www.ejthr.com

European Journal of Tourism, Hospitality and Recreation
Vol. 3, Special Issue - ITC'11, pp. 77-96, 2012

WEATHER, CLIMATE AND TOURIST BEHAVIOUR:

THE BEACH TOURISM OF THE SPANISH MEDITERRANEAN COAST AS A CASE STUDY

Emilio Martínez-Ibarra
University of Alicante, Spain

M. Belén Gómez-Martín
University of Barcelona, Spain

ABSTRACT: We study the behaviour of sun and sand tourists in Spain in relation to the prevailing summer weather conditions. To do so, we built up an image bank, supplied by web cameras and Argus video monitoring systems, located at 8 observation points along the Spanish coast. We then used a method of qualitative counting based on establishing use density categories. Once classified according to the established densities of use, the images were related to several weather variables and comfort indices, and the most appropriate thresholds for sun and sand activities were established. We thus confirmed that beach use is fundamentally governed by solar radiation (aesthetic aspect) and the maximum temperature and PET (comfort). The application of the thresholds to determine the level of beach use throughout the year could lead to anticipating the tourist season calendar. This could help to offer and administer basic tourist resources correctly during the tourist season and thus enhance enjoyment of the beaches, the provision of services and the safety measures. These aspects are fundamental when it comes to maintaining and improving the use of such leisure and recreational spaces, as well as for meeting tourist requirements and conserving the elements that allowed such activity to appear and flourish. **Keywords:** tourist behaviour, climate, weather, costal tourist management.

RESUMEN. Este artículo presenta los resultados de una investigación que explora el comportamiento de los turistas de sol y playa en España en relación a las condiciones de tiempo meteorológico reinante durante el período estival. Para ello se ha conformado un banco de imágenes, proporcionadas por cámaras web y sistemas de video Argus sitas en 8 puntos de observación del litoral español, y se ha aplicado sobre el mismo un método de recuento cualitativo basado en el establecimiento de unas clases de densidad de uso “tipo”. Catalogadas las imágenes según las densidades de uso establecidas, se han relacionado con diversas variables meteorológicas e índices de confort, y se han establecido los umbrales más adecuados para la práctica del sol y playa, comprobándose en nuestro estudio que el grado de densidad de uso de las playas está controlado fundamentalmente por la radiación solar (faceta estética) y la temperatura máxima y el PET (confort). La aplicación de estos umbrales para determinar el grado de uso de las playas a lo largo del año puede permitir prever el calendario de las

Emilio Martínez-Ibarra. Researcher at the Laboratory of Climatologyat the University of Alicante. His research is mainly focused on tourism climatology. Author’s e-mail: Emilio.Ibarra@ua.es.. **M. Belén Gómez-Martín.** Tenured Assistant Professor in the Department of Physical Geography and Regional Geographical Analysis at the University of Barcelona (Spain). Her research is mainly focused on tourism climatology and tourism geography. Author’s e-mail: bgomez@ub.edu

temporadas turísticas y ofrecer y administrar correctamente durante éstas los recursos turísticos básicos que permiten el disfrute de la playa, la dotación de servicios y el despliegue de seguridad. Estos aspectos son fundamentales para mantener y mejorar la utilización de estos espacios de ocio y recreación, satisfaciendo las necesidades de los turistas y conservando los elementos que han permitido la aparición y el desarrollo de la actividad. **Palabras clave:** comportamiento del turista, clima, tiempo meteorológico, gestión turística del litoral.

RESUMO. Este artigo apresenta os resultados de uma investigação sobre o comportamento dos turistas de sol e Praia em Espanha, relativamente às condições do tempo meteorológico durante o período estival. Para o efeito, foi criado um banco de imagens, obtidas através de câmaras web e de sistemas de video Argus, em 8 pontos de observação do litoral espanhol, e paralelamente foi utilizado o método de recontagem qualitativa, baseado no estabelecimento de várias classes de densidade de uso "tipo". Após a catalogação das imagens segundo as densidades de uso estabelecidas, estas foram relacionadas com diversas variáveis meteorológicas e índices de conforto, e foram estabelecidos os limiares mais adequados para a prática de sol e praia, comprovando-se neste estudo que o grau de densidade de uso das praias depende fundamentalmente da radiação solar (faceta estética), da temperatura máxima e do PET (conforto). A aplicação destes limiares na determinação do grau de uso das praias ao longo do ano permite prever o calendário das temporadas turísticas e, deste modo, facilitar a oferta e a correcta gestão nesses períodos dos recursos turísticos básicos para o disfrute da praia, da dotação de serviços e da implantação de meios de segurança. Estes aspetos são fundamentais para manter e melhorar a utilização destes espaços de lazer e recreio, satisfazendo as necessidades dos turistas e conservando os elementos que permitiram o surgimento e o desenvolvimento da atividade. **Palavras chave:** comportamento do turista, clima, tempo meteorológico, gestão turística do litoral.

