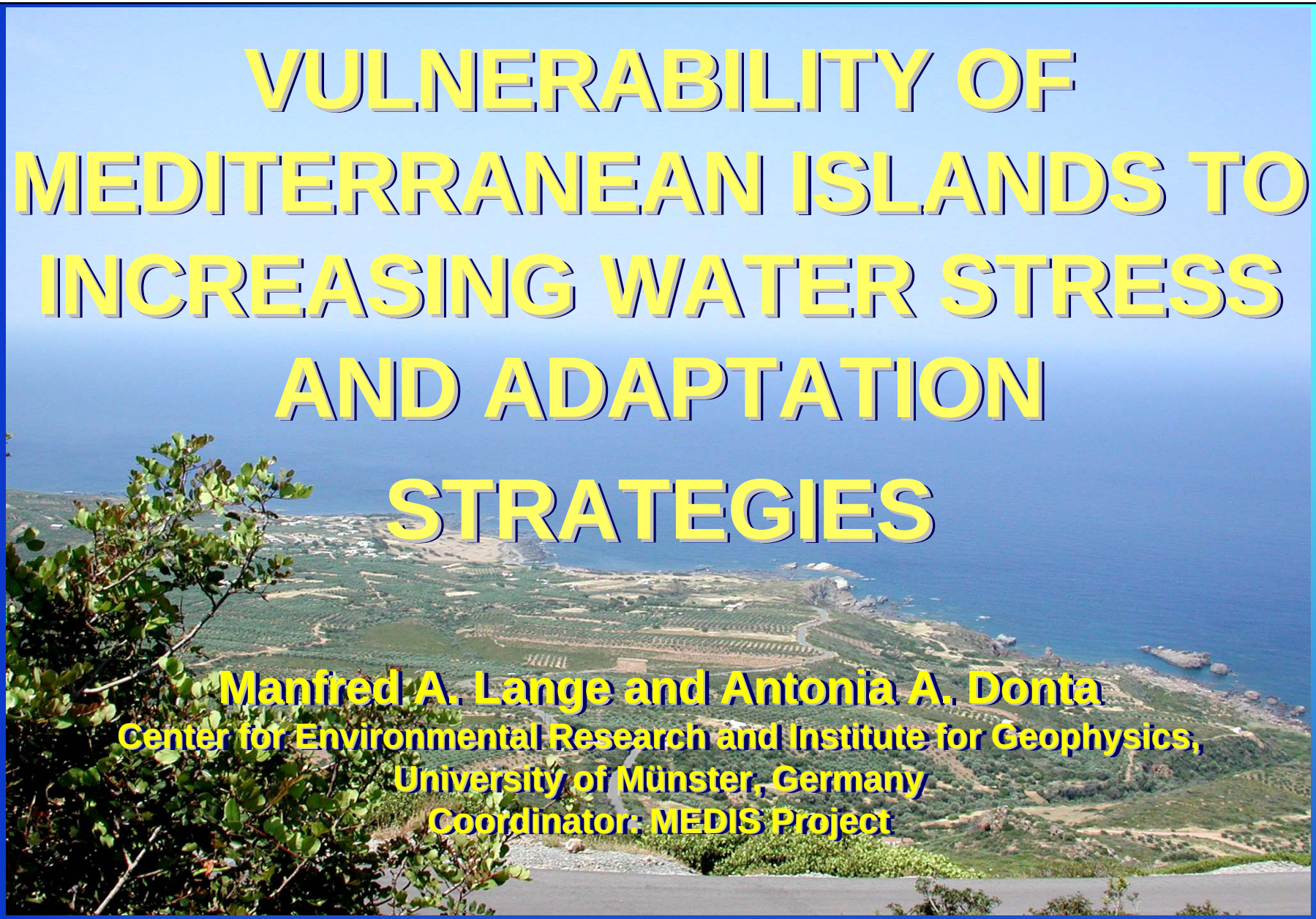
VULNERABILITY OF MEDITERRANEAN ISLANDS TO INCREASING WATER STRESS AND ADAPTATION STRATEGIES



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Introduction

- Water is an indispensable ingredient for life
- Availability of water changes in time and space
  - Quantity
  - Quality
- Arid regions require particularly careful water management strategies
- The sufficient supply of water may become even more problematic in the foreseeable future
  - Enhanced droughts in arid regions as a result of climate change
  - Increasing demand for water

