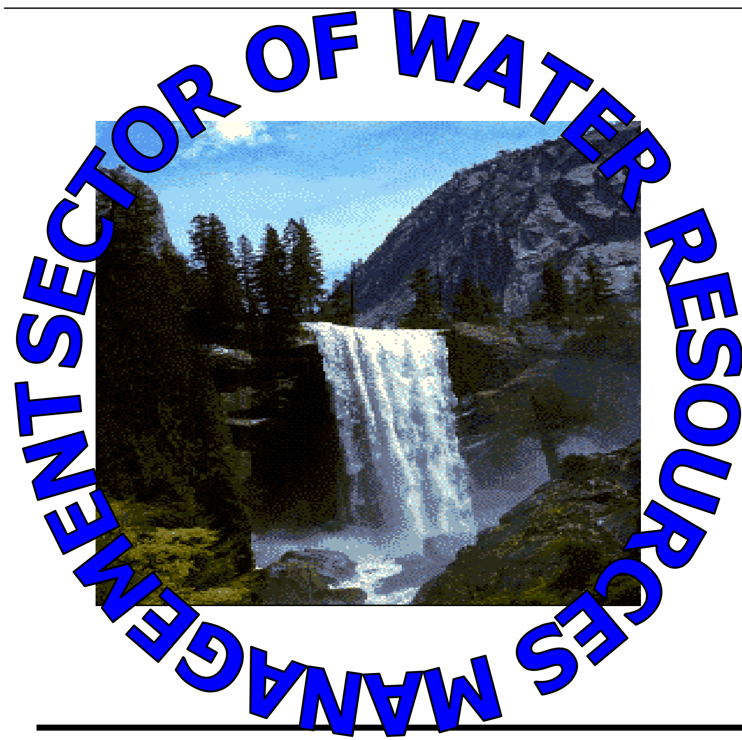
TOWARDS THE DEVELOPMENT OF DROUGHT MASTER PLAN FOR GREECE



Christos A. Karavitis,
Water Resources
Management
Agricultural University of Athens

TECHNICAL SUPPORT TO THE CENTRAL WATER AGENCY FOR THE DEVELOPMENT OF A DROUGHT MASTER FOR GREECE AND AN IMMEDIATE DROUGHT MITIGATION PLAN

Contract No. 10889/11/07 /2007
Ministry of Planning, Public Works and the Environment

To Water Resources Management Sector,
Department of Natural Resources and Agricultural Engineering,

Agricultural University of Athens

Co-ordinator Christos A. Karavitis

Submitted on October 2008

PRINCIPLES

- CONTINGENCY ORIENTED
- METHODOLOGICAL
- OPERATIONAL
- IMPLEMENTABLE TO A VARIETY OF LOCALES

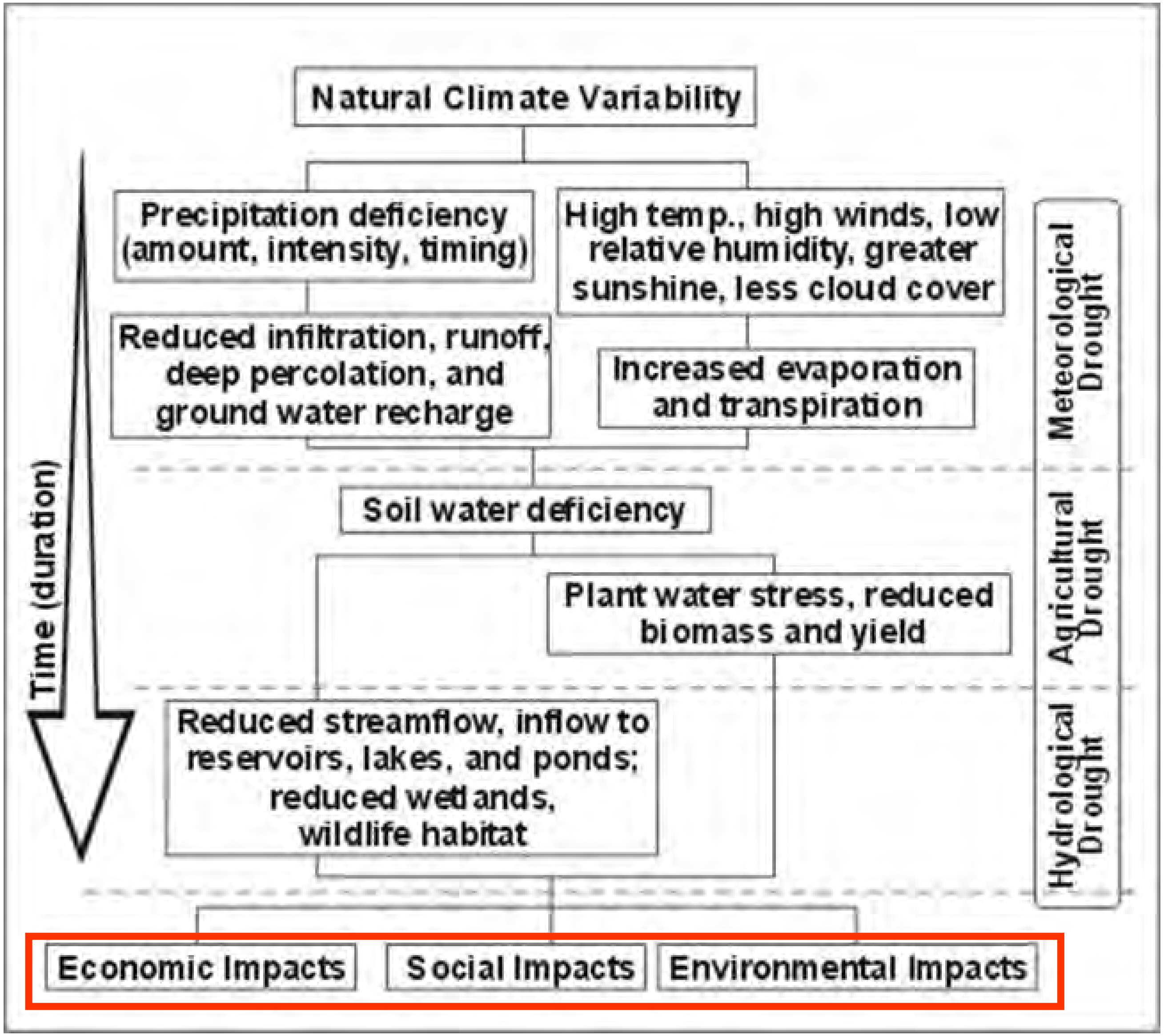
STRUCTURE

1. **Definition of Drought**
2. Policy Challenges- Indicators
3. Contingency Planning / Risk Management
4. Integrated drought management strategies
5. Forecasting-Conclusions

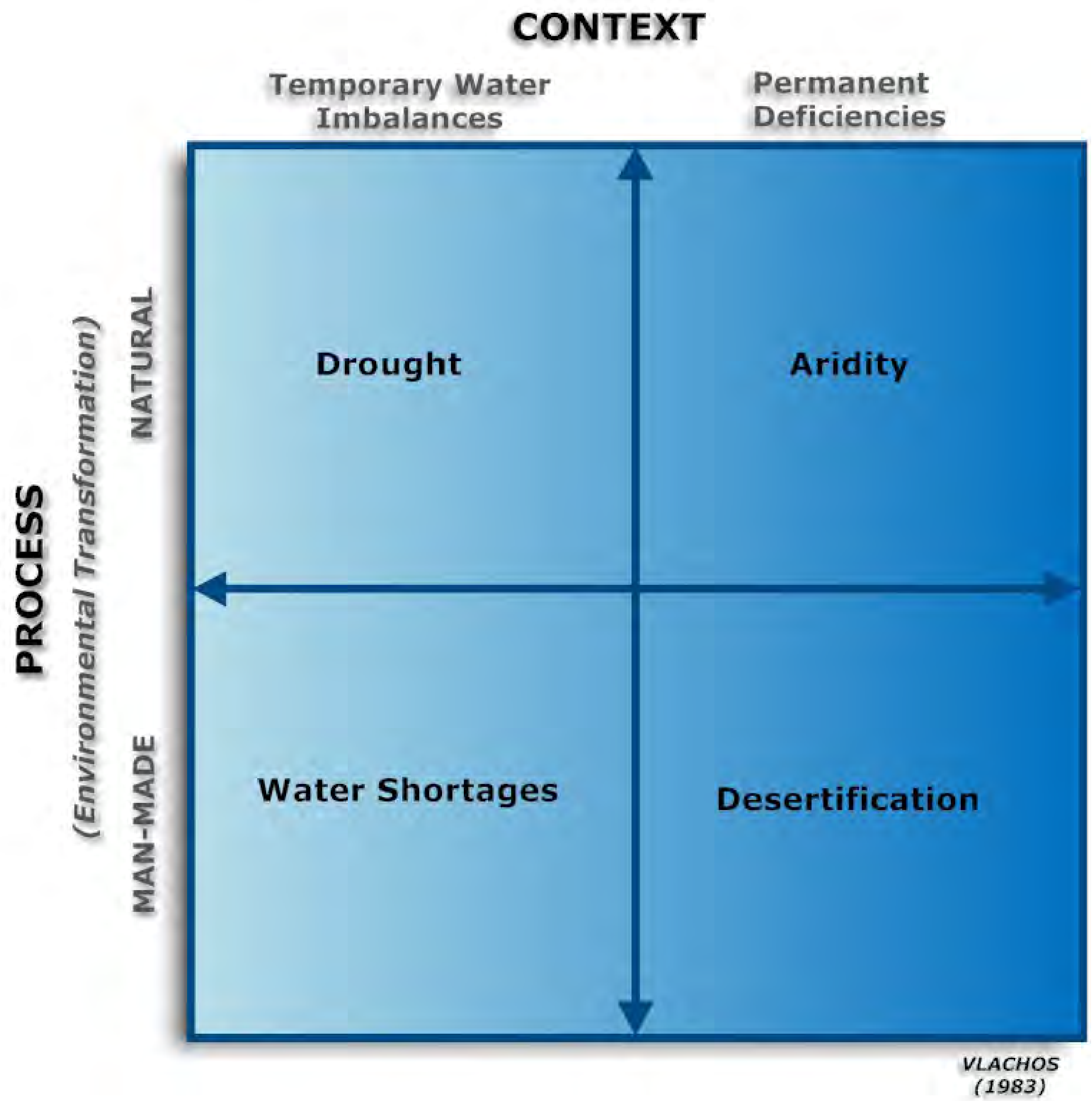
Definition of Drought

A creeping phenomenon, a “non-event”