INTRODUTION

Although studies on tourist demand are numerous and varied and the part they play in research into tourism has gained in importance (Bakkal & Scaperlanda, 1991; Crouch, 1994; Divisekara, 1995; Eymann & Ronning, 1997; Hannigan, 1994; Li, Song & Witt, 2005; Lim, 1997; Martin & Witt, 1989; Melenberg & Van Soest, 1996; Opperman, 1994; Pack et al., 1995; Pizan & Fleischer, 2002; Smeral & Witt, 1996; Song & Li, 2008; Wang, 2004; Witt & Witt, 1995), those that set out specifically to analyse the possible links between this demand and atmospheric conditions are still limited in scope and few in number (Agnew & Palutikof, 2006; Álvarez-Díaz et al., 2010; Coombers et al., 2009; De Freitas, 2003; Guillén et al., 2008; Hamilton et al., 2005; Kammler & Schernewski, 2004; Lise & Tol, 1999; Lise & Tol, 2002; 2009; Martínez-Ibarra, 2011; Moreno et al., 2008; Scott & Lemieux, 2009). This paper aims to help reduce uncertainties in this line of research and therefore focuses on studying behaviour. It is known that tourist behaviour is influenced by, among other things, atmospheric conditions (Butler, 2001; Crouch, 1994; Gómez-Martín, 2005, 2006; Hu & Ritchie, 1993). The degree of influence is determined by the extent to which any specific type of tourism is sensitive to weather and climate in general and/or certain weather conditions in particular. Sun and sand tourism is one of the types most sensitive to weather and climate, and we will therefore focus our attention on this area.

The paper presents the results of an investigation into the behaviour of sun and sand tourists in relation to atmospheric conditions for a selection of resorts on the Spanish Mediterranean coast, based on information supplied by a number of webcams and video monitoring systems and also various weather observatories. The aim here was to relate the density of beach use to various different atmospheric parameters, thereby determining a number of optimal use thresholds. Applying these thresholds to determine the degree of beach use throughout the year may enable the tourist season calendar to be planned more accurately and basic tourist resources to be provided and managed more appropriately during these periods to achieve best use of the beach, service provisions and safety measures. Comparing these calendars for potential use with those of actual use should show how well adapted the management of these tourist spaces on our coast is, at least from the atmospheric point of view. These aspects are fundamental for maintaining and improving the use of these leisure and recreation spaces, fulfilling tourist needs and preserving those elements that have enabled the activity to appear and flourish.

Following this brief introduction we present the area of study and the data and methodology followed in the research. After that we present the results for the atmospheric factors and thresholds that govern the number of people that go to the beaches chosen for the study, and then – based on these thresholds – we calculate the calendars for potential use in order to compare them with the calendars of actual use. Finally we present our conclusions and the main references for the investigation.

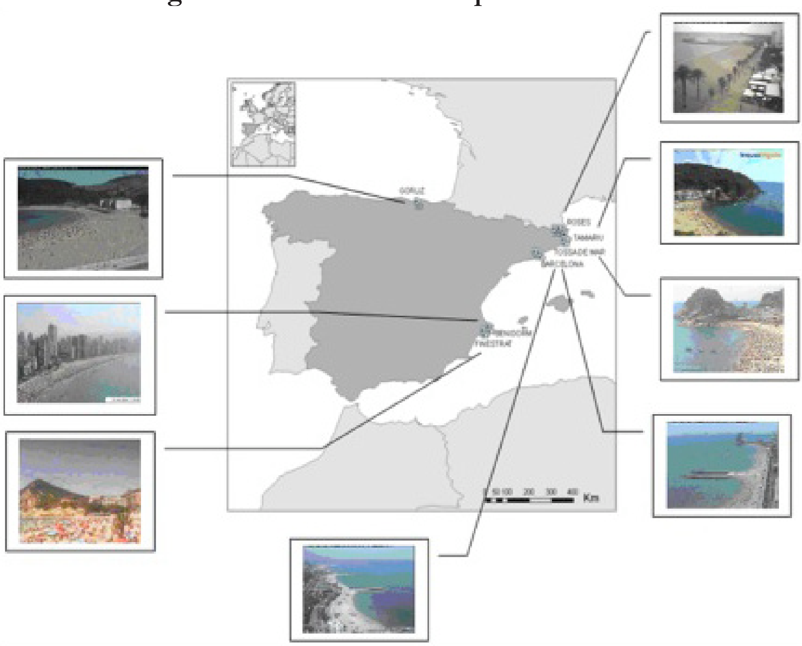
AREA OF STUDY, DATA AND METHODOLOGY

The Mediterranean is the foremost region of the world when it comes to sun and sand tourism. According to the World Tourism Organization (UNWTO), 190 million international tourists chose the Mediterranean as a destination in 2010 – 20% of world market share – and it is forecast that some 345 million tourists will travel to the area in 2020, mainly in search of sun and sand (UNWTO Tourism Highlights, 2011 Edition). Within the region, the destinations on the Spanish coast are those that record the highest and best indices of visits and evaluations. The suitability of the resources and the introduction of quality criteria in beach management along with the constant provision and renewal of equipment and the integration of complementary leisure and relaxation activities make the sun and sand destinations of the Spanish Mediterranean very competitive.

For the purposes of observing the behaviour of sun and sand tourists in relation to atmospheric conditions, an image bank has been compiled using webcams and video monitoring systems in 8 sample locations on the coastline of the Iberian Peninsula, mainly located in the region of the Mediterranean. The sample locations chosen (very popular tourist beaches) can be considered as large-scale climate and tourist laboratory centres where observation via webcams and video monitoring systems suggests itself as a non-intrusive method to enable the behaviour of individuals to be examined while avoiding undesired changes in the activity under scrutiny. In this sense, the webcams and video monitoring systems become instruments making it possible to observe patterns of temporal and spatial behaviour which can in turn be studied and described.

