

Assessment of Water Management measures through SWOT Analysis: The case of Crete Island, Greece

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Abstract: - The “Management Plan for the River Basin Districts of Crete, Greece” is a successful plan that fulfils the contractual responsibilities of the country to the European Union. However, the plan does not include an overall assessment and prioritization of the Programme of Measures (PoM) which is a prerequisite for the rational use of available resources. During this work, Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis was applied as a decision-making tool in order to assess each measure. Reduction of irrigation water, control of fertilizers, exploitation of saline karstic springs, wastewater recycling, and construction of small dams are some of measures suggested.

Key-Words: river basin, aquifer, SWOT analysis, water resources, water policy, groundwater

1 Introduction

Water is increasingly becoming a limiting factor for development and sustainable economic growth. In that context, the Water Framework Directive - WFD (2000/60/EC) reinforced the environmental perspective of water resources management goals in Europe, aiming the aquatic ecosystems protection and rehabilitation, and integrated planning. [1] Specifically, the WFD requires “good water status” for all European waters through a system of participatory river basin management planning and supported by several assessments and extensive monitoring [2]. The Directorate of Water of the Decentralized Administration of Crete under the auspices of Special Secretariat for Water of the Ministry of Reconstruction of Production, Environment and Energy developed the Water Management Plan of the Region of Crete following the guidelines of WFD and its implementation Law 3199/2003 and Ministerial Decision 51/2007. However, the plan does not include an overall assessment and prioritization of the Programme of Measures (PoM) which is a prerequisite for the rational use of available resources. In addition, sustainable river basin management requires increased levels of

integration between users, water managers, planners and policy makers and scientists across spatial scales [3]. In order to obtain a detailed analysis of each measure several methodological decision-making tools were suggested such as multi-criteria analysis, Regnier’s abacus, decision tree and SWOT analysis [4]. The main advantage of SWOT analysis in comparison with other tools is that summarizes information and contextualizes the measures [4]. Recently, research works in the literature regarding the use of SWOT analysis for water resources management was raised [5, 6, 7]. The aim of this research was to position each measure of PoM according to the resources available in the local authority (human, technical, financial resources and know-how) through SWOT analysis. It also will help policymakers to plan the various steps required to bring about change (gap between the existing situation and the planned objective).

2 Methodology

SWOT Analysis is a decision making method that has been widely used in business management. SWOT analysis also has successfully been applied in identifying and

solving problems related with water resource management which often involve interdisciplinary issues that are difficult to quantify [7]. In a similar manner, during this study SWOT analysis was applied to evaluate each measure included in PoMs. This method was selected because it has the capacity to incorporate not only the present conditions (through strengths and weaknesses) but also the future conditions (through opportunities and threats) which is very important for Greece which is undergoing rapid changes especially in terms of economic development.

Crete is the fifth largest island of the Mediterranean and the first and most populated island of Greece (Figure 1). Due to the isolation from mainland Europe, Asia, and Africa the fauna and flora of the island have many clues to the evolution of species. The Island is characterized by a dry semi-humid Mediterranean climate with dry and warm summers and humid and relatively cold winters where mean annual rainfall decreases from west to east and from north to south, but increases with altitude [8]



Figure 1. River Basin of Crete, Greece

Annual precipitations are highly variable ranging between 300 mm in coastal areas and 2000 mm in headwaters in White Mountains. The mean annual temperature ranges from 18.5° in the west to 20° in the south of island and decreases with altitude. The mountainous areas, in particular in the western part, have mountainous climate. As a consequence, Crete contains sub-regions with very different hydrological characteristics. Crete has about 2550 km² of agriculture land, about 30% of whole Crete. The main crops are olives, grapes, and the main vegetables crops are tomatoes, cucumbers, onions, potatoes, watermelons and melons. The demand for irrigation water is high

(about 360 Mm³/y), while only 47% (1200 km²) of agricultural land is irrigated [9].

In order to develop a comprehensive methodology of setting priorities for a selected set of measures for a certain water body an assessment of the program of measures for four representative basins of Crete took place a) Geropotamos Basin – most important agricultural basin in Crete with signs for desertification, b) Giofyros Basin – includes urban section with major flooding problems, c) Ierapetra Basin – agricultural basin with many greenhouses and inadequate water supplies, and d) Keritis Basin – with major karstic spring resources where the Program of measure of spring water source protection was evaluated.

The methodology applied in this study was presented schematically in Figure 2. Initially, pressures in Basins were identified and appropriate measures from PoM were selected for each Basin. SWOT analysis were conducted for each measure and the results were presented and discussed with users, water managers, planners and policy makers. Final SWOT analysis was revised according to their suggestions.

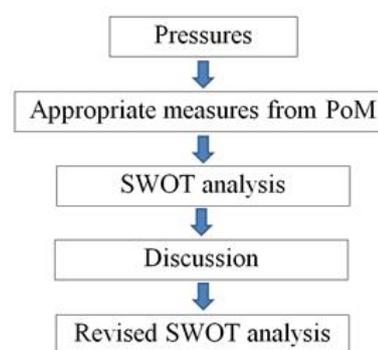


Figure 2. Overview of methodology used for SWOT analysis

3 Results

Pressures in examined Basins are presented in Table 1. Agriculture practice, domestic wastewater and olive mill wastewater are the most dominant pressures in the area. Furthermore, locally other problems such as salt water intrusion, livestock farming and winery wastewater were recorded.