- Operational definitions attempt to demarcate the severity, onset and termination point of droughts
- Conceptual definitions attempt to identify the boundaries of the drought event


Natural Climate Variability
Precipitation deficiency (amount, intensity, timing)
High temp., high winds, low relative humidity, greater sunshine, less cloud cover
Reduced infiltration, runoff, deep percolation, and ground water recharge
Increased evaporation and transpiration
Soil water deficiency
Plant water stress, reduced biomass and yield
Reduced streamflow, inflow to reservoirs, lakes, and ponds; reduced wetlands, wildlife habitat
Economic Impacts
Social Impacts
Environmental Impacts
Time (duration)
Meteorological Drought
Agricultural Drought
Hydrological Drought

Water Deficiencies



Drought

- a usually unexpected and unpredicted time period of abnormal dryness which affects water supply" (Grigg, N.S., 1988).

- The state of adverse and wide spread hydrological, environmental, social and economic impacts due to less than generally anticipated water quantities (Karavitis, 1992)

Social and Economic Drought / Water resources Engineering

- Gap between supply and demand of economic goods such as
  - water,
  - food,
  - raw materials,
  - hydroelectric power,
  - transportation

- depends on the time and space processes of supply and demand
- Social Stresses – Economic impacts

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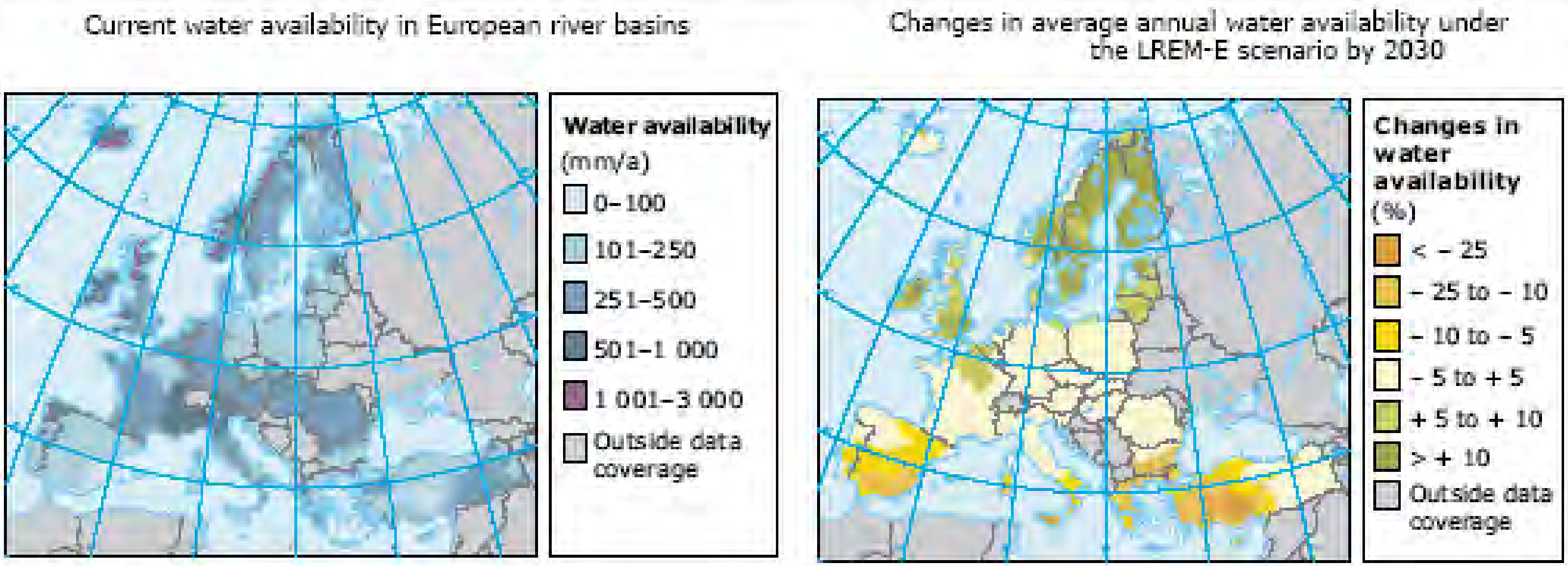
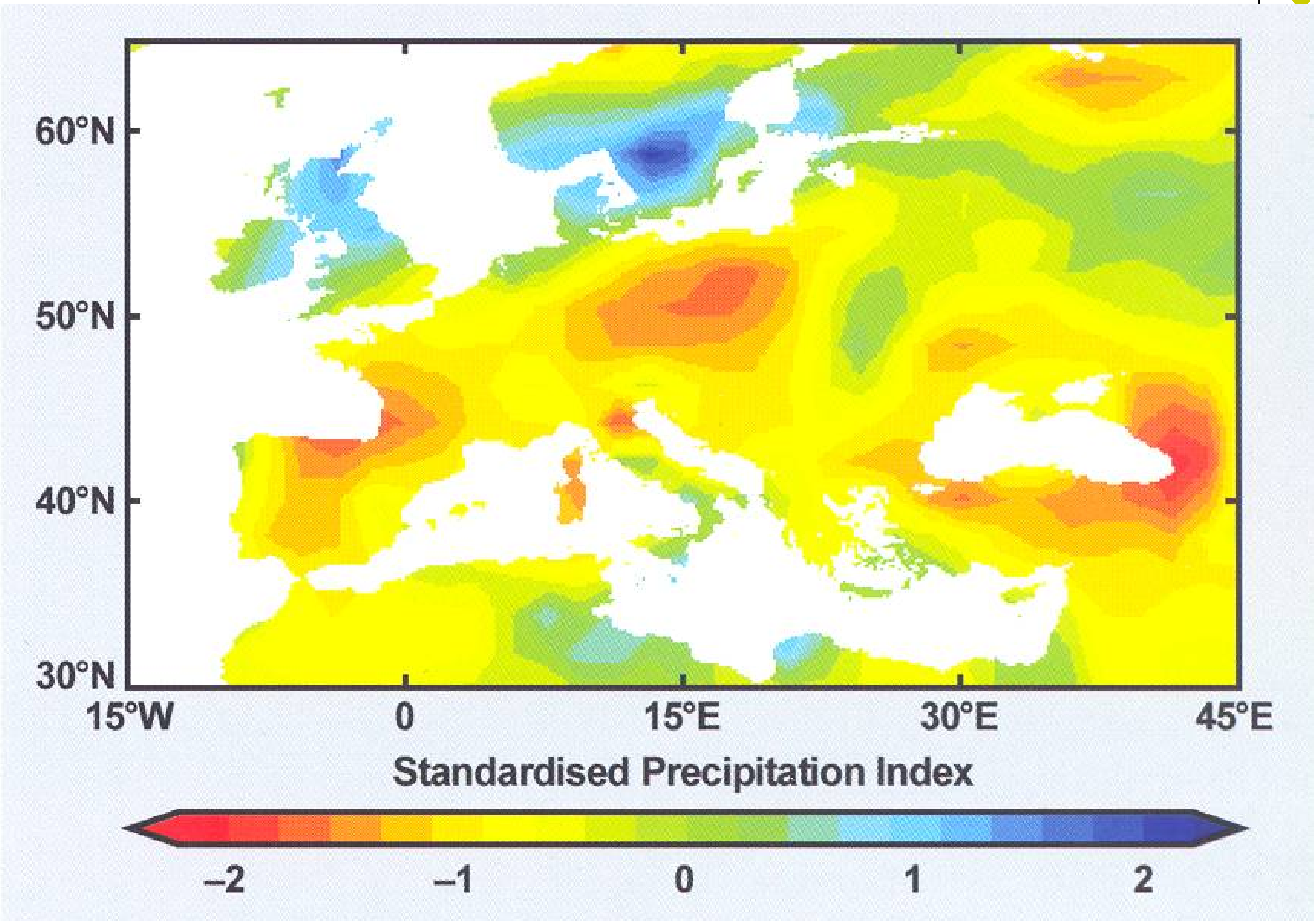
Map 5.1 **Current water availability and changes expected by 2030**



Source: EEA, 2005.

The 2003 Drought in Europe

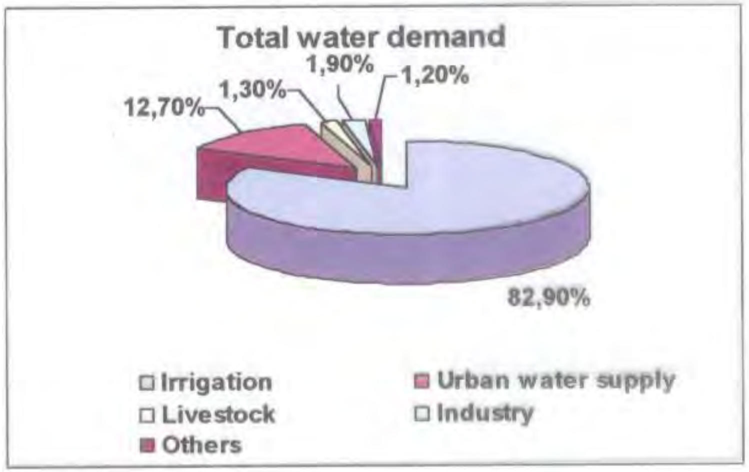


WATER DEMAND

Table 4. Annual water demand per sector and water district.

