

# INVOLVING STAKEHOLDERS IN TRANSBOUNDARY WATER RESOURCES MANAGEMENT: THE MESTA/NESTOS “HELP” BASIN

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## ABSTRACT

*Alternative options for new private and public investment projects in the transboundary Mesta/Nestos River catchment between Bulgaria and Greece involve new dams and water storage reservoirs, agricultural irrigation systems, new touristic resorts and various water related facilities for urban and industrial water supply. These developments should be implemented in both parts of the basin (Greece and Bulgaria), where there are different socio-economic conditions and therefore different preferences and different objectives. Alternative options should consider environmental consequences, impacts to ecosystems and human health, and also financial and social risks. The impacts on the environment and their prevention should be weighted against the economic benefits and social consequences.*

*Sustainable implementation of private or public utility projects cannot be achieved without public participation and a clear consensus between stakeholders. The UNESCO HELP initiative provides a rationale for breaking the “paradigm lock” existing between the most recent scientific findings on the one side and the public, stakeholders and decision makers on the other. In this paper stakeholder involvement in the decision making process is promoted firstly by communicating the results of integrated modelling of water resources management at the basin scale, and secondly by suggesting alternative models and software in order to facilitate negotiations and final decisions in transboundary water resources management. These are based on ranking different projects according to (1) every country’s stakeholders’ own objectives, (2) aggregating the stakeholders’ different objectives for both countries and (3) aggregating the countries’ different objectives.*

## KEY WORDS:

Integrated Water Management, Modelling, Stakeholders Participation, Decision Support, Conflict Resolution

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## INTRODUCTION

The Mesta/Nestos transboundary river basin between Bulgaria and Greece is a HELP [1] demonstration basin. Integrated water management in the basin involves different issues relevant to national authorities of each country, such as monitoring, planning, coordination of different uses, institutional and legal aspects and financing of water related projects. However, the key element for effective water resources management is cooperation between the two riparian countries at different levels, i.e. local, regional and national. Political willingness for cooperation is very important and institutions and stakeholders on both sides of the border should exchange data and information and develop common plans for water resources management. Lack of cooperation may lead to conflicts and disputes that may aggravate the problems and delay sustainable socio-economic development in the region.

As a member of the UNESCO-HELP network, the UNESCO Chair and Network INWEB represents different organisations and stakeholders in Greece and Bulgaria responsible for water resources management in the Mesta/Nestos river basin. The main objective of the UNESCO HELP initiative is to provide a rationale for breaking the “paradigm lock” existing between scientists on the one hand and the public, stakeholders and decision makers on the other.

In this paper the progress made towards achieving this objective is reported. Firstly, an integrated modelling approach was developed covering different main areas like hydrology, hydropower, agricultural economics and climate change scenarios. Secondly, the results of integrated modelling of water resources management were communicated to stakeholders at the basin scale to promote their involvement in the decision making process, and alternative models and software were developed in order to facilitate negotiations and decision making in transboundary water resources management. These models help to rank alternative projects according to (1) the attributes of stakeholders in each country (2) the aggregated attributes of the stakeholders in both countries (3) the aggregated goals of each country.

### Main Characteristics of the Mesta/Nestos Basin

The sources of the Mesta/Nestos River are located in the Rila and Pirin mountains in southern Bulgaria at an altitude of 2,925m (Fig.1). In Bulgaria the river flows through a valley of granite geology until it reaches the Rhodopi mountain chain, where it crosses the border between Bulgaria and Greece. Then the river follows a south-easterly direction and crosses a particularly beautiful region of crystallised schist known as the “Nestos Gorges”. The river flows some 230 km through Bulgarian and Greek territory before emptying into the Aegean Sea. About 126 km of the river flow through Bulgaria (2,770 km<sup>2</sup> catchment) and about 130 km through Greece (2,843 km<sup>2</sup> catchment); thus the total catchment area of the river is 5,613 km<sup>2</sup>. The flow of the Mesta/Nestos River is used by both countries for municipal water supply, irrigation and hydroelectric power production. The past estimated mean runoff of the Mesta/Nestos River is 20 to 30 m<sup>3</sup>/s, the maximum discharge was rarely above 150 m<sup>3</sup>/s and the annual discharge 1,120 M m<sup>3</sup>. The Mesta/Nestos River is the most important water resource in its region and has been the subject of bilateral negotiations for many years.

