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Projections of the climate potential for tourism at Mallorca Island, Spain

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Projections of the climate potential for tourism at Mallorca Island, Spain

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Abstract

The island of Mallorca, located in the western Mediterranean, was the second most visited Spanish region by tourists in 2010. It is characterized by mass tourism where the sun and sand product is the main source of income for the island. As a result of new tourist destinations and since tourists are more exigent, Mallorca is in a situation in which it needs to expand its offer to be able to maintain this economic activity as the main source of income. Furthermore, the high seasonality of the tourist product is one of the main risks to the economy itself in the region. Gradually, cycling, cultural tourism, football, golf, nautical sports and hiking are making its way among the activities that the island can offer. These tourist products increase the niche market and also contribute to de-seasonalize the tourism. The tourists' perception of these activities is directly dependent on climate. Thus, the potential climate is a key factor to study these products at present and see what changes are expected in an era of climate change. To do this, it has been used the climate index for tourism (CIT), which combines daily weather variables within thermal (T), aesthetic (A) and physical (P) aspects, giving an index measuring the perception that the tourist has on each activity. The observed atmospheric variables were obtained from the automatic weather station installed by the Spanish Meteorological Agency at the international airport of Palma de Mallorca (LEPA, 39.37^o N, 2.43^o E), while to explore the future tourism potential the database of 13 regional climate models (RCM) provided by the european ENSEMBLES project was used. The results indicate that, annually, there will be more days to practice nautical and beach tourism. In winter, all activities have a tendency to gradually increase its ideal and acceptable days at the end of the century. In spring, beach and nautical tourism improve considerably. Summer is the season that tolerates the worst climate change; all activities have a tendency to decrease their acceptable and ideal days, but the nautical tourism and golf have a higher percentage than at present. Fall is like spring, beach and nautical tourism improve but cultural tourism has a slight drop of acceptable days. With this information at hand, the authorities who manage tourism on the island can make a better projection of demand at present and over 21st century, and fight against seasonality and the possible decrease in tourism demand.

Keywords: Climate index for tourism (CIT); Climate potential; Mallorca; Cycling; Cultural; Football; Golf; Nautical; Beach; Hiking.

1. Introduction

The weather is a determinant for practicing certain tourism activities. In some kind of tourism this statement is more latent, such as in the traditional beach tourism or winter sports activities (Kimberly, M. 2009). However, there are many types of tourism in which weather also plays a key role, as is the case of outdoor activities. Therefore, the climate has a direct effect on tourism demand, as well as on the satisfaction by tourists (de Freitas et al. 2008). Other aspects such as political stability, economic infrastructure, environmental resources, cultural heritage, time and cost of travel, natural hazards or quality of life are crucial when choosing a tourism destination (Gössling & Hall, 2006; Bigano et al. 2007).

The tourism industry is constantly in evolution, tending to expand it in geographical horizons and motivations (Marchena & Repiso, 1999). Mallorca is the biggest island in the Balearic archipelago, located in the western Mediterranean area (Figure 1). It is considered a mature destination, characterized by commercialization of the of sun and beach product (Aguiló et al. 2006; Alcover et al. 2011). But in the last years, with social and economic changes, the tourist has become more stringent, requiring more specialized and complementary activities to the traditional sun and beach product (Barceló et al. 2010). Therefore, the island has begun to diversify the product offered, in order to be able to maintain and expand tourism and/or attract new niche markets that fit the new demand (Aguiló et al. 2006).

Figure 1. Geographical location of Mallorca. Custom modification of the original National Geographic Society.

Sports and cultural tourism everyday are having more weight (Marchena & Repiso, 1999; Forcades & Martorell, 2003). Given the climate of the island, Mallorca plays with an advantage to exploit these kind of tourism compared to outbound markets (Forcades & Martorell, 2003). In addition, the expansion of the market helps to reduce seasonality, being this a threatening factor for the tertiary sector (Barceló et al. 2010).

On the other hand, the effects of global warming will also induce a marked evolution of tourism. In the Mediterranean region it is estimated an increase of temperature between 2.5 and 3.5 ^{o}C per century (IPCC, 2007) and changes in other atmospheric variables, such as a reduction of rainfall, which has been observed to decline between 5 and 20% from 1901 to 2005 (IPCC, 2007). Also, there has been an increase of temperatures in high latitudes of Europe. This may facilitate that tourists from these areas do not travel that far, or even that domestic tourists prefer to move to new areas (Hamilton et al. 2005), increasing the decline in tourism demand in the Mediterranean (Kimberly, M. 2009; Amelung & Viner, 2006). Indirect global warming effects (water availability, energy prices, rising sea levels, increased fire, etc.) can affect negatively the tourism (Kimberly, M. 2009; Amengual et al. 2011b).