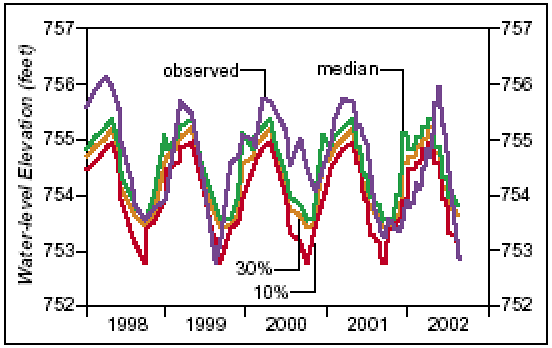
Water district	Irrigation	Livestock	Urban water supply	Industry	Others	Total
	(hm^3)					
1. W. Peloponnesus	201,0	5,0	23,0	3,0	20,0	252,0
2. N. Peloponnesus	401,5	6,6	41,7	3,0	-	452,8
3. E. Peloponnesus	324,9	4,7	22,1	-	-	351,7
4. W. Central Greece	366,5	9,0	22,4	-	-	397,9
5. Epirus	127,4	9,9	33,9	1,0	-	172,2
6. Attica	99,0	2,5	400,0	17,5	-	519,0
7. E. Central Greece	773,7	9,9	165,9 *	12,6	-	962,1
8. Thessaly	1550,0	12,0	54,0	-	-	1616,0
9. W. Macedonia	609,4	7,9	43,7	30,0	80,0	771,0
10. Central Macedonia	527,6	8,0	99,8	80,0	-	715,4
11. E. Macedonia	627,0	5,8	32,0	-	-	664,8
12. Thrace	825,2	7,1	27,9	11,0	-	871,2
13. Crete	320,0	10,2	42,3	-	-	372,5
14. Aegean Islands	80,2	6,8	37,2	-	-	124,2
Total	**6833,4**	**105,4**	**1045,0**	**158,1**	**100,0**	**8242,8**

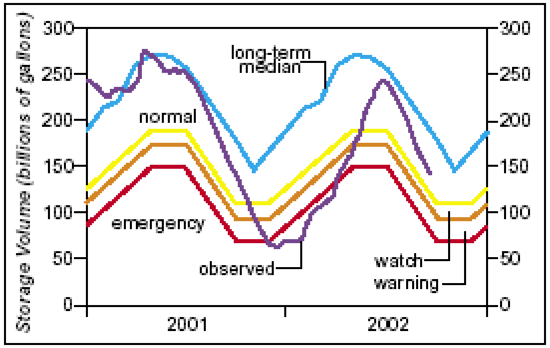
* From these, 41,6 are being used for the water supply of water district and the 124,3 for the water supply of Athens.

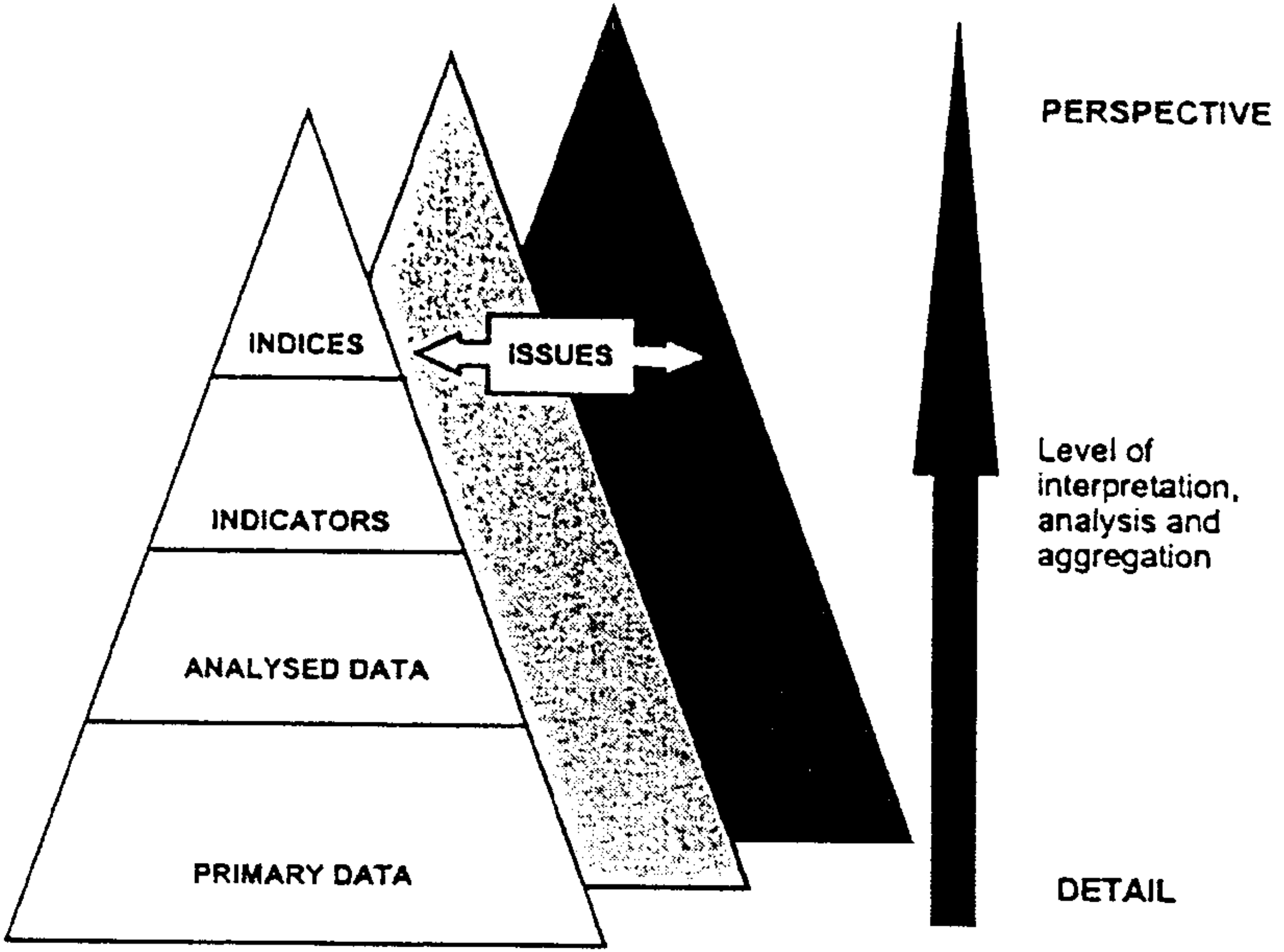


A plethora of Meteorological, Agricultural or Hydrological Drought Indices

- Percent of Normal
- Deciles
- Palmer Drought Index
  - PDSI, PHDI, CMI
- Surface Water Supply Index
- Standardized Precipitation Index (SPI)
- Vegetation indices (NDVI, VCI, SVI)
- U.S. Drought Monitor
  - Composite index approach





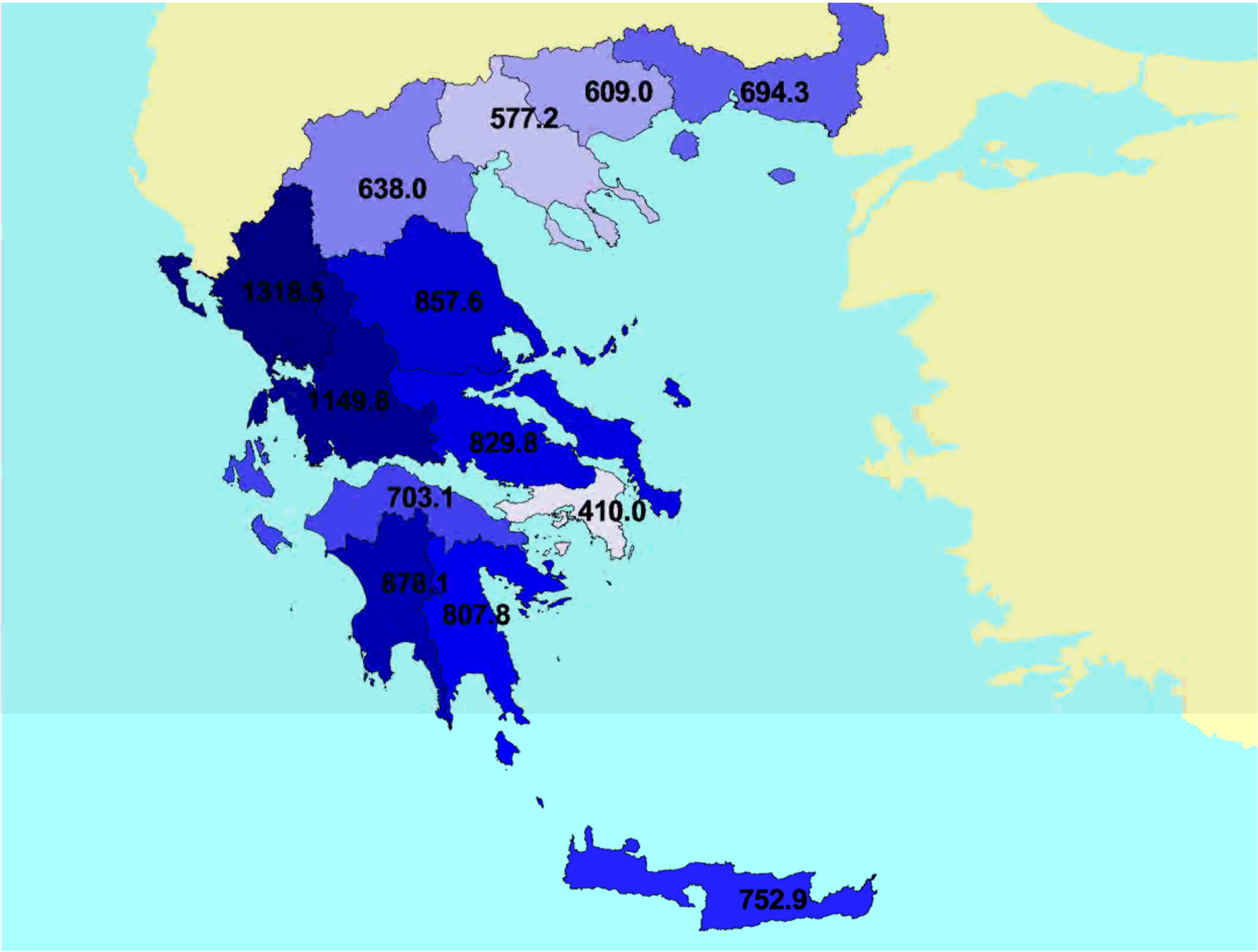


Information pyramid (adapted from Walmsley and Pretorius 1996).

