European Commission - EuropeAid Co-operation Office
Euro-Mediterranean Regional Programme For Local Water Management

Mediterranean Drought Preparedness and Mitigation Planning
(MEDROPLAN)

Workshop

Developing and Implementing Mitigation and Preparedness Water Scarcity and Drought (WS&D) Management Plans

Zaragoza, Spain, 6-8 May 2014

MEDROPLAN Mediterranean Drought Preparedness and Mitigation Planning

Mediterranean Drought Preparedness and Mitigation Planning (MEDROPLAN)

Europe Aid Cooperation Office, MEDA WATER Programme
Contract number: ME8/AIDCO/2001/0515/59770 - P 027

Objectives

1 *Develop Guidelines for Drought Preparedness Plans*

2 *Set up a Drought Preparedness Network for the Mediterranean countries*

Partners

University of Cyprus *National Technical University of Athens, Greece* *University of Catania, Italy* *Institut Agronomique et Vétérinaire Hasan II, Morocco* *Confederación Hidrográfica del Tajo; Canal de Isabel II; Fundación Ecología y Desarrollo; Universidad Politécnica de Madrid, Spain* *Direction Générale des Barrages et des Grands Travaux Hydrauliques, Ministère de l'Agriculture, Tunisia*

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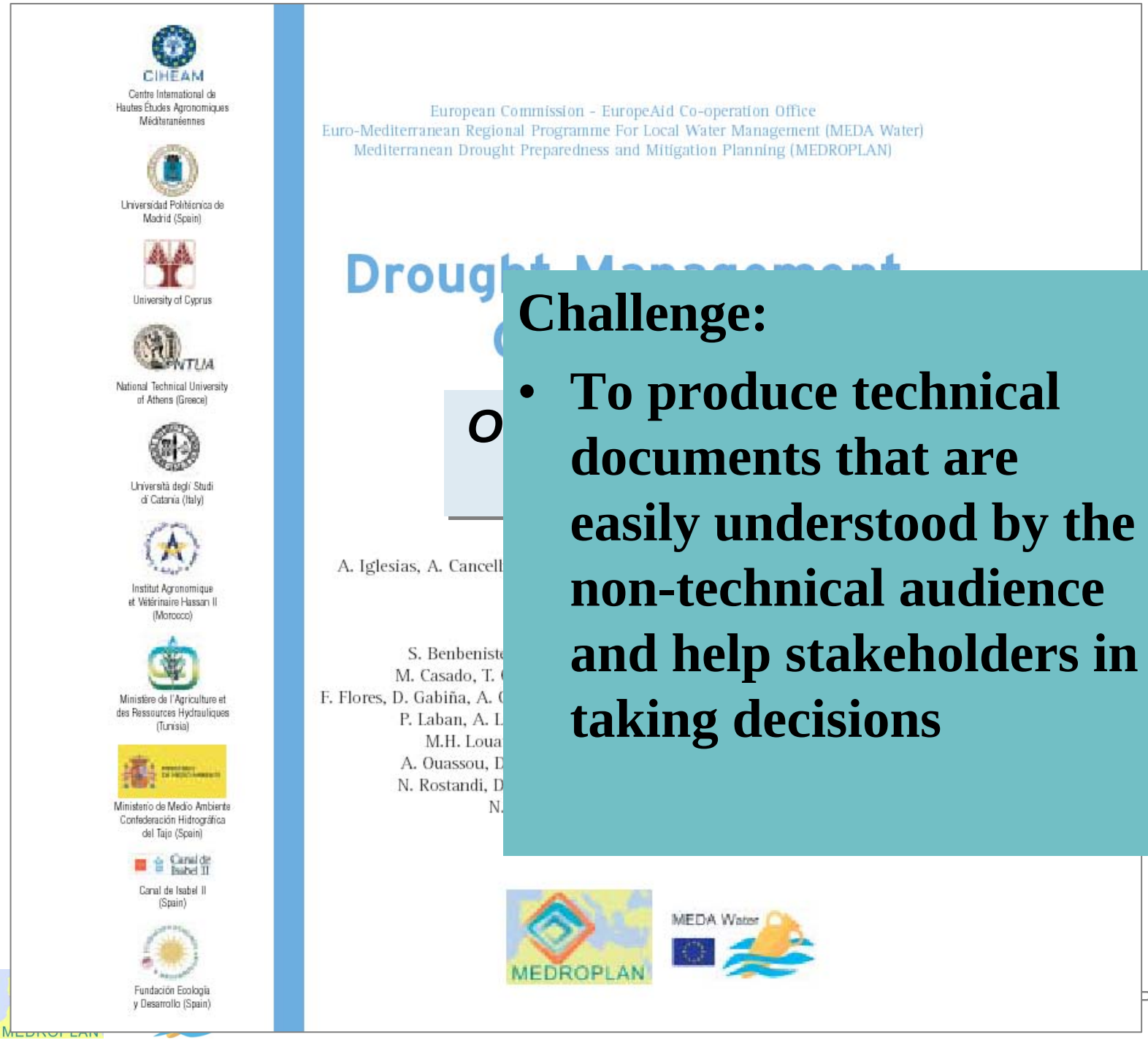


Challenge:

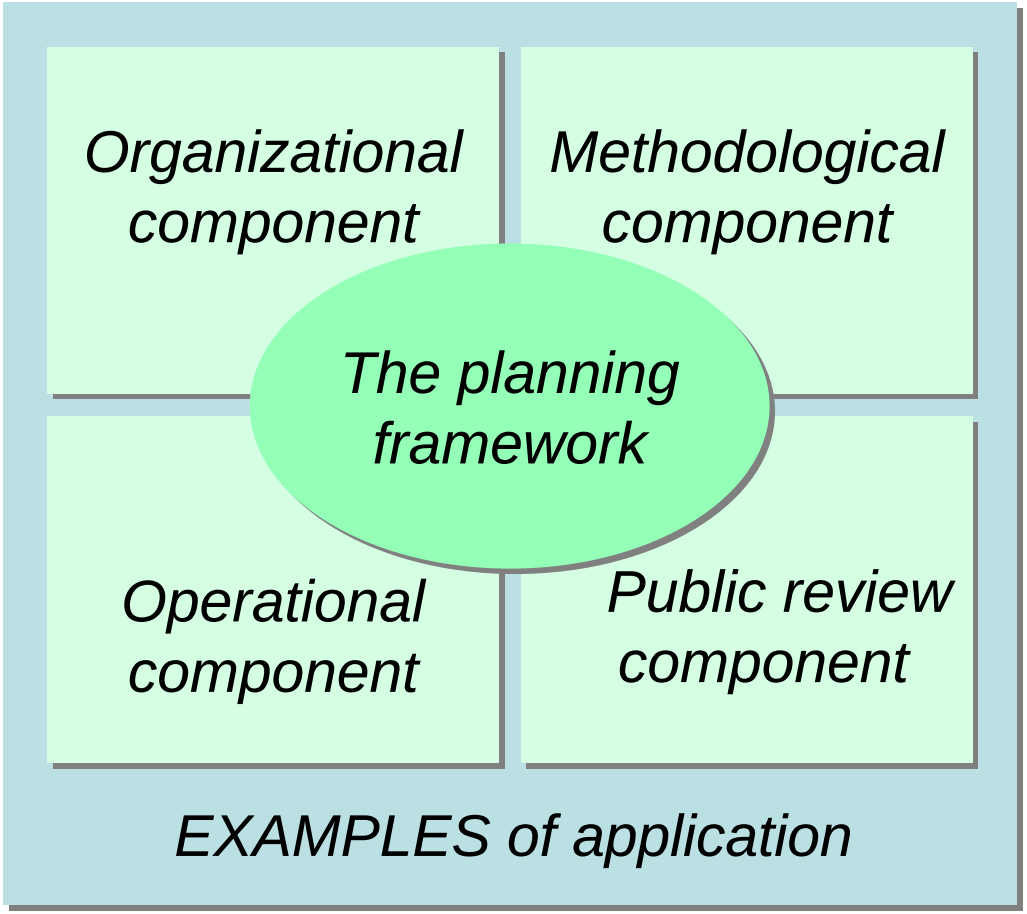
- **To produce technical documents that are easily understood by the non-technical audience and help stakeholders in taking decisions**

The Guidelines …..

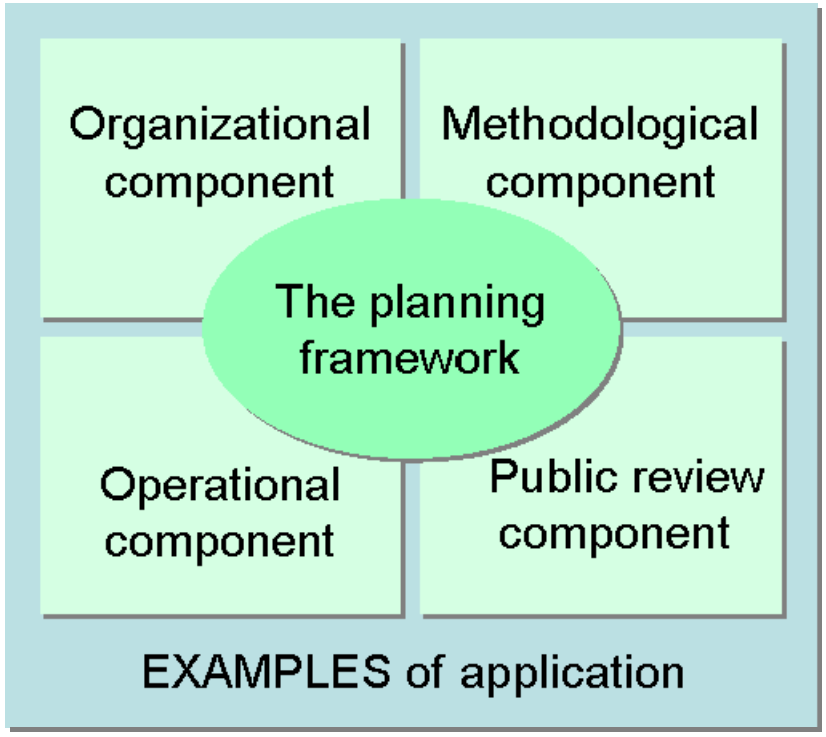
- ***Are based*** **on extensive experience and knowledge in the Mediterranean region**
- **…..*are* a complement to river basin plans**
- **…. *are not* a magic tool to avoid drought**

- ***Help formulate drought management plans*** **based on risk management approach and not a reactive crisis approach**

Components of the Guidelines



The guidelines are translated into Arabic, English, French, Greek, Italian, Spanish



Organizational component

Overview of Organizational Component

Effective Drought Management Plans require

a) Integrative approaches and

b) Integrated management, based on

- **the natural features of the area,**
- **the socioeconomic conditions,**
- **the legal and institutional framework, and**
- **the know how and expertise available**

1. Why organizational component

- **For the preparation and implementation of Drought Management Plans we need the organization component for the following reasons:**

a) **To compile and provide information and data.**

b) **To coordinate with the institutions and avoid conflicts**

c) **To provide responsible and timely public information**

d) **To define the actors responsible for drought declaration**

2. Who is affected and who is responsible

- **To be able to prepare a Drought Mitigation Plan we must define the following three elements**

a) Where (Geographical area)

b) Who is affected (Stakeholders), and

c) Who is responsible for the planning ? (Legal and institutional framework)

These questions must be answered in an extensive detail manner

3. The geographical unit

This answers the Question WHERE? and it defines the spatial extent of the Drought Plan. It may be:

- **A Hydrographic district as defined by the European Water Framework Directive,**
- **Territories with interconnected water supply systems,**
- **Region, provinces, district Municipalities,**
- **Water development projects**

Special attention: Water conflicts between neighboring regions that share water resources and interests

4. The Stakeholders

This answers the question "Who is Affected"

Each geographical unit has its own stakeholders, who are categorized in 4 groups

a) **Policy makers (Gov. Board of Dir.)**
b) **Policy executives (River Basin, Project Managers, Department ,etc)**
c) **Educational and research institutes and NGO's**
d) **Water consumers**

For each stakeholder, its participation, its expectations and the adaptive capacity must be defined.