To understand how weather is linked to tourism there are several climatic indices for tourism. Among them, the newest is the second generation climate index for tourism (CIT). It combines the daily weather variables by merging aspects of thermal (T), aesthetic (A) and physical (P) facets. At the end it is obtained a daily index that determines the subjective perception of comfort and tourist satisfaction (de Freitas et al. 2008). CIT was developed specifically for beach tourism, but one of the innovations of this study is that variables were modified to fit other types of activities that are practiced in Mallorca (cultural tourism, cycling, golf, football, nautical sports with and without engine and hiking).

This article discusses how climate change will affect different kinds of tourism that currently exist in Mallorca and in what season these activities can be more profitable. This work is intended to be a guidance tool for public administrations involved in tourism management in the island, at present and at the end of the century.

The structure of the paper is as follows: In the second section it is described the characteristics of the study area with regards to its tourist products. The third section describes the methodology used in the study. Section four presents the annual and seasonal results found for each activity, as well as variations of the ideal and acceptable CIT together. The fifth section discusses the main results, and it is followed by the conclusions in the sixth section.

2. Characteristic of Mallorca with regard to its tourist products

In 2010, Spain was the second tourist destination in the world according to the benefits (US$ 52.5 thousand million), and the fourth most visited country by tourists (52.7 million) (UNWTO, 2011). Within Spain, the Balearic Islands was the fourth most visited autonomous region, with 7.5 million tourists, but specifically, the island of Mallorca was the tourist area with the second highest influx of tourist (5.5 million/year), preceded by the coast of Barcelona (6.6 million/year). Most tourists who visited Mallorca were German (2.4 million), followed by British (1.4 million) and Spanish (0.8 million). Total nights spent in hotels by year were 3.7 million, being the months of June to September the most popular with values of between 600000 and 900000 nights spent. The annual average stay was 6.52 days (INE, 2010).

During the last two centuries, Mallorca has experienced different periods of tourism, which has moved from the first intellectual tourists who came to the island in the 19th century, till the mass tourism it is today. It was from 1960 that as a result of climate, appropriate beaches and landscapes, the short distance that separates Mallorca with the main European cities, the growth of European

economies and the emergence of tour operators and charter travels, that it was generated a tourism boom, making this product to became the first economic activity of the island (Forcades & Martorell, 2003).

Mallorca is considered a mature destination after more than 50 years of intense tourist activity which was characterized by the commercialization of sun and beach product (Aguiló et al. 2006) and therefore subjected to a strong seasonality. Some studies indicate that this product is running low and losing importance in front of the emergence of new tourism products and a change in demand (Forcades & Martorell, 2003; Aguiló et al. 2006; Barceló et al. 2010). It seems that if Mallorca wants to continue with the tourism as its main economic activity it is necessary to promote new initiatives that complement the sun and beach tourism and are able to place it in an advantageous position compared to other destinations (Barceló et al. 2010). Thus, in recent years other activities have been gaining importance on the island, as it is the case of cycling, culture, golf, football, nautical sports and hiking.

The cycling consists of travelling by bicycle visiting the places along the path. The tourists come to the island especially attracted by the weather, landscape and nature. In Mallorca, specific cycling routes have been created such as “Ruta verde del olivo”, “Ruta Sencelles”, “Ruta Llucmajor”, “Ruta Algaida”, etc. The number of cycling tourists that visit the island has grown year after year. In 1995 it was estimated to be 35000, while in 2008 was 88500 (including accompanying persons). They are of any nationality, but the Germans are the majority, with medium purchasing power. Most tourists travel to the islands between February and May, and often repeat the destination. Given the high repeatability and seasonal distribution, it can be considered as a tourism highly important to reduce seasonality (Forcades & Martorell, 2003; Barceló et al. 2010).

