impacts of drought hazards.
- The output of the assessment is a singular vulnerability score.
- This is a beneficial tool for administrators and policy makers.



Drought Vulnerability Assessment

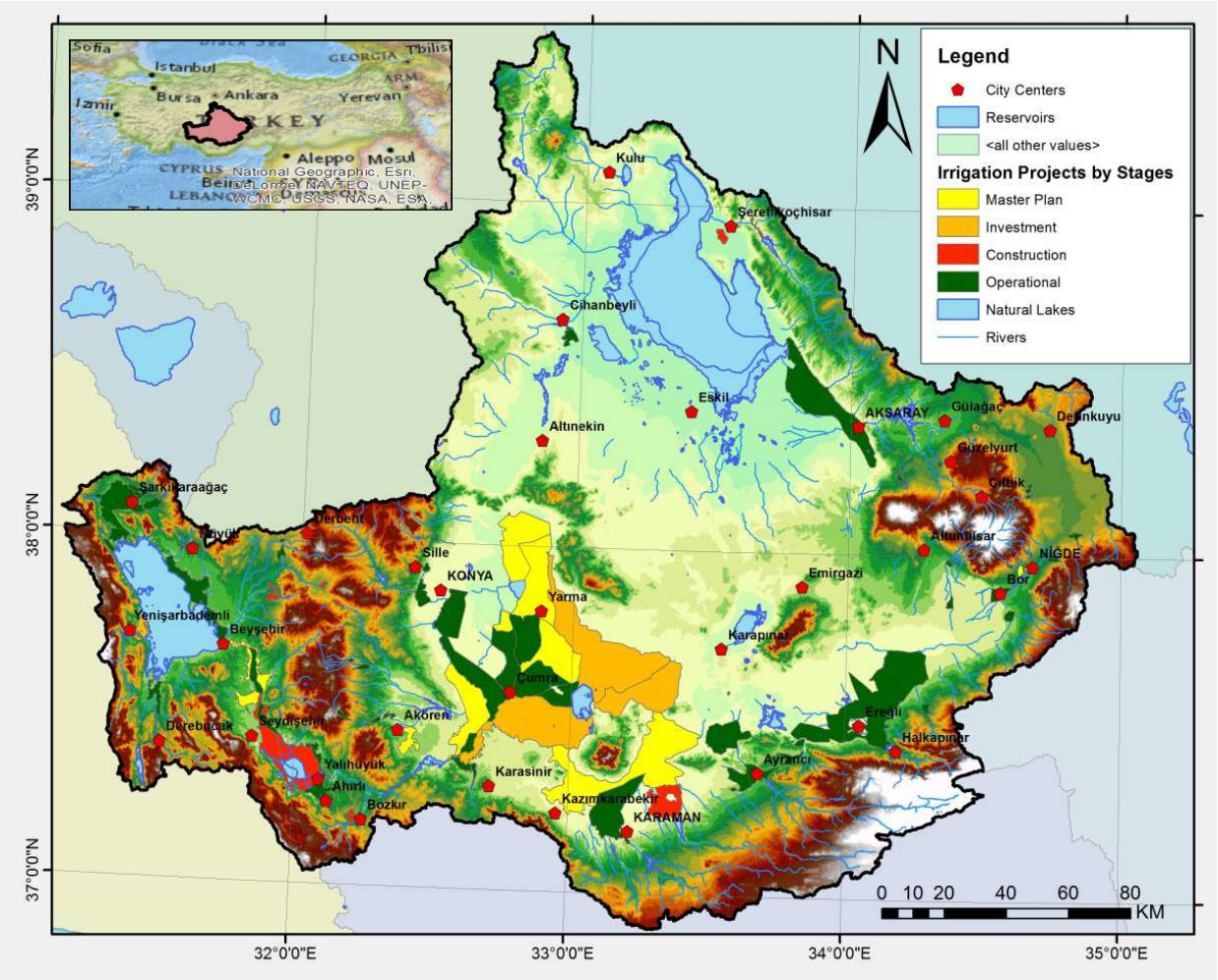


Threat x Susceptibility = Impact
Impact / (Adaptation Capacity) = Vulnerability
Prospective Threats x Vulnerability = Risk

