MULTI-CRITERIA RESERVOIR WATER MANAGEMENT

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NTUA research program

Posters presented at the same conference

- Plastiras Lake: the impact of water level on the aesthetic value of the landscape

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- Plastiras Lake: influence of the relief on the revelation of the water presence

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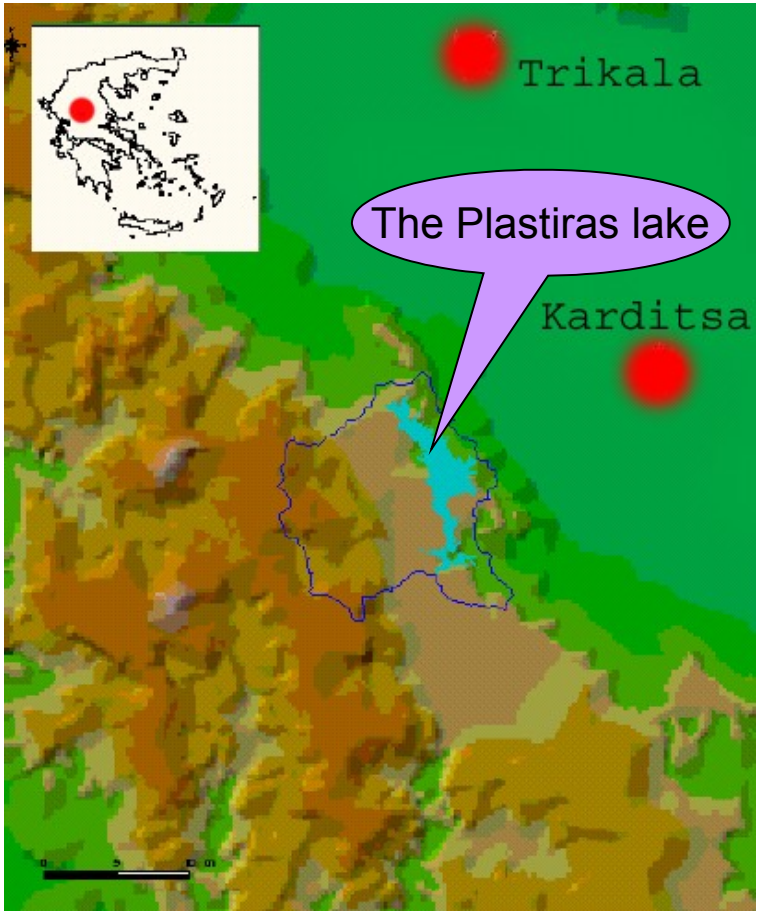
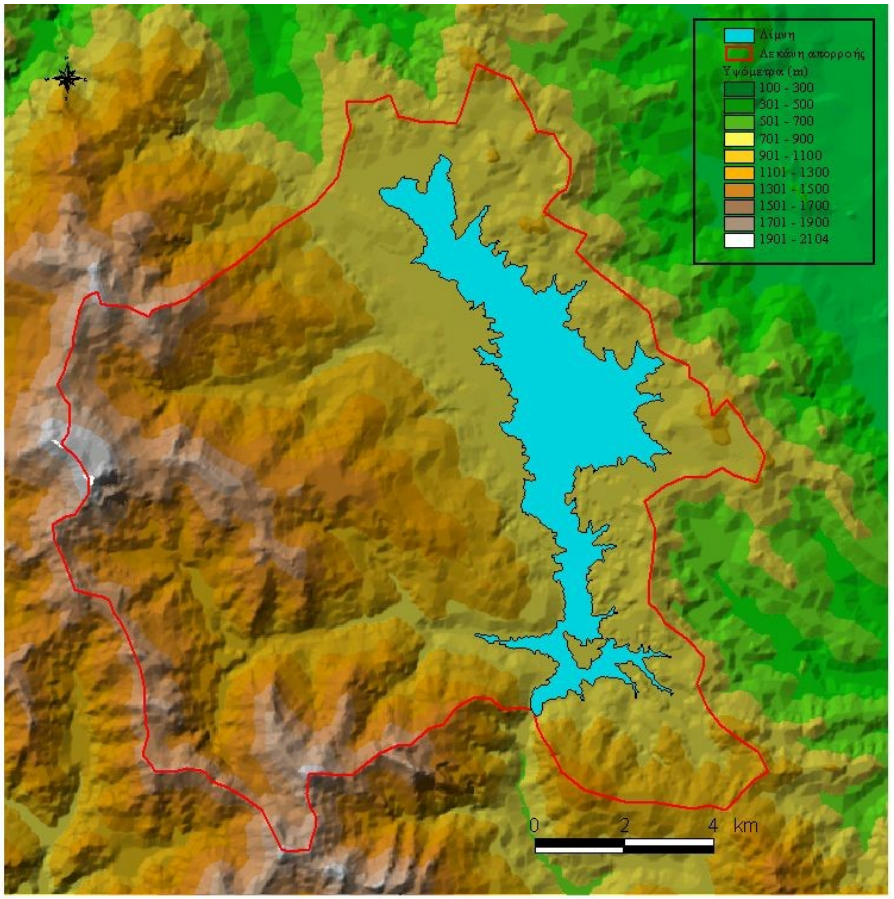