5. The Legal and Institutional framework

- **Knowledge of the legal and institutional framework that governs the planning and implementation of Drought Mitigation Plans and water resources managements is a must. Questions such as who is the legally responsible**
  - **a) For hydrological, meteorological, biological and socioeconomic data**
  - **b) For the water resources planning and operation, and**
  - **c) For drought preparedness and mitigation**

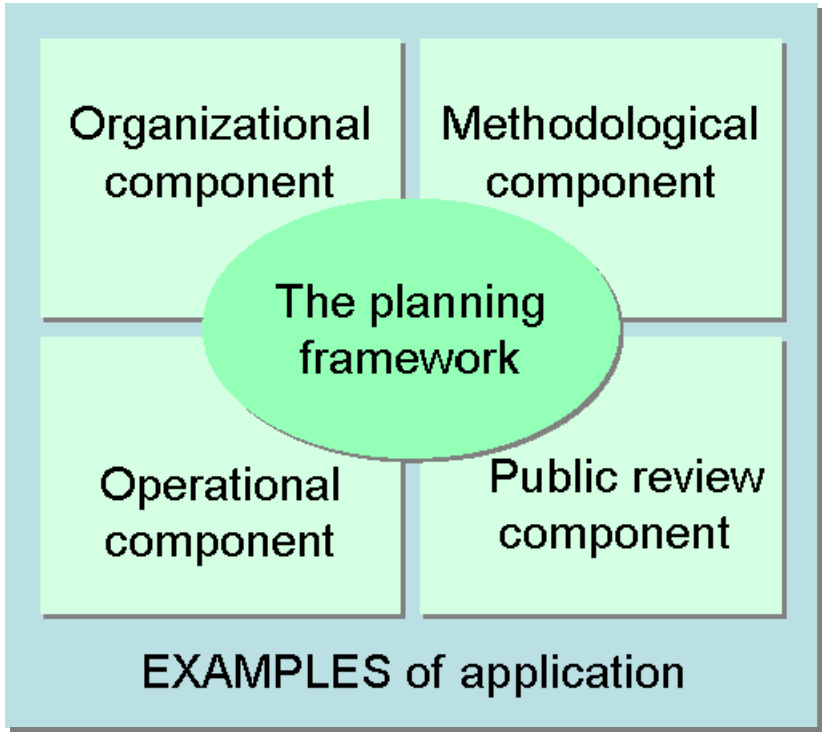
Must be answered

6. Design of drought committees

- **In some cases it may be necessary to appoint Drought Management Committees that are necessary for the preparation and implementation of Drought Mitigation Plans with special TOR's such as**
  - **a) Policy committees, made of representatives of stakeholders**
  - **b) Technical committees made up of experts for carrying out special studies**

Summary of Organizational

1. **Geographical unit: Define the spatial extent**
2. **Stakeholders: Define, describe and find details of all the stakeholders.**
3. **Legal and Institutional Framework knowledge and analysis: Elaborate a mental model of organizations, institutions, and define the policy, executive and consumers rights and obligations**



Methodological component:

Drought characterisation

Parameters for drought identification

- **Intensity**
- **Duration**
- **Cumulated deficit**
- **Timing**
- **Spatial Extent**
- **Frequency**

Types of drought

- **Meteorological drought**
- **Hydrological drought**
- **Agricultural drought**
- **Urban drought**
- **Socio-economic drought**
  - **<u>Note</u>: Drought is a meteorological phenomenon. The above characterisation is due to the affected sector.**

Basic notions for the application of drought indices

- **Normal conditions**
- **Time step**
- **Reference period**
- **Spatial interpolation of meteorological data**
- **Spatial integration**

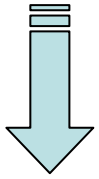
Overview of drought indices

- **General Indices**
  - **Deciles**
  - **Standardised Precipitation Index (SPI)**
  - **Palmer Drought Severity Index (PDSI)**
  - **Reconnaissance Drought Index (RDI)**

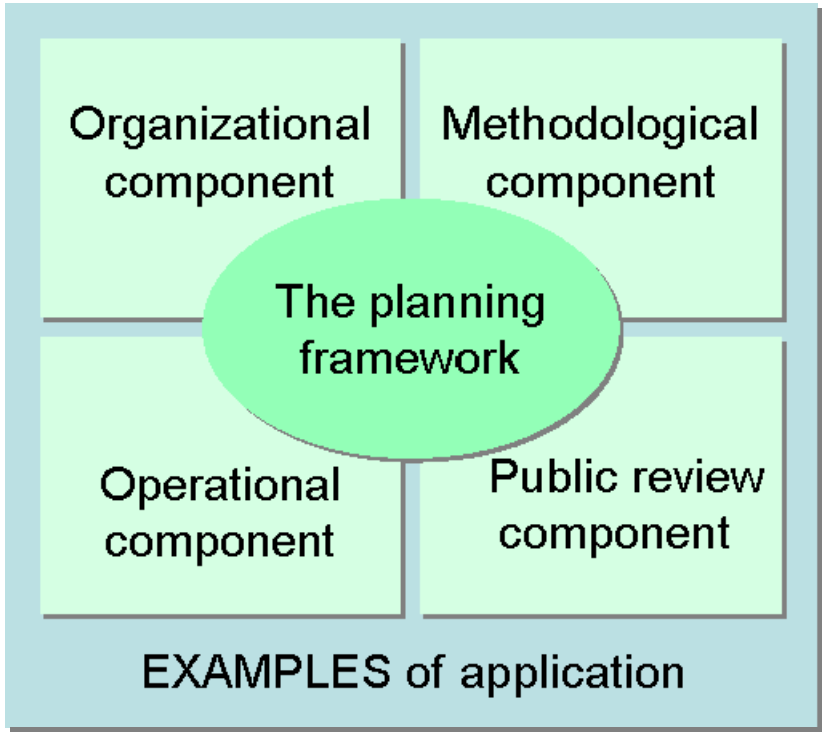
- **Other Drought Indices**
  - **Bhalme-Mooley Drought Index (BMDI)**
  - **Rainfall Anomaly Index (RAI)**
  - **Total Water Deficit**
  - **Palmer Hydrological Drought Severity Index (PHDI)**
  - **Surface Water Supply Index (SWSI)**
  - **Crop Moisture Index (CMI)**
  - **Palmer Moisture Anomaly Index (Z-Index)**
  - **Soil Moisture Anomaly Index (SMAI)**

Two dimensional representation

- **Regional phenomenon**
- **Variable intensity in space**
- **Comparison of affected area to critical area**
- **Various levels of A_c can be considered**
  - **(eg. Area under drought > 50%**
    Area under drought > 25%)



OR MORE CURVES



Methodological component:

Risk analysis

Definition of risk

- **Risk defined as probability of an adverse event**
  - according to *statistical hydrology:*