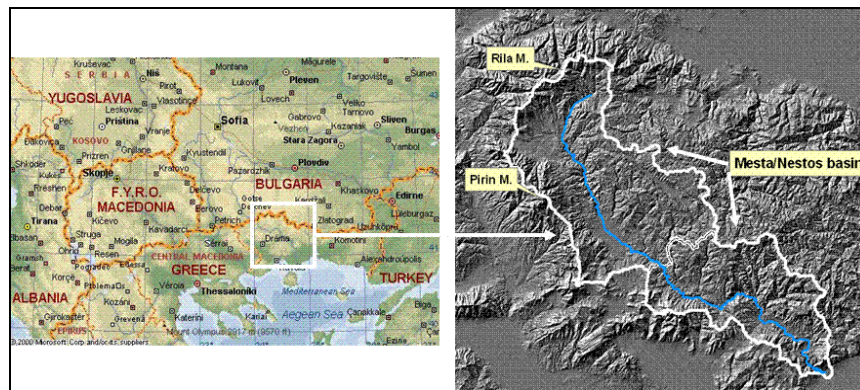


Figure 1. Geographical location of Mesta/Nestos River basin.

## INTEGRATED MODELLING AT THE BASIN SCALE

Hydrological modelling aims to simulate hydropower and agricultural water use by combining the MODCOU-NEWSAM hydrogeological model [2], with the HEC-ResSim model for dam operation [3] and the STICS agronomic model [4]. These tools were used together with the various sources of geographic and water use information. The operation of the dams in the Greek territory was also taken into account.

### Hydrology

The coupled model MODCOU-NEWSAM was used in order to simulate the spatial and temporal evolution of river flows and the water table. The water budget was computed in each grid box using the so-called 'production functions', which are a system made up of four reservoirs including seven parameters that have to be calibrated. The production functions are used to compute the actual evaporation, infiltration and runoff, with a time step of one day. Using a progressive grid system, as shown in Fig. 2.a, the hydrological model has been calibrated using monthly river flow measurements from the Momina Kula (Bulgaria) and Temenos (Greece) stations with monthly and daily precipitation records where available (Fig. 2.b).

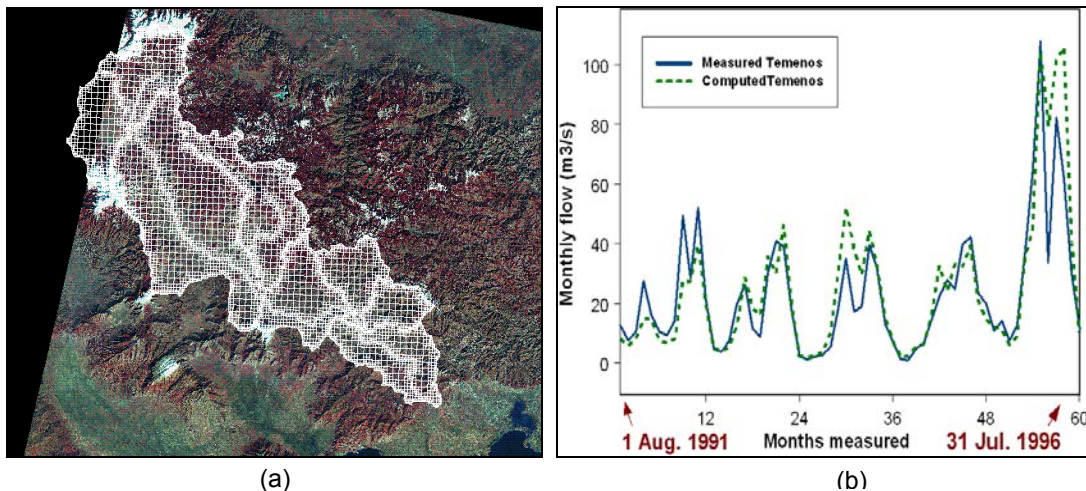


Figure 2. Multiscale grid of the MODCOU model (a); Comparison between flow rate simulation and data (b).