Trikala
The Plastiras lake
Karditsa


Λίμνη
Λεκάνη απορροής
Υψόμετρα (m)
100 - 300
301 - 500
501 - 700
701 - 900
901 - 1100
1101 - 1300
1301 - 1500
1501 - 1700
1701 - 1900
1901 - 2104
0
2
4
km

The arch dam on the river Tavropos

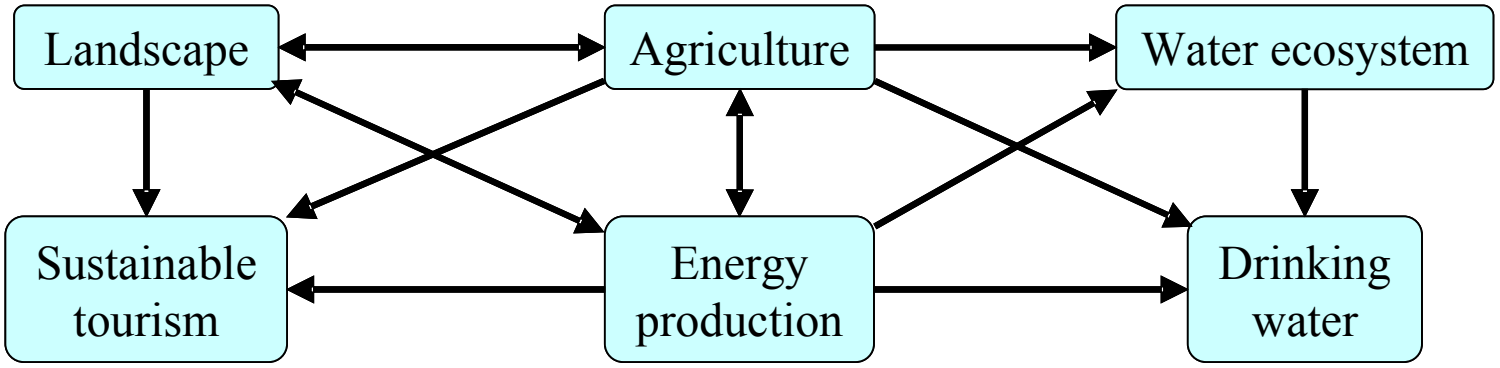
Historical background of a complex problem

- Late 1950s: Construction of the dam for hydroelectric energy production and irrigation of agricultural land
- 1980s: CAP, intensive agriculture, decreasing hydroelectric importance of the reservoir, water release adapted to increasing agricultural demand, small portion used for water supply of plain settlements
- 1980s-1990s: the artificial lake developed into an area with ecological and aesthetic interest, included in the Natura 2000 list, classified as a Site of Outstanding Natural Beauty, with possibilities of significant economic (tourist) development
- 2000: the economic importance of different water uses is being modified

Need of rational management

- The change of economic realities does not automatically lead to change of the water management priorities (delays of social origin)
- Since the late 1990s, disputes over the reservoir water exploitation have been frequent (very intense in dry years, partially forgotten when precipitation is abundant)
- Need of reservoir management according to hydrological, hydroelectric, environmental, economic, regional development criteria