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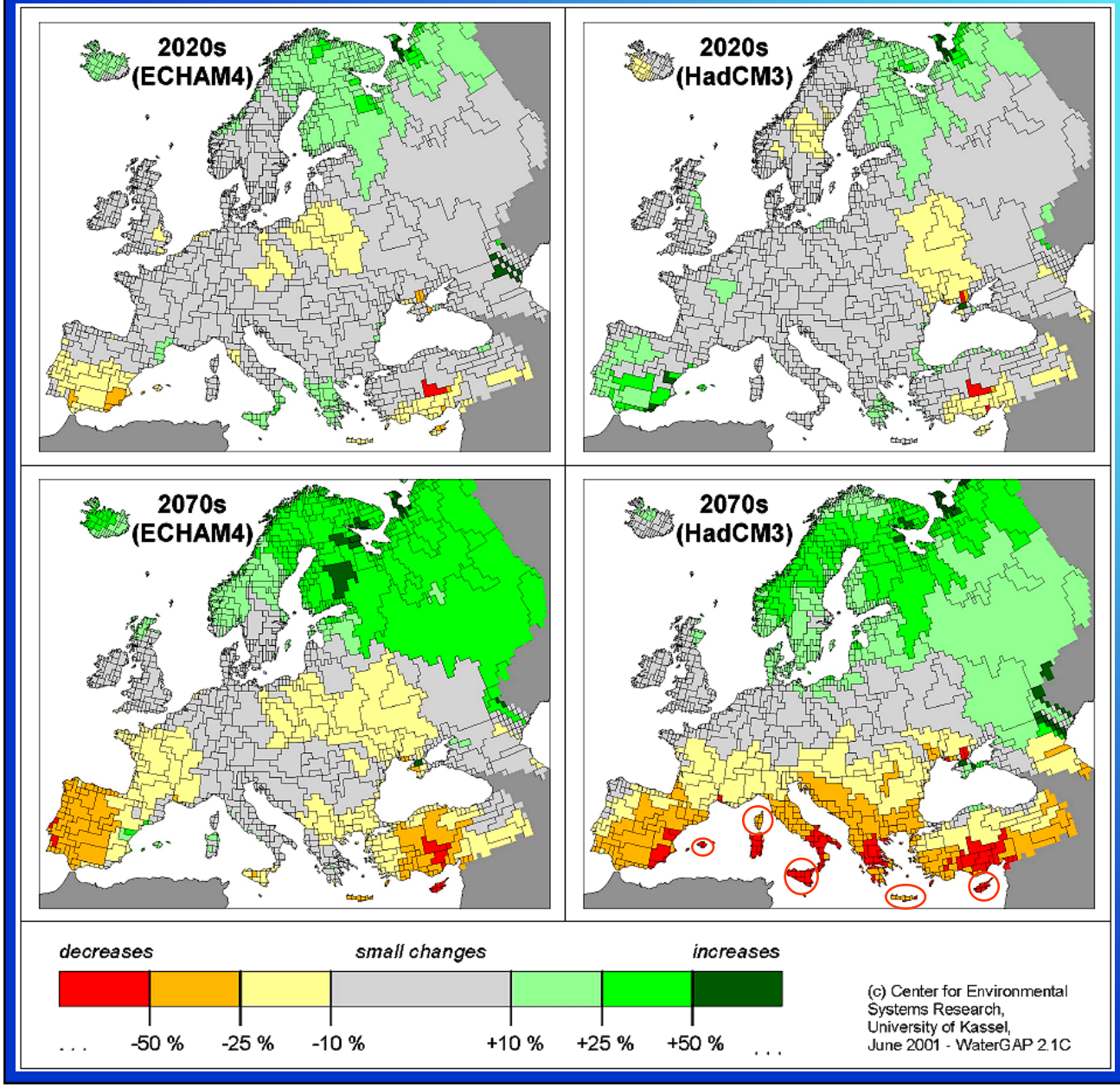
Introduction



Change in annual water availability in % (i.e., natural discharge, not accounting for consumptive water use) for European river basins based on climate simulations with two global climate models (the ECHAM4 model of the Max Planck Institute for Meteorology, Hamburg, Germany and the HadCM3 of the Hadley Centre, Bracknell, UK) and presented for 2020 and 2070 relative to present discharge values (after Lehner et al., 2001); as can be seen, Mediterranean islands are particularly susceptible to droughts

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Definitions

- **Sensitivity**
  - sensitivity is the degree to which a system is affected, either adversely or beneficially, by water scarcity stimuli
- **Adaptation**
  - adjustment in natural or human systems in response to actual or expected water scarcity stimuli or their effects, which moderates harm or exploits beneficial opportunities
- **Vulnerability**
  - the degree to which a system is susceptible to, or unable to cope with, adverse effects of water scarcity; vulnerability is a function of the character, magnitude, and rate of water scarcity to which a system is exposed, its sensitivity, and its adaptive capacity
- **Adaptability/adaptive capacity**
  - depicts the ability or potential of a system to adjust trough changes in its characteristics or behaviour to water scarcity, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences of water scarcity

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Vulnerability:
The Potential for Harm

Exposure **Sensitivity** **Adaptive capacity**

Potential impact

Vulnerability

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Vulnerability to Water Scarcity

- Water scarcity depicts an imbalance between availability of (renewable) water resources and water demand for different uses (and also embraces water quality aspects) in already water deficient regions of the world
- Water stress describes pressures on water resources quantity and quality, resulting in the inability to meet human and environmental needs and generating conflicts and negative impacts
- Both terms are often used synonymously
- Before considering vulnerabilities on the five islands under consideration, we will look at some important facts

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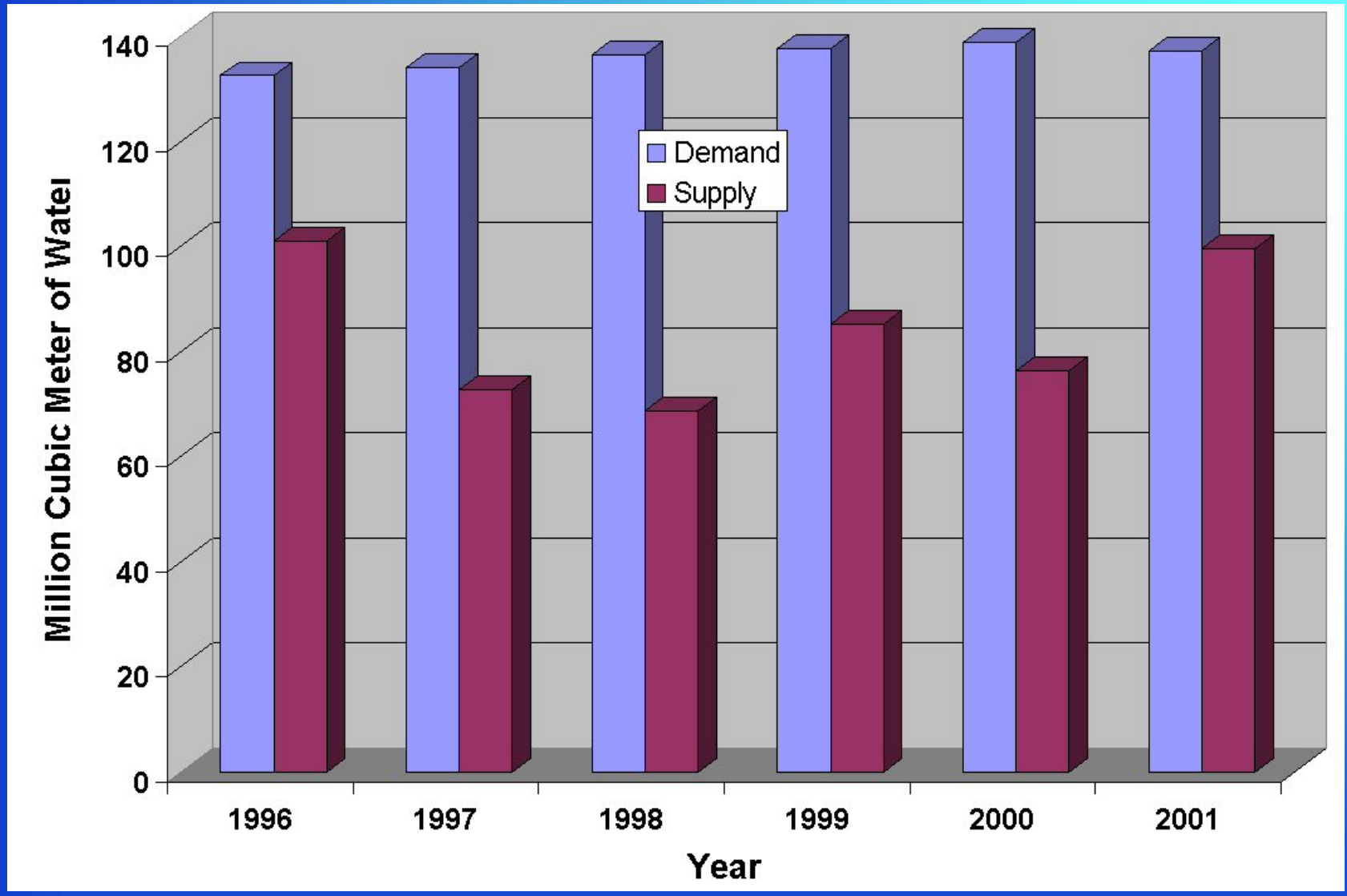
Water Scarcity: Cyprus