Despite the fact that the installation of these types of system has become widespread in recent times, they are not used for any one particular purpose and are managed by various different bodies. This means there is great heterogeneity in image quality, angles of observation, time sequences, series continuity, etc. A careful selection, therefore, had to be made of the stored material in order to work with homogeneous information that could be compared with and extrapolated to other possible locations in the area under analysis. Hence, in accordance with the aims of the investigation, the images selected for the Mediterranean coast were those for the beaches of Santa Margarida in Roses, Tamariu in Tamariu, Gran in Tossa de Mar, Somorrostro and Nova Icària in Barcelona, Levante in Benidorm and Finestrat in Finestrat. As a counterpoint, Gorliz beach on the Cantabrian coast was also selected to provide an example of a cold beach (Figure 1). The period analysed runs from 1 July to 20 October 2009 and the time chosen is midday (images taken at approximately 12.00), coinciding with the period of maximum recreational activity. The timescale covered by this analysis (limited to a single year) eliminates the role that coastal dynamics might play in determining how the beaches are used and operated, given that the exposed surface of the beach (the subject of our analysis) may react continuously to the action of marine agents and as a result present considerable fluctuations in the surface area available to users.

Figure 1. The observation points selected.



The beaches selected have a number of common characteristics in line with their being rated as tourist beaches. They are mainly of fine sand and wide enough and long enough for people to use them. They are suitable for bathing, with gentle bathymetric slopes and wind and wave systems compatible with bather safety. They are located within large resorts or cities, with many different commercial and hotel and catering services, a shoreline accessible to potential users and facilities best suited for sun and sand activities to flourish.

To analyse the level of occupation of the beaches chosen, a qualitative methodology was developed that enables different densities of use to be established by visual approximation. This methodology uses the observer's ability to extract patterns based on the dynamic visualization of an image bank. The beaches were each divided into three areas – *splash area, lounge area and transit area* – all of which are considered in the evaluation (Figure 2). The density levels established for each beach (0 – zero density – 0.5, 1, 1.5, 2, 2.5 and 3 – maximum density. See Figure 3 for examples) are used as referents in order to encode the images.

Figure 2. Example of the division into areas of Santa Margarida beach in Roses

Note: 1. Splash area (strip of beach where games are played and users enter and leave the sea); 2. Lounge area (strip that is used most intensively, typically for sunbathing); 3. Transit area (strip furthest from shoreline, behind the relaxation zone, used for access to the beach, leaving and looking for a space in the sand).

Once the occupation densities were established at the various observation points, these were related to different atmospheric elements so as to discover the human response to them and, in short, to give each atmospheric scenario a tourist significance (De Freitas et al., 2004; Martínez-Ibarra, 2011). This was done by using the daily information provided by the official meteorological services or, where appropriate, the local authorities. The observatories chosen were close to the beaches in the study.

The theoretical-methodological corpus developed by both Besancenot (1985; 1989) and de Freitas (1990) was taken into account when selecting the meteorological variables. As far as the heat aspect (thermic comfort) is concerned, we decided on maximum temperature (ºC), % relative humidity at 13.00, overall solar irradiance in $W \cdot m^{-2}$ at 13.00, and wind speed in $m \cdot s^{-1}$ at 13.00. This made it possible to calculate one of the bioclimatic indices most used today: the Physiological Equivalent Temperature PET (ºC) (Cegnar & Matzarakis, 2004; Höppe, 1999; Matzarakis et al., 1999; Matzarakis 2001; Matzarakis et al., 2009). This was calculated based on the RayMan model (Matzarakis & Rutz, 2005). For the physical aspect (basic for the tourists' enjoyment), we decided on wind speed in $m \cdot s^{-1}$ at 13.00, daily rainfall in mm, duration of daily rainfall in minutes, and rainfall between 06.00 and 13.00 in mm. Finally, the aesthetic aspect (enjoyment) took into account overall solar irradiance in $W \cdot m^{-2}$ at 13.00.

For the purposes of calculating the calendars for potential use, we used the meteorological observatories mentioned above or, if unavailable, those nearest the coastal centres analysed which had data for the international period 1961-1990.

Figure 3. Example of densities of occupation on the beach of Santa Margarida in Roses

Density 0

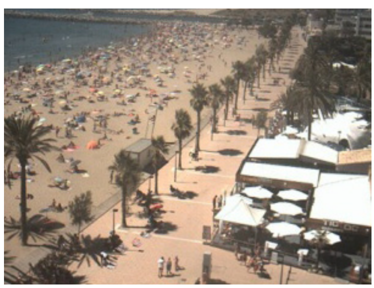
Density 1.5

Density 0.5

Density 2

Density 1

Density 2.5



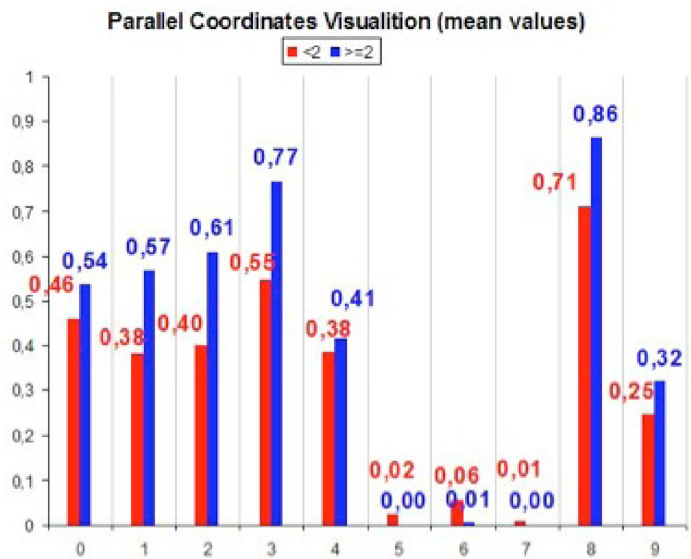
Density 3

RESULTS

Factors and thresholds governing numbers of visitors to beaches on the Spanish Mediterranean coast

To analyse the descriptors (in this case, meteorological variables and the day of the week) having an influence on the density of use of the beaches studied, we generated a parallel coordinate graph. This method allows a rapid and effective analysis of large sets of n-dimensional data (of multiple variables) starting from the same pattern (the parallel axes that represent each variable have the same scale of reference, in our case lying between 0 and 1) (see, Eickemeyer et al., 1992; Inselberg, 1985; Wegman, 1990). To do this, we divided the sample (N=782) in two representative groups (occupancy levels < 2 and ≥ 2). The results are expressed in mean values to facilitate interpretation (Figure 4).