Cultural tourism emphasizes the cultural aspects (literature, music, events, art, history, traditional heritage and modern architecture) offered by a tourist destination. Despite the variety of cultural activities, this article refers to the cultural tourism that occurs outdoors, because it must have a direct relation to climate. Mallorca has a rich cultural heritage, mainly concentrated in the city of Palma and in some towns that have maintained the architecture, traditions and customs, such as Valldemossa, Deià and Pollença (OET, 2008). There are not data available on the number of tourists who travel specifically for cultural reasons, because cultural tourism remains a minor product in the island. Generally, it is the alternative to cloudy days when the visitors cannot practice beach tourism. Tourists who specialize in this activity are usually couples with high educational level and medium-high purchasing power. This product contributes to the reduction of seasonality, because it can be practiced through the year (Marchena & Repiso, 1999; Barceló et al. 2010).

Tourists who come to play football are probably the most minority. It is a type of tourism that is still relatively unknown. It would be advisable to publicize it further to fight seasonality (Forcades & Martorell, 2003; Aguiló et al. 2006). Generally, football tourists consist of sport teams from northern Europe. They travel to the islands in the colder months in search of a warmer climate that enables them to practice outdoor sports, in this case football (Aguiló et al. 2006).

Golf tourist is the person who does a stay out of their habitual place of residence, whether for playing golf or for attending a golf show or competition. Mallorca has over 20 golf courses spread across the geography. The practice of golf has experienced a great increase in the last decade. In 1999 about 57000 golf tourists were estimated (Forcades & Martorell, 2003), while in 2008 there were 112752 tourists, increasing by 1.8% compared to the previous year (Barceló et al. 2010). They usually have medium-high purchasing power and it is one of the tourist types with higher daily expense. Spring and autumn are favorite times for the golfer, being winter the less demanded period (Barceló et al. 2010).

The nautical tourist is someone who is in contact with the sea and where practices sports, such as sailing, surfing and other water sports. In this study it was classified into two categories, nautical sports with engine or without it. We differentiated these two categories because the wind acts as a different limiting factor. In non-motorized nautical activities there is a minimum and maximum wind limit, while in the other only the maximum wind is limiting the activity. Mallorca has a large number of marinas, with nearly 20000 moorings for vessels (IBATUR, 2011). In addition, climate, adequate infrastructure and the quality of the coast make the island a

suitable setting to nautical tourism. In recent years the nautical tourism has trended upward. In 2007 it reached 315000 nautical tourists. They are usually tourists with high purchasing power, who travel in family. Competitions like the Copa del Rey de Vela or Trofeo de Vela S.A.R. Princesa Sofía, as well as the participation of members of the Spanish royal family, have promoted this type of tourism in the island. The nautical tourist prefers to visit the island in summer, thereby promoting seasonality. Only 4% of nautical tourists prefer to come in winter. (Forcades & Martorell, 2003; Barceló et al. 2010).

Hiking is the activity that practices a person who walks or makes routes within a natural environment. Mallorca has many hiking routes, most concentrated in the Sierra de Tramuntana, in the north of the island, being the most important the GR "La Pedra en Sec" with 150 kilometers, running through the Sierra de Tramuntana from Andratx to Pollença . There are no data on the number of tourists who visit the island motivated by hiking. The profile of this tourist is a young person, with medium studies level and medium purchasing power, that travels with a partner or group of friends. They do not have a clear preference about the season to practice the activity (OET, 2008; Barceló et al. 2010).

3. Methodoly

3.1. Weather variables

Observed atmospheric variables used in this study were obtained from an automatic weather station which belongs to Spanish Meteorological Agency (AEMET). This station is situated at Palma International airport (LEPA; 39.37^{o}N, 2.43^{o}E) and collects data since 1973. Throughout this period no significant changes have occurred around this station, because it is located far from the urban core, in the head of the first runaway, and the effects such as heat island warming or precipitation sheltering are negligible. For that reason, we have a homogeneous data series. To determine the climate potential for tourism, daily observed series since 1973 till 2008 of 2m maximum temperature, accumulated precipitation, 2 m mean relative humidity, mean cloud cover and 10m mean wind speed have been used (Amengual et al. 2011b).

To study the future climate potential for tourism, we used a date base of regional climate simulations available from the ENSEMBLES European project. This database contains daily climate data from 13 different regional climate models (RCMs) that were run from 1951 to 2100 under the A1B SRES emission scenario. This scenario is characterized by emphasis on globalization, material wealth, but an equitable balance between use of fossil and non-fossil energy (IPCC, 2000). The spatial resolution of this model data is 25 km over an area that covers Europe, the eastern Atlantic, northern Africa and western Asia. The option to use a multimodel strategy allows the analysis of uncertainties associated with RCM's and inaccuracies that arise when using different boundary conditions in which these models are nested. On the other hand, it has not been possible to study the inter-scenario variety since most on the RCMs were only run for A1B scenario (Amengual et al. 2011a, 2011b).