Source: Ocean Tipping Points project

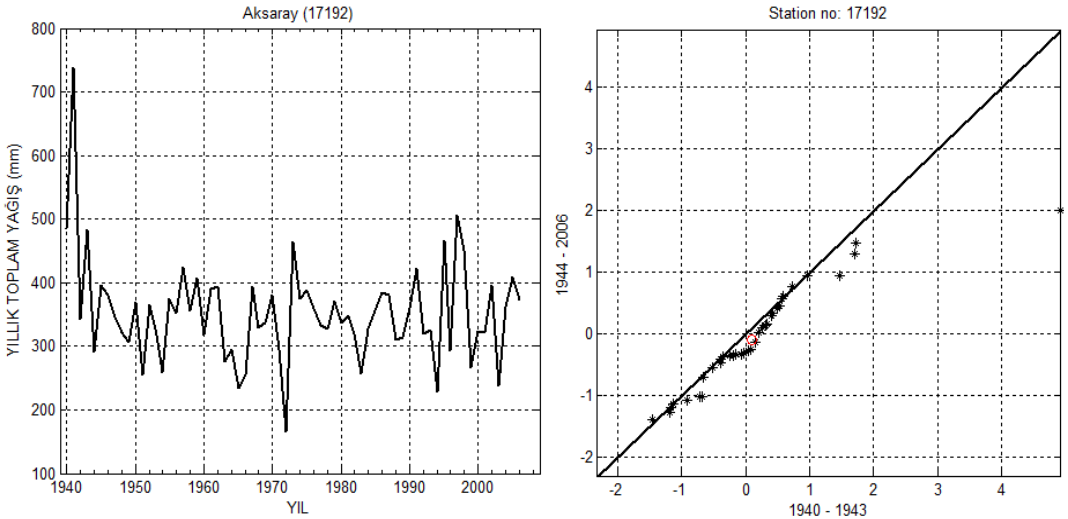
Study Area: Konya Closed Basin, Turkey

- Area: 50000 km²
- Pannual: 275-755 mm (347mm)
- EP: 220-320 mm in July
- ETannual: 290-320 mm
- Surface Water Potential: 2500 hm³/year
- Ground Water Potential: 2000 hm³/year
- Inter-Basin Water Transfer Potential: 414 hm³/year
- Arable Lands: 25000 km²

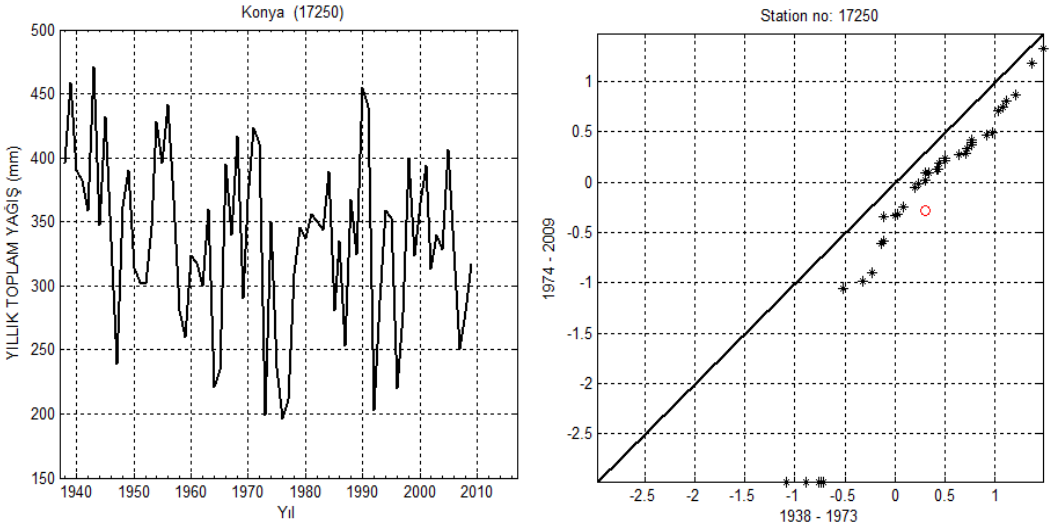


Trends in Precipitation Records

- Annual precipitation rates decreased about 5-10% in the region.
- The frequency of light rains remains constant, but high and moderate rainfall frequencies decrease in the basin.



