Developing water management strategies for arid regions

Prof. D. Assimacopoulos

WaterStrategyMan

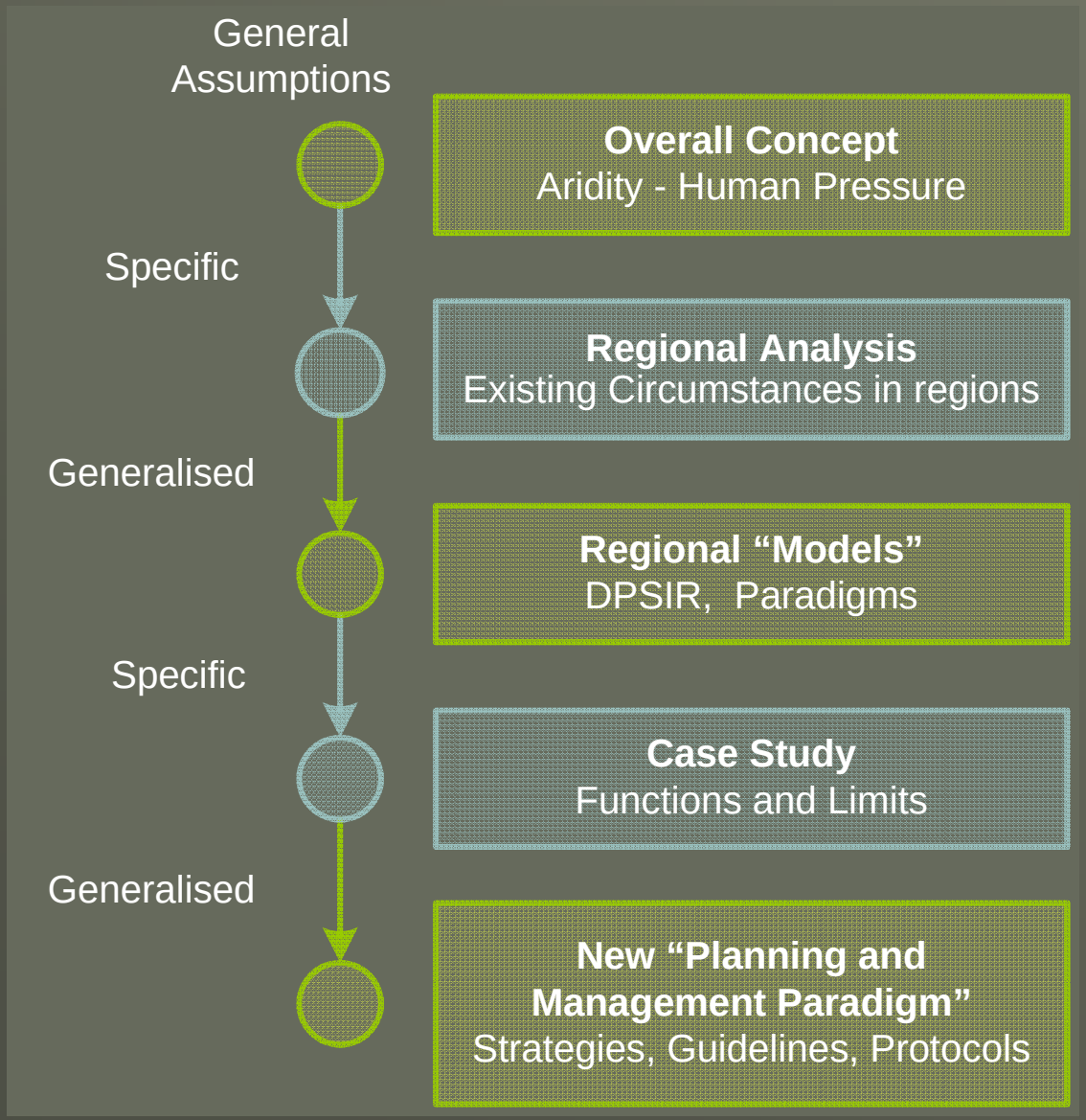
"Developing strategies for regulating and managing water resources and demand in water deficient regions" EVK1-CT-2001-00098

- Partnership
  - NTUA, Greece
  - Ruhr University, Germany
  - ProGeA S.r.l., Italy
  - Office International de l' Eau, France
  - The Hebrew University of Jerusalem, Israel
  - Water Development Department, Cyprus
  - INSULA, Spain
  - Aeoliki Ltd, Cyprus
  - Porto University, Portugal

Project Objectives

- A Typology for arid and semi-arid regions
  - Highlight commonalities and gaps among regions of southern Europe
  - Defined in terms of water deficiency types
- Conceptualised into Paradigms
- Selection of a set of representative regions and definition of Case Studies for evaluating IWRM options appropriate for the identified Paradigms
- Adaptation of tools and development of a DSS able to:
  - Analyse quantitative and qualitative impacts
  - Analyse intersectoral competition of water uses
  - Suggestion of appropriate responses and implementation alternatives
- Development of improved management strategies
- Formulation of widely applicable guidelines and protocols for their implementation

The WSM approach

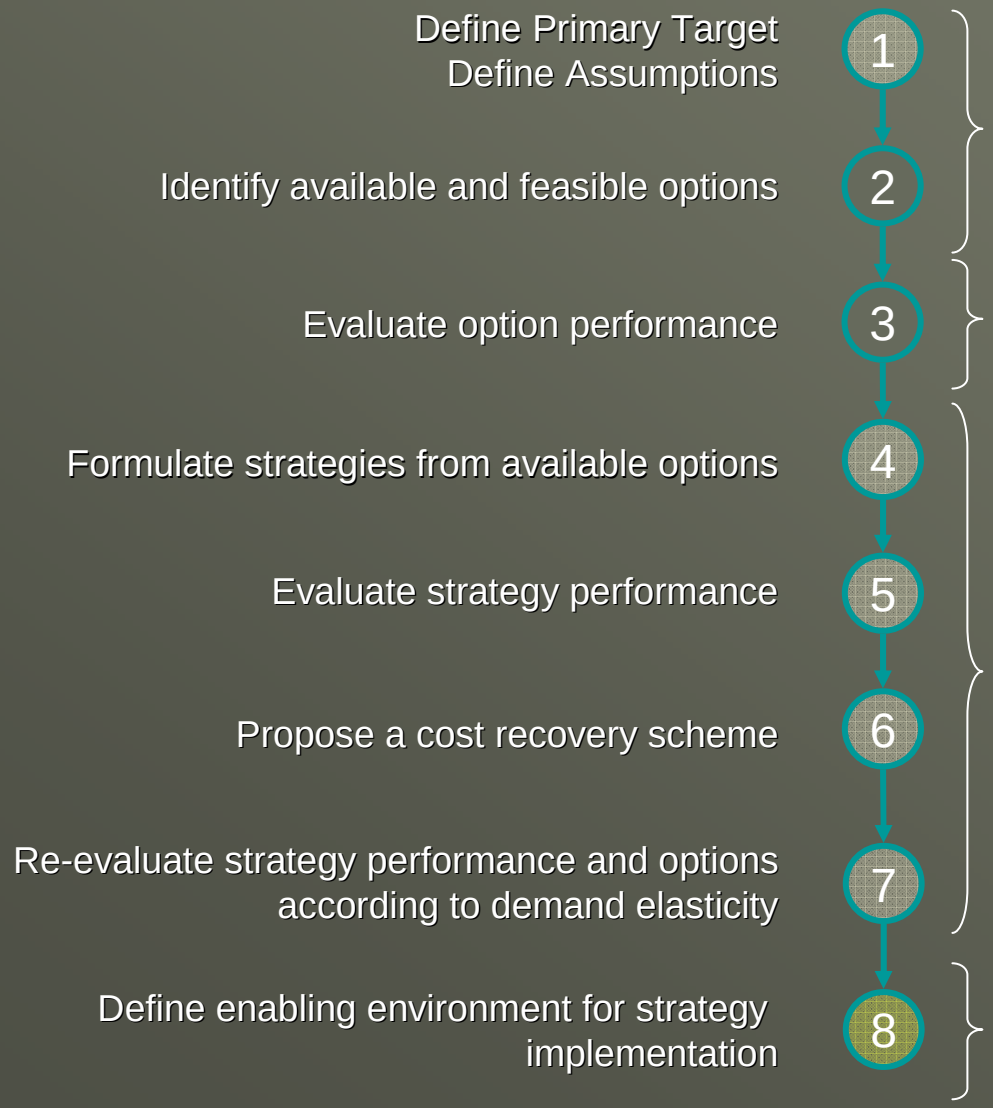


Successive generalisation resulting from systematic analysis of specific conditions

Water stress types
Identified Pressures

- Peak demand during summer due to irrigation demands
  - Belice Basin, Italy
- Peak demand during summer due to tourism
  - Paros Island, Greece
- Year-round high demand due to tourism
  - Tenerife Island, Spain
- Competition between tourism and agriculture
  - Cyprus
- Conflict between urban water supply and agriculture
  - Tel- Aviv and Arava regions, Israel
- Salinity problems due to over-abstraction
  - Ribeiras do Algarve, Portugal
- Fragile environment threatened by local development
  - Doñana, Spain