Relation between supply by the Government Water Works and the demand for water on Cyprus (Iacovidis, pers. comm.)

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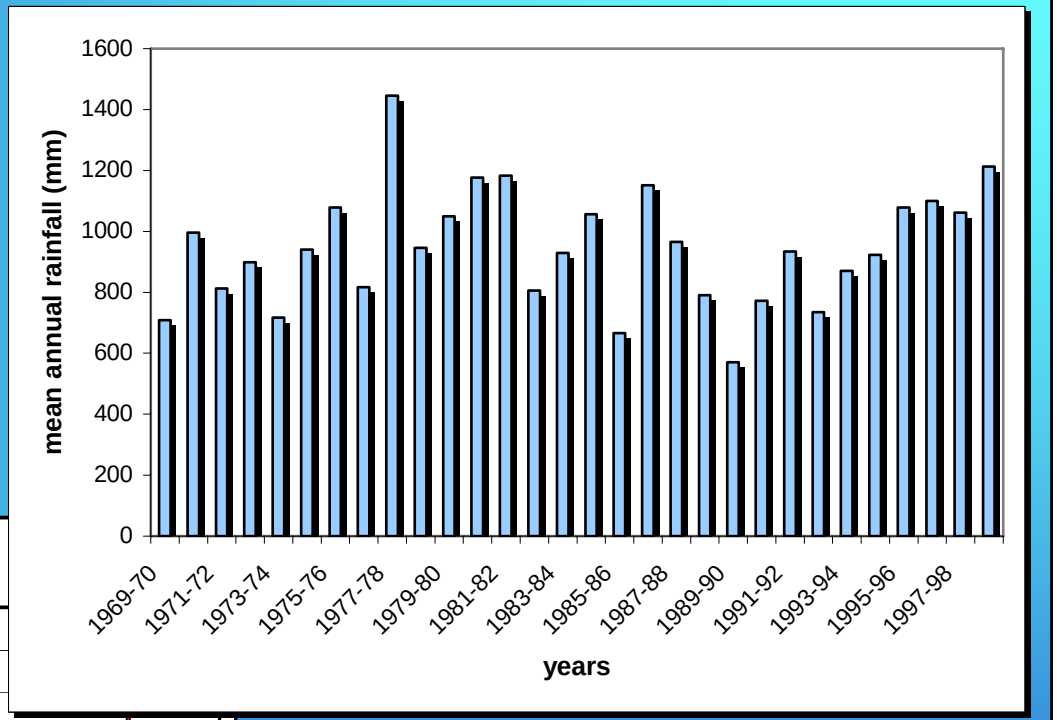
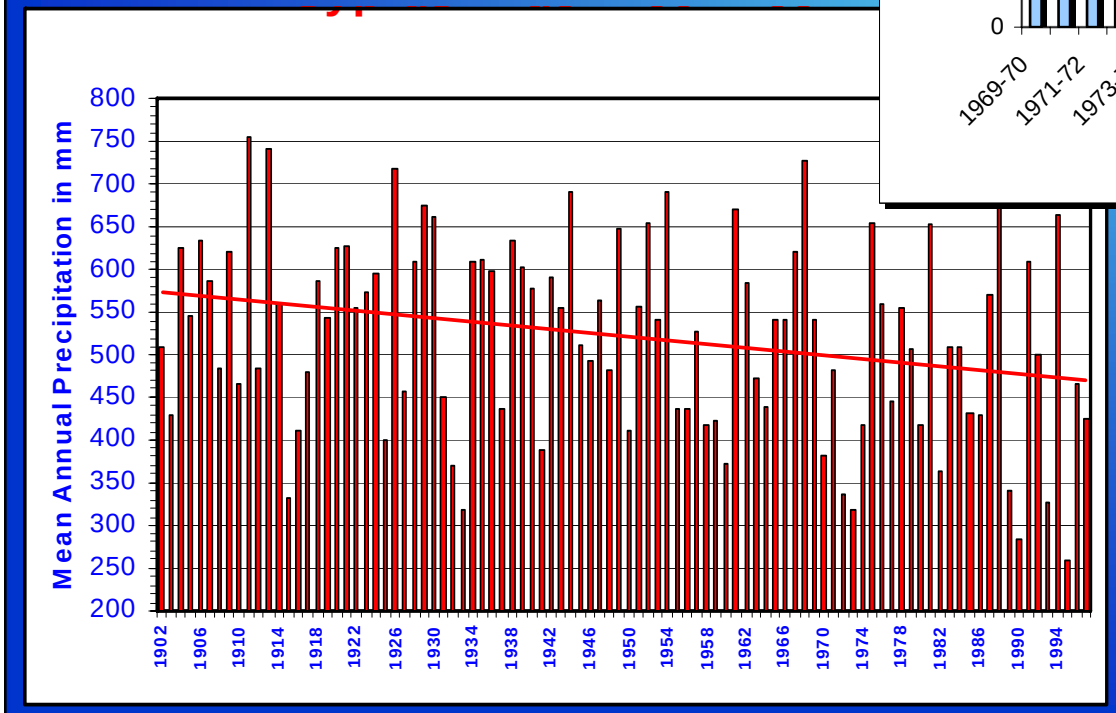
Precipitation: Inter-annual Variability