Figure 4. Descriptors of beach use for the two groups of density considered(occupancy levels < 2 and ≥ 2)



0:Day of the week (1 – 7); 1: Maximum Temperature (ºC); 2: Maximum PET value (ºC); 3: Solar radiation at 13h (W ·m^{-2}); 4: Wind speed at 13h (m ·s^{-1}); 5: Daily precipitation (mm); 6: Duration of daily precipitation (minutes); 7: Morning precipitation (mm); 8: Fraction of solar radiation at 13h (%); 9: Weekday/Weekends

If we examine the graph and the numerical results, we can conclude that the factors that had most impact on the daily use of the beaches were, in the following order of importance, solar radiation at 13:00 h, the maximum PET value, maximum temperature and the fraction of radiation at 13:00 h. The day of the week (the study focused above all on the summer months) was of only secondary importance. Two further factors were found to have very little significance at all: daily rainfall totals and the daily duration of precipitation events (albeit that they were negative factors for beach use) and wind speed at 13:00 h (given the few days on which the wind speed was of any note). The importance of thermal comfort and solar radiation for sun and beach tourism coincides with the results obtained through surveys conducted with students, for this same type of tourism, by de Freitas et al. (2008) and Scott et al. (2008).

If the comparative analysis is conducted for pairs (density/ meteorological variables or day of the week), and we analyze the Pearson correlation (r) and determination coefficients (R^2), the results are fairly similar. Thus, in agreement with these findings, the variables that are most closely related to beach occupancy levels were maximum temperature (r=0.7 and R^2=0.48; N=816), the PET (r=0.7 and R^2=0.48; N=816) and solar radiation at 13:00 h (r=0.7 and R^2=0.44; N=810). These were followed, albeit at some distance, by the fraction of radiation at 13:00 h (r=0.4 and R^2=0.2; N=810), and even further by the duration of daily precipitation events (r=0.3 y R^2=0.1; N=816). By contrast, daily rainfall (r=0.2 and R^2=0.1; N=812), morning rainfall (r=0.2 and R^2=0.0; N=813), the day of the week (r=0.1 and R^2=0.0; N=819) and wind speed (r=0.1 and R^2=0.0; N=819) were not very representative. The low correlation between beach occupancy and the day of the week during the summer holiday period as mentioned by Sinclair-Hannocks (1994) and Moreno and Amelung (2009) can also be extrapolated to our study.

The behavioural analysis of the distribution (concentration-dispersion) of the values of the meteorological variables considered, by groups of density use, was considered opportune for identifying the most appropriate meteorological thresholds for going to the beach. In the case of maximum daily temperatures, we observed that the mean increased as we reached values of density use equal to 2, with the limits of the third quartile remaining between 20.8-23.5°C (density 0, N= 129), 25-26.3°C (density 0.5, N= 95), 25.6-27.5°C (density 1, N= 110), 27.3-28.7°C (density

1.5, N= 98), 28.83-30.85°C (density 2, N= 154), 29.2-30.6 (density 2.5, N=116) and 29.5-31°C (density 3, N=114). Thus, it seems that the optimum maximum temperature for going to the beach lies between 28.83 and 31°C. These results agree with those of Martínez-Ibarra (2008) and Moreno and Amelung (2009). In addition, it should be noted that the lowest maximum daily temperature corresponding to densities of at least 1.5 was 18.7°C. On this point, Martínez-Ibarra (2008) proposed a threshold for the lowest maximum daily temperature of 18°C for tourists going to the Levante Beach in Benidorm.

The affinity between the density of use and the PET is reminiscent of that mentioned above for the maximum temperature. Here, the mean values also increased up to beach densities of 2. The limits of the third quartile were 19.8-23°C (density 0, N= 109), 26.6-29.8°C (density 0.5, N= 105), 28.6-31.6°C (density 1, N=106), 32-34.5 (density 1.5, N= 97), 34.5-37.8°C (density 2, N= 162), 34.8-37.4°C (density 2.5, N=104) and 35.8-38.8 (density 3, N=110). Thus, it can be concluded that the optimum PET value for going to the beach ranges between 34.5 to 38.8°C. Similarly, the lowest value guaranteeing a level of occupancy of at least 1.5 stands at 15.9°C. Both the optimum threshold and the lower limit coincide with the results obtained by Martínez-Ibarra (2011).

The median percentage values of solar radiation at 13:00 h increased up to occupancy levels of at least 1.5, and the mean up to values of at least 2. The inter-quartile limits fell markedly to occupancy levels of 2, remaining, after this threshold, at between 9-15%. The lower limit of the second quartile was in this case highly representative, with values of 30% (density 0, N=111), 57.6% (density 0.5, N=107), 64.7% (density 1, N= 106), 76.6% (density 1.5, N=95), 82.1% (density 2, N=163), 85.8% (density 2.5, N=107) and 79.5 (density 3, N=119). The lowest values are also relevant so that for occupancy levels of at least 2, only in 2.6% of cases (N=389) were radiation values below 50% recorded.