Primary Data for Meteorological, Agricultural or Hydrological Drought Indicators

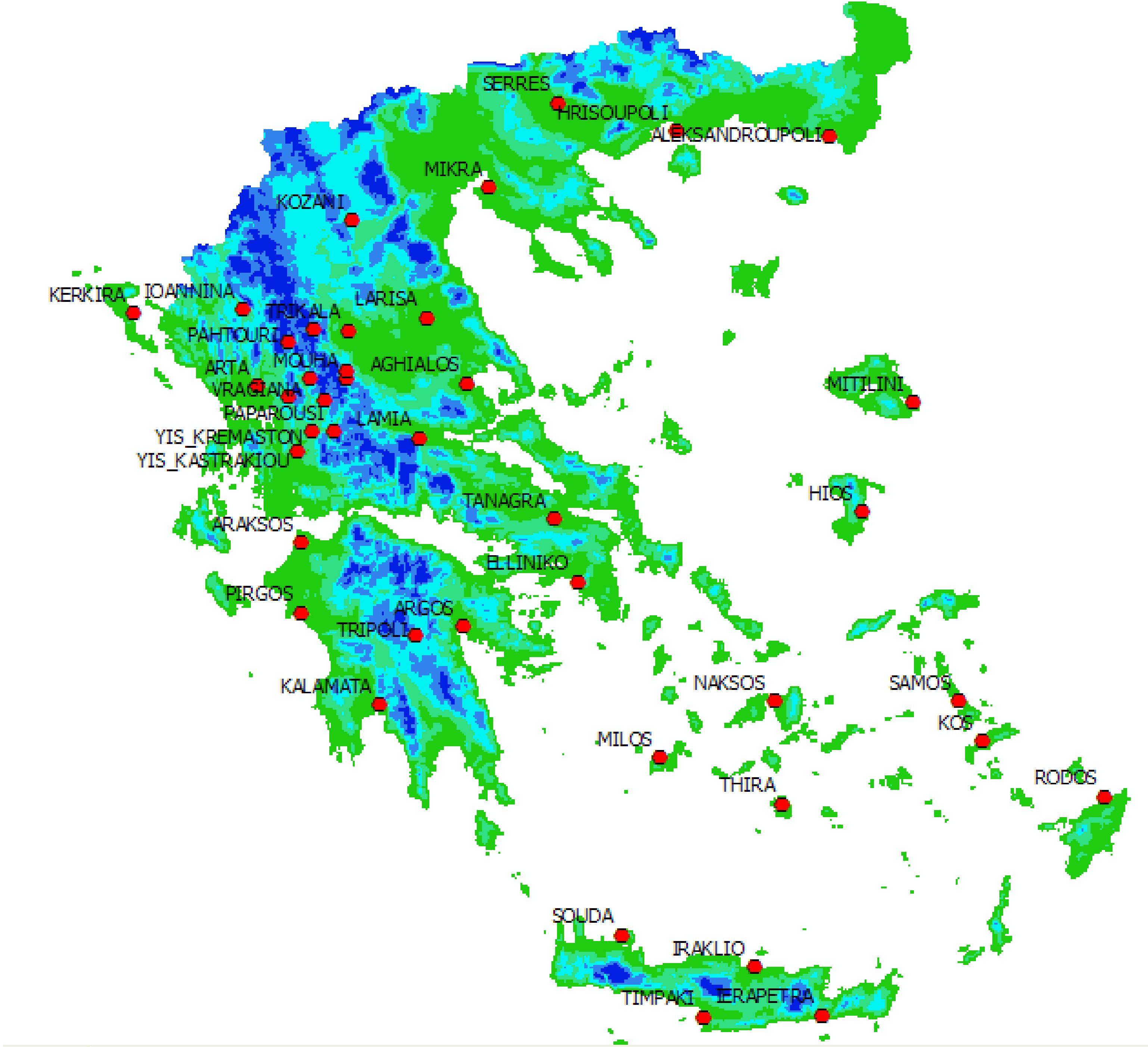
- Climate variables (e.g., precip., temp.)
- Reservoir and lake levels
- Soil moisture
- Ground water
- Snow pack
- Stream flow
- Vegetation

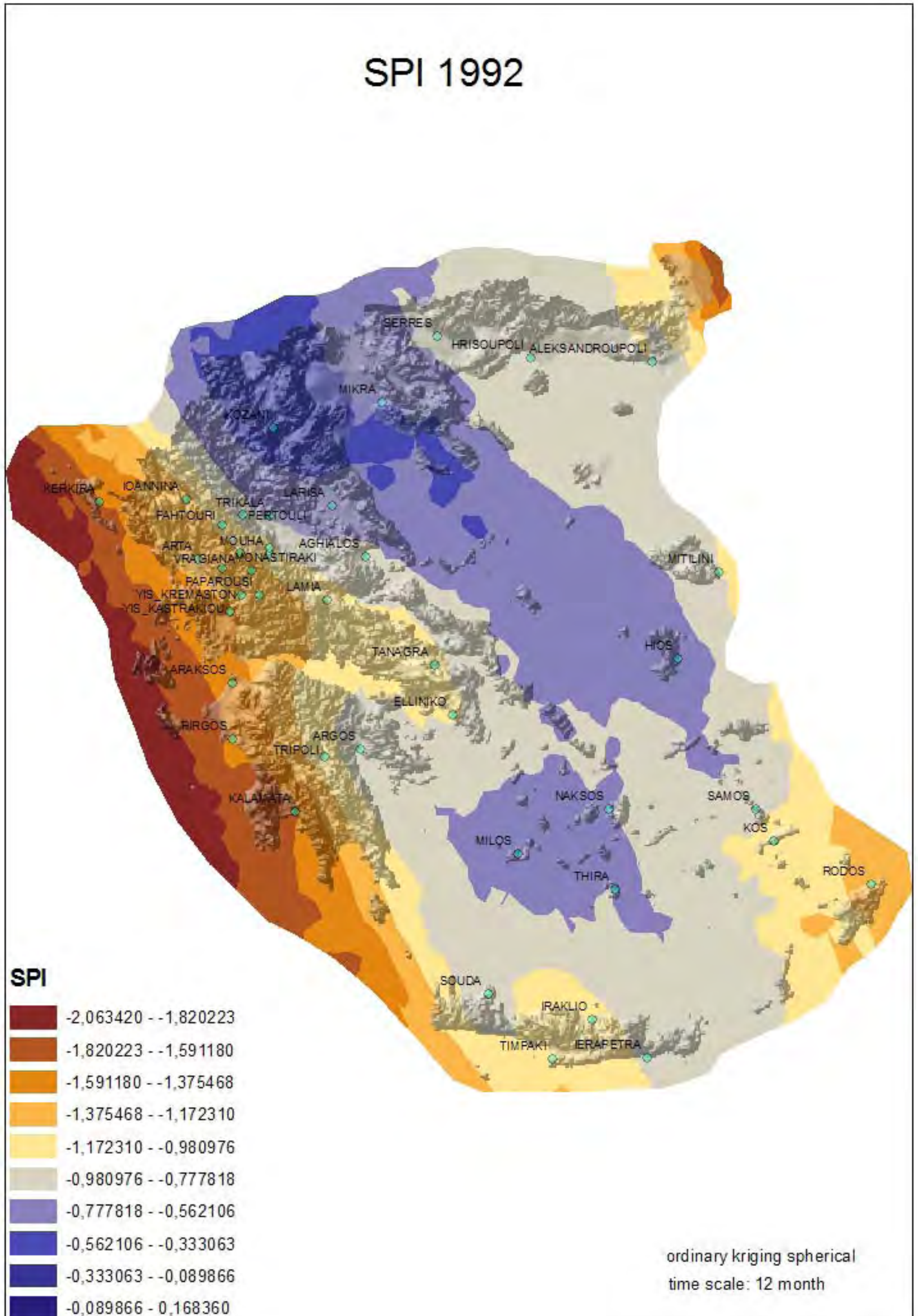
AVERAGE ANNUAL PRECIPITATION in mm
(MCPPWE 2007)



SPI Application

precipitation data from 41 meteorological stations, covering the periods 1959- 2001 were used