Steps in developing strategies

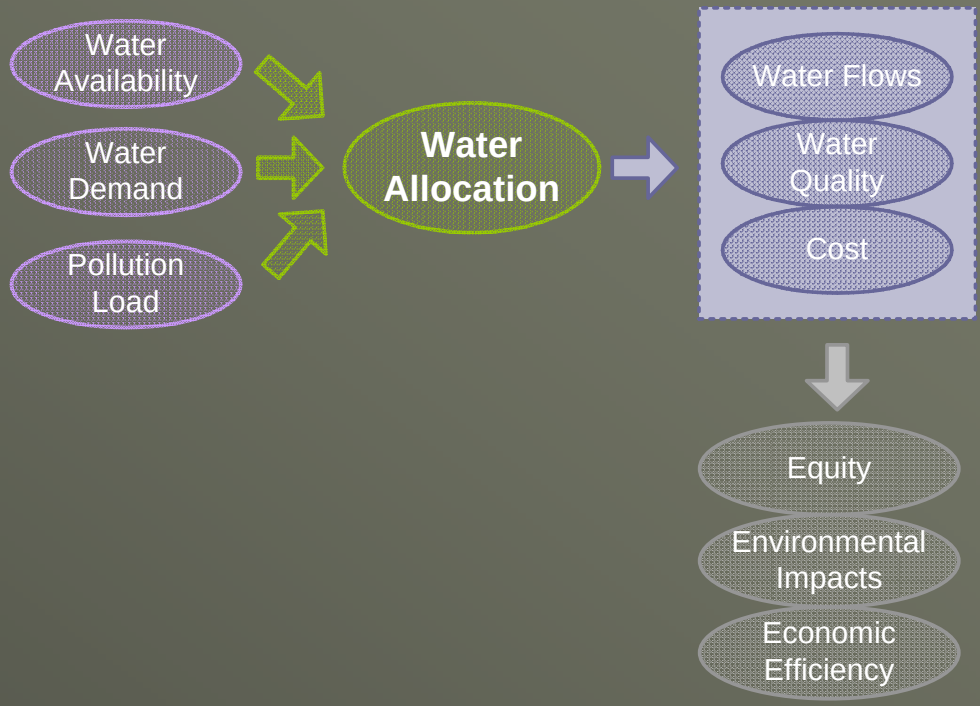


Setting strategy goals

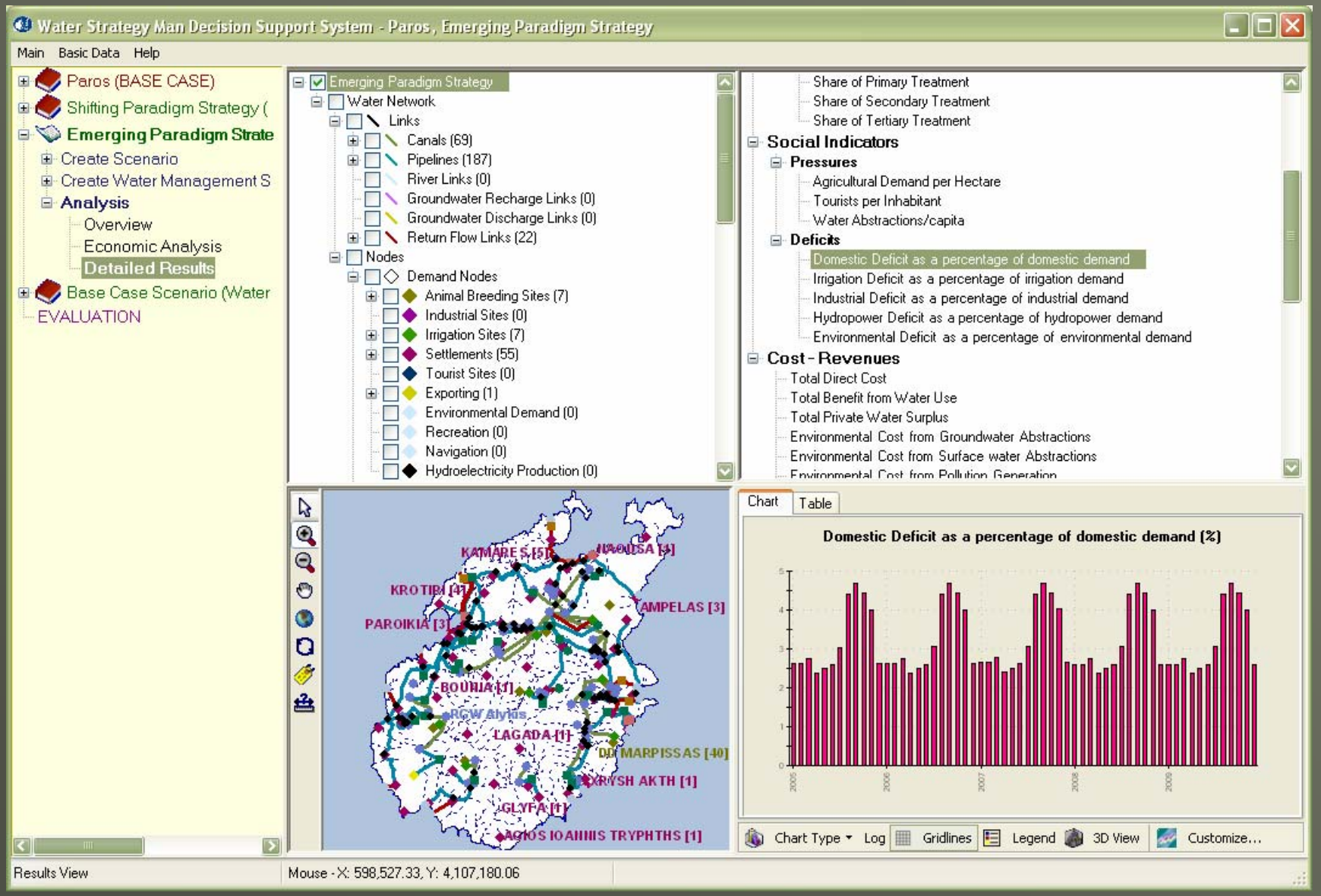
- Principal Goal
  - Mitigation of water stress conditions
- Secondary Goals
  - Equity
    - Distribute cost equitably among users (Domestic, Tourist, Agriculture, Industry)
  - Environmental Sustainability
    - Mitigate Impacts
      - Reduce drillings to sustainable levels
  - Economic efficiency
    - Cost recovery (which, how much)
      - Direct, Opportunity, Environmental
      - Recovery on a local level, reducing State subsidies to a minimum

Evaluation of interventions and options
A GIS Decision Support System

- Assess the State of the Water System in terms of:
  - Sources
  - Usage
  - Water cycles
  - Environmental quality
- Actions and measures analysed:
  - Supply management
  - Demand management
  - Socio-Economic instruments

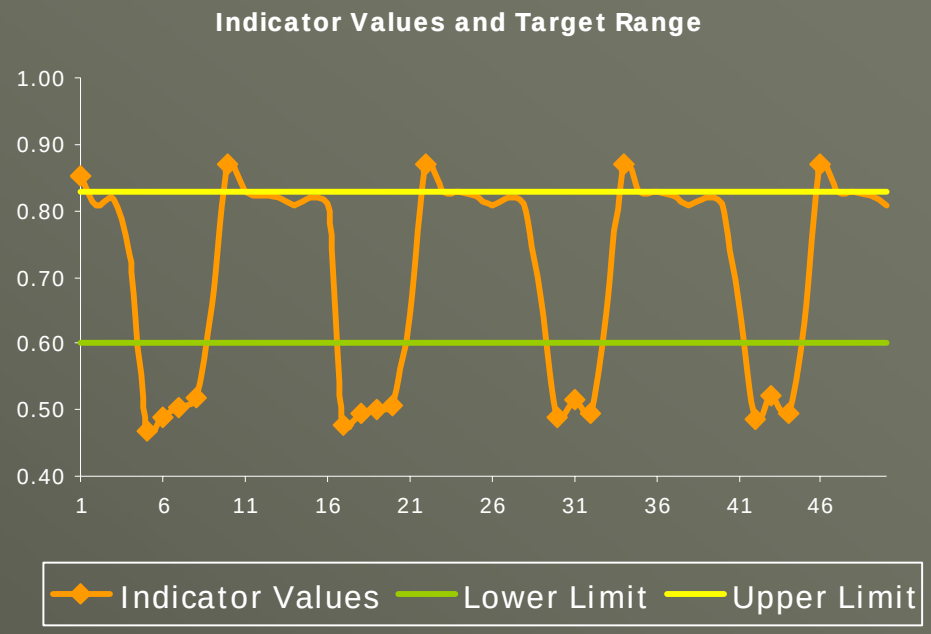


The WSM Decision Support System



Indicators for evaluation

- Indicators
  - Environmental
  - Efficiency
  - Economic analysis (direct and indirect costs)
- Temporal aggregation
  - Reliability (probability of indicator to be within a range of values)
  - Resilience (speed of recovery from an unsatisfactory condition)
  - Vulnerability (extend and duration of unsatisfactory values
- Total score obtained through user-defined weights and multi-criteria analysis



