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A study on assessing the domestic water resources, demands and its quality in holiday region of Bodrum Peninsula, Turkey

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HIGHLIGHTS

- Domestic water supply, demand, and its quality of Tourism regions.
- Population diversity and projection of Bodrum peninsula, tourism region in Turkey.
- Water needs of tourism regions according to population diversity and water resources.
- Domestic water project needs for tourism region.
- Importance of water for Bodrum peninsula.

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ABSTRACT

The Bodrum peninsula is one of the more important tourist locations in Turkey. Due to an increasing population and tourism demand, water shortages have emerged as a significant problem during the summer months in recent years. It has now reached the point where the peninsula no longer has a sufficient, safe and continuous water supply to meet its needs. In this study, population projections of the peninsula until the year 2060 are provided along with estimates of the water needs of the population, the amount of water resources available and the resources that need to be developed to supply water of the required quality. It is concluded that, given population growth and tourist demands, in each of 2020, 2030, 2040, 2050 and 2060 water needs will be 23.47; 32.46; 45.52; 60,76 and 83.18 hm^3/year.

1. Introduction

In tourist areas, resident populations can show seasonal variation in numbers as they respond to tourist visitation patterns. Such population variations may also be exacerbated by holiday home ownership when owners not only reside there but may also rent out the accommodation. In the regions where there is mountain tourism, there is a definite increase of population in the winter months, while in the areas where coastal tourism exists there is a peak increase in the summer months. The summer population in these regions can be multiple times of the winter population.

Given these variations in population, there will be a corresponding increase in the summer need for water as compared to the low seasons. Thus the management of water resources becomes more important in regions that experience such changes in their population. The water consumed in the Spanish Balearic Islands in July of 1990 was equivalent to 20% of the total water consumed by the local population in one year (EEA, 2003, p. 341). Due to the development of tourism in that part of Spain, the demand for water increased by 15 times from 1980 to 1995. Another example is that of Noirmoutier, an island off the Atlantic coast of France. The local population of the island is about 9000 people. In the summer

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months, the population can increase to between 90,000 and 130,000 people. Correspondingly, water consumption also increases in the summer months. Daily water consumption is 11,000 m^3/day in August and 1800 m^3/day in the winter months (Xu, Valetta, Brissaud, Fazio, & Lazarova, 2001). While the share of water use for tourism in Rhodes is unknown, it reaches about 4.8% of domestic water use in nearby Cyprus (Gössling et al., 2012), or 10% of indirect water use (Hadjikakou, 2014). A lack of studies on tourism and the demand for water relation has made it difficult for the tourism sector to engage in the political debate about these concerns (Crase, O'Keefe, & Horwitz, 2010). Most research on the direct consumption use of water for tourism has been in the dry areas of Australia (Crase et al., 2010; Pigram, 2001; Lehman, 2009) and in relation to the Mediterranean countries (Kent, Newnham, & Essex, 2002; Garcia & Servera, 2003; De Stefano, 2004; Essex, Kent, & Newnham, 2004; Rico-Amoros, Olcina-Cantos, & Sauri, 2009; Tortella & Tirado, 2011; Gössling, 2015; Stefano, 2004; Tekken & Kropp, 2015).

The trend for tourism development, which started in the Western Mediterranean, has shown a rapid growth in Turkey and more generally the Aegean in the last 30 years, and the Mediterranean coasts have quickly become home to tourist facilities and second homes. However, uncontrolled population growth, and failure to keep pace with planning, technical infrastructure, legal systems and business systems, along with administrative and political failings, have increased pressure on drinking water resources and led to the emergence of extensive negative impacts on the environment.

While freshwater availability is increasingly under pressure (WWAP, 2012), water use in the tourism sector has received growing attention by organizations such as UNEP (2011), UNWTO, (2013), and OECD (2013, p. 24). Water demand from tourism tends to be exceptionally concentrated in space and time (Essex et al., 2004; Hadjikakou, Chenoweth, & Miller, 2012). This can create significant stress on local water resources, generally accounting for a considerable percentage of water use in places where tourism is an important economic activity (Gössling et al., 2012; Hadjikakou, Chenoweth, & Miller, 2013). In the tourism sector, hotels, swimming pools, and golf courses mean people are prone to excessive water consumption. Consequently, difficulties arise in obtaining water and large amounts of waste water are formed. In the Mediterranean basin, water shortages in arid and semi-arid regions, including those where the tourism industry operates, has become a major problem. According to research carried out in Spain, the hot climate and the tourists' tendency to use more water than the amount they normally use at their house, cause water consumption to reach levels of 440 l/person/day (UNEP, 2002; Burak, Doğan, & Gazioğlu, 2004; Lehmann, 2009). Water use in tourism accommodation varies from 84 to 2425 l/per person/per day, including water use in rooms, for gardens, pools and irrigation, with activities adding 10–875 l/person/night (Gössling et al., 2012; Hadjikakou et al., 2013; Tortella & Tirado, 2011). Based on the aforesaid studies, average total water use values may be in the order of 350 l/day for tourism accommodation, and 20 l/day for activities, i.e. values about 15% higher than averages reported in earlier studies (Gössling et al., 2012). In Turkey, the amount of water used per person for tourism purposes is estimated at 400 l/day (Gössling, 2006).