SERRES
HRISOUPOLI
ALEKSANDROUPOLI
MIKRA
KOZANI
KERKIRA
IOANNINA
TRIKALA
LARISA
PAHTOURI
ARTA
MOUHA
AGHIALOS
VRAGIANA
PAPAROUSI
LAMIA
YIS_KREMASTON
YIS_KASTRAKIOU
MITILINI
HIOS
TANAGRA
ARAKSOS
ELLINIKO
PIRGOS
ARGOS
TRIPOLI
KALAMATA
NAKSOS
SAMOS
KOS
MILOS
THIRA
RODOS
SOUDA
IRAKLIO
TIMPAKI
IERAPETRA


SPI 1992
SERRES
HRISOUPOLI
ALEKSANDROUPOLI
MIKRA
KOZANI
KERKIRA
IOANNINA
TRIKALA
LARISA
FAHTOURI
PERTOULI
ARTA
NEOHA
AGHIALOS
VRAGIANA
MONASTIRAKI
PAPAROUSI
YIS_KREMASTON
YIS_KASTRAKIOU
LAMIA
MITILINI
TANAGRA
HIOS
ARAKSOS
ELLINIKO
PIRGOS
ARGOS
TRIPOLI
NAKSOS
SAMOS
KALAMATA
KOS
MILOS
RODOS
THIRA
SOUDA
IRAKLIO
TIMPAKI
IERAPETRA
SPI
-2,063420 - -1,820223
-1,820223 - -1,591180
-1,591180 - -1,375468
-1,375468 - -1,172310
-1,172310 - -0,980976
-0,980976 - -0,777818
-0,777818 - -0,562106
-0,562106 - -0,333063
-0,333063 - -0,089866
-0,089866 - 0,168360
ordinary kriging spherical
time scale: 12 month

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Drought Research Methods

- according to the field of study (i.e., meteorology, agriculture, hydrology, economics, biology, sociology, etc.).
- centering on a specific drought physical variable (i.e., soil moisture, precipitation, evapotranspiration, streamflow, groundwater level, etc.)

Why are Drought Contingency Policies Needed?

- Prevailing crisis management attitude
- Natural Hazards Emergency Response Procedures
- Protocols for Processes and Procedures
- Create a wider menu of options and alternatives

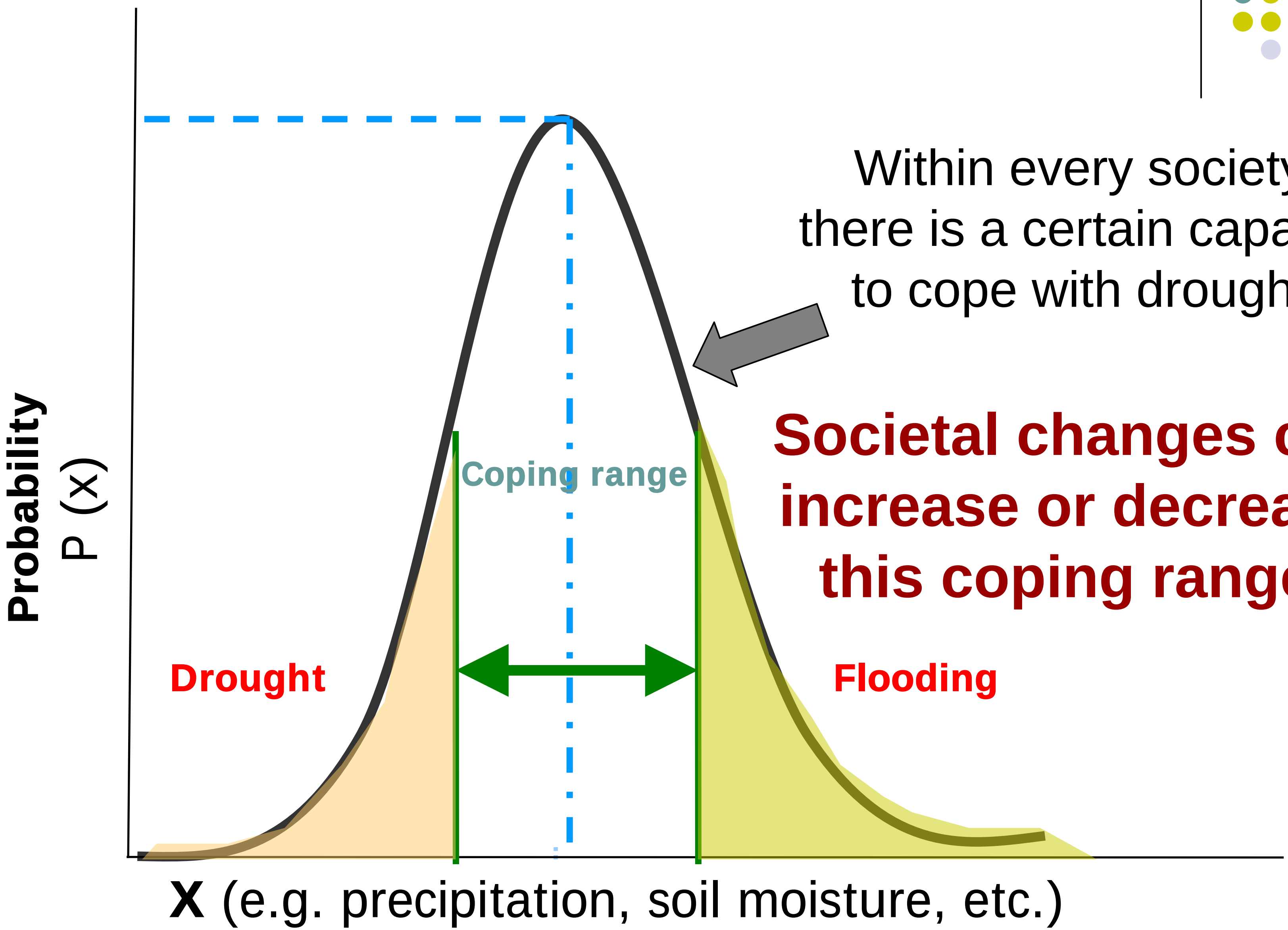

Preparedness
Prediction
Warning
Mitigation
Risk/Adaptive
Management
Disaster
Crisis
Management
Reconstruction
Impact
Assessment
Recovery
Response
C.A. KARAVITIS, 2004

Aggregation in Space and Time

- Frequencies (risks, reliabilities)
- Durations
- Spatial Extent

As impacts differ within and between spatial scales, risk indicators should reflect who and what is at risk and why.

Drought vulnerability is a variable.



Within every society, there is a certain capacity to cope with drought.

Societal changes can increase or decrease this coping range.