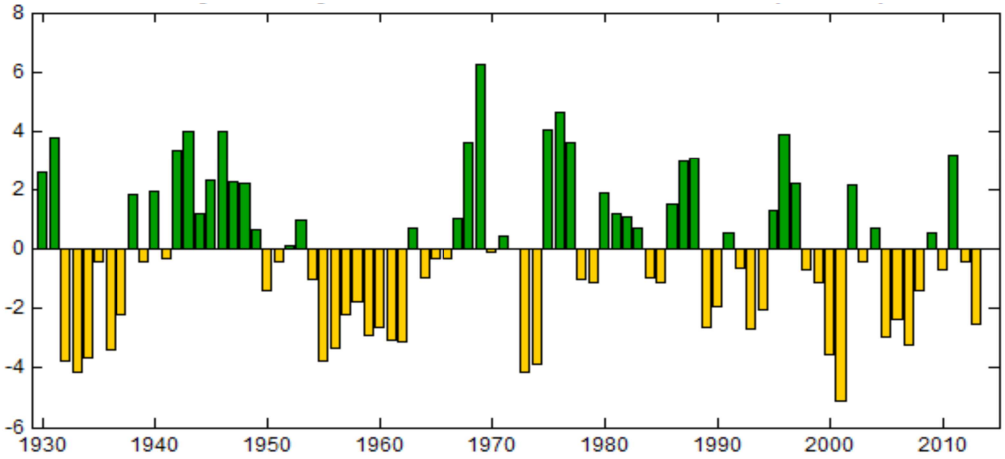
Trends in Rainfall recorded at Aksaray Meteorological Observation Station



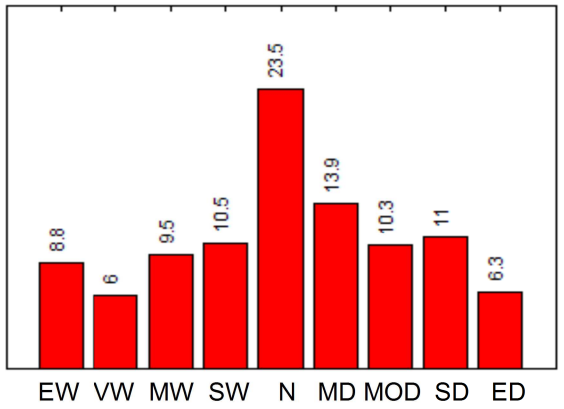
Trends in Rainfall recorded at Konya Meteorological Observation Station

Droughts in the Basin

- The basin has been overwhelmed by droughts at various severity levels once in every 2½ to 3 years.
- Mild and moderate droughts are computed most frequent and recurred once in every 5½ to 7 and 9 to 10 years, respectively.
- Severe droughts are experienced between 1973-1974, 1984-1985, 2000, 2004-2009 and 2013.