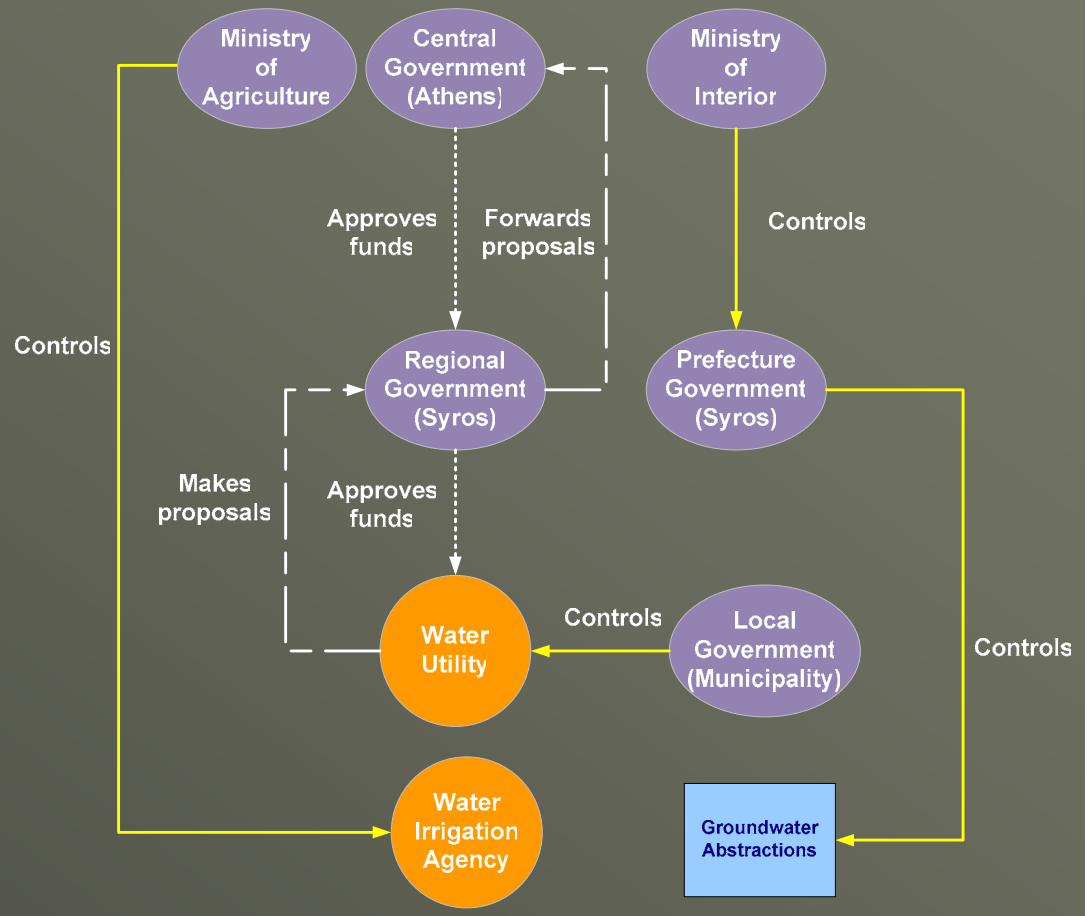
Methodology Example

Paros Island, Cyclades, Greece

Step 1

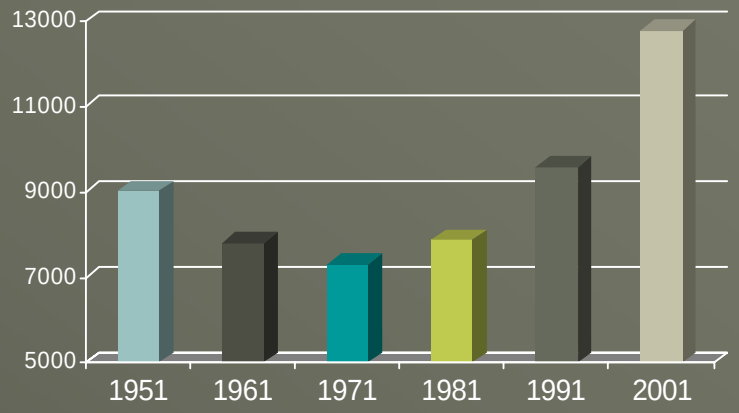
Analysis of regional information
Stakeholder Consultation
Primary Goal Definition

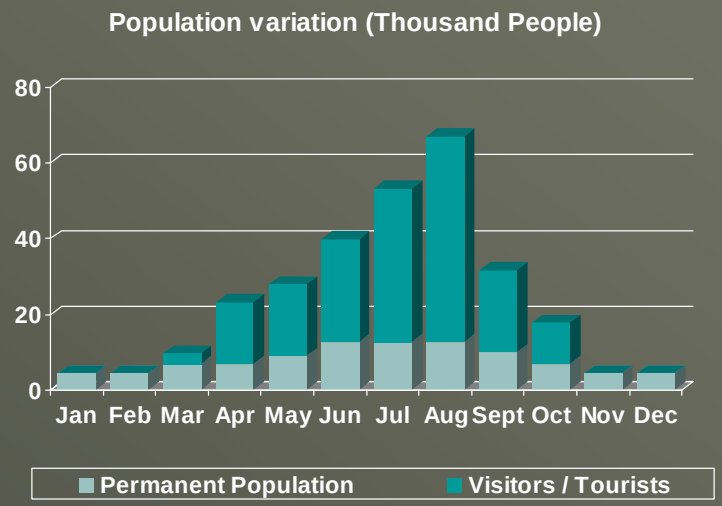
Paros island in the Cyclades



Historical background

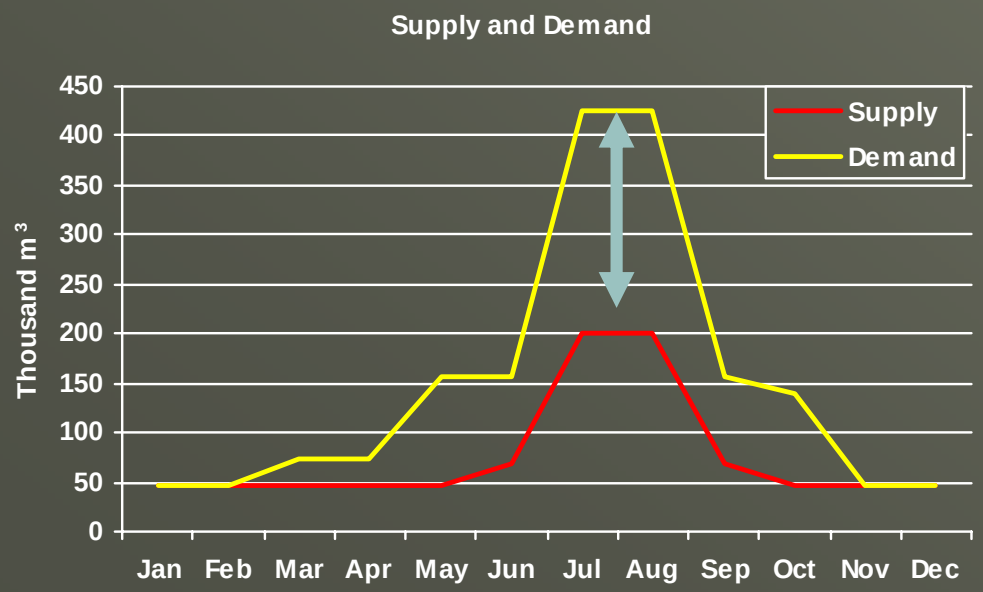
- Emigration to mainland (1950-1965)
- State subsidizes tourism (1960-)
- Popular tourist destination in the Cycladic complex
  - Seasonal population is almost 5 times greater than permanent population
  - Both tourism and agriculture exert great pressure on the water resources
- Population growth (1990-)
- No long-term or systematic planning and control





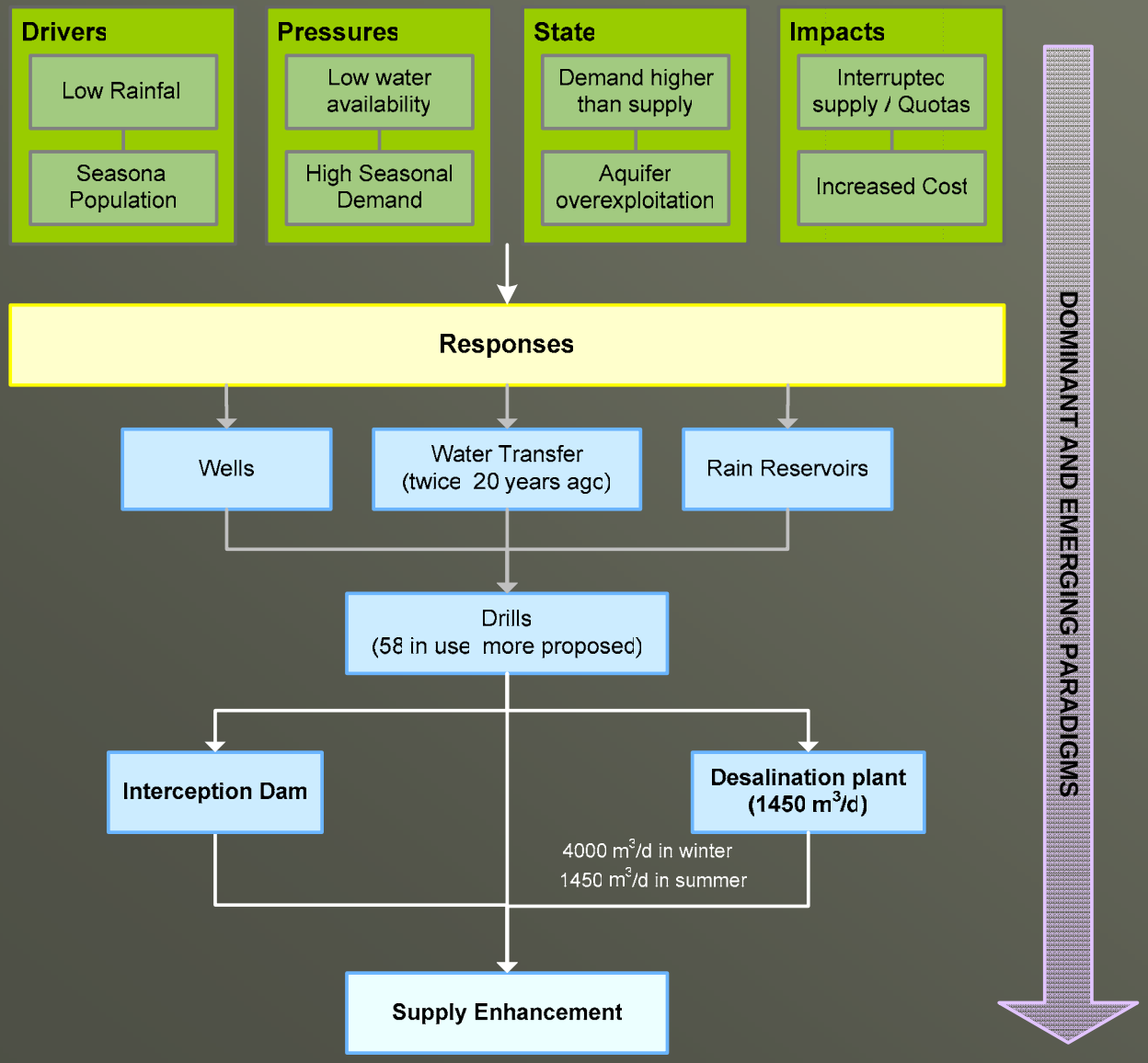
STEP 1A: Target Definition for Paros

- Strong seasonal demand exerting pressure on available water resources
- Management of the peak demand without incurring excessive direct & Environmental Costs