Mean annual precipitation Cyprus wide: 1902-1997; data shown are taken from a station on Troodos (Amiantos) and from a station in the plains (Nicosia). (Geological Survey Study, 1998 in Donta et al, 2003c)





Mean annual precipitation for the prefecture of Rethymnon, Crete

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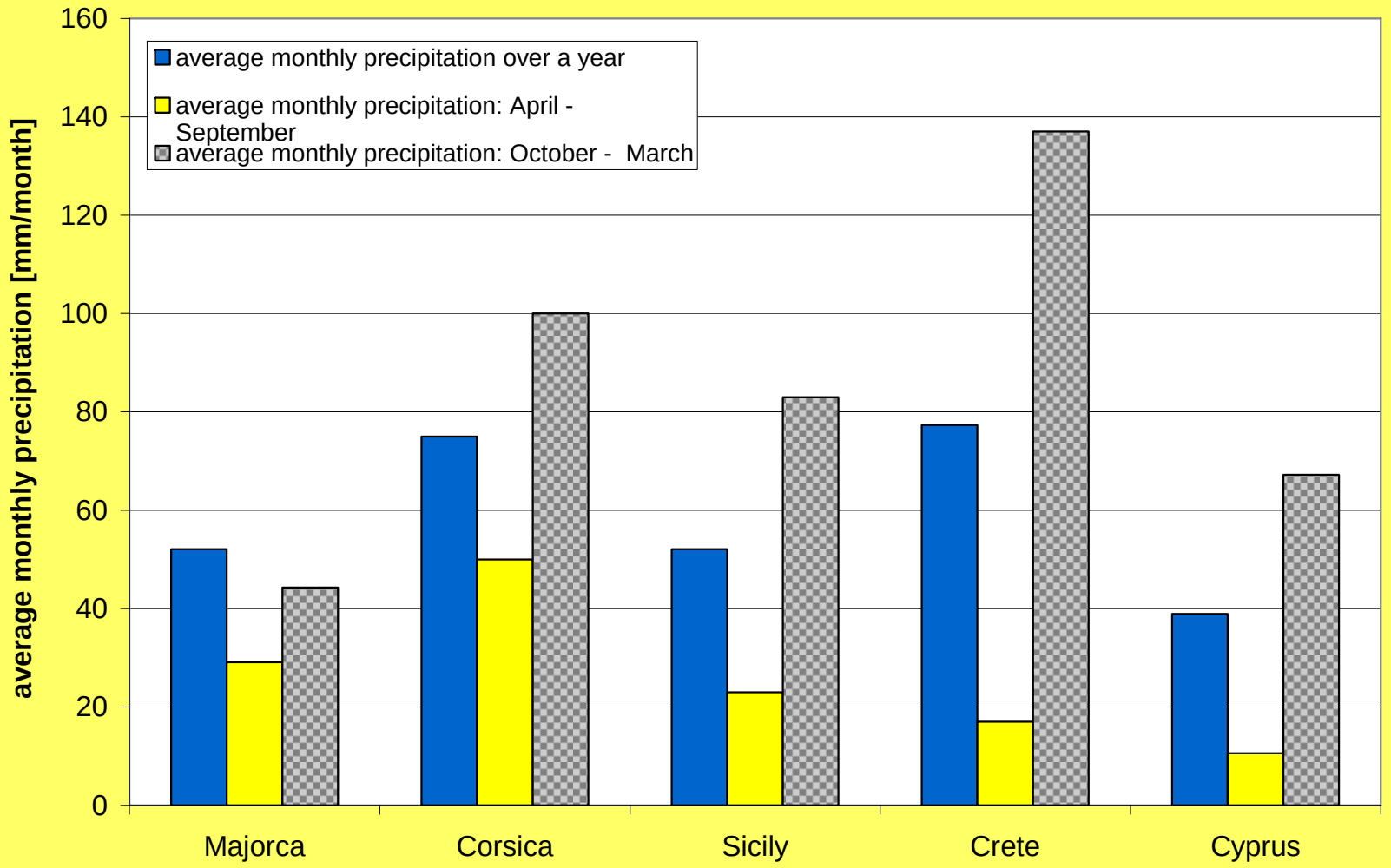
Precipitation: Seasonal Variability