Adapted from work by Barry Smit, University of Guelph

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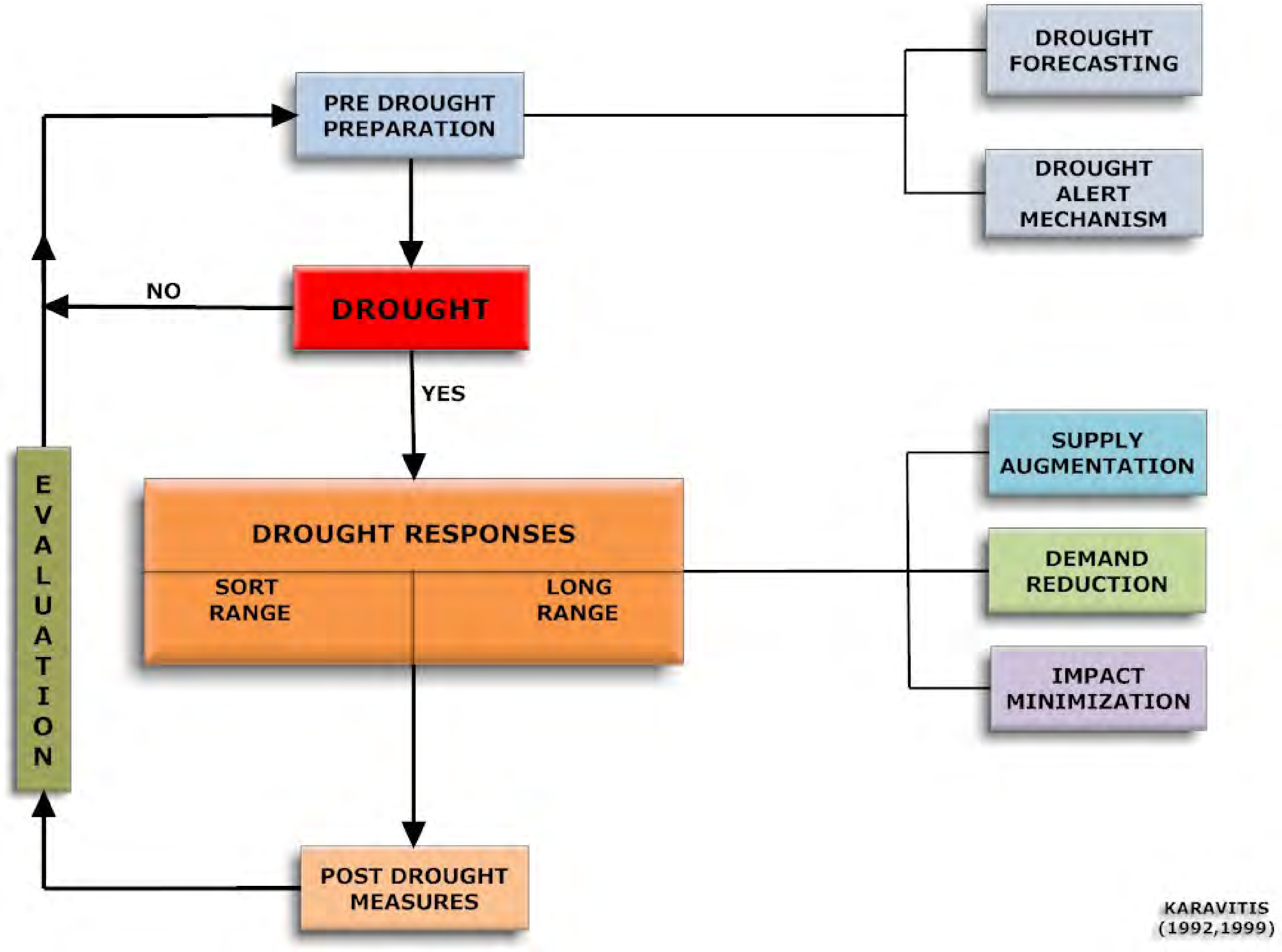
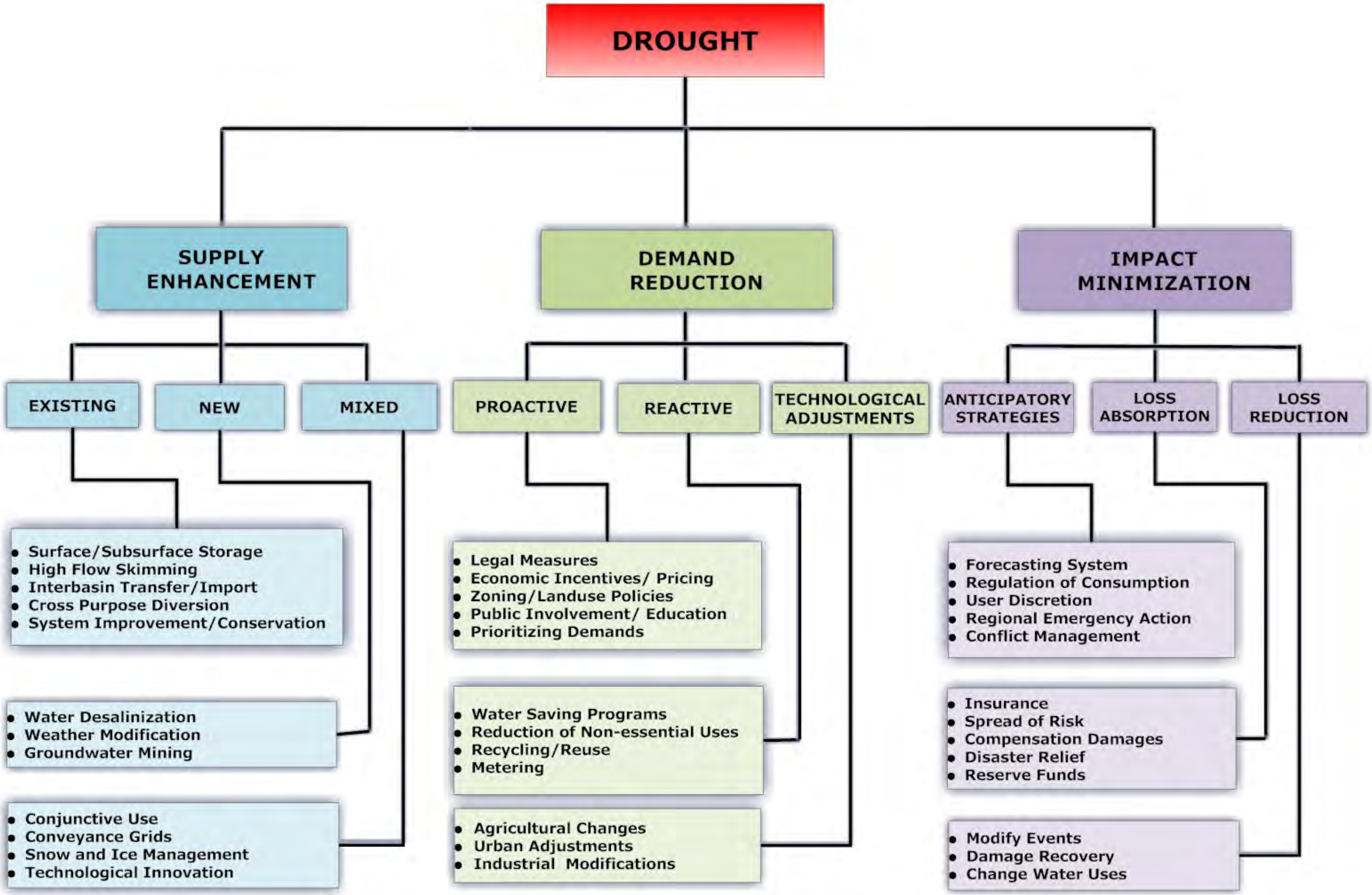
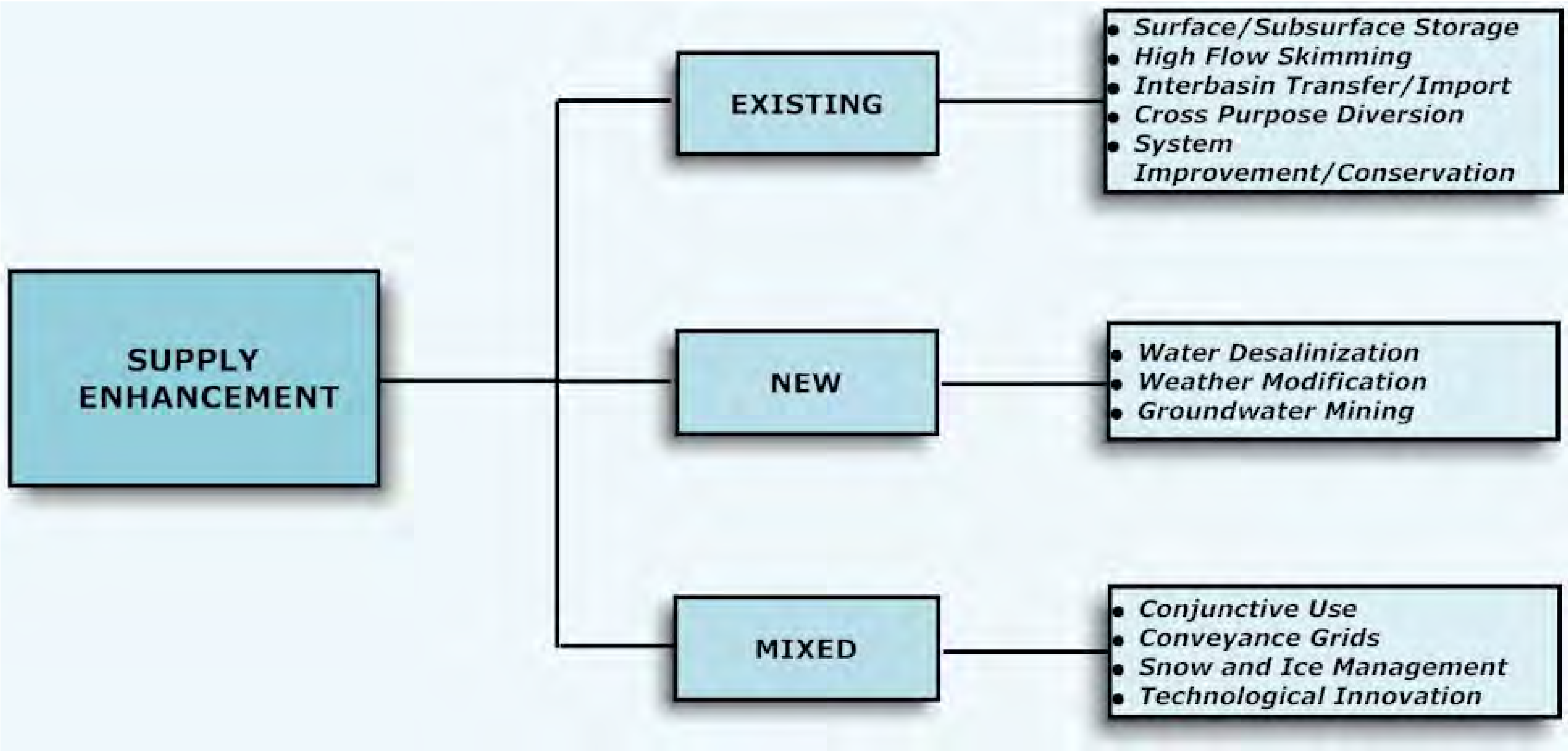
Drought contingency Plan