In the case of wind speed at 13:00 h the homogeneity of values should be noted, reflecting the season and the climate studied. It, therefore, would appear to be more appropriate to analyze the extreme values (specifically at the upper end). Here, we should point out that velocities above 10 m $\cdot s^{-1}$ were never recorded for densities equal to or greater than 2, and that velocities greater than 8 m $\cdot s^{-1}$ for densities equal to or greater than 2 were only reached in 2.4% (N=376) of cases. Note that the maximum accepted limit in the classifications of weather types suitable for sun and beach tourism is 10 m $\cdot s^{-1}$ (Martínez-Ibarra, 2008; 2011).

The absence of summer rainfall events in most of the areas considered here also makes it more relevant to study the extreme values. Thus, for 77% of the days for which data were collected no rainfall was recorded (N=807). Here, we can associate the lower frequency of atypical values both for duration, quantity of daily rainfall and quantity of morning rainfall to densities equal to or greater than 2. Thus the daily rainfall, morning rainfall and duration of daily rainfall limits were below 3.9 mm, 3.9 mm and 140 minutes (N=812, N=813, N=807). For these densities of use (≥2), the values were greater than 0 (mm and minutes) in 16%, 15.7% and 9.2% of the cases, respectively. Whereas if we consider values of at least 1 mm or a duration of at least 60 minutes, these percentages only rise to 9.7%, 7.7% and 4.6%, in each case. Thus, we are able to demonstrate the importance that there should be no precipitation or that levels should not exceed 1 mm and that precipitation events should not last for more than 60 minutes (Besancenot, 1989).

Calendars of actual and potential use for beaches on the Spanish Mediterranean coast.

Although the mildness of the Mediterranean climate means that beaches along the coastline can be used throughout the year, large numbers of people only start using them from spring onwards, and especially in summer. Hence these are the times when the organizations in charge of beach management (generally local councils) concern themselves with providing services and facilities to guarantee that they can be used to the full and in safety. These services and facilities are provided following calendars of use established by the competent authority. In some places these calendars are divided into high season, shoulder season and low season (this being the case of the beaches in the city of Barcelona), while in others (the majority) they are simply divided into high and low seasons[1].

Comparing the calendars established by the councils with any that may derive from our analysis would be interesting for exploring the extent to which beach management corresponds to the possibilities allowed by atmospheric conditions. In order to do this we have taken one of the main factors that, according to our study, governs the numbers of people visiting the beaches every day – maximum temperature – and the average maximum temperatures for a 30-year period have been calculated for each day of the year. Based on these averages, we have also calculated the moving average using subsets of seven so as to observe the annual average thermic pattern of maximum temperatures. In this investigation it is considered that the high season (or in some cases high and shoulder seasons) could begin when the maximum temperatures can guarantee that the beach will have a density of use of at least 1.5. According to our study, the value we need to take as a reference for determining this season is 18.7ºC, and it is on the basis of this that the calendar of potential use is drawn up. Once these potential calendars are completed, they are compared to the calendars of actual use supplied by the councils of the different sample locations chosen.

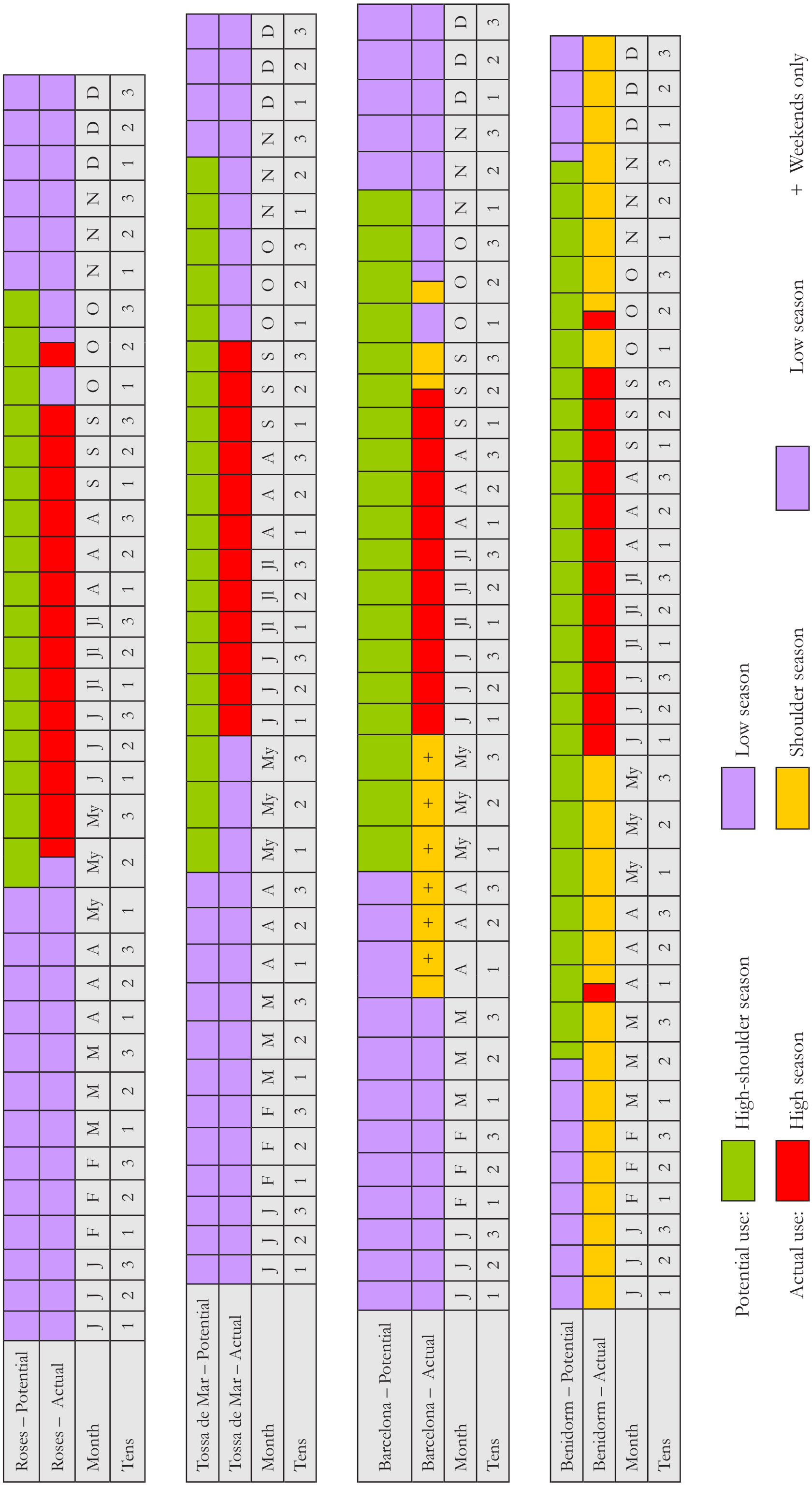
In general terms we see that the calendar of potential use is longer than the calendar of actual use (see Figure 5 for examples of calendars for Roses and Tossa de Mar). Services and facilities