Mean monthly precipitation on a yearly and a seasonal base

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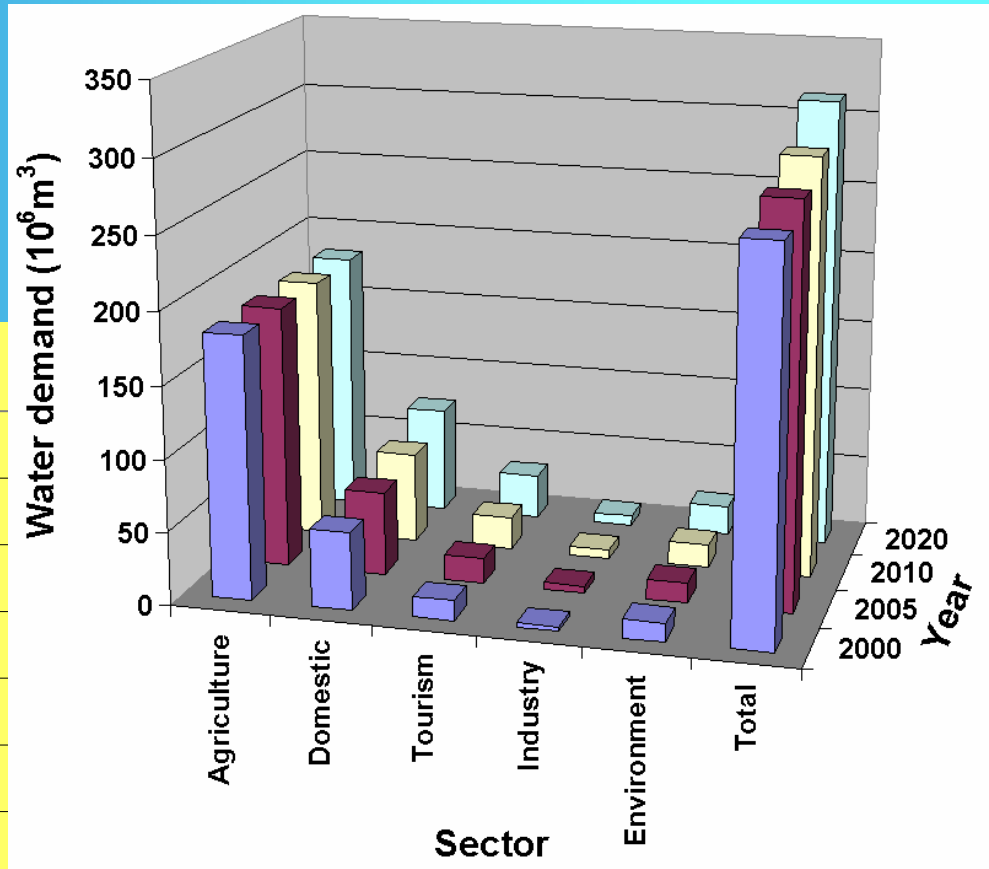
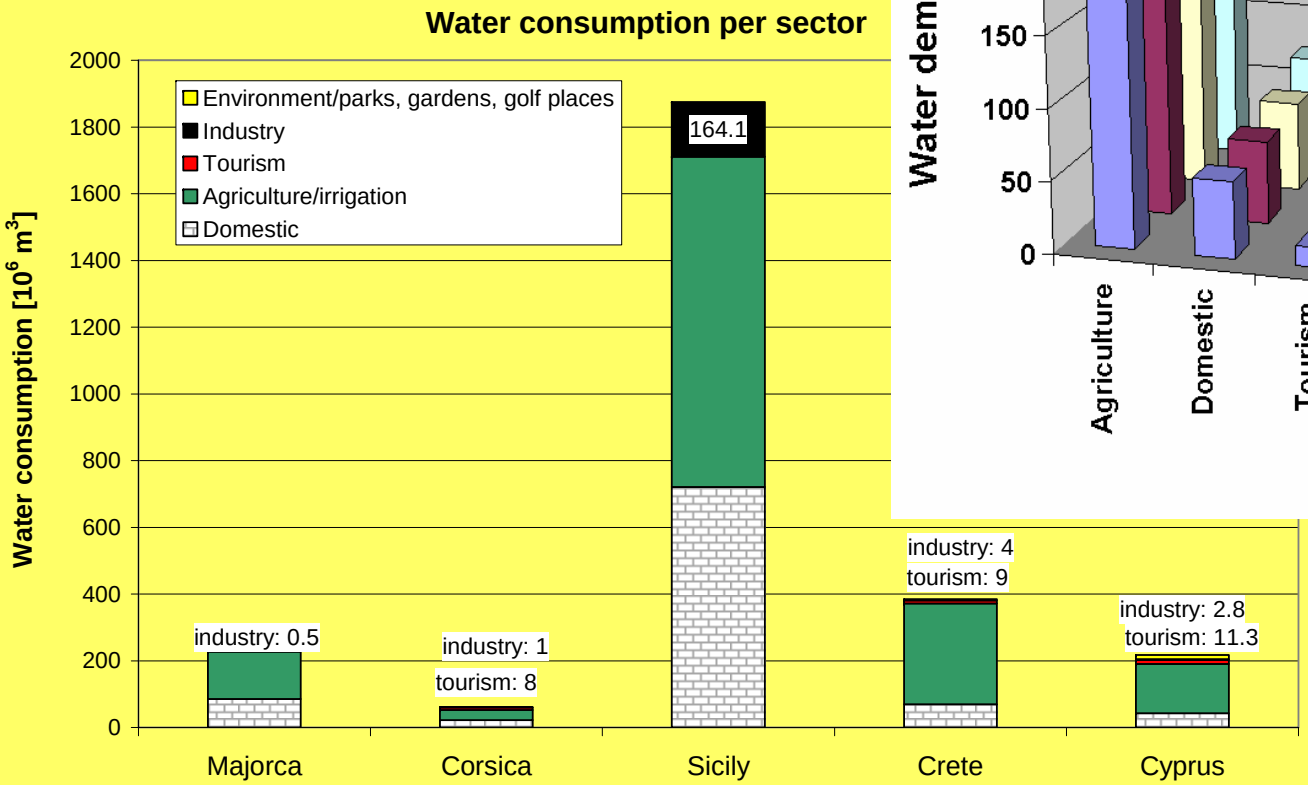
Water Consumption

Projected future water demand for the major water consumers on Cyprus (with the assumption of constant demands for agriculture) (Iacovidis, pers. comm.)