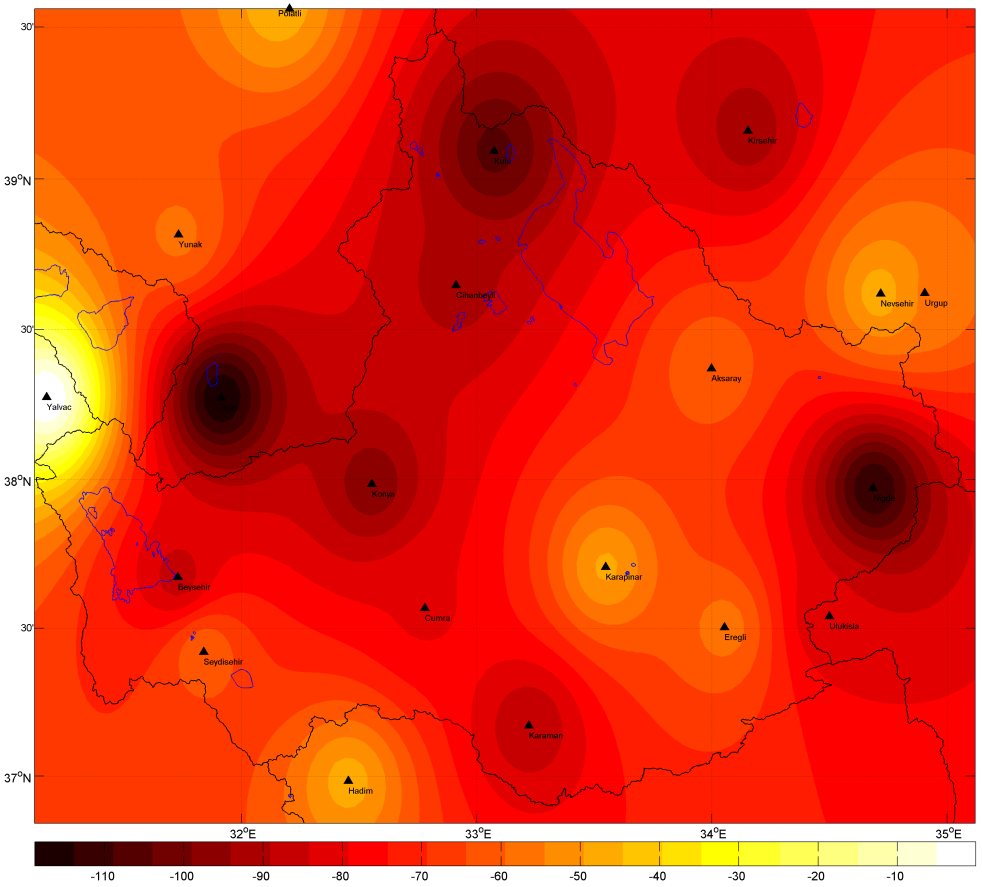


The PDSI Values computed at Konya MOS

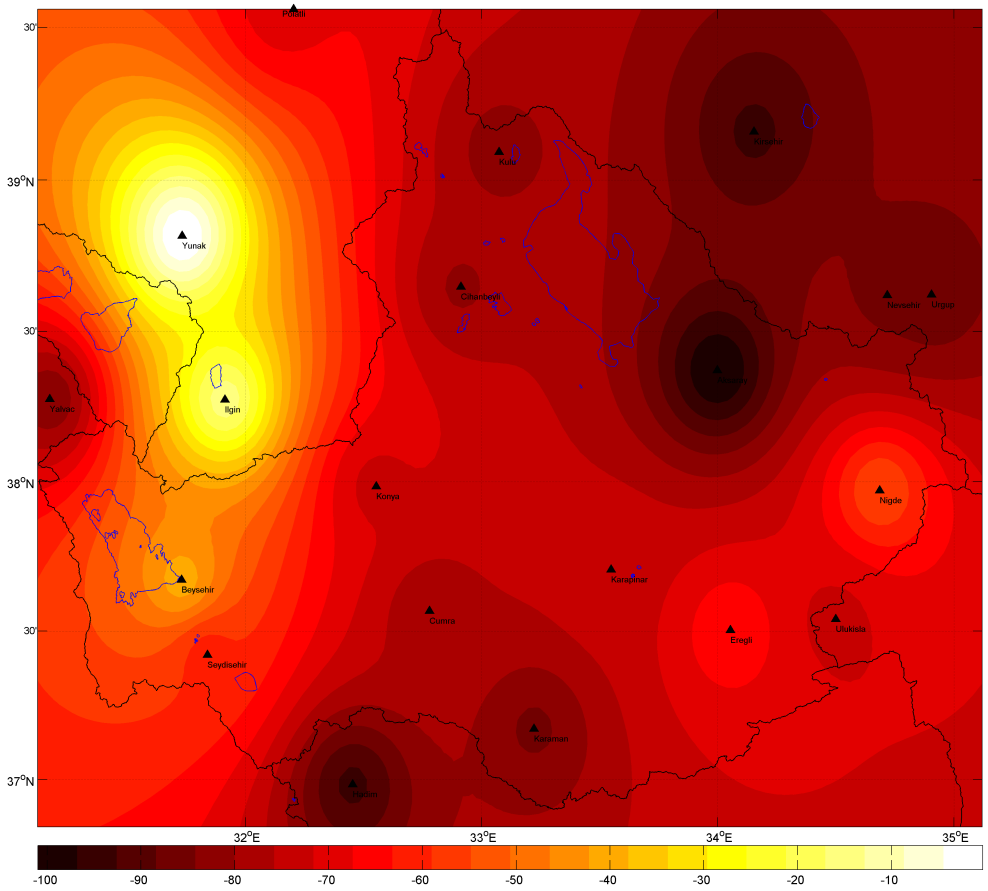


The Risk of Dry/Wet Conditions based on PDSI Values

Severe Prolonged Droughts