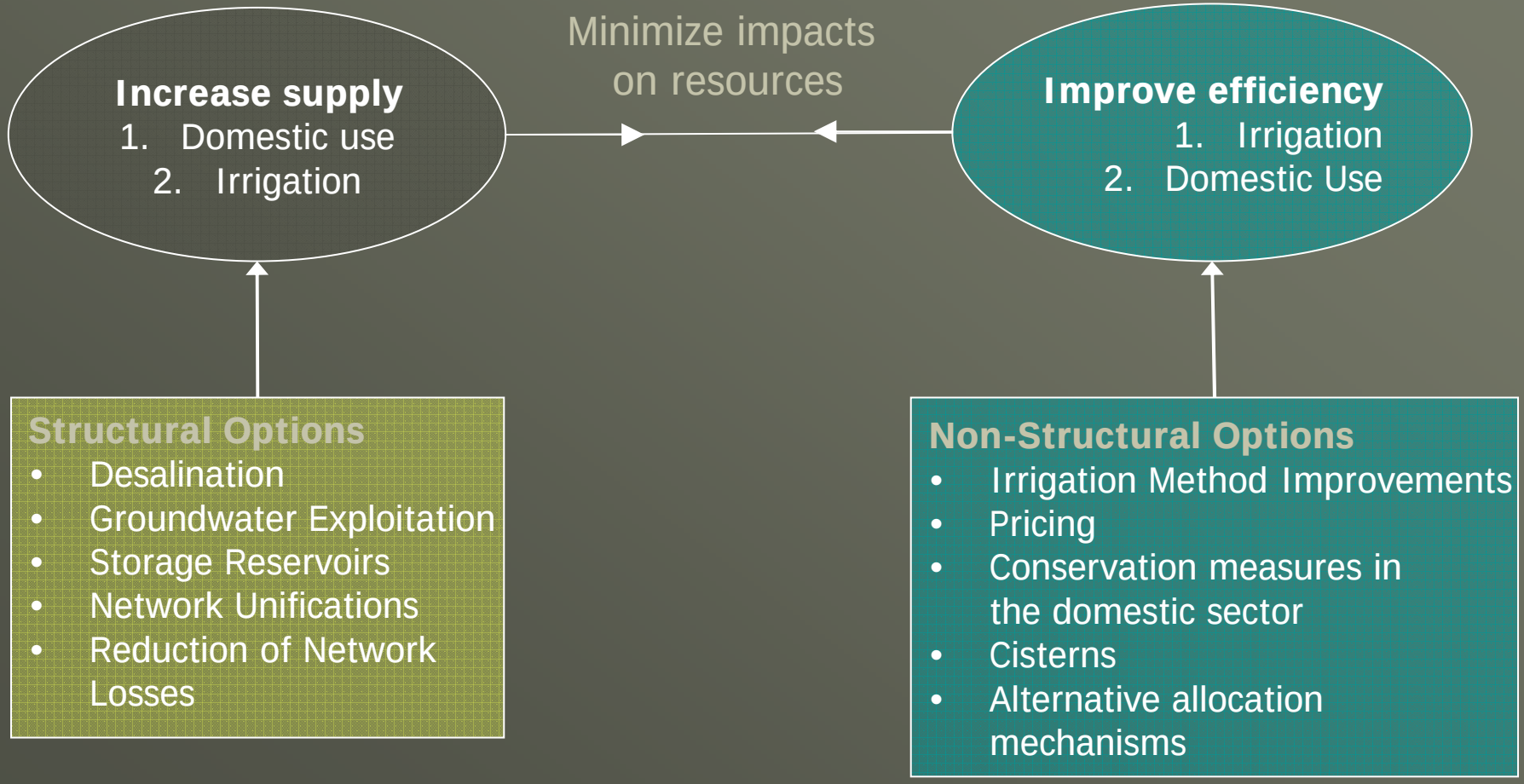


- Primary Target
  - Meet at least 80% of domestic and irrigation needs in the peak summer period
  - Meet 100% of domestic and irrigation needs during the rest of the year
- Justification
  - Tourism development is a priority supported by most stakeholders
  - Resolve social conflicts
  - Maintain agricultural activities

DPSIR analysis and Dominant - Emerging Paradigms



STEP 2: Identify available and feasible options*



Step 3

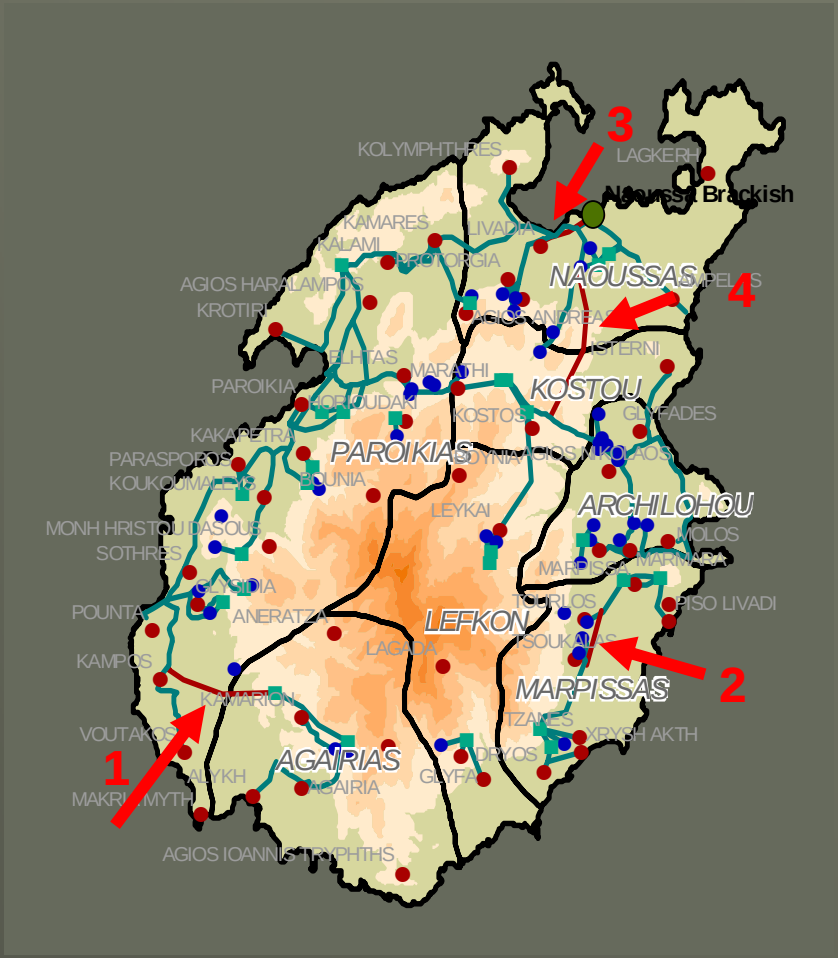
Evaluation of performance

An example: Network Unifications

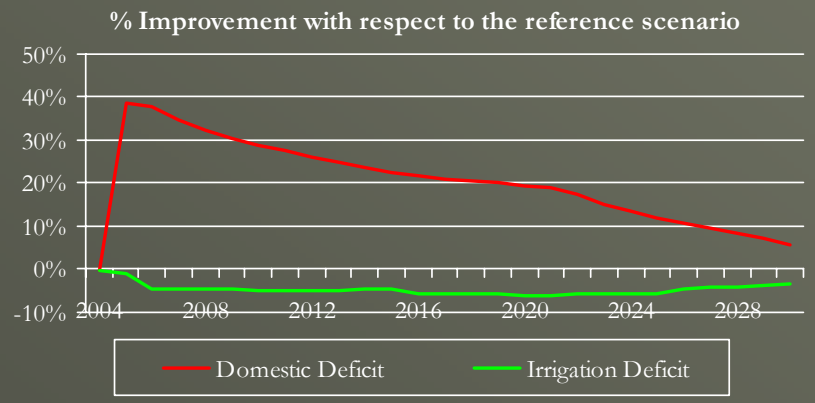
- Current practices
  - High fragmentation of water supply networks
    - Past administrational structures
      - Each municipal department was responsible for construction, maintenance of distribution systems and local water resources management
    - Separate water supply networks
- Proposed option
  - Unification of fragmented networks
  - A measure
    - Against the uneven distribution of resources
    - That creates strong conflicts