### Hydropower and Irrigation

The results from the hydrologic simulation were used for the simulation of the recently constructed dams' complex on the Greek side. The HEC-ResSim software was implemented to simulate both the dams' operational and economic feasibility and the water flow; the latter in order to guarantee the ecological discharge of 6 m<sup>3</sup>/sec and the agricultural demands on water. Future scenarios have been developed not only for the construction of future projects, such as the construction of the Temenos dam and diversion tunnels for the irrigation of Drama's and Xanthi's plains, but also for climate changes.

### Agricultural Economics

The model of crops and farming economy will be based on the coupling of the STICS agronomic crop model and the AROPAj micro-economic farming model, both developed by the French National Institute for Agricultural Research - INRA. Their coupling allows the modelling of a wide range of alternative economic policy scenarios combined with various management and agro-environmental conditions.

The economic model AROPAj determines for every exploitation, which combination and level of livestock and agriculture production afford the greatest benefits. The STICS model is a tool for harvest simulation in real conditions. Its principal goal is to simulate the effect of the climate, ground management and farming techniques on production (quantity and quality) and the environment. The "coupling" of the two models allows a search for an economic optimum under two variable conditions, firstly the use of fertilisers (here quantity of nitrogen) and secondly the quantity of irrigated water.

### Climate Change Scenarios

Any sustainable integrated project for river basin management should take climate change into account. Therefore, the results from climate change models should be coupled with other modelling techniques for river basin management. It is particularly important to study the irrigated agriculture regions of a basin in the

light of climate change in order to achieve an economic and environmental balance for the sustainable development of the basin.

Using the results of the Hamburg World Data Center for Climate (CERA), the climate change scenario A2 represents the worst case of the climate evolution range. The results are given in the form of average precipitations on 200 km<sup>2</sup> grid cells. The “downscaling” of the data and their adaptation to the Mesta/Nestos basin is real a challenge. The implementation of the A2scenario proved that neither the multipurpose (hydropower and irrigation) dams’ complex, nor any other investments related to the Mesta/Nestos River, will be economically feasible. The administrative authorities of the dams should give priority either to power generation or to irrigation because this current coupled operation will not be feasible. The impacts of this scenario on agriculture are under further investigation.

## **RESOLVING POTENTIAL CONFLICTS**

Despite earlier agreements, Bulgaria has in the past withheld water for increased agricultural and industrial needs. Since 1975 the Mesta/Nestos yearly flow has declined from 1500 million m<sup>3</sup> to 600 million m<sup>3</sup> resulting in repeated Greek protests. Despite a series of negotiations no new, satisfactory agreement has been reached; and failure to resolve the situation has resulted in conflicts between the two countries. In 1995 an agreement was reached concerning the sharing of water quantity between the two countries. According to this agreement, Bulgaria should leave to Greece 29% of the total flow generated in Bulgaria for the 35 years following the agreement. Nowadays noticeable pollution from the Bulgarian part, especially after heavy rainfall, has raised the level of tension in a region of Greece highly dependent on irrigated agriculture and hydropower. Since the beginning of 2007 Bulgaria has been a full member of the EU. There is an urgent need for cooperation and application of European Union (EU) guidelines for Integrated Water Resources Management (IWRM) in the Mesta/Nestos transboundary river basin.

### Goals, Objectives and Attributes

Conflict situations in transboundary water resources management occur on at least two levels:

- conflicts between stakeholders over objectives and attributes, and
- conflicts between countries over different goals.

#### *Goals:*

Broadly speaking, every state has social, economic and political goals linked to water resources development, conservation, and control and protection of the river basin. Economic goals may be to obtain new water resources in order to increase food production, conservation goals may be to control water pollution, and control and protection goals may concern defence from floods or drought control. These goals may be achievable by jointly building water reservoirs. This would entail the states involved cooperating together and solving possible areas of conflict.

#### *Purposes in accomplishing goals:*

Goals are accomplished by various water resources developments, transfers of water from adjacent river basins with surpluses, water conservation, control and protection. Each particular goal means satisfying some particular purpose, which may have to do with irrigation, drainage, hydropower production, navigation, water supply, water pollution control, flood defence, drought control, or other.

