



# Modelling climate change impacts on tourism demand: A comparative study from Sardinia (Italy) and Cap Bon (Tunisia)



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## HIGHLIGHTS

- We model climate change impacts on tourism demand in Sardinia and Cap Bon.
- Climatic conditions for beach tourism are expected to improve in shoulder seasons.
- Increased heat stress may cause tourism demand to decline in summer peak season.
- Annual net impacts on tourism demand are expected to be (slightly) positive.
- Increasing water scarcity may raise water costs and decrease tourism profits.

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## ABSTRACT

Tourism represents an important source of income and employment in many Mediterranean regions, including the island of Sardinia (Italy) and the Cap Bon peninsula (Tunisia). Climate change may however impact tourism in both regions, for example, by altering the regions' climatic suitability for common tourism types or affecting water availability. This paper assesses the potential impacts of climate change on tourism in the case study regions of Sardinia and Cap Bon. Direct impacts are studied in a quantitative way by applying a range of climate scenario data on the empirically estimated relationship between climatic conditions and tourism demand, using two different approaches. Results indicate a potential for climate-induced tourism revenue gains especially in the shoulder seasons during spring and autumn, but also a threat of climate-induced revenue losses in the summer months due to increased heat stress. Annual direct net impacts are nevertheless suggested to be (slightly) positive in both case study regions. Significant climate-induced reductions in total available water may however somewhat counteract the positive direct impacts of climate change by putting additional water costs on the tourism industry.

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## 1. Introduction

In the surroundings of the river basins 'Rio Mannu di San Sperate' (Sardinia, Italy) and 'Chiba' (Cap Bon, Tunisia) – two of the altogether seven study sites investigated within the EU-FP7 project 'Climate Induced Changes on the Hydrology of Mediterranean Basins (CLIMB)' (Ludwig et al., 2010) – tourism represents an important source of income and employment. According to the Italian National Institute of Statistics (ISTAT, 2012), Sardinia's 'Accommodation & Restaurants' sector generated 2.4 billion € in direct value added in 2010, accounting for 7% of the island's gross regional product (GRP). Moreover, 6% of all Sardinian employees work in the 'Accommodation & Restaurants' sector. In Cap Bon, a peninsula in the northeast of Tunisia and the country's

leading sea destination, the sector 'Hotels, Restaurants & Travel Agencies' as well contributed about 7% to GRP (Gafsi and Ben-Hadj, 2010). Besides, roughly 90,000 people were directly or indirectly employed by Cap Bon's tourism sector, compared to 51,000 and 70,000 employees in the agricultural and industrial sector (Gafsi and Ben-Hadj, 2010).

Tourism in Sardinia and Cap Bon, however, not only represents an important source of income and employment, but it is also an intensive water consumer (Corsale, 2011; Gafsi and Ben-Hadj, 2010). The seasonal coincidence of tourist and dry seasons (see Section 2.1), especially, puts additional pressure on available water resources and contributes to water conflicts. Since water of proper quantity and quality represents an important factor for tourism development, climate-induced changes in its availability could impact the regions' tourism industries considerably. Besides these indirect impacts via water availability, climate change also poses the potential to affect tourism in a direct way, as many tourism types – including the predominant sea, sand and sun (3S) tourism in Sardinia and Cap Bon – show a strong link to the climate

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(UNWTO-UNEP-WMO, 2008). 3S tourism, for instance, needs a climate characterized by plenty of sunshine, sufficiently high temperatures as well as little rain (Moreno, 2010; Rutty, 2009; Rutty and Scott, 2010). In other words, a region's climate co-determines its basic suitability for particular outdoor-based tourism types, such as 3S tourism, and hence also ranks among those factors driving a region's tourism seasonality (Lohmann and Kaim, 1999; Scott and Lemieux, 2010). The climate's short-term manifestation, i.e. the weather actually experienced by tourists at the destination, by contrast may affect the tourists' activities and holiday satisfaction and – given sufficient flexibility – lead to holiday extension, early termination or even cancellation. Hence, changes in both, the climate's mean and its variability may directly affect tourism in Sardinia and Cap Bon.

Various studies have addressed the potential direct impacts of climate change on tourism in (selected regions of) the Mediterranean, including Amelung and Viner (2006), Hein (2007), Moreno and Amelung (2009), Rutty (2009), Rutty and Scott (2010), Perch-Nielsen et al. (2010), Cai et al. (2011) and Amelung and Moreno (2012). Some of them concentrate on the supply side only by comparing the region's observed and projected climatic attractiveness for tourism purposes, using single or composite climatic indices such as Mieczkowski's (1985) Tourism Climate Index (TCI), Morgan et al.'s (2000) Beach Climate Index (BCI) or temperature thresholds indicating ideal/unacceptable conditions for particular tourism types (e.g. Amelung and Viner, 2006; Moreno and Amelung, 2009; Perch-Nielsen et al., 2010; Rutty and Scott, 2010). Others additionally account for the relationship