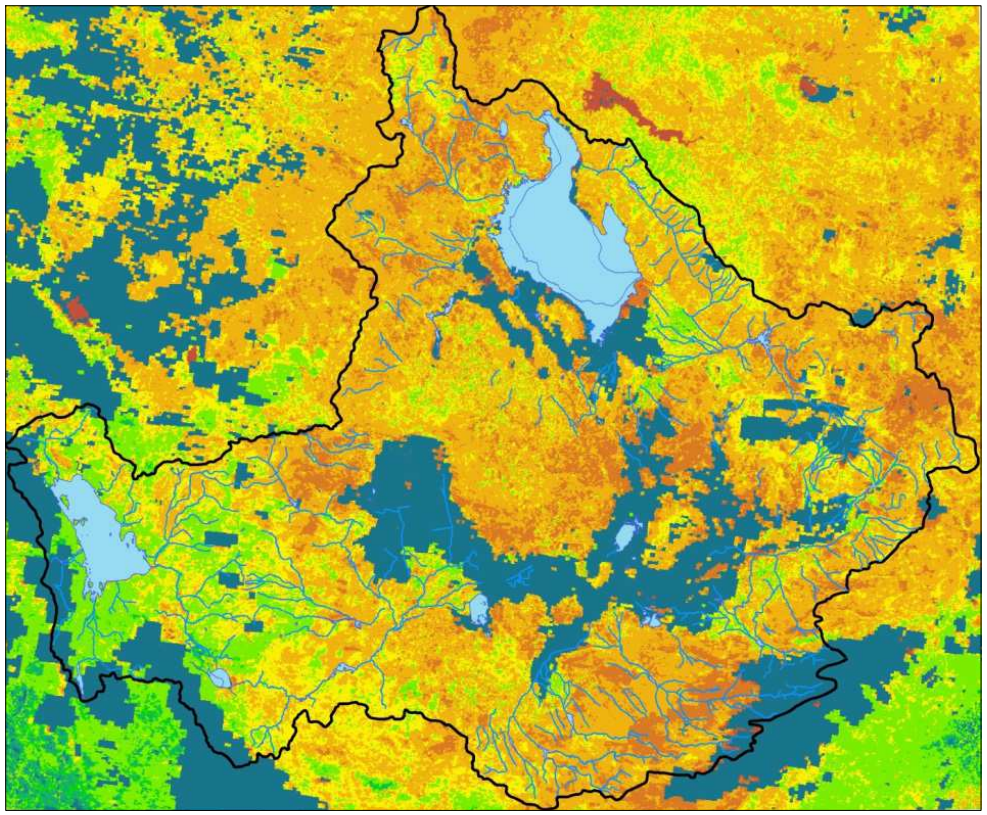


The spatial distribution of cumulative PDSI value in the 1973-74 drought

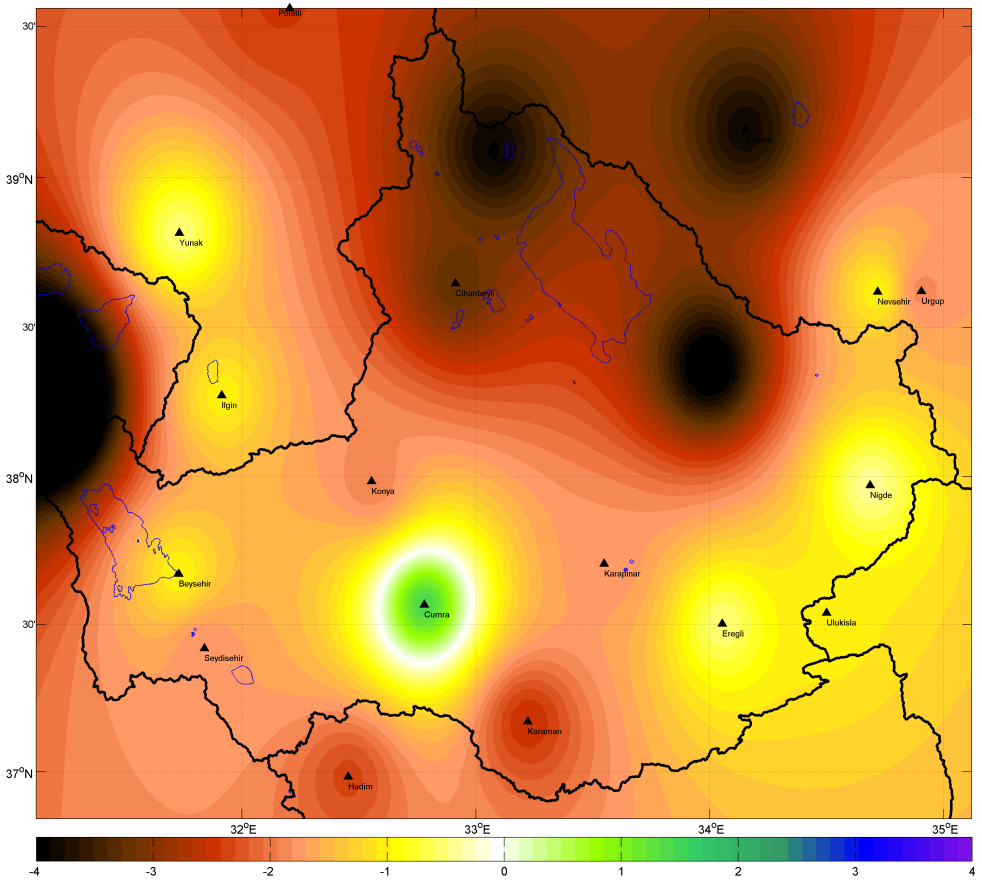


The spatial distribution of cumulative