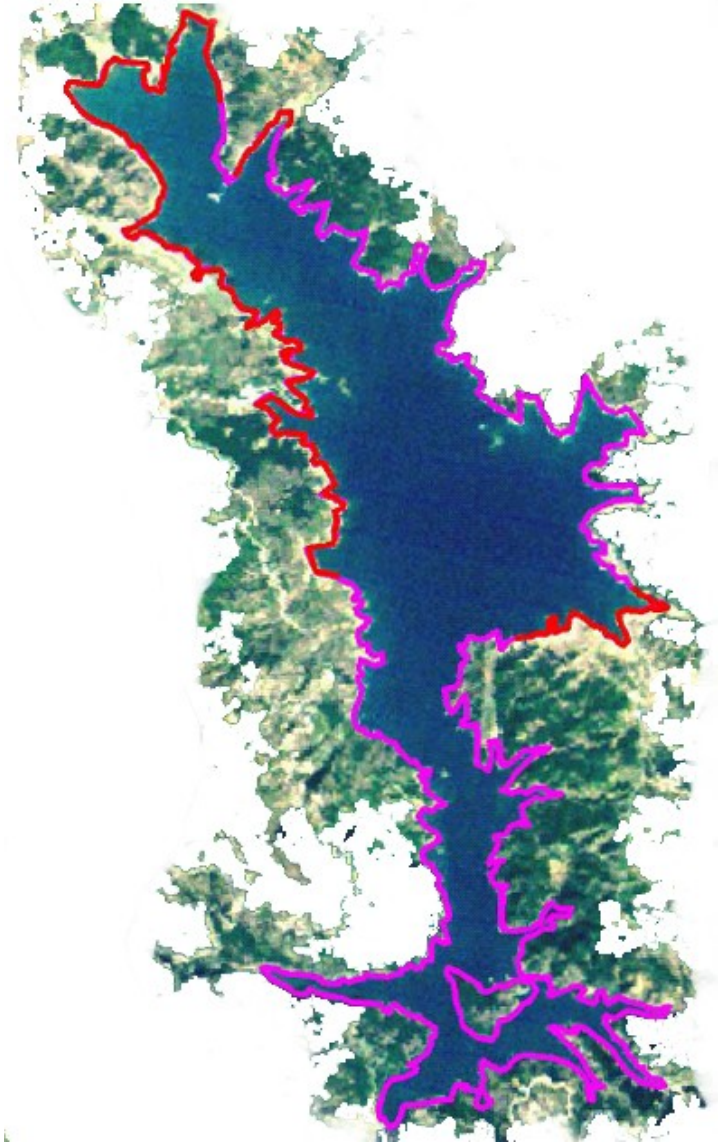
Main interactions between water uses of the Plastiras reservoir



Negative and positive influences between different uses

Direction of the influence	Energy production	Irrigation	Drinking water	Sustainable tourism	Water quality	Landscape quality
Energy production →	§	– –	– –	– – –	– –	– – –
Irrigation	– –	§	– –	– – –	– –	– – –
Drinking water	–	–	§			
Uncontrolled tourism			– –	– –	–	– –
Water quality	–	–	+ + +	+	§	
Landscape quality	– –	– –		+ + +		§

Normal and subnormal dead-zone



Important parameters

- Quantity of water release
- Water level (776m-792m)
- Landscape quality
- Tourist development perspectives, uncontrolled tourist activities
- Disposal of liquid or solid waste
- Lake volume, pollutant loads, trophic state, concentration of chlorophyll-a
- Quality of drinking water
- Schedule of water release

The parameters to be examined in order to define rational management

- water release
- water quality
- landscape quality

Need of scientific knowledge and mutual compromises

Respect recent legislation (EU directives 92/43, 2000/60)

Instruments for a rational management of the reservoir

- Establishment of a minimum permissible water level (MPL)
- Constant annual water release (reliability 90%)
- Maintain level rather than release in case of failure (probability 10%)
- Constant monitoring of water level, of water and landscape quality
- Measures for protection or rehabilitation of the riparian landscape pressed by uncontrolled tourist development

Evaluation, quantification of impact on the environment

- landscape quality (size of dead-zone, opinion of observers)
- water quality (simulation models, EU classification systems for lakes)

Correspondence between MPL and landscape or water quality

MPL	**Landscape quality**	**Water quality**
790 m	excellent	(not estimated)
788 m	very good	(not estimated)
786 m	altered but good	very good
784 m	acceptable	good
782 m	just tolerated	acceptable
780 m	not acceptable	fair

Evaluation, quantification of impact on productive activities

- agricultural production (value of safe annual release, reliability for every MPL calculated by hydrological models)
- energy production (quantity of electricity produced as a function of the MPL and the rate of water uptake calculated by hydrological models)