Risk=P[at least 1 year in *n* years with $x > x_o$]=

=1-P[$x \leq x_o$ in *n* years]=

=1-P[$x \leq x_o$]^n (assuming stationarity and independence of events)

  - according to reliability theory (system failure) :

$$Reliability\ \ \alpha = P[non\ \ failure]$$

$$Risk = P[\ failure] = 1 - \alpha$$

- **Risk defined as the expected consequences of an adverse event**
  - according to *natural disasters mitigation* => expected losses

If affected goods are expressed in economic terms

Risk = expected economical damage

Definitions adopted by UNDRO, 1991

Natural Hazard
The probability of occurrence, within a specified period of time in a given area, of a potentially damaging natural phenomenon

Vulnerability
The degree of loss to a given element at risk or set of such elements resulting from the occurrence of a natural phenomenon of a given magnitude and expressed on a scale from 0 (no damage) to 1 (total loss)

Risk
The *expected losses* due to a particular natural phenomenon *as a function* of natural hazard and vulnerability and element at risk

Risk analysis

The procedure for identifying the relevant probabilistic features of an adverse phenomenon and of its consequences and for evaluating alternative solutions to manage the risk

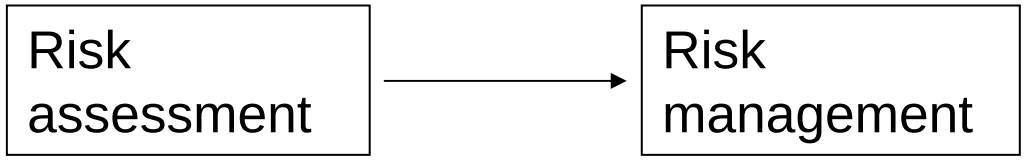
- **Risk assessment**

  Estimate of the probabilistic features of an adverse phenomenon

- **Risk management**

  A pro-active approach for coping with risk through planned actions (as apposite to crisis or emergency management)

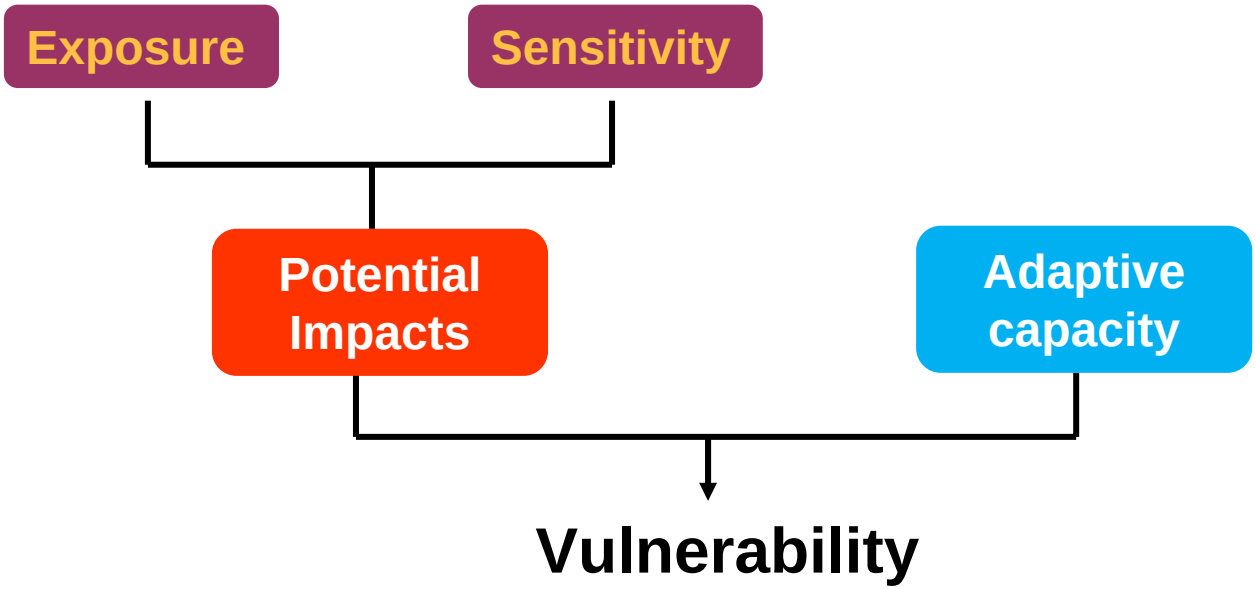
RISK ANALYSIS



Risk analysis in agricultural systems

Risk = Hazard x Vulnerability

Vulnerability and its components



Agricultural systems in the Mediterranean

Three broad agricultural systems :

- *Rainfed arable* (Wheat based system, barley based system , tree based system)
- *Irrigated arable* (field crops and orchards)
- *Rangeland, livestock and forest.*

In each system:

- *Subsistence farming*: easy to analyze risk through direct drought impact on income
- *Commercial farming*: more complex relationship because production systems are greatly affected by policy, markets, technology and financial instruments

Risk in water supply systems

- **When dealing with water supply systems, shortages can be assumed as a proxy of damages**
- **Thus risk assessment has the objective of quantifying probabilistically both the occurrence and the magnitude of shortages**
- **For instance, the following features of shortages can be considered:**
  - **Probability of shortages**
  - **Magnitude of shortages**
  - **Time span when shortages occur**
  - **Economic impact of failures**

