Development and Operation Issues of a Decision Support System for Water Management in Areas with Limited Water Resources

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Objectives of the Work

❖To investigate the possibility of developing a decision support system for the optimal operation of water systems in areas with limited water resources.

❖To identify the critical parameters for the successful implementation of this system.

❖To underline the significance of the optimisation model that dictates the results of the decision support system.

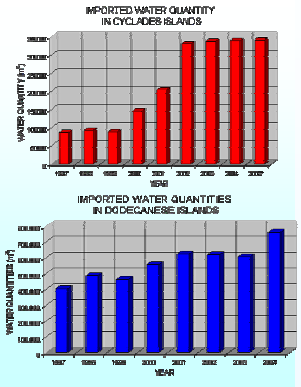
The Problem

❖Water is a constrained resource and in many areas there are serious temporal or permanent shortages.

❖The sustainable use of water is critical for the future of the resource.

❖The water users pose conflicting demands that may not be feasible to be totally satisfied.

❖There is a need for decision support system that will suggest the water allocation, according to priorities and taking into account all system parameters.



The Optimisation Model

Optimization criterion : Maximisation of

(the Total Benefit from the use of Water – the Total Cost)

$$Max \sum_t \sum_j B_{jt} * Q_{jt} - [\sum_t \sum_i C_i * F_{jt} + \sum_t \sum_j p_{jt} * (D_{jt} - Q_{jt})]$$

Constraints

The water balance in the water storage tank:

$$V_t = V_{t-1} + \sum_i F_{it} - \sum_j Q_{jt}$$

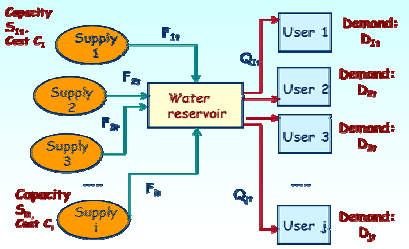
Upper and lower bounds of the water in the reservoir: $V_{min} <= V_t <= V_{max}$

Capacity limitations of each supply scheme: $F_{it} <= S_{it}$.

Flows allocated to each user should not exceed the corresponding Demands. Also minimum water quantities may be allocated to some users.

$$Q_{jt}^{min} <= Q_{jt} <= D_{jt}$$

The Structure of the Optimisation Model

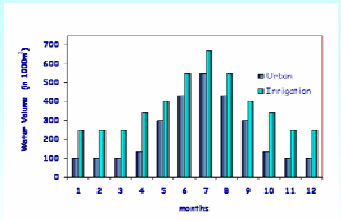


Application Data

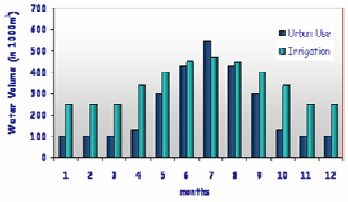
Time horizon	12 months, time step 1 month
Water supply sources	1: Desalination 2: Ground reservoir, 3: Transfer by ships
Water Users	A: Urban Use, B: Irrigation
Water Demand	(Figure 2)
Benefits	(Table 1)
years, years	1.000.000 m³ and 10.000 m³ respectively
Capacity of water supply	S_1= 100000, S_2= 200000 m³/month, S_3=500000 m³/year
Water supply cost	C_1= 3 €/m³, C_2= 4,1 €/m³, C_3= 7 €/m³

months	1	2	3	4	5	6	7	8	9	10	11	12
D_{1t}	5	5	7	15	20	25	25	25	15	5	5	5
D_{2t}	5	5	5	5	5	5	5	5	5	5	5	5

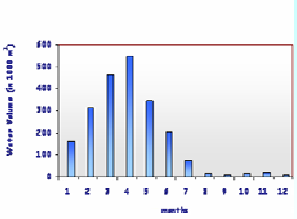
Application Results



Water demand profile for the application



Water distribution to users



Water storage distribution

Implementation issues

❖The suggested DSS introduces a novel approach in the water resources management, especially in areas where the demand is more than the water availability.

❖Its successful implementation requires correct and reliable data.

❖Even more critical is the determination of the water use benefits and the penalties for not satisfying the demand.

❖The definition of these values should be consistent and agreed between the various interesting parties.

Conclusions

❖A mathematical model has been developed for the optimal operation of complex water systems.

❖A decision support system is suggested, based on the optimisation model, that will be a valuable tool for determining the operation of water systems.

❖The decision support systems will determine the quantities of water to be allocated in each user, according to their priorities.

❖The implementation of the system will rationalise conflicts and optimise the use of a very valuable resource, the water.

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