1 During the high season on the beaches of the Spanish Mediterranean coast, all the following are kept functioning on a daily basis: sand-cleaning services, showers, rubbish bins, security services and lifeguards, sports facilities and children's playgrounds, hire of skates, windsurf boards and so on, hire of sunshades and loungers, food and drink stands, information points and terraces, signage for swimming areas and channels for boat arrivals and departures. These services and facilities are only kept partially functioning (either only at weekends and/or every day but at reduced levels) during the shoulder season. Services and facilities are not provided during the low season.

start to function with a slight delay at the start of the season and stop somewhat early at the end of the season, oddly enough when the sea temperature is higher and more agreeable (fluctuating between 22ºC on the northern Mediterranean coast and 26ºC on the southern coast). It should also be pointed out that at the extremes of these periods when services and facilities are not provided, the presence of users on the beaches is not inconsiderable.

Although this is the general trend in the sample locations chosen, we can see two exceptions that correspond to two very specific cases: the beaches of Benidorm and the beaches in the city of Barcelona (Figure 5). In the first case it can be seen that the council's Department of Beaches keeps services and facilities functioning throughout the year, although at different intensities: high season, which lasts from 1 June to 30 September plus the period covering Easter and the long break around 12 October, and shoulder season, which covers the rest of the year. Here we have "a town specializing in the provision of tourist services, fundamentally linked to sun and sand" with a "considerable number of provisions subject to regulation, especially the hotel and catering industry" and in which there is little difference between seasons (Vera et al., 2010:5). The way the beaches are managed is seen to be appropriate given the exceptional characteristics of this tourist resort: services and facilities are provided even beyond the period which we have marked as potential from an atmospheric point of view. The case of the city of Barcelona is slightly different in so far as these are urban beaches that were reclaimed in the early 1990s mainly for the use of the city's inhabitants. Barcelona City Council differentiates between high season, shoulder season and low season. High season covers from approximately 1 June to 15 September; shoulder season covers Easter, weekends in April and May, the period from 15 to 30 September and the long break around 12 October. Beach management in Barcelona is only partially appropriate given that the season starts earlier than shown on the potential calendar but ends earlier than recommended.

Figure 5. Calendars for potential and actual use of beaches



CONCLUSIONS

The main conclusions deriving from the study are as follows:

1. The systems for gathering information based on the presence of stationary cameras connected to computer systems enabling the transmission of live images via internet open the door to a new way of obtaining quantitative and qualitative data on different aspects relating to tourism. These are relatively cheap systems with easy access and high temporal and spatial resolution which are versatile in having a multitude of uses and applications. In this sense, webcams and video monitoring systems are good instruments for studying the behaviour of tourist demand in relation to atmospheric conditions. The information they provide, which is dealt with rigorously and complemented by other more traditional systems such as manual counting, the taking of photographs at particular times and the carrying-out of surveys and interviews, can make it possible to understand one of the many aspects involved in the decision-making process as regards the tourist-consumer's destination, and this in turn may be useful in the work carried out by specialists and managers involving the territory or the activity itself. Thus determining the temporal and spatial distribution habits of sun and sand tourists (in this case and as far as motor responses to weather and climate stimuli are concerned) and the ways in which they may change depending on atmospheric variability can be of help in coastal management.

2. Atmospheric conditions have an effect on sun and sand tourist behaviour in so far as our study has shown that the degree of density of use of beaches in Spain is basically governed by solar radiation (aesthetic aspect) and maximum temperature and PET (comfort). According to our results, the most appropriate threshold limits for the meteorological variables governing beach visits are: maximum temperature between 28.83ºC and 31ºC, maximum PET between 34.5ºC and 38.8 ºC, at least 50% solar radiation at 13.00, wind speed under $8 \text{ m} \cdot \text{s}^{-1}$ at 13.00 and under $10 \text{ m} \cdot \text{s}^{-1}$ maximum, and no rainfall or under 1 mm/day maximum or less than that in a 60-minute period.