Present water consumptions for the major consumers on the islands

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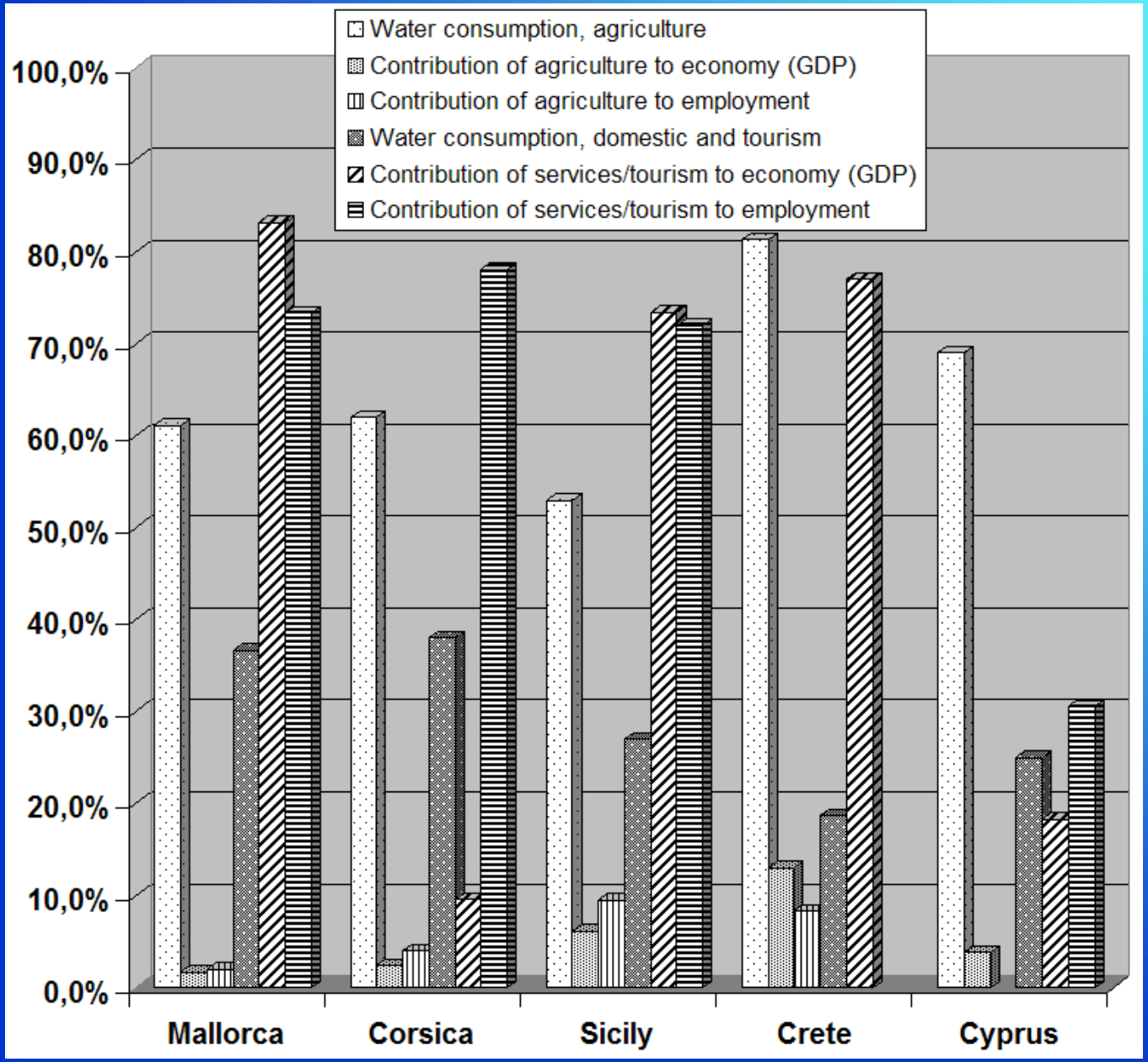
Water Consumption vs Economic Indicators



Water consumptions for agriculture and services/private households in comparison to the contribution of agriculture and services/tourism to the GDP and the employment on the islands

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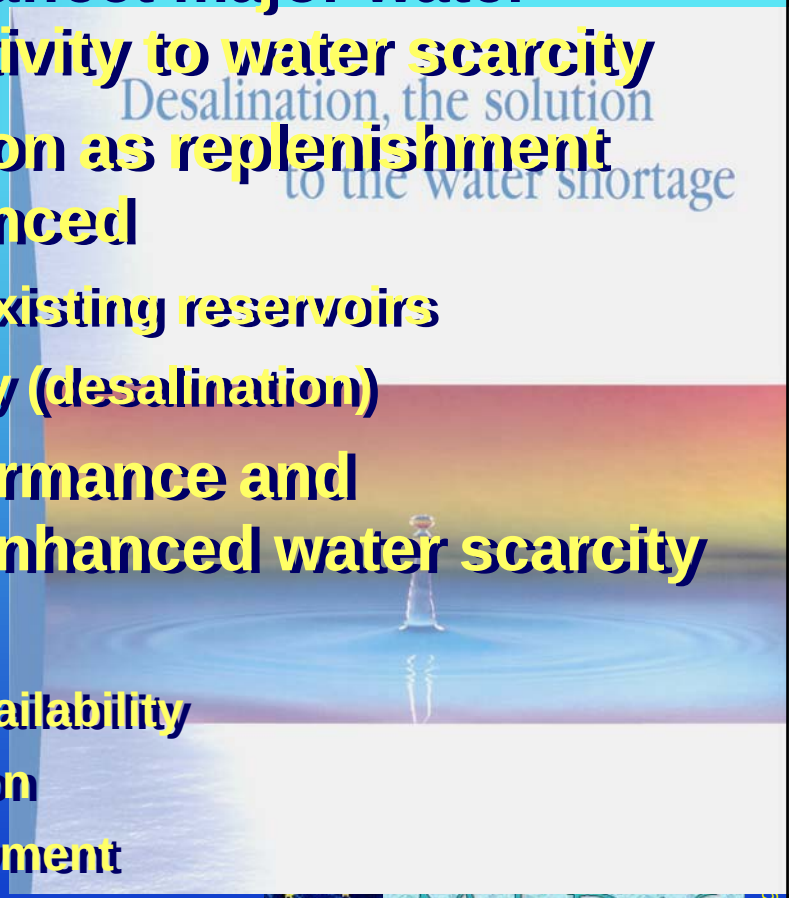
Sensitivity/Vulnerability to Water Scarcity

- All sectors are exposed to varying amounts of precipitation and resultant water availability
- Reduced water availability will affect major water consumers ⇨ significant sensitivity to water scarcity
- Sole dependence on precipitation as replenishment mechanism ⇨ sensitivity enhanced
  - ➲ Continued (over-) exploitation of existing reservoirs
  - ➲ alternative sources of water supply (desalination)
- Vulnerability of economic performance and employment on the islands to enhanced water scarcity
  - ➲ Moderate to low in agriculture
    - Remaining relatively high water availability
    - Reasonable autonomous adaptation
    - Minimal effect for GDP and employment



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Sensitivity/Vulnerability to Water Scarcity