Water problems in the Mediterranean countries, as well as in the islands located in Mediterranean and Aegean Sea, have been known for many years. Malta has a high population density and is also poor in terms of freshwater resources. Freshwater needs of locals and tourist attractions have been handled by the conversion of salt water into fresh water since 1980. In particular, available freshwater resources in the Mediterranean basin are steadily decreasing due to climate change (Sapiano, 2008). The lack of water resources in the island of Cyprus, the Greek islands, Israel, Jordan, Egypt, Palestine, Libya and in the Gulf countries leads to serious problems. Furthermore, in the United Kingdom, despite the floods, there is a shortage of water in the southeast of England. The most important reasons are hot summers, population growth, new home constructions, and watering of agricultural lands and gardens. There are also water problems in Southwest Europe. In particular, hotels in the tourist zones obtain water through deep well drilling and this causes soil salinity due to corresponding reduction in groundwater levels (Bilgin & Bakış, 2000; Bakış, 2001; Bakış and Bilgin, 2002; PAP/RAC, 2005; Goodwin, 2007, p. 39; Karagiannis & Soldatos, 2007; El-Sadek, 2010; Hadadin et al 2010). Recent publications related to tourism and water use are indicative of the need to better quantify both direct and supply chain water consumption for the tourism sector in academic (Cazcarro, Hoekstra, & Sanchez Choliz, 2014; Cole, 2014; Gössling et al., 2012; Hadjikakou et al., 2013; Kasim, Gursoy, Okumus, & Wong, 2014; Sun & Pratt, 2014) and non-academic circles (Becken, Rajan, Moore, Watt, & McLennan, 2013; Tourism Concern, 2012; UNEP-UNWTO, 2012).

This study aims to examine the drinking water and potable needs of the Bodrum peninsula, which is one of the more important tourism centers found in the Mediterranean Region. The study provides an analysis until the year 2060 along with expected population growth, the amount of present and the future water resources, their location and development, along with the quality of water being utilized.

2. Material and methods

2.1. Material

The Bodrum peninsula is located at the south western tip of Turkey and has a rich history due to its geographical location in the Mediterranean basin. It has the Gulf of Güllük to its north, Gulf of Gökova to its south and the Aegean Sea to its West. The Bodrum peninsula covers an area of 680 km^2. The coastline of the peninsula is 174 km. The peninsula consists of the central town of Bodrum and its 55 districts (Fig. 1).

The geological structure comprises Paleozoic aged schists and limestone. Limestone is a carbonated rock with a permeable structure (usually located in the area closest to the sea) and is common in the peninsula. Carbonated limestones transport the water they absorb directly to the sea. Therefore, limestone regions close to the sea tend to be poor in terms of surface water, and lack the springs and groundwater that are more abundant in interior regions and areas with impermeable beds. Karaova and groundwater reserves in Milas illustrate this situation (MM, 1996, 1998; Bakış, 2001). There are no rivers with a steady flow in the Bodrum peninsula; therefore it is not possible to construct any dams (DSİ, 2010). The peninsula has a Mediterranean climate. Summers are hot and dry, winters are mild and rainy (Arı, 2010). The average annual rainfall is 681.9 mm. Average highest and lowest temperatures are respectively between 23.8 C° and 18.9 C°. The average sea temperature is 19.4 C°, and the highest values can be seen in the months of August and September (23.5 C°). The total evaporation in the study area is 1862.8 mm and the average monthly relative humidity is 63.66%.

The most important settlements in the Bodrum Peninsula comprise the center of Bodrum along with Turgutreis, Ortakent (Yalikavak), Türkbükü and Karaova. The data obtained on the Bodrum peninsula (for this study) includes information obtained from the Forestry and Water Affairs Ministry, Tourism Ministry, General Directorate of State Hydraulic Works, Municipalities, General Directorate of Environment and Forestry and also earlier