3. Determining the thresholds for beach weather and density of use may be of interest in coastal management. Applying these thresholds to determine the degree of beach use throughout the year can make it possible to anticipate the tourist season calendar and therefore best provide and administer during those seasons the basic tourist resources that enable the beach to be enjoyed to the full (preventing its deterioration as far as possible), services to be provided (walkways, showers, toilets, cleaning services, etc.) and health and safety issues to be dealt with (security, first-aid posts, lifeguards, signage, etc.). These aspects are fundamental for maintaining and improving the use of these leisure and recreation spaces, satisfying tourist needs and preserving those elements that enabled the activity to appear and flourish. Within the geographical framework of the study it has been shown that, apart from in two cases that are exceptional due to the size of their tourist industry and urban setting (Benidorm and Barcelona), the calendar of actual beach use does not tally with the calendar of potential use determined by atmospheric characteristics, given that services and facilities are shown to start functioning rather late at the beginning of the season and cease to function rather too early at the end, when the sea temperature is higher and more agreeable.

ACKNOWLEDGMENTS

This study was carried out within the framework of a research project under the Spanish Ministry of Science and Innovation's National Plan for R+D+I, reference CSO2008-01346, led by Professor M. Belén Gómez-Martín. The images of the beaches in the city of Barcelona come from the Coastal Ocean Observatory (http://coo.icm.csic.es/) of the Institute of Marine Sciences-Spanish National Research Council (ICM-CSIC).

REFERENCES

Agnew, M., & Palutikof, J. (2006). Impacts of short-term climate variability in the UK on demand for domestic and international tourism. *Climate Research, 31,* 109-120.

Álvarez-Díaz, M., Otero, S., & González Gómez, M. (2010). Statistical relationships between the North Atlantic Oscillation and international tourism demand in the Balearic Islands, Spain. *Climate Research, 43,* 207-214.

Bakkal, I., & Scaperlanda, A. (1991). Characteristics of U.S. Demand for European Tourism: A Translog Approach. *Weltwirtschaftliches Archiv, 127,* 119-137.

Besancenot, J.P. (1985). Clima et turisme estival sur les côtes de la péninsule Ibérique. *Revue Géographique des Pyrénées et du Sud-Oest, 56(4),* 427-451.

Besancenot, J.P. (1989): Clima et turismes. Barcelona, París.

Butler, R. (2001): "Seasonality in tourism: Issues and implications". In: T. Baum & S. Lundtorp (Eds.): *Seasonality in Tourism.* London: Pergamon, 5-22.

Cegnar, T. & Matzarakis, A. (2004): "Climate and bioclimate variations in Slovenia and their application for tourism". In: Matzarakis A, De Freitas CR, Scott D (eds) Advances in tourism climatology. Nr.12. Berichte des Meteorologischen Institutes der Universität Freiburg, Freiburg, pp 66–73.

Coombers, E.G., Jones, A.P., & Sutherland, W.J. (2009). The implications of climate change on coastal visitor numbers: a regional analysis. *Journal of Coastal Research, 25(4),* 981-990.

Crouch, G. I. (1994). The study of international tourism demand: A review of practice. *Journal of Travel Research, 33,* 41-54.

De Freitas, C.R. (1990). Recreation climate assessment. *International Journal of Climatology*, *10,* 89-103.

De Freitas, C.R. (2003). Tourism climatology: evaluating environmental information for decision making and business planning in the recreation and tourism sector. *International Journal of Biometeorology*, *48,* 45-54.

De Freitas, CR., Scott, D., & McBoyle, G. (2004): "A new generation climate index for tourism". In Matzarakis, de Freitas and Scott (eds) *Advances in tourism climatology.* Nr 12, Berichte des Meteorologischen Institutes der Universität, Freiburg.

De Freitas, C.R., Scott, D., & McBoyle, G. (2008). A second generation climate index for tourism (CIT): specification and verification. *International Journal of Biometeorology, 52,* 399-407.

Divisekera, S. (1995). An Econometric Model of International Visitor Flows to Australia. *Aust. Econ. Papers, 34,* 291-308.

Eickemeyer, J. S., Inselberg, A. & Dimsdale, B. (1992): *Visualizing p-flats in n-space Using Parallel Coordinates.* Technical Report G320-3581, IBM Palo Alto Scientific Center.

Eymann, A., & Ronning, G. (1997). Microeconometric Models of Tourists' Destination Choice. *Region. Sci. Urban Econom., 27,* 735-761.

Gómez-Martín, M. Belén (2005). Weather, Climate and Tourism. A Geographical Perspective. *Annals of Tourism Research, 32(3),* 571-591.

Gómez-Martín, M. Belén (2006). Climate potential and tourist demand in Catalonia (Spain) during the summer season. *Climate Research, 32,* 75-87.

Guillén, J., García Olivares, A., Ojeda, E., Osorio, A., Chic O., & González, R. (2008). Long-Term Quantification of beach users using video monitoring. *Journal of Coastal Research, 24(6),* 1612-1619.

Hamilton, J., Maddison, D., & Tol, R. (2005). Effects of climate change on international tourism. *Climate Research, 29,* 245-254.

Hannigan, K. (1994). A Regional Analysis of Tourism Growth in Ireland. *Regional Studies, 28,* 208-214.

