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Water supply management approaches using RES on the island of Rhodes, Greece

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Abstract

Desalination powered by renewable energy sources (RES) is presented as an alternative option for the water supply augmentation in the semi-arid region of the island of Rhodes. The case study was chosen as the island relies mostly on the exploitation of groundwater resources and faces serious water shortage problems in an already stressed environment. Alternatives are discussed and compared in contrast to the construction of storage dams to meet urban water needs up to the year 2040. Results may indicate that through the use of financial incentives coupled with holistic water management approaches, desalination powered by RES could be an attractive and environmentally friendly option in an effort to solve problems related to water quantity and quality in semi-arid regions with adequate renewable energy potential.

Keywords: Desalination; Renewable energy sources; Rhodes; Semi-arid regions

1. Introduction

In many southern Mediterranean regions water is used in an unsustainable manner. The landscape, as a whole, is ecologically fragile and seriously endangered by prevailing social and economic trends. The future of the region may be threatened by increasing coastal area stress, by expanding differences between tourist areas and the rural hinterlands, and by the sensitivity between the water and soil equilibrium [1]. Most of the population is concentrated in the coastal zone, and increasing tourism causes a strong, seasonal water demand. Thus, uneven water demands in both space and time greatly increase the cost of making water accessible. Such conditions are exemplified very accurately in the case of the island of Rhodes.

Desalination, compared to more conventional water supply related interventions, may take an

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advantageous position in terms of economic costs and environmental impact. Amongst the various desalination techniques, reverse osmosis (RO) has been widely used during the last years. Technology advances in the field of energy recovery have managed to reduce, with the use of pressure exchangers, the specific energy consumption at 2.0 kWh/m^3 for seawater desalination [2]. Low energy requirements are expected to render the particular desalination technology more competitive compared to other desalination techniques and conventional interventions. Under these conditions, wind-powered RO desalination units could offer an effective, economic and environmentally friendly solution in water stressed areas where adequate wind potential exists.

The island of Rhodes presents a unique challenge of a semi-arid region where shoddy water resources management and uncontrolled development have led to severe water shortages and environmental stresses. The island with an excellent wind potential seems ideal for the implementation of desalination powered by renewable energy sources (RES) to confront proliferating water resources problems. Such a policy option should be incorporated in an overall management framework in an effort to ensure the long term sustainability of the region.

2. The island of Rhodes

2.1. Physiography, social and economic profile

The island of Rhodes is located in the SE corner of Greece and is one of the largest and most populated of the Aegean Islands, with an area of 1400 km^2. The permanent population of the island was 117,792 inhabitants (NSCG, 2001). The most densely populated and urbanized area is the northern part of the island around the municipality of Rhodes per se and its coastal suburbs. The remainder of the island is mainly rural with decreasing population density from the north to the south.

The predominant economic activity is tourism. Approximately half of the labor force is occupied with tourism related activities, thus strongly contributing to the coastal development schemes. The rural hinterland, which has been affected by tourism development to a far lesser degree, relies still on agriculture and confronts serious depopulation problems.

Despite the fact that agriculture is the second most important economic activity, the local market demand is not satisfied, and agricultural products have to be imported from the mainland. The reasons for such a case as well as the corresponding declining future trend may be attributed to the lack of capital investments, the ageing of the rural population and the shift towards the service sector.

2.2. Water resources issues

UNEP [3] estimates produce an overall annual average rainfall of 586 mm, resulting in 753×10^6 m^3 of potential water volume from which about 70% is lost to evapotranspiration. From the remaining volume, 108×10^6 m^3 (14.4%) and 120×10^6 m^3 (15.9%) constitute the infiltration and the surface run-off, respectively (Table 1). Urban water supplies in the island are still solely obtained from groundwater resources, and in most cases do not require treatment other than chlorination to meet the urban water supply sanitation requirements.

Water supply for irrigation is similarly dependent on groundwater except for the case of the southwest part of the island where the possibility exists for the use of surface water impounded from the Apolakkia storage dam and reservoir (8×10^6 m^3/y).

The strong dependence on groundwater resources along with the large urban population concentration and tourist development in the northern part of the island has led to the depletion and overexploitation of the adjacent, mostly coastal, aquifers. From Fig. 1, it can be deduced