Preliminary assessment

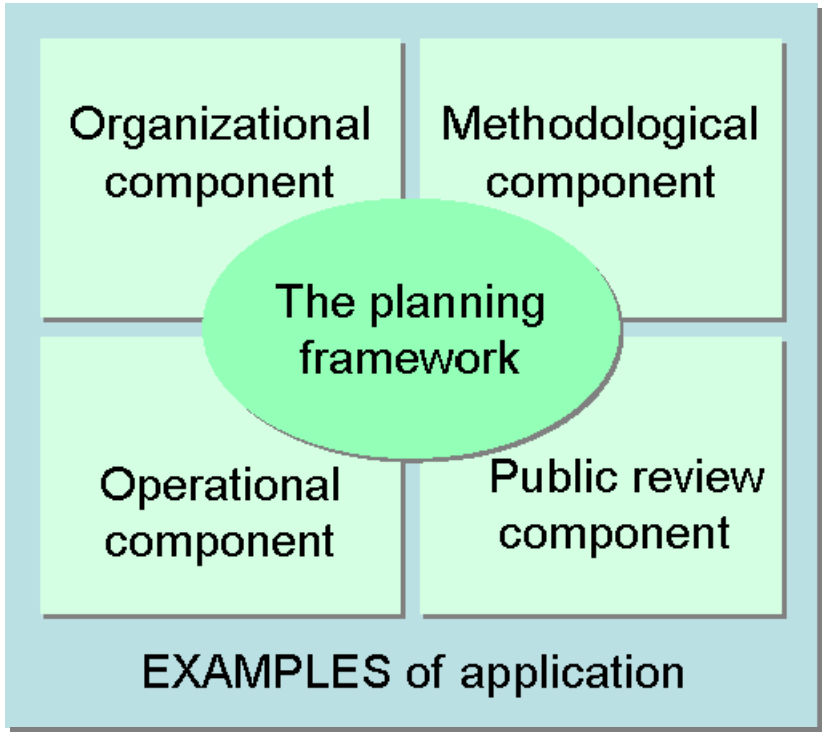
- Some indicators can provide preliminary (rough) assessment of risk:
  - *Water demand / Average inflows*. Provides information about the degree of development of water resources in the system. Ratios close to 1 mean frequent system failures, depending on inter-annual or seasonal variability of hydrologic series.
  - *Water demand / Reservoir capacity*. This provides information about the quantity that the system is able to supply.
  - *Reservoir capacity / Average inflows*. This provides information on the capacity of the system to overcome inflow irregularities (droughts).
  - *Annual water demand / Current reservoir storage*. This represents the expected time to failure, in years, if future inflows are neglected. The variable provides information on the margin of operation of the system.

More complex tools?

- **When dealing with large systems, the use of more complex tools is preferable in order to take into account:**
  - **The stochastic nature of hydrological inputs**
  - **The allocation of water from different sources to different demands**
  - **The operating rules of the system**
- **Although in principle, both simulation and optimization models can find application, simulation techniques appear preferable since they are more easily accepted and understood by decision makers**

Analysis of results

- **Performance indices**
  - **Reliability => probability to be in a satisfactory state**
    - **Temporal reliability => frequency of intervals (e.g. months) where the demand is satisfied**
    - **Volumetric reliability => total volume supplied divided by the total demand over the simulation period**
  - **Resilience => ability to recover from shortage conditions**
    - **(Inverse of) average shortage periods length**
  - **Vulnerability => severity of shortages**
    - **Max monthly and annual shortage**
    - **Sum of squared shortages**
- **Frequency plot of shortages**
  - **Histogram of frequencies of shortages (expressed as percentage of demand)**
  - **Sample frequency of monthly shortages**
- **Return period of shortages**
  - **Average interarrival time between two annual shortages exceeding a given value**



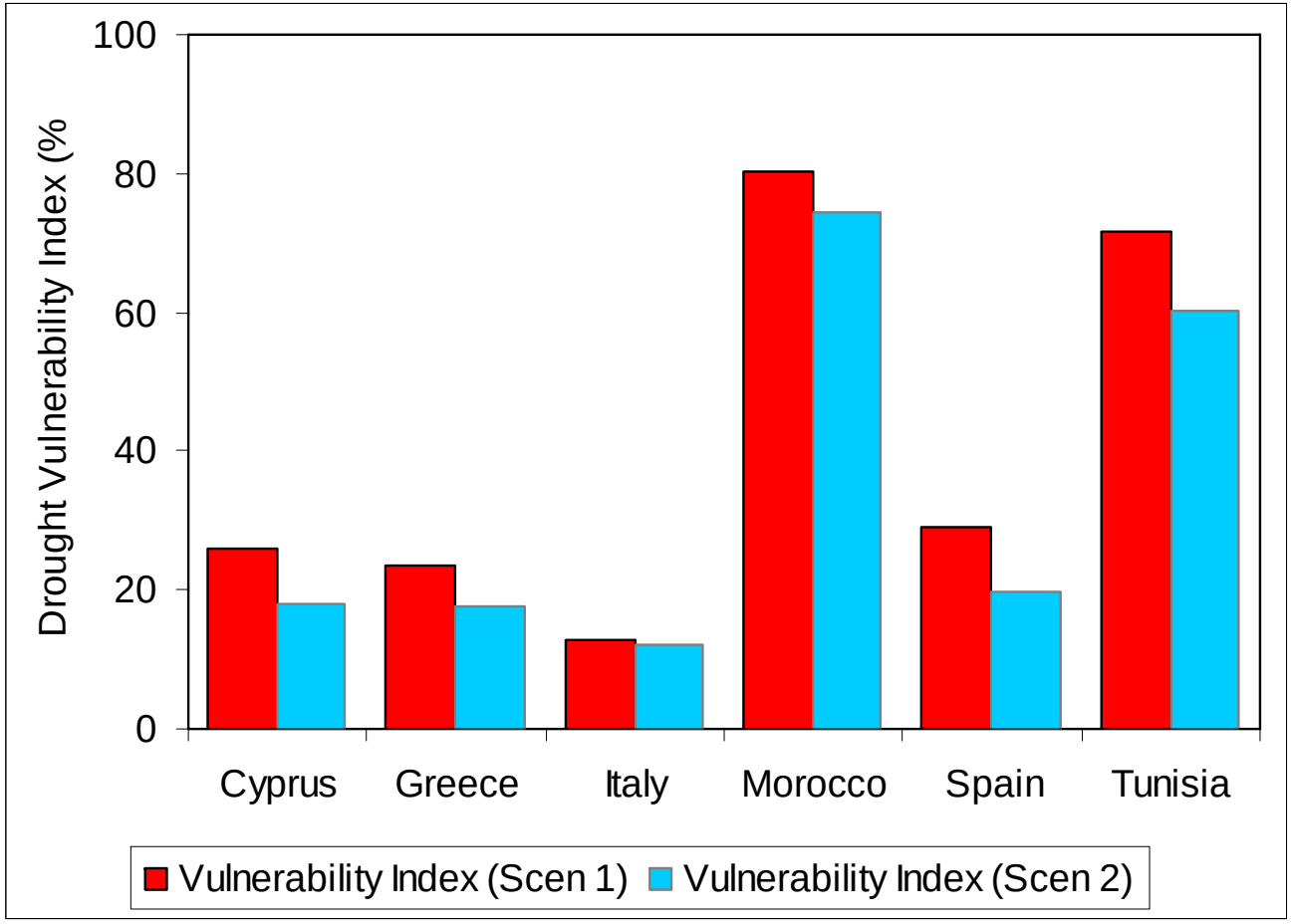
Methodological component:

Vulnerability analysis

Drought Vulnerability Index

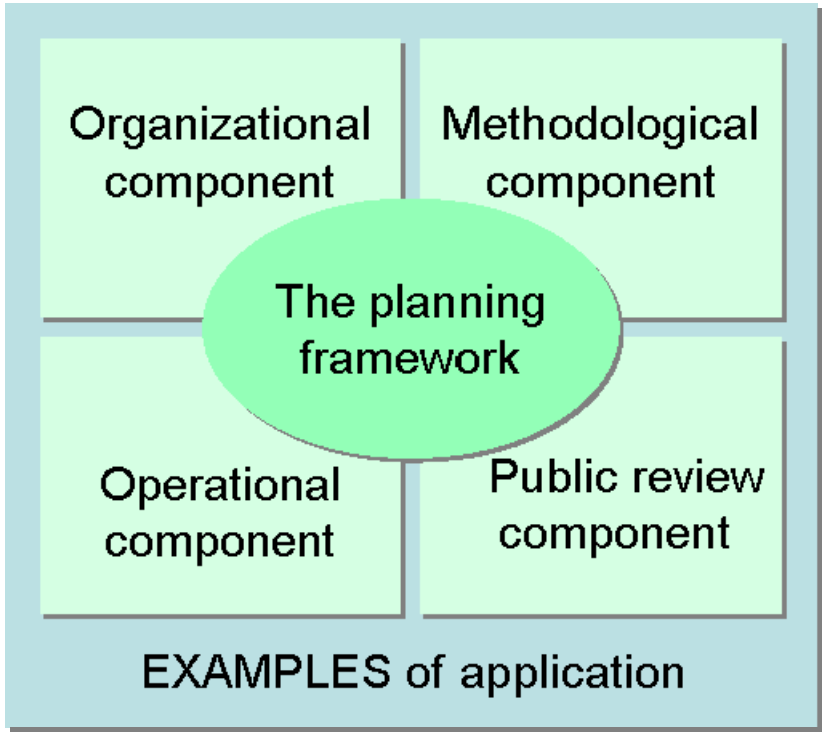
Component	Indicators
Renewable natural capital	Agricultural water use; precipitation; soil degradation; area salinised
Human and civic capital	Life expectancy at birth; Literacy rate Active population in agriculture Population without sanitation water
Institutional response	Drought regulations; Coordination among institutions
Economic capacity	GDP and GDP from agriculture/GDP Energy use; Population below poverty line Access to drinkable water
Mechanisms of risk sharing	Insurance Agricultural policies
Agricultural innovation	Cultivation techniques (fertilizer, machinery); Crop varieties

Drought Vulnerability Index



Scen 1 All components weighted equally

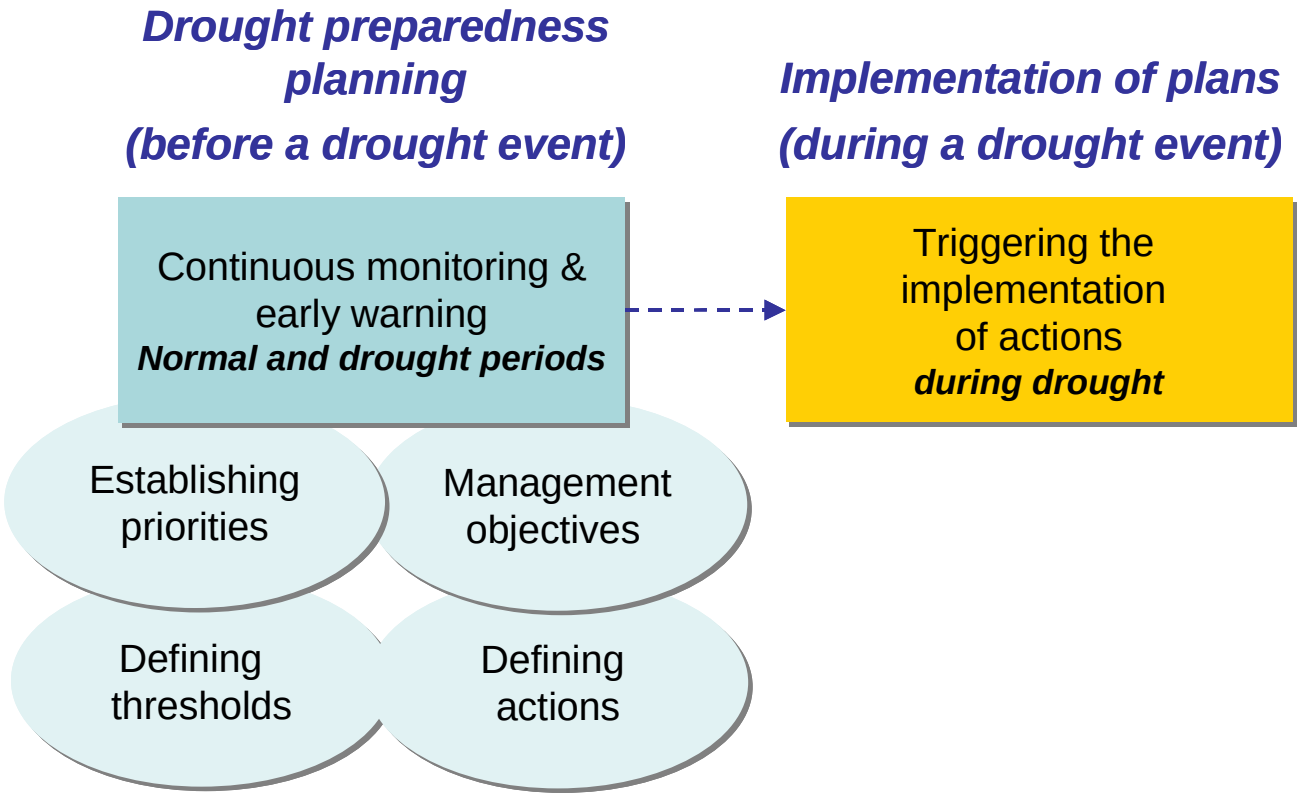
Scen 2 Human and civic resources more important