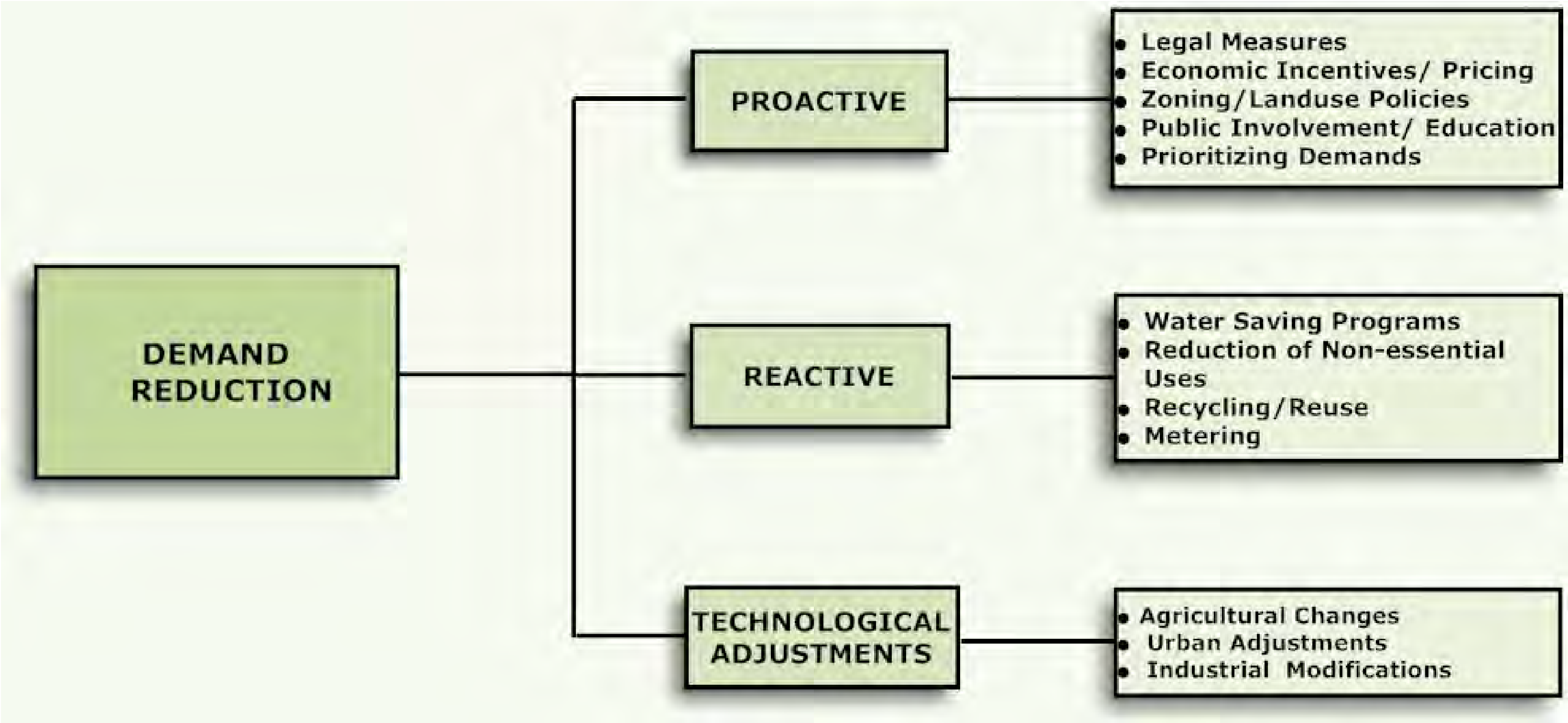


From V. Yevyevich and E. Vlachos, 1983; C. A. Karavitis and N.S. Grigg, 1992, 1999

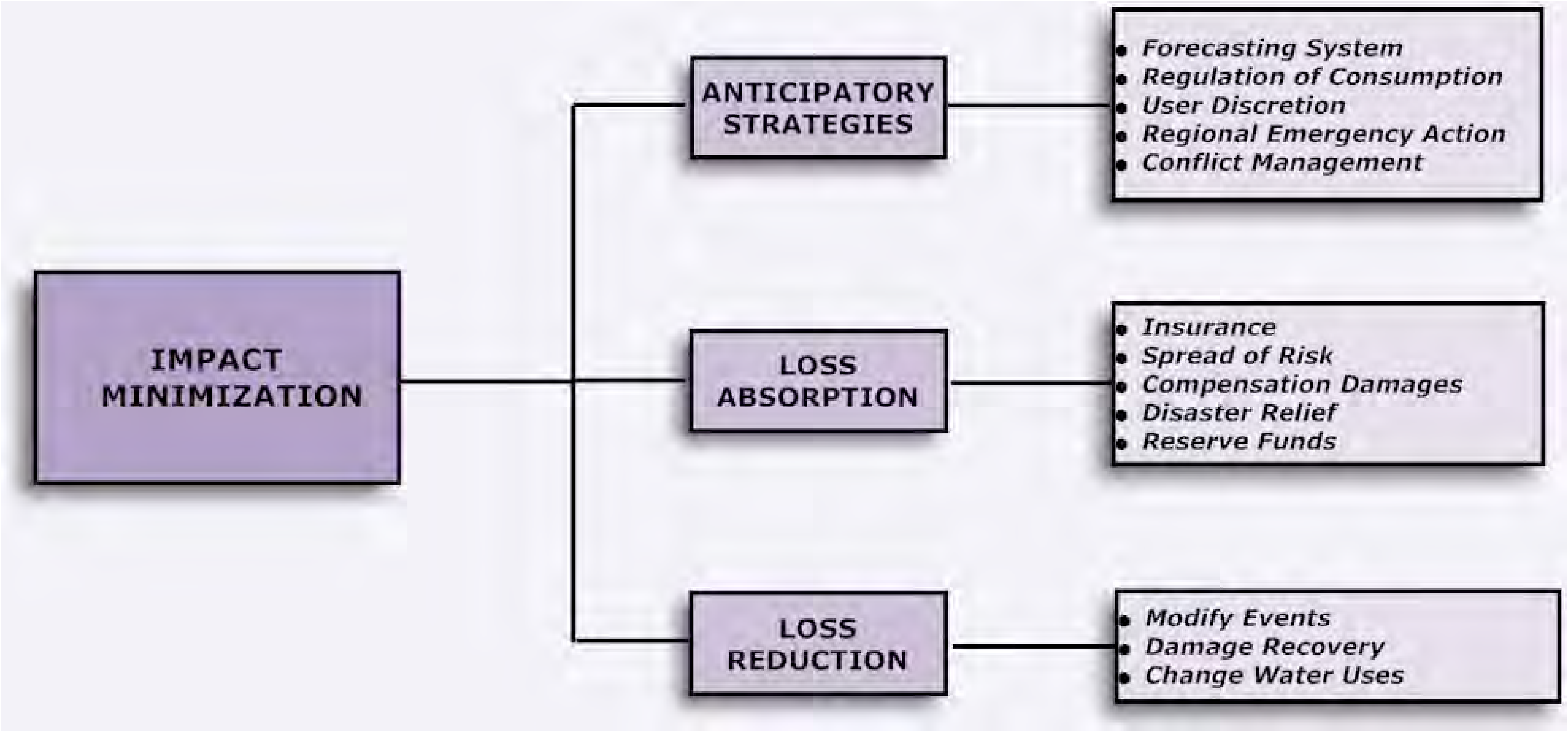
TOOLBOX FOR SUPPLY MANAGEMENT



TOOLBOX FOR DEMAND MANAGEMENT



TOOLBOX FOR IMPACT MINIMIZATION



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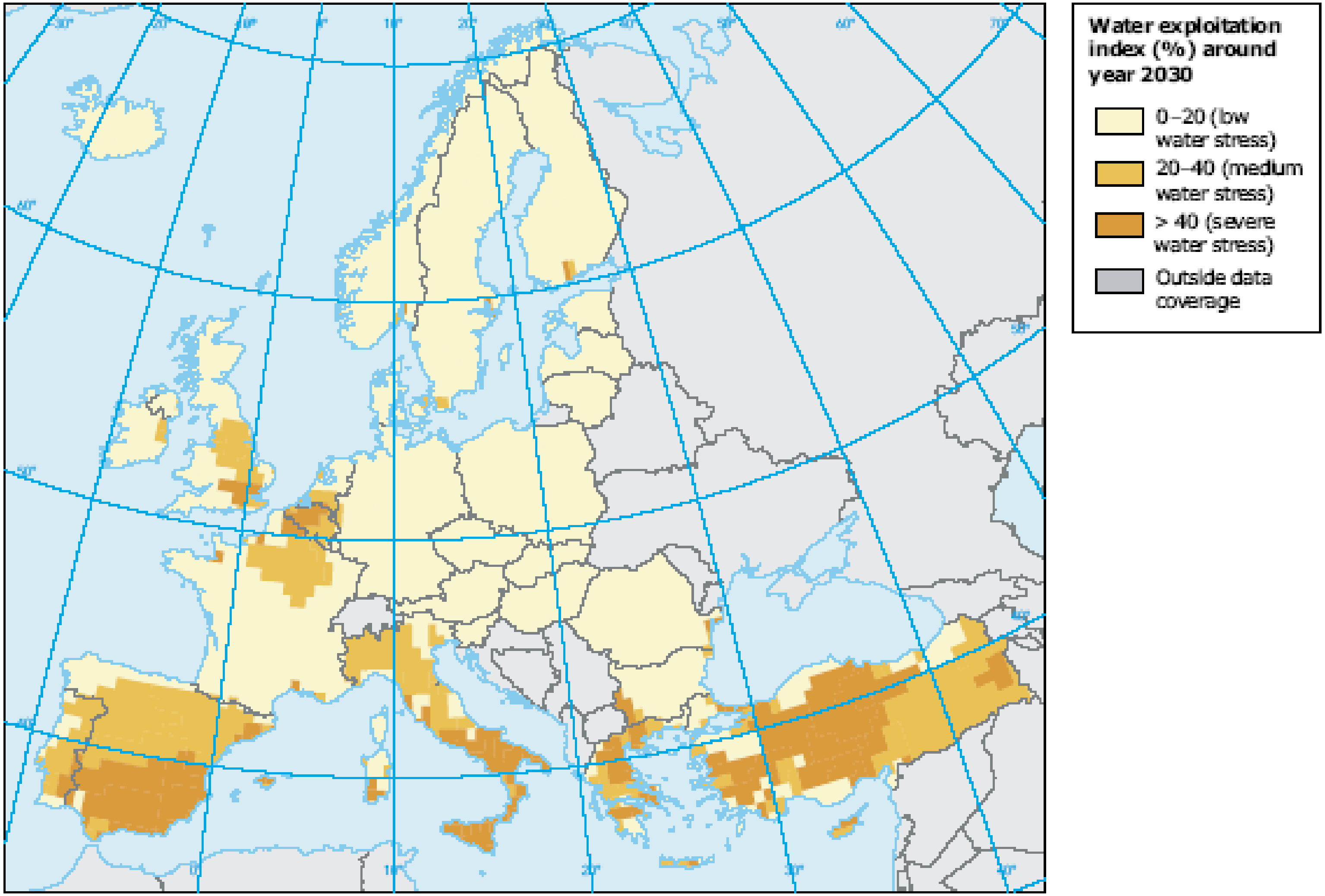
DROUGHT FORECASTING

- Statistical predictions: based on lagged relationships between regional meteorological patterns (i.e. rainfall) and actual data.
- Probabilistic predictions: by trying to estimate the mathematical probability of a given phenomenon in a certain time frame based usually on analysis of time series data.
- Deterministic predictions: which attempt to model important features of the existing system and provide a basis for contingency analysis through simulation

Map 5.3 Water stress in 2030



Source: EEA, 2005.