between climatic conditions and tourism demand when assessing the potential impacts of climate change on tourism in (selected regions of) the Mediterranean (e.g. Amelung and Moreno, 2012; Hein, 2007). Depending on the region, the tourism type and the season considered, these studies suggest climate change impacts to range from improvements to deteriorations in climatic conditions and hence from tourism demand gains to losses. Using the BCI, Moreno and Amelung (2009), for instance, find the climatic conditions for beach tourism in summer to remain very well in most regions of Sardinia until the 2060s. However, some areas within Sardinia currently enjoying very good conditions are expected to see the suitability of their climate resources for beach tourism to somewhat deteriorate in summer. Regarding the climatic suitability for sightseeing, analyses of Perch-Nielsen et al. (2010) suggest conditions in Sardinia to improve or remain the same during winter, spring and autumn, but to deteriorate during summer by the end of the century. For the north of Tunisia, including the peninsula of Cap Bon, improving conditions are found for the winter season, whereas both summer and autumn are expected to face deteriorating sightseeing conditions, primarily due to an increase in too hot temperatures. Based on the relationship between TCI values and tourism demand, Amelung and Moreno (2012) find evidence for a net loss of tourism demand potential in the European Mediterranean countries by the 2080s, with increases in spring and autumn however likely to compensate for much of the decrease in summer.

The objective of the present paper is to assess the potential impacts of climate change on tourism in the case study regions of Sardinia and Cap Bon. Direct impacts are studied in a quantitative way by applying a range of climate scenario data to the empirically estimated relationship between weather/climate conditions and tourism demand, using two different approaches. In addition, potential implications from climate induced changes in water availability are shortly addressed in the Results and discussion section. The structure of this paper is as follows. Section 2 describes the methods and data used, including a short characterization of the case study regions. The potential impacts of climate change on tourism are presented along with a discussion of the results in Section 3, whereas Section 4 concludes.

## 2. Materials and methods

### 2.1. Case study regions

Sardinia, an island of 24,090 sq. km located 250 km west of the Italian coastline, and Cap Bon, a peninsula of 2788 sq. km in northeastern Tunisia, represent the case study regions in the focus of the present paper. The climate of both regions is characterized by hot and dry summers as well as mild and wet winters. In January, daily mean temperature in Sardinia is on average 8 °C (Cap Bon: 12 °C), whereas in August it rises to 24 °C (Cap Bon: 27 °C) (see third plot in Fig. 1). Average annual precipitation totals 500 mm (Cap Bon: 425 mm), with considerable variations from year to year. In Sardinia, these fluctuations may range from 287 mm (1970) to 948 mm (1984), in Cap Bon from 144 mm (1981) to 772 mm (2003). But variability is also high during the course of the year and dry periods occur frequently. During July and August there is often no precipitation at all (see second plot in Fig. 1). Consequently, both case study regions repeatedly suffer from water shortages due to the prevalent climatic conditions.

In both case study areas, 3S tourism represents the dominant tourism type. Overnight stays in Sardinia show a highly pronounced seasonality, with the by far highest shares of annual overnight stays reported in July and August. Overnight stays in Cap Bon are, by contrast, distributed somewhat more evenly throughout the year. Nevertheless, they still show a noticeable peak during the summer months. Hence, as illustrated in Fig. 1 by the grey-shaded rectangles, the period of the tourism industry's highest water needs, i.e. the most tourism intensive period, coincides with the driest time of the year. The increasing importance of tourism – overnight stays showed an increasing tendency over the

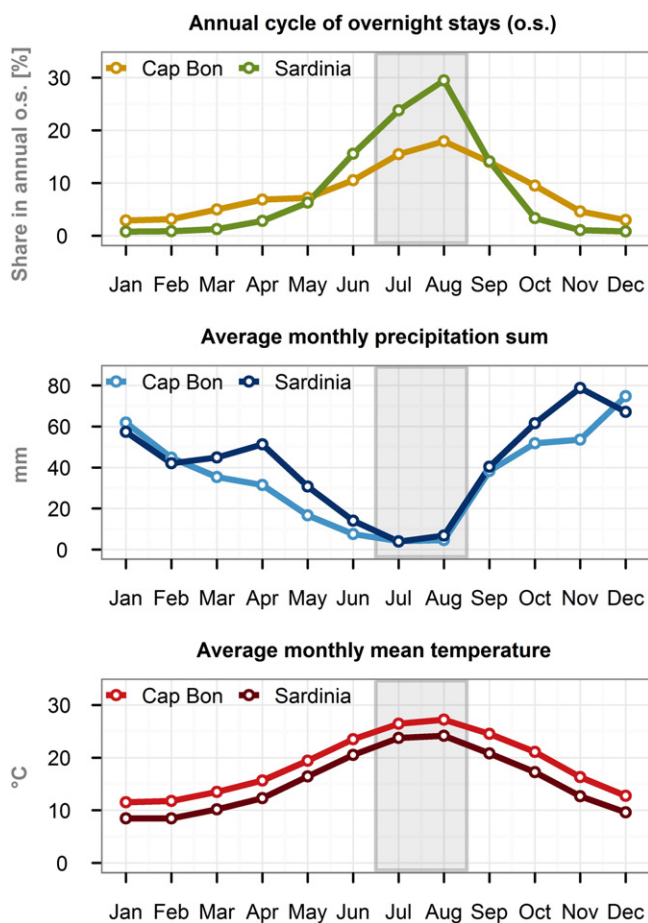


Fig. 1. Annual cycle of monthly overnight stays (first plot), precipitation sums (second plot) and mean temperatures (third plot) in Sardinia and Cap Bon. Data sources: ISTAT (2010), ONTT (2014), ECA&D (2011).

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