sc-PHDI value between 2007-09 drought

Detecting Drought using Remote Sensing Techniques



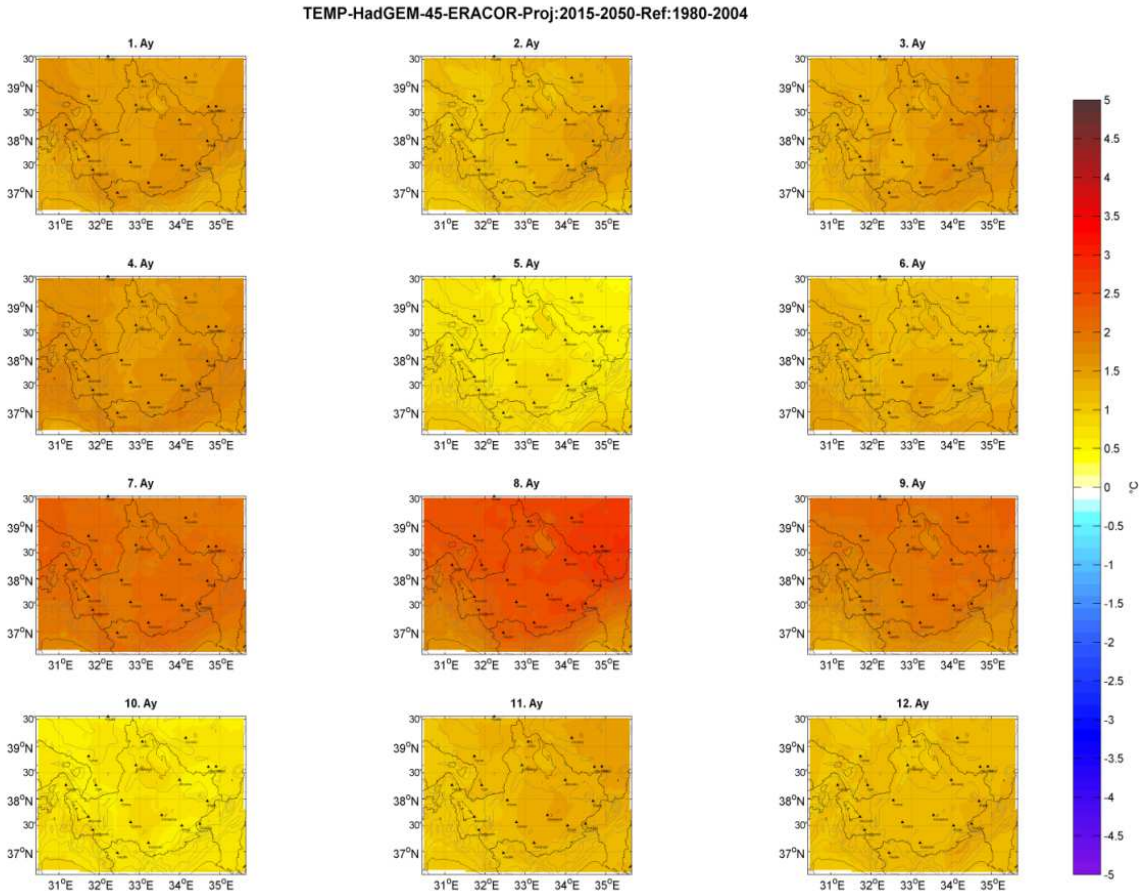
The NDVI computed using the MODIS image acquired on March, 22nd 2008