Precipitation extremes

1976–1999:

- Southern Europe: decrease
- Mid and northern Europe: increase

past trends

Very heavy precipitation days (p >= 20mm)
Changes in 1976–1999

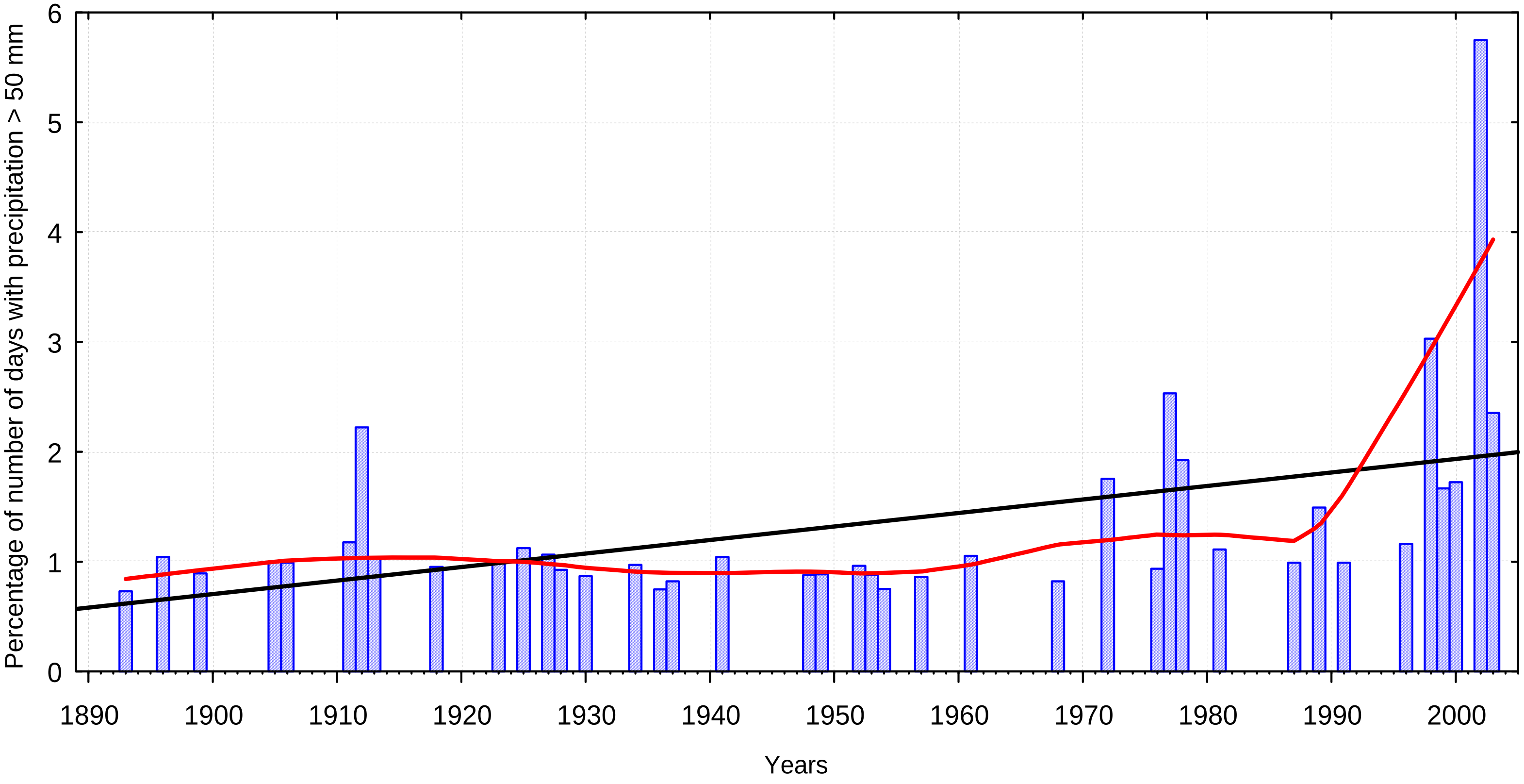
Projections:

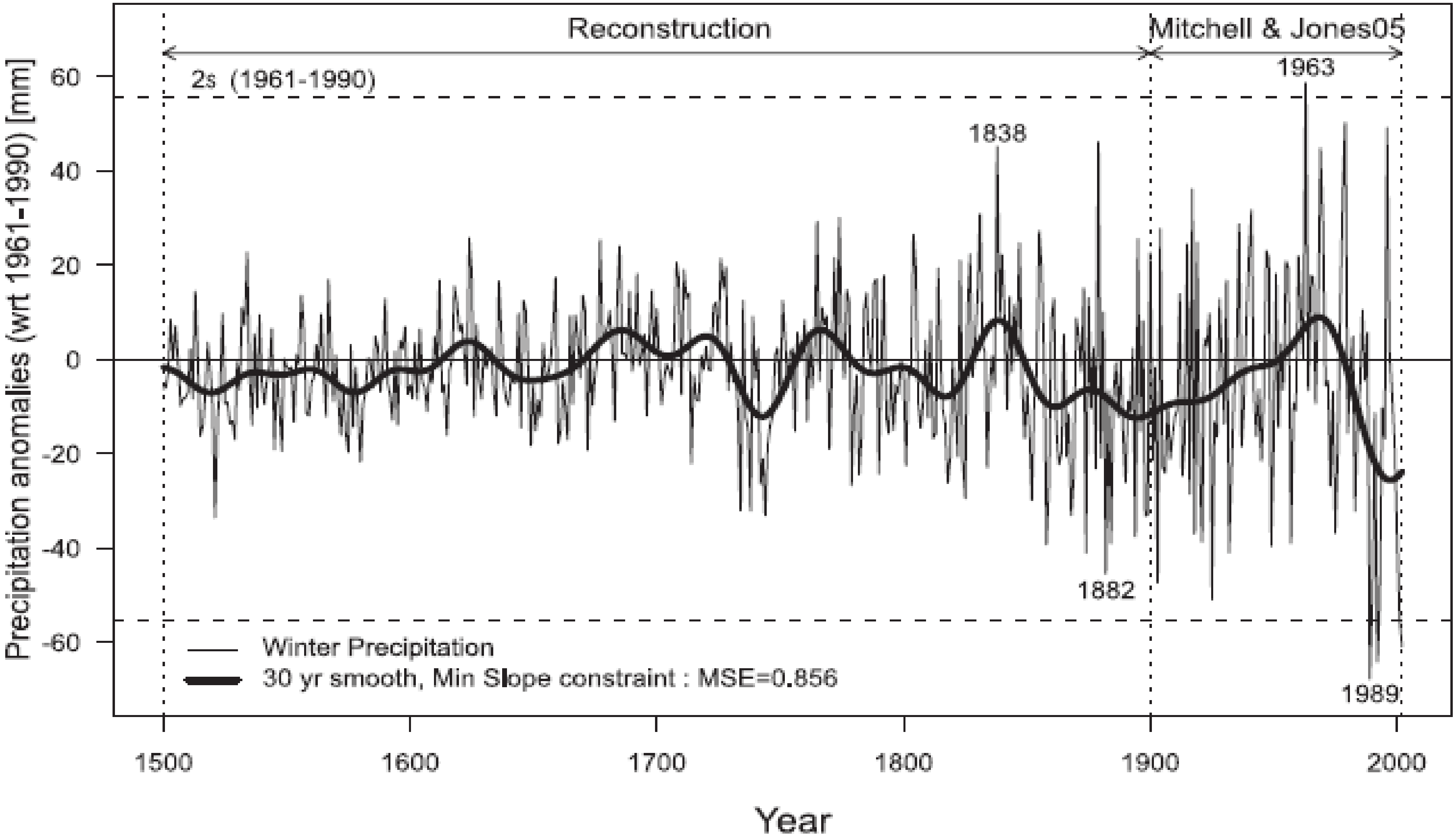
- Likely more frequent droughts and intense precipitation events

future projection

)ata-source: ECA, IPCC, ACACIA, ...

Percentage of rain days with rain more than 50 mm from 1891 to 2004 over Athens (NOA)





Winter (DJF) averaged-mean Mediterranean precipitation anomalies (with respect to 1961-1990) from 1500 to 2002, defined as the average over the land area 10°W to 40°E and 35°N to 47°N (thin black line). The values for the period 1500 to 1900 are reconstructions (Pauling *et al.,* 2005); data from 1901 to 2002 are derived from Mitchell *et al.* (2004) and Mitchell and Jones (2005). The thick black line is a 30-year smooth 'minimum slope' constraint (mean squared error, MSE=0.856) calculated according to Mann (2004). The dashed horizontal lines are the 2 standard deviations of the period 1961-1990. The driest and the wettest Mediterranean winters for the reconstruction and the full period are denoted.


THE EL NINNY EFFECT
NORMALLY THE GOVERNMENT DRIFTS ALONG AT ABOUT 8,000 METRES...
EVERY FEW YEARS, THERE'S A DROUGHT. WHEN IT GETS REALLY BAD, IT SUDDENLY RAINS POLITICIANS, EXPERTS AND MEDIA.
THEY FORM POOLS OF EXPERTISE AND FUNDING TO COPE WITH THE DROUGHT CYCLE...
AS SOON AS THE GOOD YEARS RETURN, THEY EVAPORATE BACK TO 8,000 METRES.
Nicholson
5 OCT '02

Questions ?