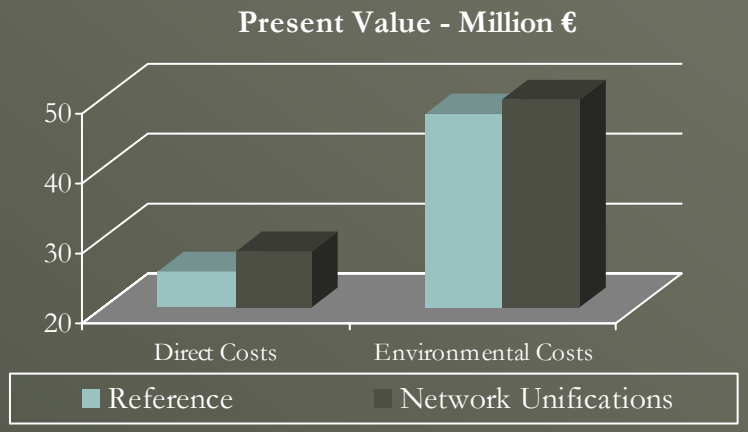
An example: Network Unifications

- 2005:
  - Network in 1, 2 and 3
- 2028:
  - Network in 4



Example of Step 3: Network Unifications





Step 3: Normalised Performance Matrix

Option	Relative Sustainability Index for Demand Coverage	Economic Efficiency	Environmental Cost
Base Case	O	+	+ +
Network Unifications	+	+	+ +
Storage Reservoirs	+	+	O
Loss Reduction	+ +	+ + +	+ +
Irrigation Method Improvements	+ +	+ +	+ +
Irrigation Pricing	+ + + +	+ + + + +	+ + + +
Domestic Pricing	+ + +	+ + + + +	+ +
Desalination	+ + + + +	+	+ +
Conservation	+ +	+ + +	+ +
Cisterns	O	O	O
GW Exploitation	O	+	+ +

Step 4

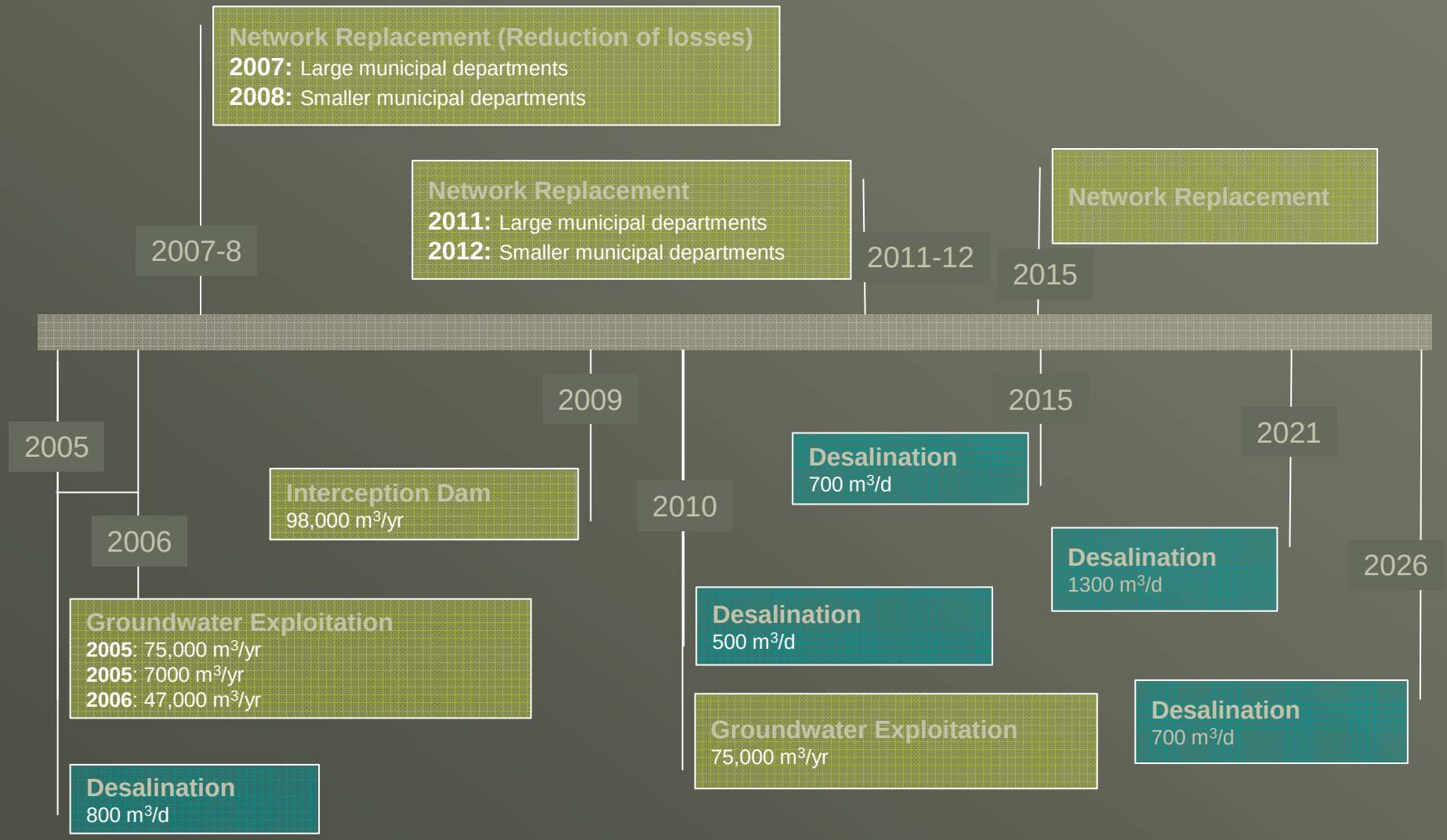
Formulation of alternative water management strategies

Strategy 1: The emerging paradigm

- Emphasis on “hard” interventions
  - Groundwater Exploitation
  - Interception dam
  - Network improvements
  - Desalination

- Groundwater Exploitation
  - A total of 4 additional boreholes, yielding 204,000 m^3/yr
- Surface water exploitation
  - Interception dam for aquifer enhancement
    - Capacity of 98,000 m^3
- Reduction of Network Losses
  - From 25 to 20 %
- Desalination
  - Total capacity of:
    - 1300 m^3/d in 2010
    - 2000 m^3/d in 2020
    - 2700 m^3/d in 2030

Strategy 1: Tentative Timeframe



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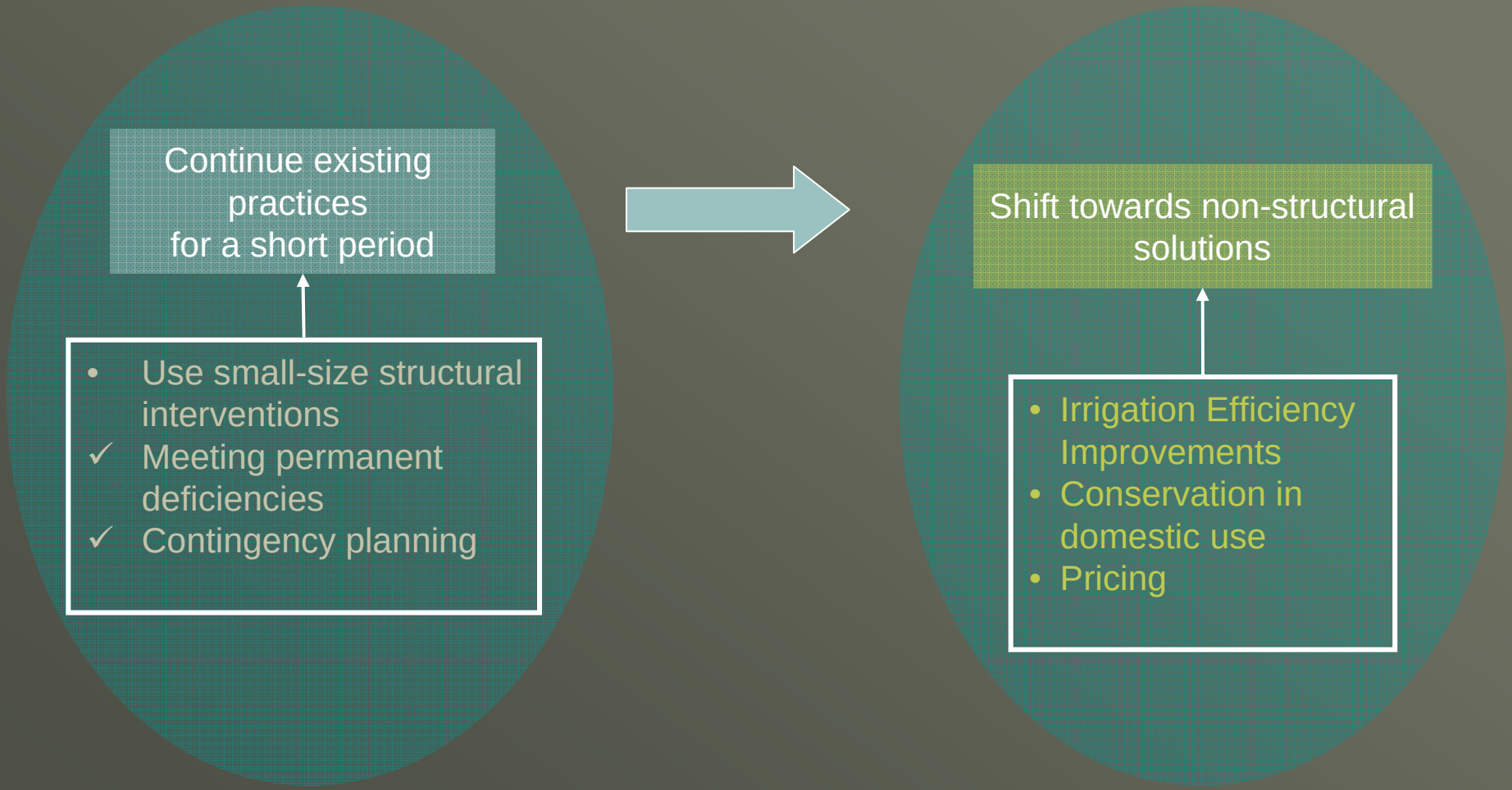
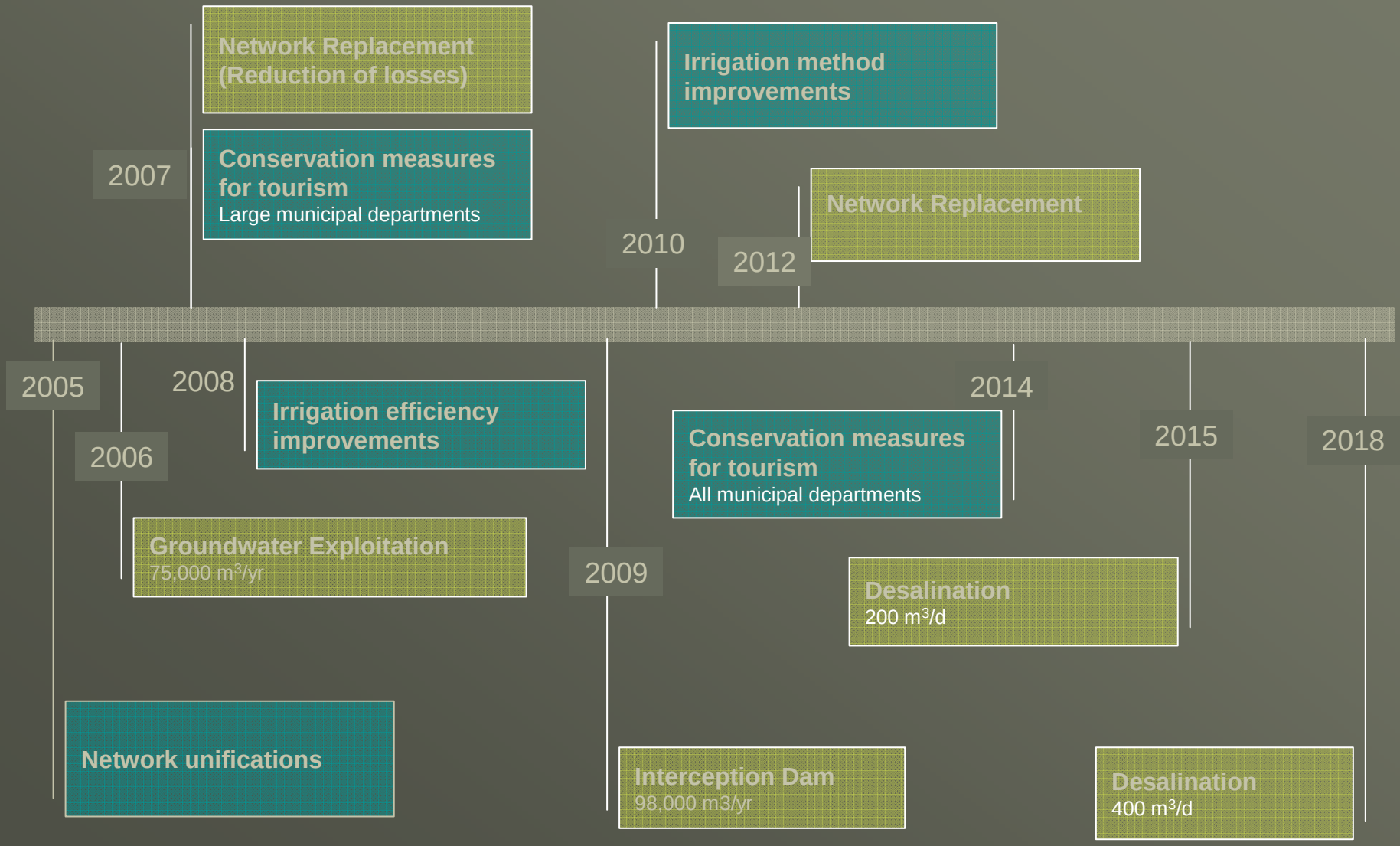
Strategy 2: The shifting paradigm