- **Vulnerability of economic performance and employment on the islands to enhanced water scarcity**
  - ➲ **Significant impacts for tourism**
    - **Further reduction in water supply**
    - **Limited autonomous adaptation**
    - **Sizeable effects of reduced tourism on economic performance and resultant reductions on the labor market**

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Sensitivity/Vulnerability to Water Scarcity

Vulnerability of Economic Sectors to Enhanced Water Scarcity

	Agriculture		Industry		Services/Tourism	
	GDP	Employment	GDP	Employment	GDP	Employment
Majorca	😐	😐	😐	😐	☹	☹
Corsica	😐	😐	😐	😐	☹	☹
Sicily	☹	☹	☹	☹	☹	☹
Crete	☹	☹	😐	😐	☹	☹
Cyprus	😐	☹	😐	😐	☹	☹

😐 = contribution < 5% ☹ = contribution > 5%

Adaptation Measures

- Vulnerability = f (exposure, sensitivity, adaptability)
- Assuming that exposure and sensitivities are relatively stable → vulnerability ≅ the impact of changes in water availability not to be compensated by **planned** adaptation

→ Reducing vulnerability requires effective adaptation strategies

- A number of aspects/dimensions need to be considered:
  - Physical/environmental dimension
  - Economical/technical dimension
  - Social/regulatory/political dimension
- Aspects will have to be considered holistically → interdisciplinarity
- Views of stakeholders will be essential → stakeholder involvement

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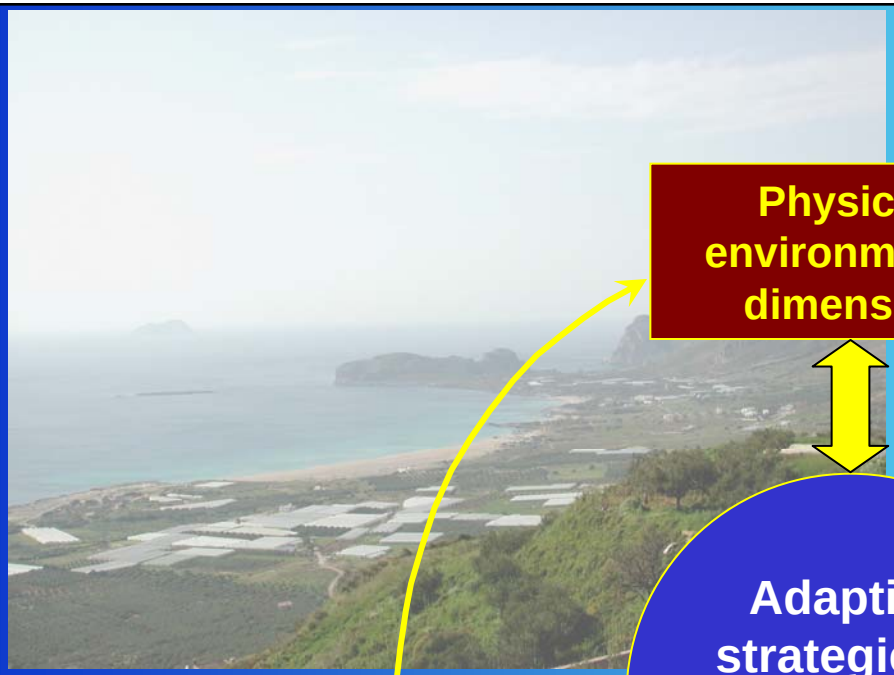
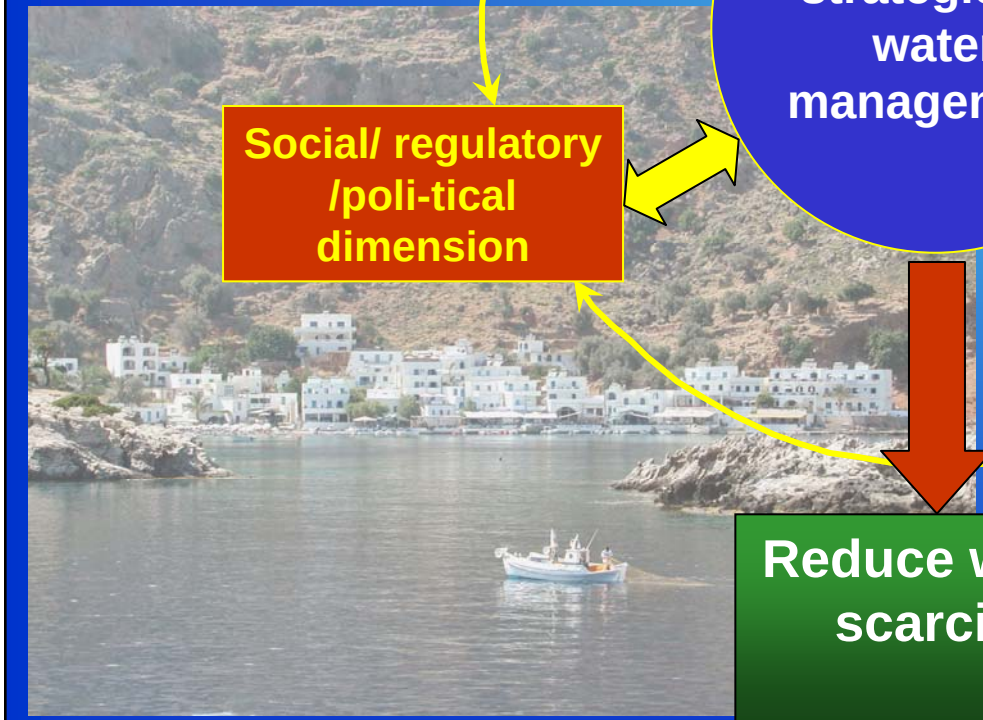
Adaptation Measures