#### *Objectives and attributes in accomplishing purposes and goals:*

Finally, to satisfy the purposes of state goals in water resources development one must define and then maximise or minimise the economic, social, monetary and political objectives. The particular goals, purposes, objectives and interests in water resources development of the river basin should be carefully taken into consideration in any cooperation on conflict resolution between the states.

### Multi-Criterion Decision Analysis (MCDA)

MCDA techniques help to consider different alternative projects, the best of which may then be analysed in depth before being finally implemented [5]. As shown in Figure 3, starting from a list of attributes as basic indicators, the three pillars of sustainability, i.e. the economic, social and environmental objectives are defined hierarchically, which are then aggregated into third level socio-economic and social indicators.

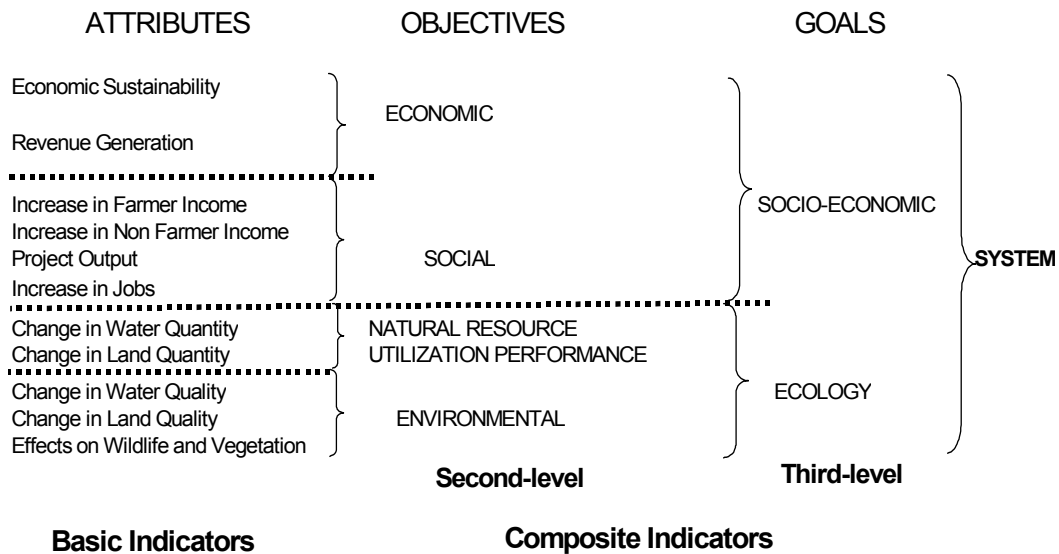


Figure 3. Social, economic and environmental attributes, objectives and goals.

*Multicriterion Decision Analysis* (MCDA) was adapted as a decision support methodology for managing potential conflicts in transboundary areas related to different attributes and goals set by different countries. For this purpose, alternative methods are suggested in order to facilitate negotiations and reach final decisions. All are based on the combined use of integrated modelling, experts' opinions and a decision support methodology called *Composite Programming* (CP). This is a distance-based technique, which defines the 'best' solution as the one whose point is at the least distance from an ideal point [6]. The aim is to obtain a solution that is as 'close' as possible to some ideal. The distance measure used in CP is the family of  $L_p$  - metrics given as:

$$L_p(a) = \left[ \sum_{j=1}^J w_j \left| \frac{f_j^* - f_j(a)}{M_j - m_j} \right|^p \right]^{\frac{1}{p}} \quad (1)$$

where:

- $L_p(a)$  =  $L_p$  - metric or *composite index* for alternative  $a$ ,
- $f_j(a)$  = Value of attribute  $j$  for alternative  $a$ ,
- $M_j$  = Maximum value of attribute  $j$ ,
- $m_j$  = Minimum value of attribute  $j$ ,
- $f_j^*$  = Ideal value of attribute  $j$ ,
- $w_j$  = Weight of the attribute  $j$ ,
- $p$  = Parameter reflecting the attitude of the decision maker with respect to compensation between deviations.