3.2. Physiological equivalent temperature and climate index for tourism

To explore the climate potential it was used the second generation climate index for tourism (CIT) in which one of the involved factors is the thermal sensation. Thermal sensation was calculated using the RayMan Model. The model simulates the flow of heat between the human body and the atmosphere from the energy balance. This model determines the mean radiant temperature (T_{mrt}), needed to calculate physiological equivalent temperature (PET). To obtain T_{mrt} the following meteorological variables are needed: maximum temperature, relative humidity, wind speed, short- and long-radiation and cloud cover. Also, RayMan requires three thermo-physiological parameters: human activity, body heat production and heat transfer resistance of clothing (Table 1). Standard personal parameters were considered and kept constant in all kind of tourisms: height=1.75 m; weight=75 Kg; age=35 years; sex=male. (Matzarakis et al. 2007; Amengual et al. 2011b). Finally, it was necessary to transform PET into standard ASHRAE scale (Figure 2.a), the appropriate parameter to formulate CIT.

Table 1. Thermo-physiological parameters (ASHRAE, 2004).

	Cycling	Cultural	Football	Golf	Nautical	Hiking
Clothing (Clo)	0,7	0,6	0,7	0,6	0,4	0,7
Activity (W)	250	115	365	205	205	205

(a)

Cycling	ASHRAE scale TSN [T]		Cloud (<45%) [A]	Cloud (≥45%) [A]	Rain (>10mm/d) [P]	Wind (≥8m/s) [P]
	Very hot	(+4)	3	2	3	2
	Hot	(+3)	4	3	3	2
	Warm	(+2)	6	5	4	2
	Slightly warm	(+1)	7	7	4	3
	Indifferent	(0)	7	6	4	2
	Slightly cool	(-1)	6	5	3	2
	Cool	(-2)	5	4	3	1
	Cold	(-3)	4	3	2	1
	Very cold	(-4)	3	2	1	1

Golf	ASHRAE scale TSN [T]		Cloud (<45%) [A]	Cloud (≥45%) [A]	Rain (>10mm/d) [P]	Wind (≥4m/s) [P]
	Very hot	(+4)	3	2	3	1
	Hot	(+3)	5	4	3	1
	Warm	(+2)	6	5	4	2
	Slightly warm	(+1)	7	6	4	2
	Indifferent	(0)	7	6	4	3
	Slightly cool	(-1)	6	5	3	2
	Cool	(-2)	5	4	3	2
	Cold	(-3)	4	3	2	1
	Very cold	(-4)	3	2	1	1

Cultural	ASHRAE scale TSN [T]		Cloud (<45%) [A]	Cloud (≥45%) [A]	Rain (>5mm/d) [P]	wind (≥10m/s) [P]
	Very hot	(+4)	3	3	2	2
	Hot	(+3)	4	3	3	3
	Warm	(+2)	6	5	4	4
	Slightly warm	(+1)	7	6	4	4
	Indifferent	(0)	7	6	4	4
	Slightly cool	(-1)	6	5	4	4
	Cool	(-2)	5	4	3	3
	Cold	(-3)	4	4	2	2
	Very cold	(-4)	3	2	1	1

Hiking	ASHRAE scale TSN [T]		Cloud (<45%) [A]	Cloud (≥45%) [A]	Rain (>5mm/d) [P]	wind (≥10m/s) [P]
	Very hot	(+4)	3	3	2	2
	Hot	(+3)	4	3	3	3
	Warm	(+2)	6	5	4	4
	Slightly warm	(+1)	7	6	4	4
	Indifferent	(0)	7	6	4	4
	Slightly cool	(-1)	6	5	4	4
	Cool	(-2)	5	4	3	3
	Cold	(-3)	4	4	2	2
	Very cold	(-4)	3	2	1	1