Physical/ environmental dimension

Social/ regulatory /poli-tical dimension

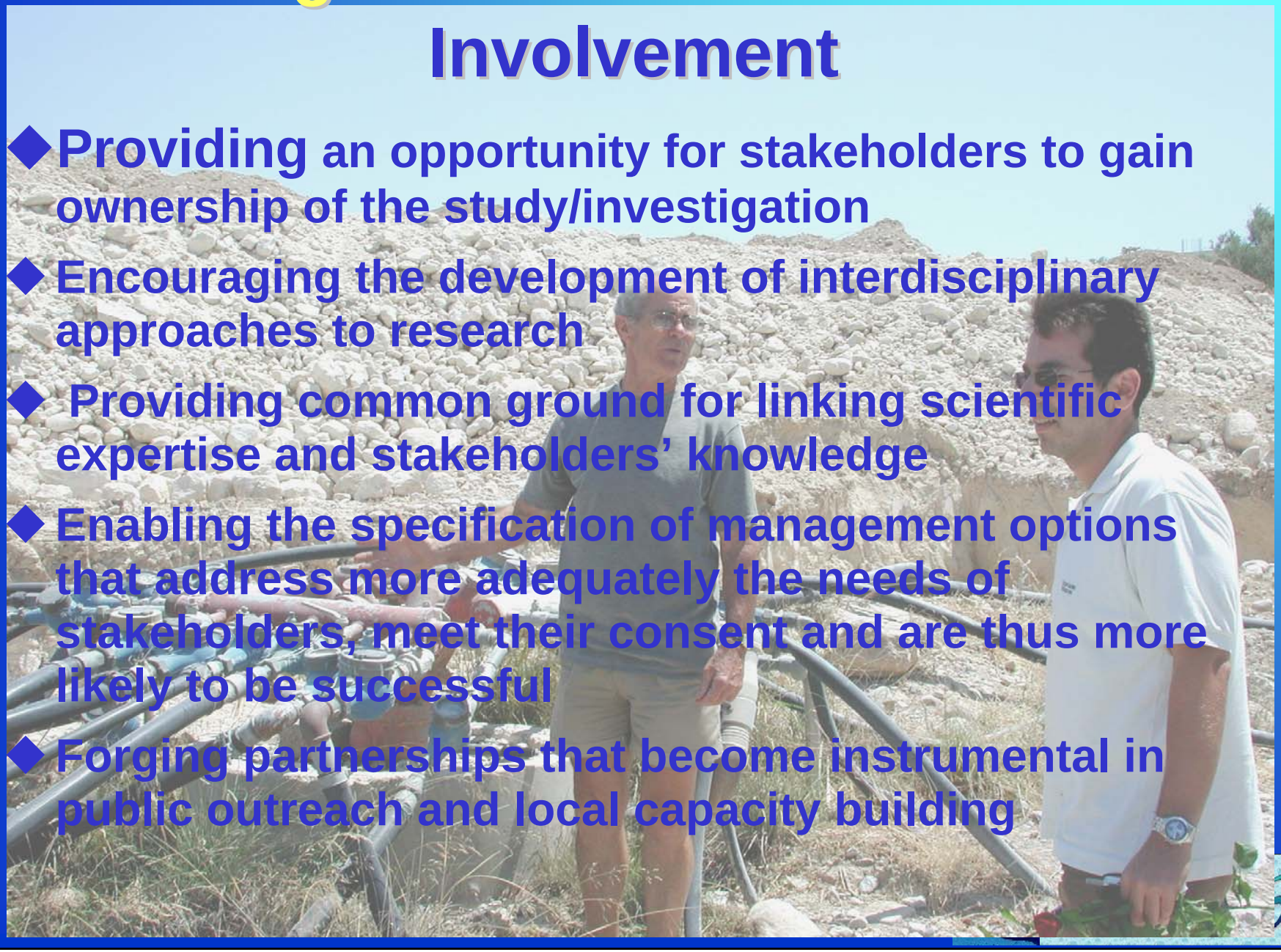
Adaptive strategies in water management

Economical/ technical dimension

Reduce water scarcity

Stakeholder Involvement

Advantages of an Active Stakeholder Involvement



- **Providing** an opportunity for stakeholders to gain ownership of the study/investigation
- Encouraging the development of interdisciplinary approaches to research
- Providing common ground for linking scientific expertise and stakeholders' knowledge
- Enabling the specification of management options that address more adequately the needs of stakeholders, meet their consent and are thus more likely to be successful
- Forging partnerships that become instrumental in public outreach and local capacity building

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Adaptation Options: Physical

- Reduce water consumption
  - Water pricing; quotas
  - Incentives (subsidise water saving not consumption)
- Change water allocation
  - Introduce specifically targeted quota systems that encourage water savings in water-intensive sectors
- Reduce losses
  - Eliminate loss of water to sea and (if possible) the loss of water through sub-sea groundwater discharge (SGD)
  - Lower evaporation, e.g., through covers on open reservoirs
  - Reduce losses and contamination of water in distribution networks (e.g., on Cyprus: annually 40 Mm^3 = 15% of total demand; 23% of total domestic demand; in Paphos: 30%)
- Increase utilisation of additional water resources
  - Waste water recycling
  - Rainwater harvesting
  - Utilisation of brackish water
  - Use of water of lower quality for artificial recharge

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Adaptation Options: Economical

- Support sectors with high economic potential and small water needs (without neglecting the needs of the more water intensive sectors!)
- Change agricultural practices (quantity, quality of water)
- Eliminate/reduce subsidies for water prices
- Encourage changes in cultivated crops to less-water intensive species
- Promote cultivation of crops that have a high potential on the domestic and the foreign market (eliminate wasting products and water)
- Provide assistance in capacity building of farmers and for investments in modern irrigation technology
- Provide economic incentives for rational water use in all sectors

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Adaptation Options: Political

- Public awareness campaign (water use, ownership, conflicts); capacity building
- Reduce unaccounted water through the implementation of a more complete monitoring system
- Improve enforcement of existing rules and regulations
- Simplify/enhance efficiency of water administration
- Transfer of power to regional and local decision makers
- Encourage stakeholder-controlled water management
- Ensure/improve adequate factual basis for political decision making

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Conclusions

- Water scarcity is and will continue to be a problem on Mediterranean islands
- Sensitivity and vulnerability to water scarcity differs between islands and between major economic sectors
- Vulnerability may be reduced through planned adaptation
- When designing adaptation strategies, different sectors should be considered but measures will have to be implemented holistically

Thank you for your attention

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http://www.uni-muenster.de/Umweltforschung/medis/index.html

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