Strategy 2: Tentative Timeframe



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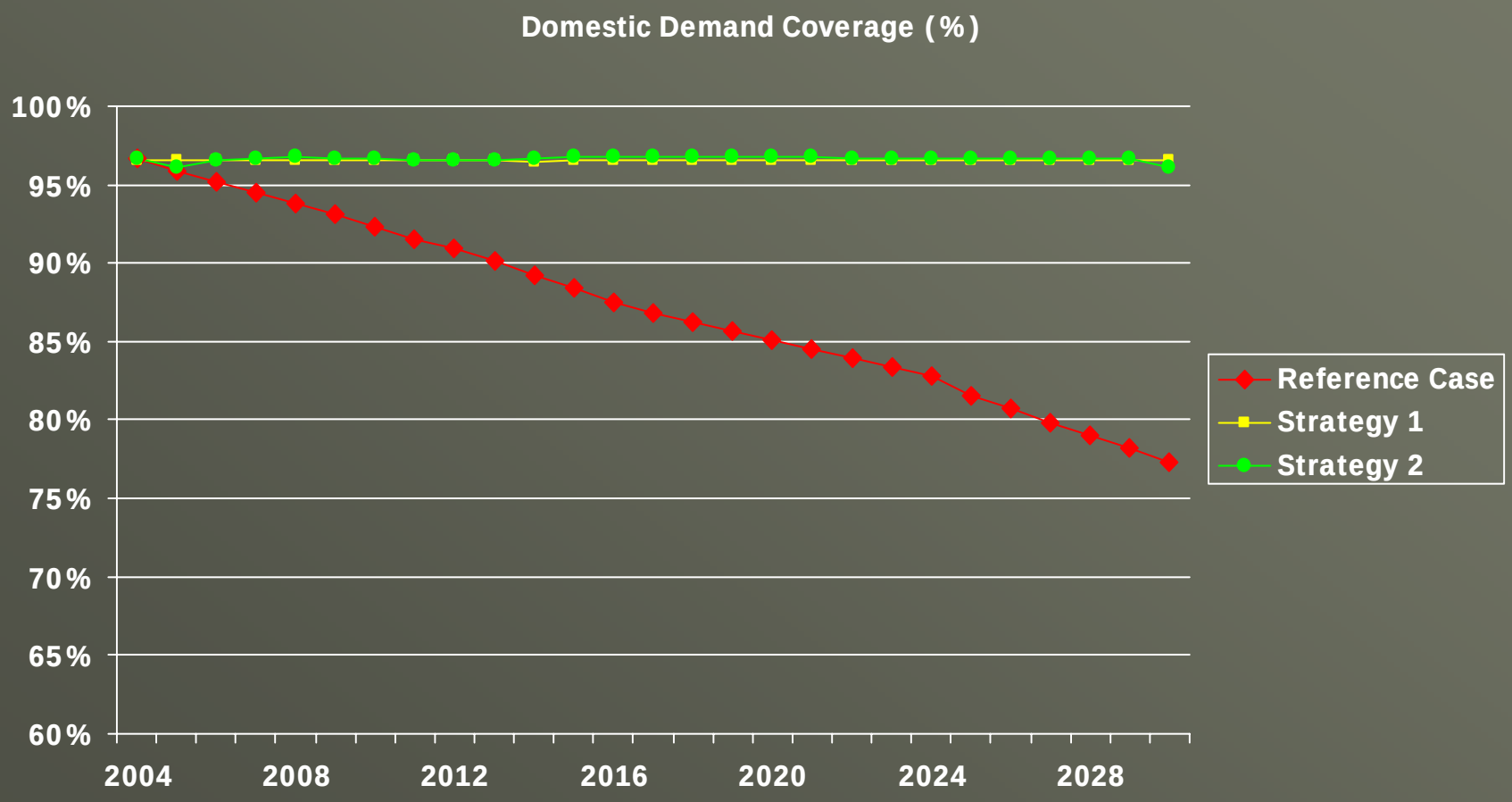
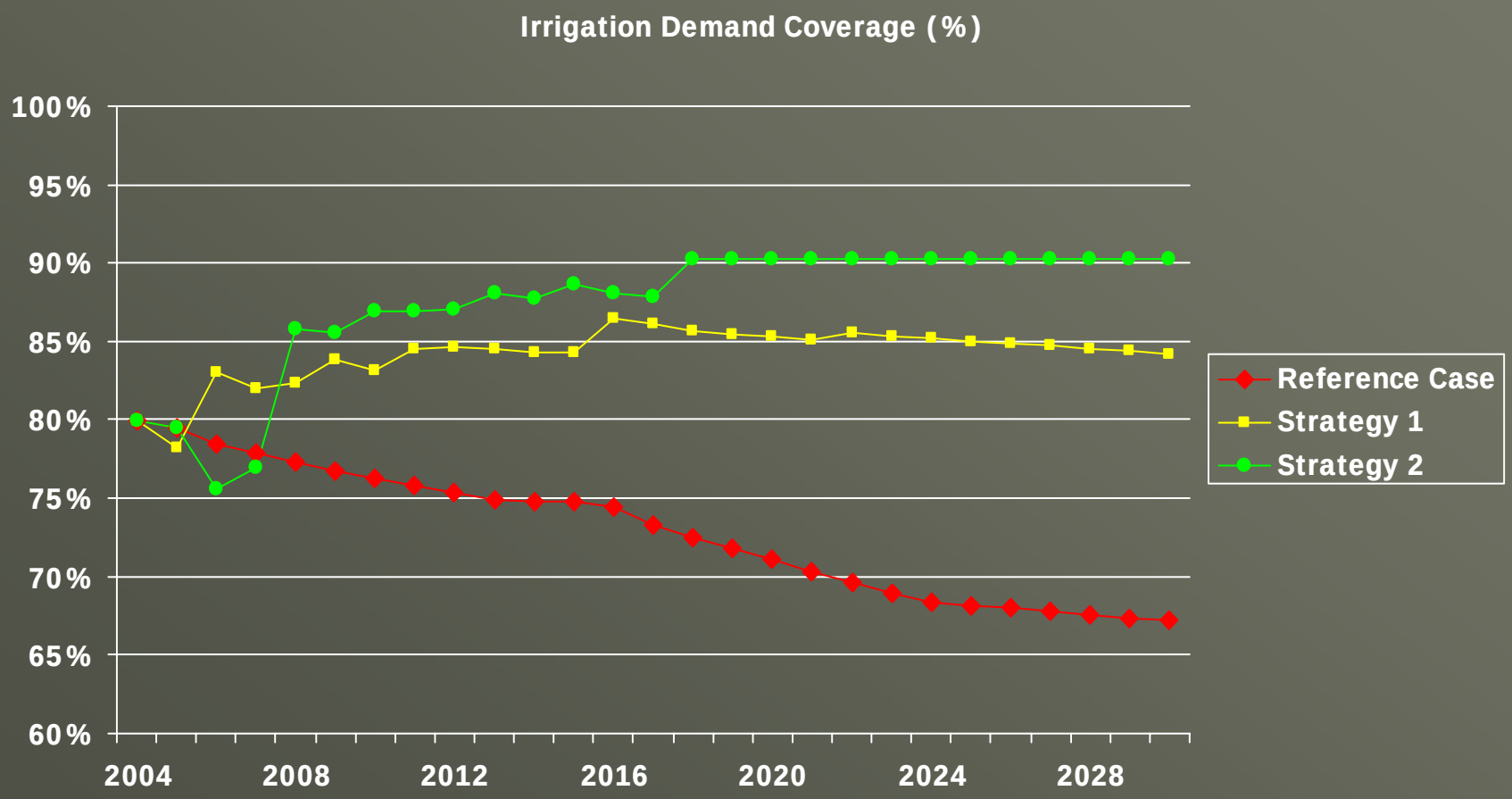
Result Summary