Table 2. Pressures identified in examined water systems

Pressures	B1	B2	B3	B4
Domestic wastewater	√	√	√	√
Olive mill wastewater	√	√	√	√
Over-exploitation		√		√
Nitrates		√		√
Agriculture	√	√	√	√
Livestock farming	√	√	√	
Floods			√	
Winery wastewater			√	

B1: Keritis Basin, B2: Geropotamos Basin, B3: Giofyros Basin, B4: Ierapetra Basin

In order to determine which measures will be priority, the region's water needs must first be prioritised. The freshwater needs of the Cretan region were estimated to reach 535 hm³ annually. About 65 hm³ are needs for the human water supply and tourism, 6.2 hm³ for livestock, 460 hm³ for agriculture, 0.9 hm³ for olive mills and 3.2 hm³ for industrial purposes. Around half (46%) of the total water needs is requested by Heraklion prefecture. The available water volume on an annual basis is estimated as 372 hm³ and is extracted from alluvial and karstic aquifers. The increased water demand for agricultural use on the island, which absorbs approximately 86% of the water use, cannot always be met [10].

The geology of Crete is composed of carbonate rocks (limestone, marble and dolomite) which allow water to penetrate, creating major karst formation. The total karst area covers about 2730 km² and the water contribution to the karst aquifer is estimated around 2000 Mm³/y which discharges out in many springs. The water management in Crete is performed by eleven Municipal Water Supply and Sewerage Companies, 38 Local Agriculture Authorities and the Organization for the Development of Crete (OAK), which is the core manager of the large water projects. OAK, is responsible for operation, maintenance, administration, management, and use of water resources in Crete; the systematic monitoring and recording of the source levels, dams, reservoirs and

underground aquifers; the monitoring of water quality; input–output in the plants; and for the improvements and interventions in necessary cases for the proper and efficient operation of the system.

PoM contains two categories of measures: basic measures which are the same for all regions of Greece and additional measures which are specified for the Region of Crete. In total there are 65 basic measures and 45 additional measures. From that, 69 (48 basic + 21 additional) potentially could be applied in Keritis Basin, 79 (49 basic + 30 additional) in Geropotamos Basin, 75 (48 basic + 27 additional) in Giofyros Basin and 80 (49 basic + 31 additional) in Ierapetra Basin.

Basic measures are compulsory for all PoMs in Greece related with European Policy on water management. On the contrary, additional measures correspond to specific needs and requirements for water management in Region of Crete. Include measures for regarding legislation, administration, economic, water abstraction control, pollutant control, agriculture code of practice, demand management, reuse, aquifer recharge, wetland restoration, constructions, desalination project, research & development and education.

Strengths and weakness are internal factors considered in the basin under study, while opportunities and threats posed by external factors. The internal factors, strengths and weakness, give certain advantages or disadvantages of the water management in the basin. On the other hand, the external analysis examines the opportunities and threats that exist independently of the basin. SWOT matrix for the implementation of measures contained in PoMs in the study area is shown in Table 2.

Although Crete, as water district, surplus in water resources compared to other Greek water regions, their proper use is hampered by the unequal distribution of the annual volume of precipitation, both geographically (Western Crete receives 25% more annual rainfall than the eastern Crete) and morphology (i.e.

mountains and lowlands). On the other hand, water status in Crete is in general good (with small exceptions).

Table 2. Summary of SWOT analysis regarding the implementation of measures contained in PoMs

<p>Strengths</p> <ul style="list-style-type: none"> - In general, the status of surface water and groundwater are good - There are a significant number of dams in the islands - Water management governance, decision support systems and engineering expertise - Existence of adequate statistics to monitor the parameters involved in the threats. 	<p>Weakness</p> <ul style="list-style-type: none"> - Strong seasonality in the annual rainfall volume can lead to complications of supply - High consumption of water for irrigation. - limited data exchange between authorities involved in water quality monitoring
<p>Opportunities</p> <ul style="list-style-type: none"> - Improvement of surface water and groundwater status - Increasing availability of water data to R&D activities - Improving irrigation efficiency. - Cost recovery of water-related services. 	<p>Threats</p> <ul style="list-style-type: none"> - The present economic and financial situation limits the funds available for public investments - Major drought periods during the summer months by processes associated with climate change

4 Conclusion

During this study, a SWOT analysis was conducted in order to assess the measures described in Water Management Plan of the Region of Crete. The main problems in the area are the overexploitation of water resources for irrigation and pollution from domestic wastewater and olive mill wastewater. A balance between what is needed by people and what is needed in the environment is an important step in the sustainability of water resources. Reduction of irrigation water, control of fertilizers, exploitation of saline karstic springs, wastewater recycling, and construction of small dams are some of measures suggested.

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