Football	ASHRAE scale TSN [T]		Cloud (<45%) [A]	Cloud (≥45%) [A]	Rain (>10mm/d) [P]	Wind (≥8m/s) [P]
	Very hot	(+4)	3	3	2	2
	Hot	(+3)	4	4	3	2
	Warm	(+2)	6	6	4	3
	Slightly warm	(+1)	7	7	5	4
	Indifferent	(0)	7	7	4	3
	Slightly cool	(-1)	6	6	3	2
	Cool	(-2)	5	5	2	1
	Cold	(-3)	4	4	1	1
	Very cold	(-4)	3	3	1	1

Nautical with engine	ASHRAE scale TSN [T]		Cloud (<45%) [A]	Cloud (≥45%) [A]	Rain (>20mm/d) [P]	Wind (≥15 m/s) [P]
	Very hot	(+4)	5	4	3	1
	Hot	(+3)	6	5	3	2
	Warm	(+2)	7	6	4	2
	Slightly warm	(+1)	7	6	4	3
	Indifferent	(0)	6	5	4	2
	Slightly cool	(-1)	5	4	2	2
	Cool	(-2)	4	3	2	1
	Cold	(-3)	3	2	1	1
	Very cold	(-4)	2	1	1	1

Nautical without engine	ASHRAE scale TSN [T]		Cloud (<45%) [A]	Cloud (≥45%) [A]	Rain (>20mm/d) [P]	Wind (<5 or ≥15m/s) [P]
	Very hot	(+4)	5	4	3	1
	Hot	(+3)	6	5	3	2
	Warm	(+2)	7	6	4	2
	Slightly warm	(+1)	7	6	4	3
	Indifferent	(0)	6	5	4	2
	Slightly cool	(-1)	5	4	2	2
	Cool	(-2)	4	3	2	1
	Cold	(-3)	3	2	1	1
	Very cold	(-4)	2	1	1	1

(b)

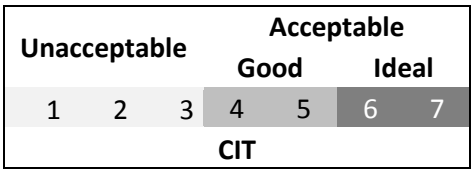


Figure 2. (a) Weather matrix rated with Climate Index for Tourism to each kind of tourism and (b) Climate Index for Tourism (CIT) rating scale.

Climate Index for Tourism (CIT) was designed specifically for beach or 3S (sea, sun, sand) tourism. CIT combines thermal (T), aesthetic (A) and physical (P) facets in a weather typology matrix which ranges from very poor conditions (CIT=1) to ideal or very good conditions (CIT=7). Also, the index recognizes the dominating effects of these facets when they exceed certain thresholds (de Freitas et al. 2008; Amengual et al. 2011b). For this study, new matrices were designed for the different kinds of tourism analyzed. To this end, activities were divided into two groups, depending on whether it was necessary tools or items to practice it. On one side there were cycling, golf and nautical sports. It was asked to experts in the field about ideal and limiting weather conditions. Furthermore, this information was

contrasted with monthly weather statistics of the most famous places to practice the activities, especially in the case of nautical sports, helping thus to confirm the data given by specialists. In the second group, there were cultural tourism, football and hiking. As they do not depend on tools, climatic variables were decided in a way more subjective, after a consensus among a group of people involved in tourism research (Figure 2.a). Finally, output data were grouped as unacceptable (CIT=1,2,3), good (CIT=4,5), ideal (CIT=6,7) and acceptable (CIT=4-7) (figure 2.b).

3.3. Calibration of time series

Before producing the final results, it is necessary to calibrate the CIT daily series by statistical corrections. This correction adjusts, percentile to percentile, the cumulative distribution functions of the CIT derived from successive 30-year simulations (2010-2039; 2040-2069; 2070-2099). Shortly, the simulated distribution of CIT for the control period (1979-2008) is compared against the observed distribution and percentile-wise corrections necessary to conciliate both distributions are determined. The same corrections are then transferred to the future cumulative distribution functions. With this method, it is possible to obtain new future daily series of CIT, calibrated with respect to the present while preserving the climate change print of the Regional Climate Models (see Amengual et al. 2011a for details). The last step to deduce the climate potential for tourism was the calculation of the relative frequencies for each model and each category of CIT (unacceptable, good, ideal, acceptable) and a subsequent derivation of the model ensemble mean and uncertainty (i.e. ensemble standard deviation).