Höppe, P. (1999). The physiological equivalent temperature—a universal index for the bio-meteorological assessment of the thermal environment. *International Journal Biometeorologie*, *43,* 71-75.

Hu, Y., & Ritchie, J. (1993). Measuring destination attractiveness: a contextual approach. *Journal of Travel Research, 32(20),* 25-34.

Inselberg, A. (1985). The plane with parallel coordinates. *The Visual Computer, 1,* 69-91.

Kammler, M., & Schernewski, G. (2004): *Spatial and temporal analysis of beach tourism using webcam and aerial photographs.* Paper presented at the BaltCoast 2004 – Managing the Baltic Sea, Warnemünde, Germany.

Li, G., Song, H., & Witt, S. F. (2005). Recent developments in econometric modelling and forecasting. *Journal of Travel Research, 44,* 82-99.

Lim, C. (1997). Review of International Tourism Demand Models. *Annals of Tourism Research, 24,* 835-849.

Lise, W., & Tol, R. S. J. (1999). *On the Impact of Climate on Tourist Destination Choice*, Working Paper W-99/30, Institute for Environmental Studies, Amsterdam.

Lise, W., & Tol, R. S. J. (2002). Impact of climate on tourist demand. *Climatic Change, 55,* 429-449.

Martin, C. A., & Witt, S. F. (1989). Forecasting Tourism Demand: A Comparison of the Accuracy of Several Quantitative Methods. *International Journal Forecasting, 5,* 7-19.

Martínez-Ibarra, E. (2008). Tipos de tiempo para el turismo de sol y playa en el litoral alicantino. *Estudios Geográficos, LXIX, nº 264,* 135-155.

Martínez-Ibarra, E. (2011). The use of webcam images to determine tourist–climate aptitude: favourable weather types for sun and beach tourism on the Alicante coast (Spain). *International Journal of Biometeorology, 55,* 373-385.

Matzarakis, A., Mayer, H., & Iziomon, M.G. (1999).Applications of a universal thermal index: physiological equivalent temperature. *International Journal Biometeorologie*, *43,* 76-84.

Matzarakis, A. (2001). Assessing climate for tourism purposes : Existing methods and tools the thermal complex". In: en MATZARAKIS y de FREITAS (eds) *Proceedings of the Firts International Workshop on Climate, Tourism and Recreation*. International Society of Biometeorology, Commission on Climate Tourism and Recreation, Porto Carras y Halkidiki (Greece), pp. 101-111.

Matzarakis, A., & Rutz, F. (2005). Application of RayMan for tourism and climate investigations. Ann Meteorol, *41(2),* 631-636.

Matzarakis, A., de Rocco, M., & Najjar, G. (2009). Thermal bioclimate in Strasbourg—the 2003 heat wave. *Theor Appl Climatol, 98,* 209-220.

Melenberg, B., & Van Soest, A. (1996). Parametric and Semi-Parametric Modelling of Vacation Expenditures. *J. Appl. Econometrics, 11,* 59–76.

Moreno, A., Amelung, B., & Santamarta, L. (2008). Linking beach recreation to weather conditions: a case study in Zandvoort, Netherlands. *Tourism Mar Environ*, *5,* 111-120.

Moreno, A., & Amelung, B. (2009). Climate change and tourist comfort on Europe's beaches in summer: a reassessment. *Coastal Management, 37,* 550-568.

Opperman, M. (1994). Regional Aspects of Tourism in New Zealand. *Regional Studies, 28,* 155-167.

Pack, A., Clewer, A., & Sinclair, M. T. (1995). Regional Concentration and Dispersal of Tourism Demand in the U.K. *Regional Studies, 29,* 570-576.

Pizan, A., & Fleischer, A. (2002). Severity versus Frequency of Acts of Terrorism: Which Has a Larger Impact on Tourism Demand? *Journal of Travel Research, 40,* 337-339.

Scott, D., Gossling, S., & De Freitas, C.R. (2008). Preferred climates for tourism: case studies from Canada, New Zealand and Sweden. *Climate Research, 38(1),* 61-73.

Scott, D., & Lemieux, C. (2009): *Weather and Climate Information for Tourism*. White Paper, commissioned by the World Meteorological Organisation.

Sinclair-Hannocks, S. (1994): *Sustainable ecological and recreational management of sandy beach systems.* PhD, University of Technology, Sydney.

Smeral, E., & Witt, S. F. (1996). Econometric Forecasts of Tourism Demand to 2005. *Annals of Tourism Research, 23,* 891–907.

Song, H., & Li, G. (2008). Tourism demand modelling and forecasting. A review of recent research. *Tourism Management, 29,* 203-220.

Vera, J.F., Rodríguez, I. & Capdepón, M. (2010): Reestructuración y competitividad en destinos maduros de sol y playa: la renovación de la planta hotelera de Benidorm. Universidad de Alicante.

Wang, C.H. (2004). Predicting tourism demand using fuzzy time series and hybrid grey theory. *Tourism Management, 25,* 367-374.

Wegman, E.J. (1990). Hyperdimensional Data Analysis Using Parallel Coordinates. *J. Amer. Statist. Assoc., 85, 411,* 664-675.

Witt, S. F., & Witt, C. A. (1995). Forecasting Tourism Demand: A Review of Empirical Research. *International Journal Forecasting, 11,* 447-475.

UNWTO (2011): Tourism Highlights, 2011 Edition. UNWTO, Madrid.

Submitted: 15th October, 2011 *Accepted: 24th April, 2012*
Final version: 28h February, 2012 *Refereed anonymously*