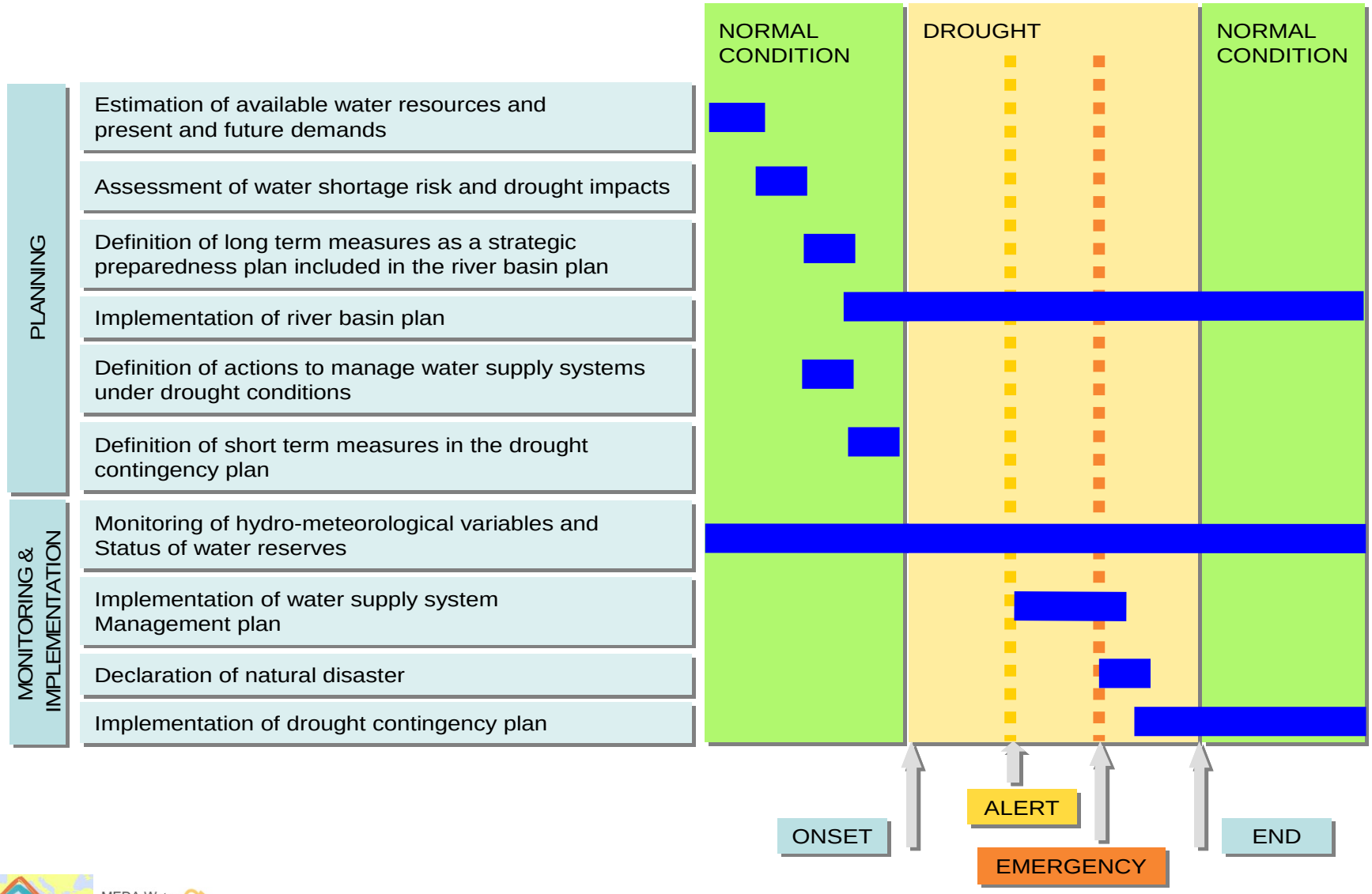
Operational component: Overview

Operational component

According to a proactive approach, operational component includes planning and implementation of the long and short term measures to reduce drought vulnerability and to mitigate drought impacts.



Sequential steps for planning and implementing drought management actions



Role of a drought monitoring system

Planning in advance and early warning are the key factors for an effective drought management.

A drought monitoring system:

- **aims to help decision-makers to identify drought conditions and to implement mitigation measures**
- **is the basis for an objective drought declaration**
- **provides information for improving management of water supply system under drought conditions and avoiding severe shortages**
- **should include monitoring of hydrometeorological variables and water reserves status (e.g. reservoirs, aquifers)**
- **requires several drought indicators to be selected with reference to different demand centers (e.g. rainfed agriculture, users supply by surface or groundwater sources, etc.)**
- **requires graphical representation of indices and access by stakeholder and/or public access through web sites**

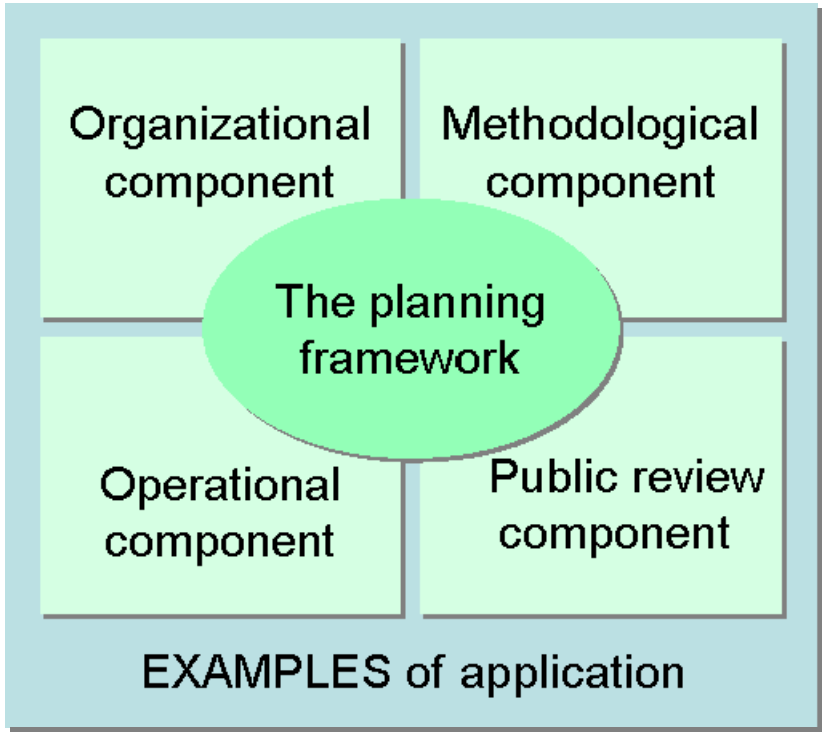
Establishing priorities for water use

- **First: ensure adequate supplies of domestic water for public health, safety and welfare.**
- **Second: minimize adverse drought effects on the economy, environment, and social well-being.**

In several countries after the municipal use (particularly for drinking need) the second priority is for agricultural use (in many cases limited to the supply of perennial crops only) after industrial use and/or the ecological requirements (protection of fluvial ecosystems).