4. Results

4.1. Changes in annual regimes of climate potential for tourism

After the daily CIT data has been adjusted statistically, we examine the changes on the annual mean relative frequencies of the unacceptable, good and ideal conditions for the control period (Present: 1979-2008) and for the three future multimodel time-slices (Early future: 2010-2039; Mid Future: 2040-2069 and Late Future: 2070-2099)

To simplify the paper, the two types of nautical tourism are unified, because the relative frequencies differ only in tenths of percentage. Moreover, results are complemented with histograms in the annex A.

Cycling

At present, we can see that ideal days dominate during the year (43%) followed by the good (37%) and unacceptable (20%). Throughout the 21st century it is shown that the ideal conditions are

Table 2. Relative frequencies (%) and standard deviation of the annual mean regimes for the unacceptable, good and ideal conditions of the climate resource for the present, early, mid and late future time-slices to each kind of tourism.

	Annual CIT	Present (1979-2008)	Early (2010-2039)	Mid (2040-2069)	Late (2070-2099)
Cycling	Unacceptable	20	21 ± 1.6	21 ± 2.7	22 ± 4.1
	Good	37	37 ± 1.8	36 ± 3.1	35 ± 4.6
	Ideal	43	42 ± 1.7	43 ± 2.5	43 ± 2.2
Cultural	Unacceptable	15	17 ± 1.5	20 ± 2.5	23 ± 3.1
	Good	40	38 ± 2.0	36 ± 3.3	33 ± 4.0
	Ideal	45	44 ± 1.5	45 ± 2.0	45 ± 1.6
Football	Unacceptable	13	15 ± 1.7	15 ± 3.0	17 ± 4.1
	Good	29	30 ± 2.0	29 ± 3.1	27 ± 4.5
	Ideal	57	56 ± 2.5	56 ± 3.1	56 ± 2.5
Golf	Unacceptable	30	30 ± 1.2	29 ± 2.0	30 ± 2.5
	Good	34	35 ± 1.1	34 ± 1.7	35 ± 3.1
	Ideal	36	36 ± 1.1	36 ± 2.3	35 ± 2.8
Nautical with engine	Unacceptable	16	14 ± 0.8	11 ± 1.3	9 ± 2.2
	Good	40	40 ± 1.5	39 ± 2.7	38 ± 4.3
	Ideal	44	46 ± 1.9	49 ± 3.1	53 ± 5.1
Nautical without engine	Unacceptable	16	14 ± 0.7	12 ± 1.3	9 ± 2.1
	Good	40	40 ± 1.4	39 ± 2.7	38 ± 3.8
	Ideal	44	46 ± 1.9	50 ± 3.3	53 ± 4.6
Hiking	Unacceptable	16	18 ± 1.5	19 ± 3.5	21 ± 5.5
	Good	42	42 ± 2.0	39 ± 4.1	37 ± 6.4
	Ideal	42	41 ± 1.4	42 ± 2.3	42 ± 2.1

maintained, however the good conditions fall by 2% (from 37% to 35%) and the unacceptable conditions grow by 2% (20% to 22%) (Table 2). The present and late future annual average of CIT is 4.99 and 4.98.

Cultural Tourism

Present shows that heaviest days are ideal (45%), followed by the good (40%) and unacceptable conditions (15%). As the century progresses the ideal conditions will remain, but the unacceptable will have increased by 8% compared to the present, as opposed to the good, which decrease by about 7%. Thus, the sum of days that favor the practice of cultural tourism is 85%, but this value decreases to 78% in the last 30 years of the century (Table 2). The average will remain almost constant, 5.07 for the present and 4.98 at the end of the century.

Football

Ideal conditions dominate throughout the study period, remaining nearly constant in percentage, at 57% for the present and 56% for the remaining periods. They are followed by good conditions, which show a slight fall (from 29 to 27%). Finally there are unacceptable conditions, which as the century progresses are increasing (13% at present, 17% in the late time-slice) (Table 2). The annual CIT average is always 5.3.

Golf

There is not great variability over the years. Good and ideal conditions are leadership nearly with the same values; at present, ideal conditions have 36% and the good 34%. At the end of the century, ideal conditions get down to 35% and good conditions increase to the same value (35%). In the case of unacceptable conditions the percentages lie between 29% and 30% (Table 2). The annual average for CIT is 4.5 in all periods.