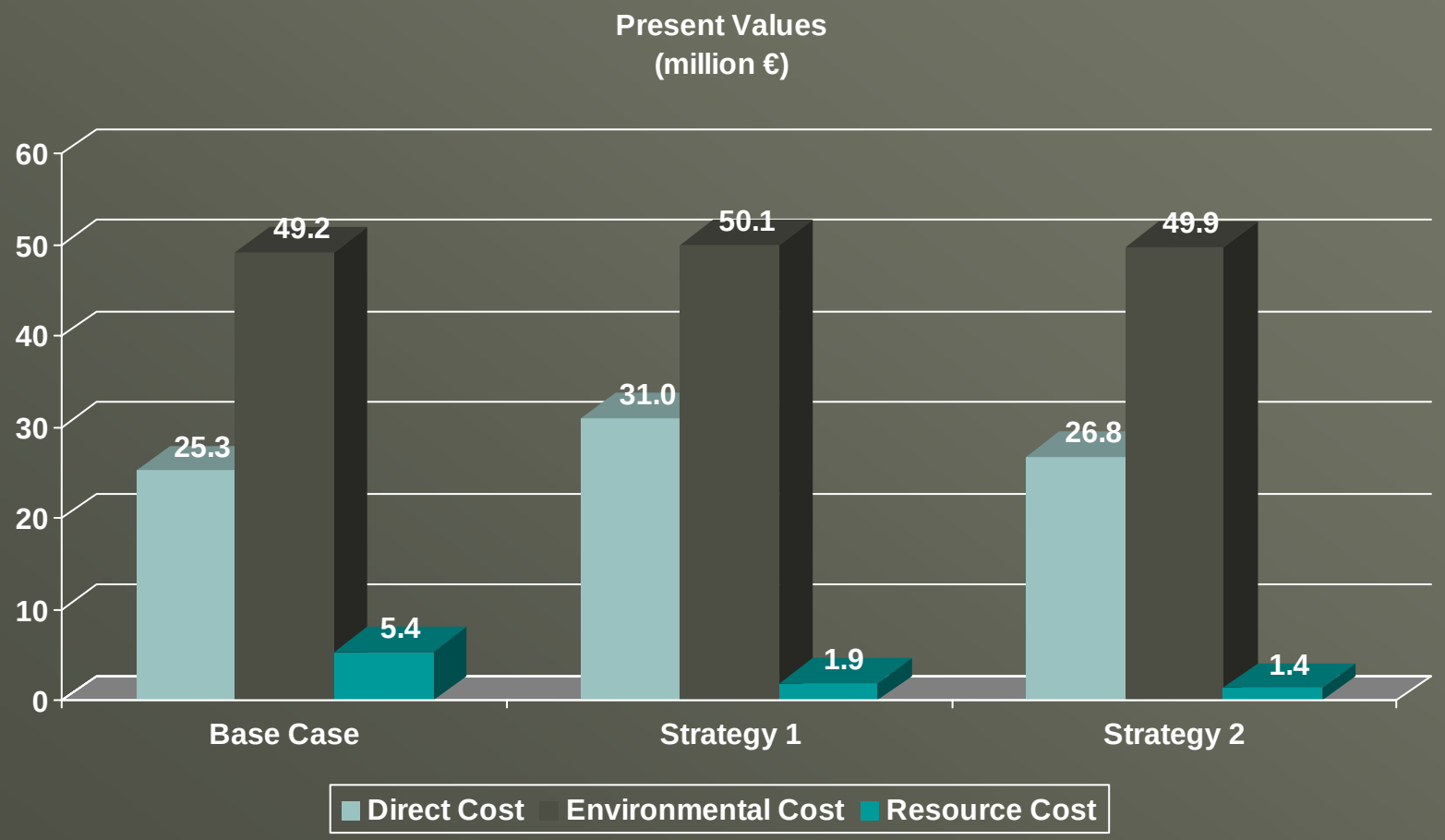
Principal Goal – Domestic Use



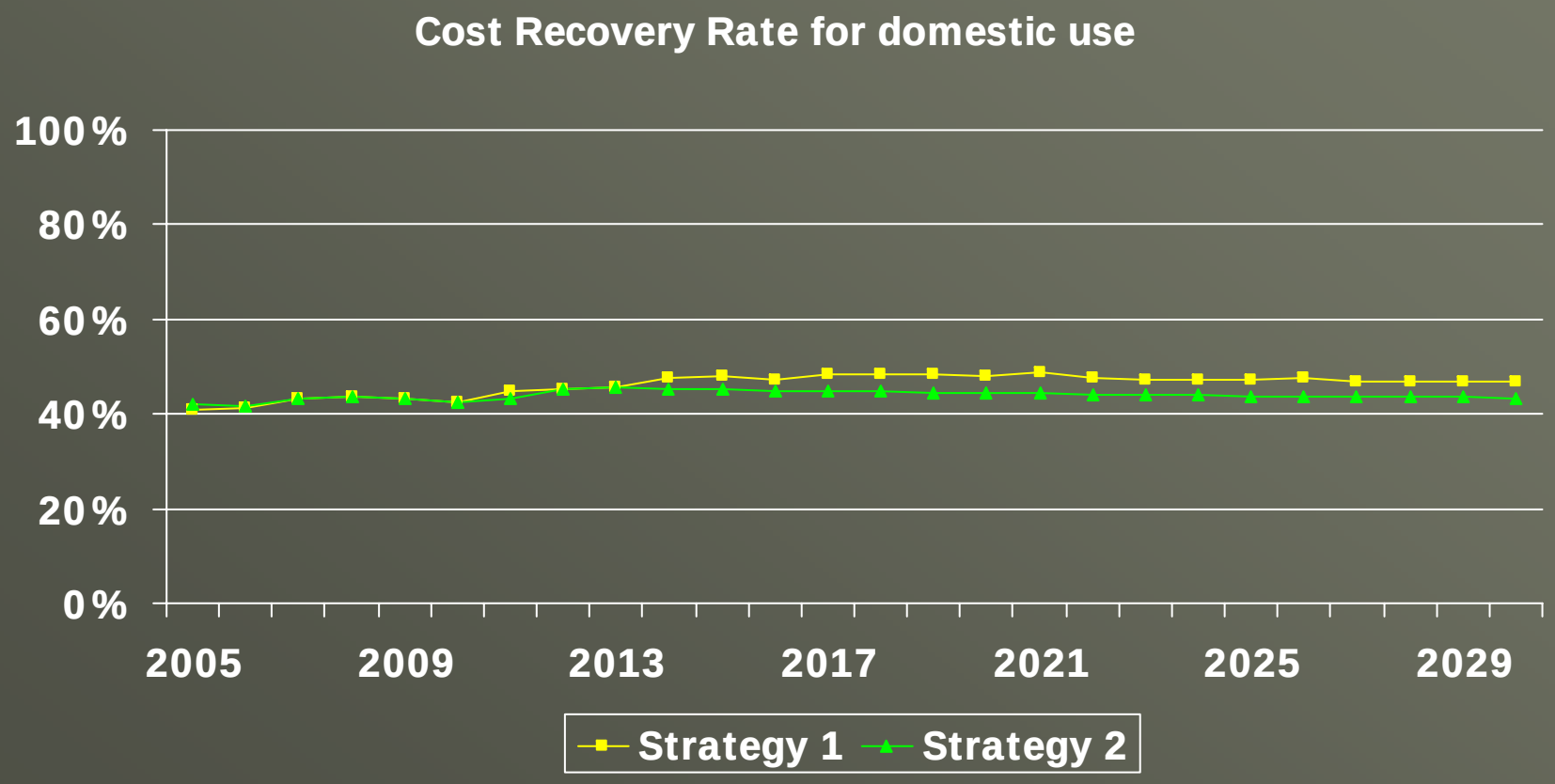
Principal Goal - Irrigation



Step 5: Strategy Evaluation



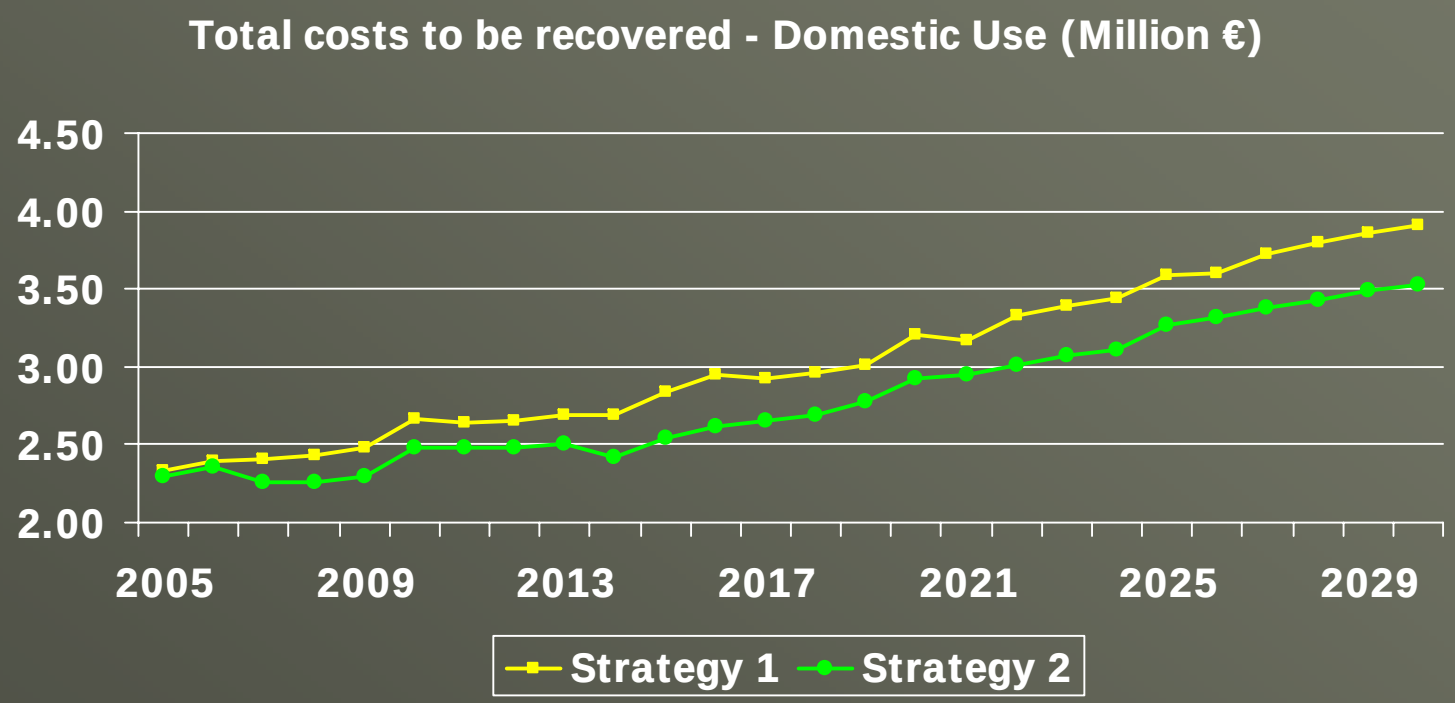
Step 6: Cost recovery under the current price levels



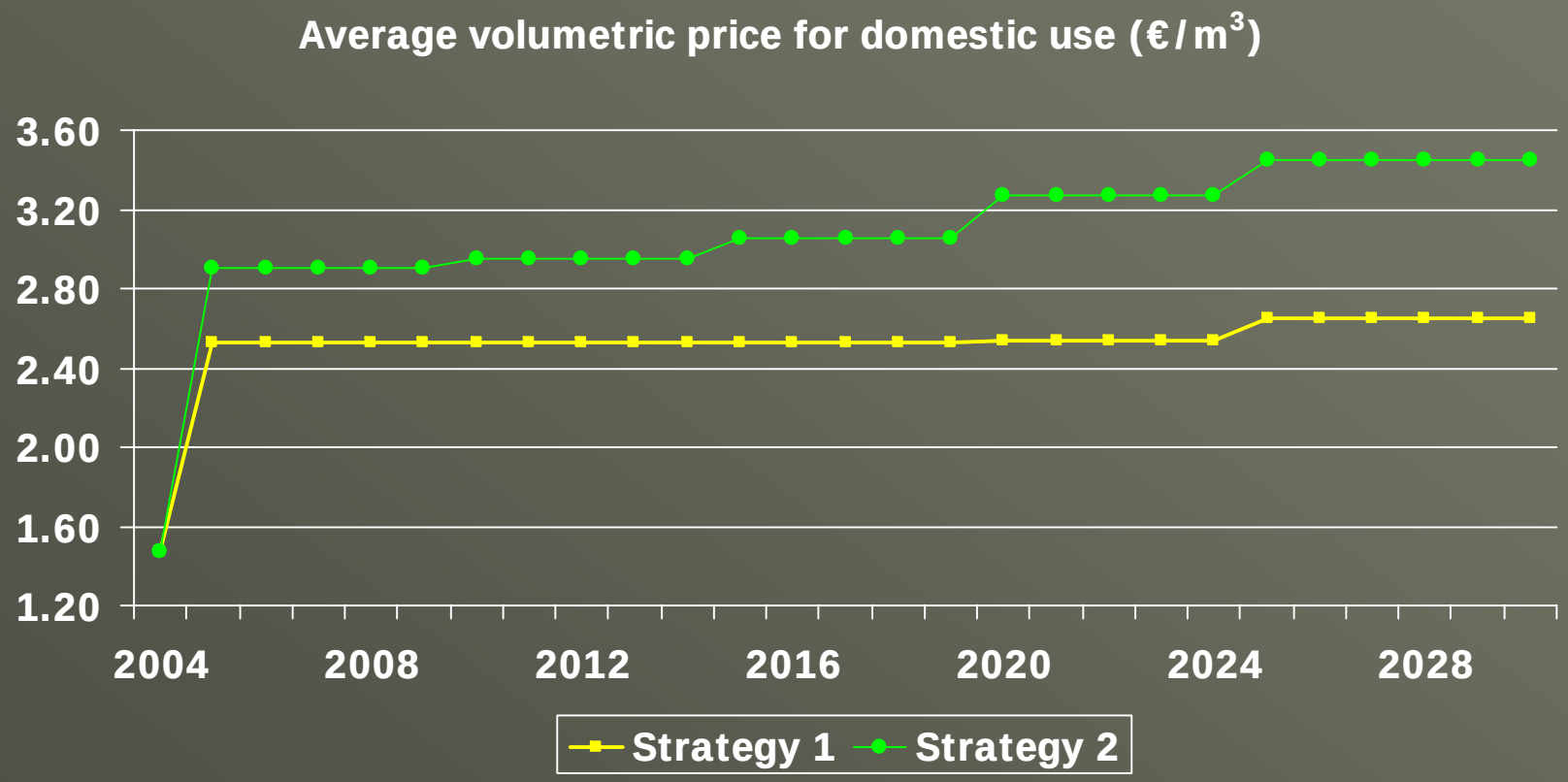
A pricing scheme for domestic use

- Price Estimation
  - Average volumetric prices for 5-year periods
  - Recovery of costs
    - 100% recovery of direct costs for the period 2005-2030
    - Initial (2005) recovery of 50% for environmental and resource costs
    - Gradual increase of prices for a targeted (2030) recovery of 70% for environmental and resource costs

Total cost to be recovered

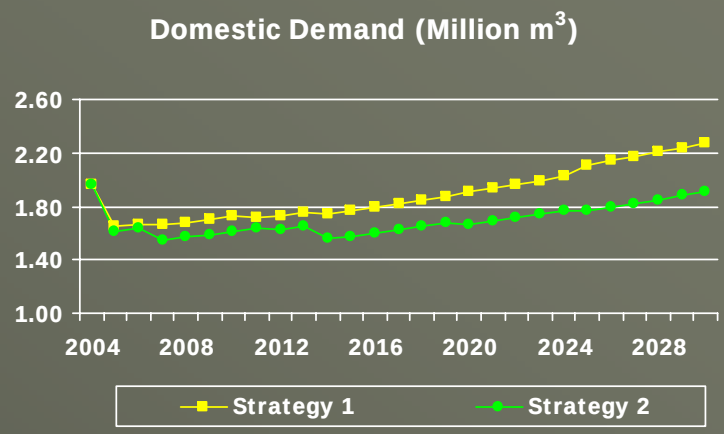