## INVOLVING STAKEHOLDERS

Different degrees of socio-economic development on each side of the border resulted in different problems and issues related to water related projects. In the Greek part the river flow is controlled by 3 major dams for energy production. Downstream of the dams there is significant agricultural activity and the river's delta is protected by the Ramsar treaty. Intensive use of fertilisers, overexploitation of groundwater and the intensive use of drills have created water quantity and quality problems. As irrigated agriculture is the main area of development in the region, it is important to maintain a level of involvement through a long-term programme and a level of interference. The water from the river also covers urban needs and provides the opportunity for recreational activities. In the Bulgarian part the lack of Waste Water Treatment Plants (WWTP) and significant shortcomings in infrastructure have created unfavourable conditions for water use. Tourism is negatively affected by the underdeveloped road infrastructure, and agriculture by the limited availability of land for the development of intensive farming.



## Options for Water Management

In a framework of virtual negotiations different projects or options are supposedly suggested by the two countries. These are options 1 to 4 for Greece (GR) and options 5 to 8 for Bulgaria (BUL):

*Option 1 (GR):* Strengthening Agricultural Practices and Crop Redistribution

*Option 2 (GR):* Review and Reappraisal of Irrigation Development Projects

*Option 3 (GR):* International Wildlife Tourism Development

*Option 4 (GR):* Inland Fisheries Resource Development Project

*Option 5 (BUL):* Water Supply Distribution Project

*Option 6 (BUL):* Construction of New Reservoirs for Multiple Water Uses

*Option 7 (BUL):* Construction of WWTP

*Option 8 (BUL):* Development of Local Tourism and Related Activities

## Ranking by using each country's attributes

Because of different attributes used by the two countries, ranking of alternatives options differ, each country giving priority to its own suggestions. When options are to be implemented in the entire river basin area, this may result in a conflicting situation.

## Ranking by aggregating stakeholders attributes and countries' goals

Using formula (1), the stakeholders' attributes are aggregated in two composite indices: a socio-economic one, which integrates all social and economic attributes (Fig.3) and an ecological one, which integrates environmental, water and land quality and also biological attributes. (Fig.3). In the case of countries' goals, each option may be defined by two indices, one for each country, resulting in the integration of the different attributes up to the third level as shown in Fig.3. Composite indices and countries' goals range from 0 (worst case) to 1 (ideal case). In a two-dimensional representation the better options are those located nearest to the ideal point. Options 3 and 6 are in both cases preferable, as they are closest to the ideal case (Fig. 4,a; b) and could be suggested as a compromise solution during negotiations. Special software under development may help calculations and the drawing of figures such as Fig.4.

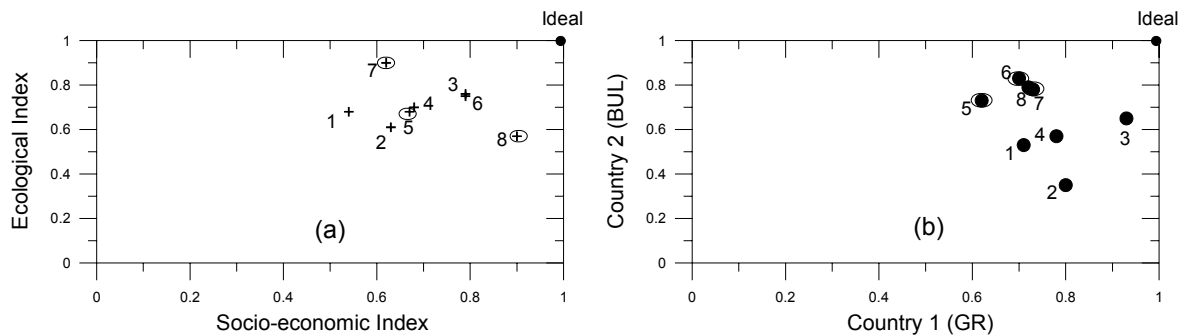


Figure 4. Ranking options 1 to 8 by aggregating stakeholders' attributes (a) and countries' goals (b).

## CONCLUSIONS

A methodology is suggested based on MCDA techniques in order to facilitate stakeholder involvement in conflict resolution in transboundary water management problems. Trade-offs are made either at the level of stakeholder attributes, or at the level of countries' different goals. The methodology is easy to use and the results obtained are fair, transparent and simple to communicate to decision makers.

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