The spatial distribution of original PDSI value in March 2008

Regional Climate Modeling (RCM)

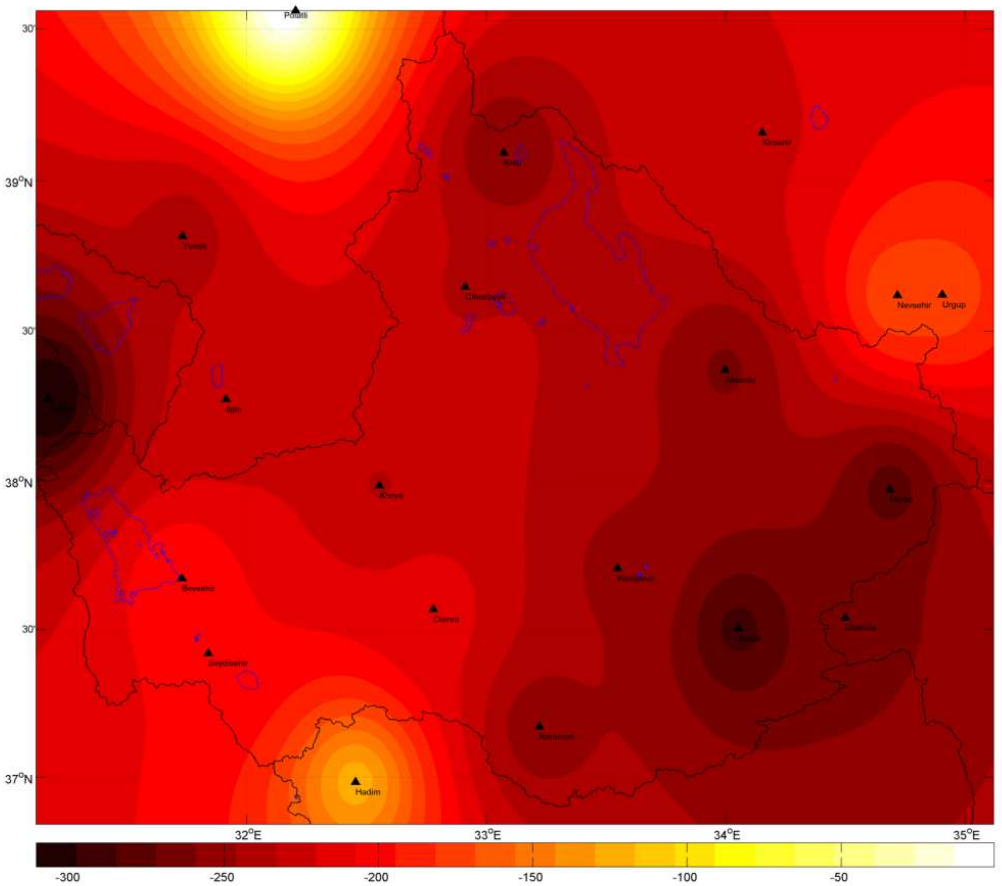
- GCMs used in the study:
  - MPI-ESM-MR (Max Planck, Ger)
  - HadGEM2-ES (Met Office, UK)
  - GFDL-ESM2M (NOAA, USA)
- RegCM 4.3.5 run under RCP 4.5 and RCP 8.5 scenarios at 10 km resolution.
- Bias-correction applied to the outputs.



Spatial distribution of monthly changes for temperature projections

Prospective Droughts in the Basin

- Prospective drought hazards are forecasted for the 2015-50 period using RCP4.5 outputs of HadGEM2 GCM.
- Simulations established that three major droughts would emerge in the next 35 years.
  - 2024-25 Drought
  - 2035-40 Drought
  - 2047-49 Drought



The spatial distribution of cumulative PDSI value of prospective 2037-40 drought

Conclusion

- More frequent droughts and floods are anticipated in following decades as a consequence of global warming and climate change.
- Institutions and organizations commissioned to act for the prevention of extreme hydrological hazards should develop strategies and management plans.
- Most of the countries have national strategy document or guideline for drought mitigation; however, there are very few plans exist for regional or basin-wise drought management.

THANK YOU FOR YOUR ATTENDANCE

Photos of Bagbasi Dam and the 17km long Derivation Tunnel from The Mavi Tunnel Inter-Basin Water Transfer Project (414 hm³/year)

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