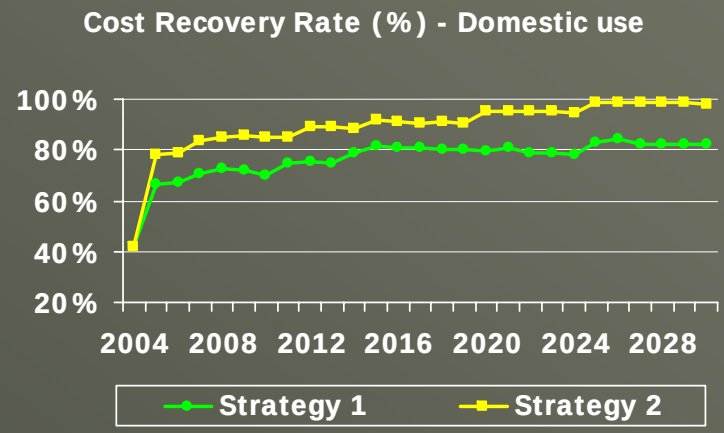
Average prices for domestic use



Step 7: Re-evaluation of strategy options and performance

- Demand elasticity of -0.2
- Iterations are required because of changes in:
  - Size of interventions that are needed
  - Operational Costs
- Final Prices (2030)
  - Strategy 1: 2.7 €/m^3
  - Strategy 2: 2.9 €/m^3





Conclusions

- The transition to a comprehensive “soft path” is already under way, but we must move more quickly to address serious unresolved water problems (Gleick, 2003)
- Appropriate tools for the formulation and evaluation of alternative IWRM management strategies are necessary
- An enabling environment is required
- WFD & CIS may facilitate the transition process