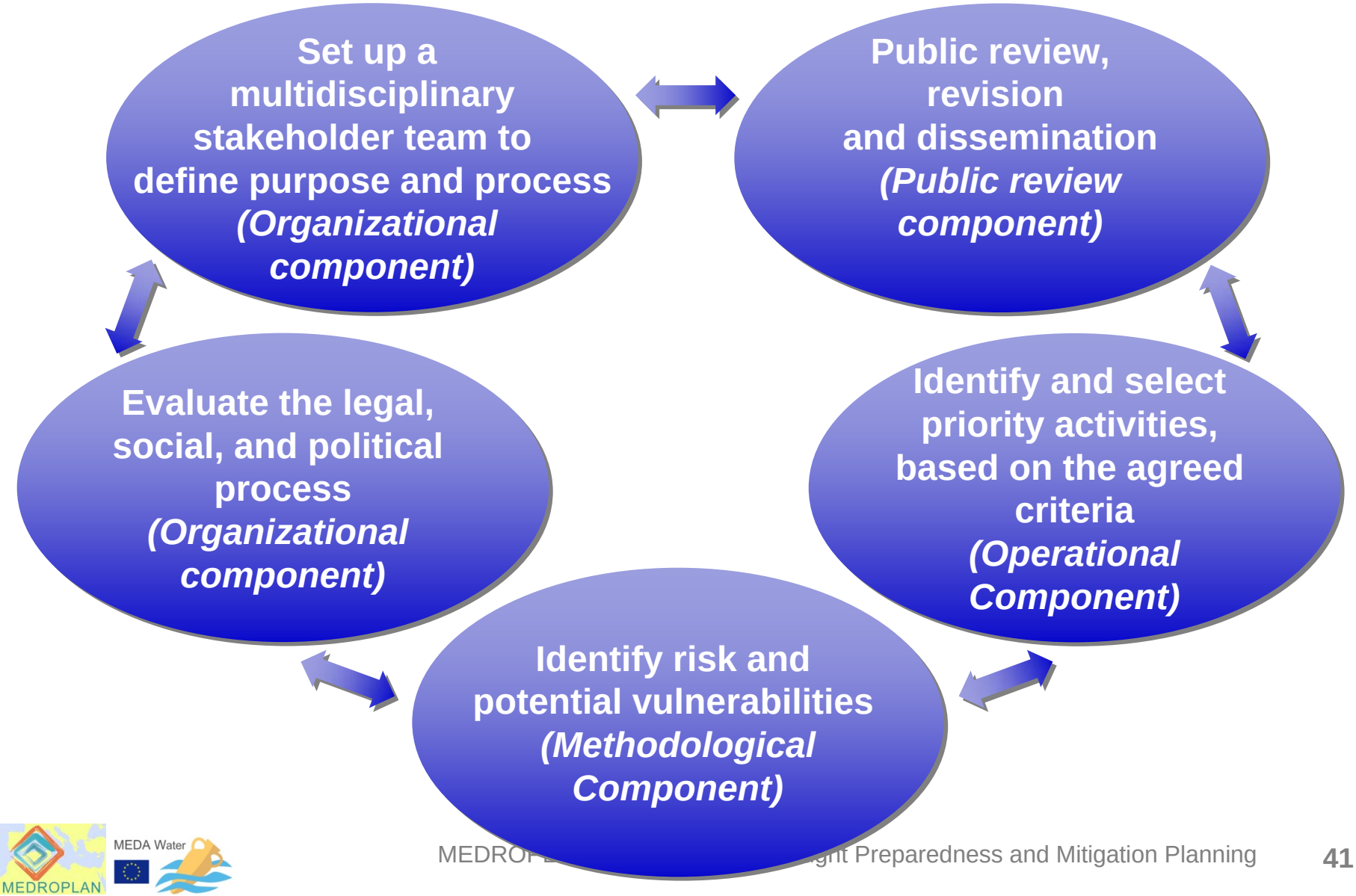
Development of alternatives and ranking

- **Definition of long term measures**
- **Definition of short term measures**
  - **within the management of water supply systems under normal or drought conditions**
  - **after the calamity declaration**
- **The choice of the best (preferable) mix of measures requires:**
  - **a cost-benefit analysis and/or**
  - **a ranking of alternatives through multicriteria analysis (including economic, environmental and social points of view and multi stakeholder's interests)**



Public review component

Public review of the drought management plans



Why is it necessary to establish a dialogue among all stakeholders from the beginning?

- **To enhance the quality and acceptance of drought management plans**
- **To enhance trust in incorporation of scientific and technical knowledge in management**

Role of the public review

- **Verify the adaptation of the designed plan to real evolving conditions**
  - **Changes in social and environmental conditions**
  - **Risk analysis and management development**

- **Periodical revision of the plan is needed**

Aspects of public review

- **Two aspects:**
  - **Dissemination of the information to be revised and**
  - **Multi-stakeholder dialogue to revise the information.**

- **The feedback from stakeholders may be collected:**
  - **by questionnaires,**
  - **by group interviews,**
  - **by public participation and discussions among all stakeholder groups.**

Plan testing

Why is it necessary to test the drought management plan?

- **Singularity of drought events**
- **New collection of knowledge and previous experiences**
- **Dynamic drought, climate, institutions, society**

Periodic revision of the plan

- **Advisable periodic revision of the plan by institutions and stakeholders**
- **In-depth revision of drought management plan should be made after each drought episode, analysing:**
  - **response of all the aspects of the plan,**
  - **ability of prediction and warning,**
  - **effectiveness of adopted measures**
- **Continuous feedback process that keeps the plan updated.**


Thanks for your attention
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