Nautical tourism (nautical tourism with/without engine)

Throughout the study period, the ideal conditions dominate the situation, followed by good and unacceptable categories. In the case of ideal conditions there is an improvement as the years pass (44% at present, 53% in the late future). The good conditions have a slight decrease of 40% at present to 38% in the late future. Unacceptable conditions recede from 16% to 9% (Table 2). The average of CIT is slightly better in the future (5.35) than in the present (5.06).

Hiking

At present both the ideal and good conditions dominate with 42%, but the ideal conditions remain constant throughout the century, while the good category drops to 37% at the late future. Unacceptable conditions are increasing in value from 16% at present to 21% for the late future (Table 2). The CIT average for all periods is 4.9.

4.2. Changes in seasonal regimes of climate potential for tourism

It was considered that winter are the months of December, January and February; Spring are March, April and May; June, July and August are summer, and autumn is in September, October and November.

Like in the previous section, they were unified the two types of nautical tourism. Also, is possible to complete the results with histograms presented in Annex B.

Cycling

In winter, the unacceptable conditions will be increased by 13% in the early future. On the other hand, ideal conditions will fall by 16% compared to the present. Good conditions will have a slight increase (5%). However, while the century advanced, the ideal conditions will recover and the unacceptable go back to the present percentage (36 and 18% respectively). Good conditions dominate throughout the century, with approximately 47%. In spring, during the 21st century there is very little evolution. Good conditions suffer a slight decline of 3%, which days will be divided equally, increasing the unacceptable conditions and ideals. In summer, good conditions will remain constant throughout the century. The sharpest change is perceived in the first period where the unacceptable conditions drop by 11% respect to the present in favour of ideal conditions. But as the century progresses, unacceptable conditions will increase 8% every 30 years, subtracting it to the ideal conditions. Thus, at the end of the century be observed an increase of 5% of unacceptable days compared with the present and a 3% drop in ideal conditions. During the fall season, over the next century will see a slight increase in unacceptable and ideal conditions at the expense of good conditions which fell by 6%. However, it seems that the trend at the end of the century is to continue to increase the unacceptable in front of ideal and good conditions. (Table 3)

Cultural

In winter, the good and ideals conditions dominate along all the century. Unacceptable conditions never exceed 13%. In the first three decades of the century, good and unacceptable conditions increase by 7% but at the end of the century will decrease to values close to the present. The same applies to ideal conditions, but in reverse. In the first time-slice fall till 14% but throughout the century will recover to equal the value of the present (42%). In spring, ideal conditions dominate by far over the century, with approximately 70%. Followed by good conditions, that as the century progresses has a slight decrease (from 28 to 24%). Unacceptable conditions remain constants with approximately 4%. In summer, good and

Table 3. Relative frequencies (%) and standard deviation of winter, spring, summer and autumn mean regimes for the unacceptable, good and ideal conditions of the climate resource for the present, early, mid and late future time-slices to each kind of tourism.