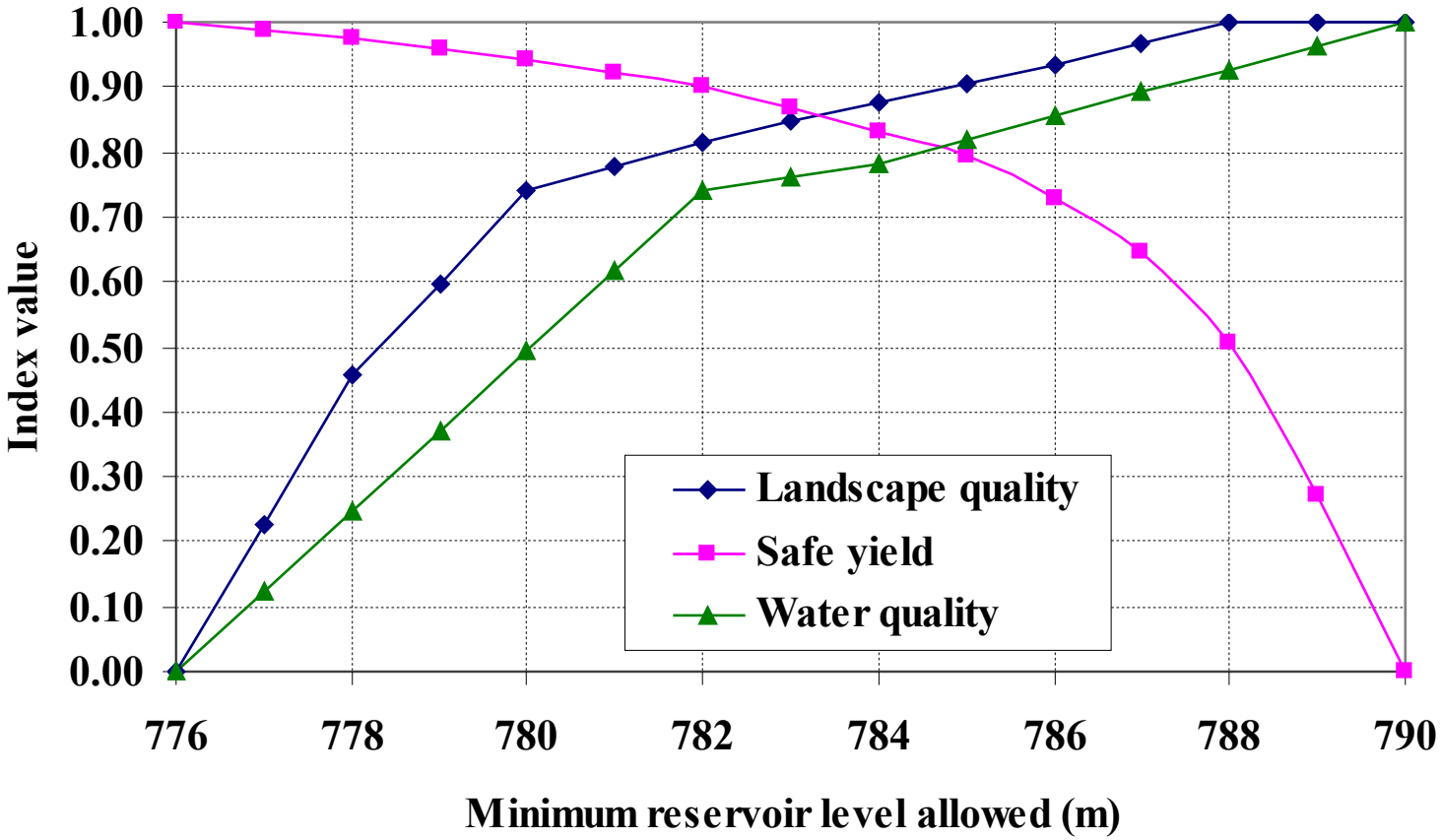
An “objective” quantification procedure with many arbitrary aspects

- Aesthetic assessments and classification system categories transformed into percentages?
- Fully mixed state of the lake?
- The quantity of water for irrigation determines the increase in value of the agricultural or of electric energy production?
- The landscape quality determines the increase of income from tourism?

Transformation of criteria to indices

- Linear transformation and interpolation of intermediate values
- Take account of the time distribution of different water levels in relation to the MPL (landscape quality indice)

Indices of safe release, landscape and water quality against MPL



Decision tools, Multi-criteria analysis

- $F = w_1 I_1 + w_2 I_2 + w_3 I_3$
- MPL at +785 m maximizes utility function if all the three criteria are considered to be equivalent
- Greater weight for the release leads to a MPL at +782 m
- Greater weights for water or landscape quality lead to a MPL at 787-788 m

Comments on multi-criteria analysis

- Methodological weaknesses and arbitrariness
- Delimitates the problem, indicates solutions

Choice of MPL

- +780 m leads to non acceptable water and landscape quality
- +790 m or +788 m lead to excessively low release with a small environmental benefit
- +782 m leads to a non negligible landscape degradation for a significant part of the year and to a just acceptable water quality (high risk, rejected for precautionary reasons)
- Desirable at +786 m, acceptable at +784 m

Discussion-1

- Stricter mathematical approaches (stochastic simulation of reservoir hydrological operation) + simpler quantitative or qualitative approaches (size of dead-zone) => composite estimations (impact on landscape quality)
- “Simplifying the problem”=(underestimation of impact on water quality) => trade-off between water yield and aesthetics: can we quantify beauty?

Discussion-2

- Cost-benefit analysis, translating all criteria into monetary values
- Equilibrium between opposite forces
- Legal and economic aspects
- Appropriate scientific arguments can accelerate social processes