	CIT		Present	Early	Mid	Late		Present	Early	Mid	Late
Cycling	Unacceptable	Winter	19	32 ± 8.2	24 ± 8.4	18 ± 8.1	Spring	6	9 ± 4.7	8 ± 4.0	7 ± 3.5
	Good		43	48 ± 5.0	48 ± 6.3	46 ± 8.4		27	26 ± 5.8	24 ± 5.6	24 ± 3.4
	Ideal		37	21 ± 8.5	28 ± 11.6	36 ± 14.3		67	65 ± 8.7	68 ± 8.2	69 ± 5.9
Cultural	Unacceptable		6	13 ± 6.9	10 ± 6.4	8 ± 5.7		2	5 ± 2.5	5 ± 2.1	5 ± 2.2
	Good		52	59 ± 3.8	55 ± 6.2	50 ± 7.9		28	28 ± 5.1	26 ± 4.8	24 ± 3.7
	Ideal		42	28 ± 8.9	35 ± 11.4	42 ± 12.7		70	68 ± 7.2	70 ± 6.5	71 ± 5.2
Football	Unacceptable		12	21 ± 6.2	16 ± 6.4	13 ± 6.4		4	6 ± 3.8	5 ± 3.4	5 ± 3.0
	Good		32	39 ± 8.5	34 ± 10.5	28 ± 11.7		13	14 ± 4.5	14 ± 4.1	14 ± 3.1
	Ideal		55	40 ± 13.4	50 ± 14.8	60 ± 15.7		83	79 ± 6.6	80 ± 6.0	81 ± 4.9
Golf	Unacceptable		28	47 ± 9.8	41 ± 8.1	37 ± 7.5		24	26 ± 3.2	25 ± 3.8	24 ± 4.4
	Good		37	33 ± 9.9	33 ± 8.2	33 ± 8.4		19	27 ± 8.8	25 ± 8.6	26 ± 8.9
	Ideal		34	20 ± 8.5	26 ± 9.4	30 ± 10.7		58	48 ± 8.1	50 ± 7.4	50 ± 7.8
Nautical with engine	Unacceptable		42	40 ± 2.5	34 ± 3.5	29 ± 6.4		12	9 ± 2.0	7 ± 1.8	6 ± 1.8
	Good		44	55 ± 2.2	57 ± 1.5	58 ± 2.0		36	43 ± 6.2	37 ± 5.7	31 ± 4.9
	Ideal		14	5 ± 2.1	9 ± 3.6	13 ± 6.0		52	47 ± 7.0	56 ± 7.1	63 ± 6.4
Nautical without engine	Unacceptable		42	41 ± 2.2	34 ± 3.5	29 ± 6.2		12	9 ± 1.9	8 ± 1.9	5 ± 1.8
	Good		44	54 ± 2.0	57 ± 1.6	58 ± 2.3		36	43 ± 6.3	36 ± 5.6	31 ± 5.0
	Ideal		14	5 ± 2.2	9 ± 3.6	14 ± 6.2		52	47 ± 7.2	56 ± 7.1	64 ± 6.5
Hiking	Unacceptable		9	18 ± 8.1	13 ± 6.8	10 ± 5.0		3	6 ± 2.6	5 ± 1.8	5 ± 1.3
	Good		55	62 ± 5.2	58 ± 7.2	55 ± 9.5		31	31 ± 6.2	28 ± 6.2	27 ± 5.2
	Ideal		37	20 ± 8.2	28 ± 11.5	35 ± 13.7		66	64 ± 8.3	67 ± 7.7	68 ± 6.0
Cycling	Unacceptable	Summer	43	32 ± 13.7	40 ± 17.2	48 ± 21.2	Autumn	13	12 ± 2.0	13 ± 3.1	15 ± 4.7
	Good		42	42 ± 9.6	41 ± 11.6	40 ± 16.6		37	32 ± 2.2	31 ± 2.3	31 ± 1.7
	Ideal		15	26 ± 13.8	19 ± 13.1	12 ± 10.8		51	56 ± 2.3	56 ± 2.5	55 ± 4.0
Cultural	Unacceptable		42	42 ± 12.2	52 ± 13.9	61 ± 14.0		9	10 ± 1.9	13 ± 3.7	16 ± 5.5
	Good		42	33 ± 6.1	30 ± 6.7	27 ± 8.4		40	34 ± 1.4	32 ± 2.0	30 ± 2.7
	Ideal		15	25 ± 13.4	18 ± 12.9	12 ± 10.3		51	56 ± 2.6	55 ± 2.9	54 ± 4.5
Football	Unacceptable		31	24 ± 11.3	32 ± 15.9	41 ± 20.3		6	7 ± 2.1	8 ± 2.6	10 ± 3.8
	Good		47	45 ± 9.2	45 ± 11.3	43 ± 15.2		26	22 ± 2.6	23 ± 2.3	24 ± 3.0
	Ideal		22	32 ± 15.8	23 ± 15.4	16 ± 12.9		68	71 ± 3.2	69 ± 4.2	66 ± 5.8
Golf	Unacceptable		46	25 ± 6.9	30 ± 8.9	36 ± 12.1		22	21 ± 3.2	21 ± 3.4	21 ± 3.5
	Good		44	46 ± 7.9	47 ± 9.7	48 ± 13.3		35	33 ± 5.0	33 ± 4.2	34 ± 3.9
	Ideal		10	29 ± 11.0	23 ± 12.4	16 ± 12.1		43	45 ± 4.6	46 ± 5.1	45 ± 5.8
Nautical with engine	Unacceptable		0	0 ± 0.1	0 ± 0.0	0 ± 0.0		9	7 ± 1.2	5 ± 1.4	3 ± 1.2
	Good		48	27 ± 10.6	31 ± 12.6	34 ± 14.9		32	37 ± 4.0	32 ± 3.7	30 ± 4.7
	Ideal		52	73 ± 10.7	69 ± 12.6	66 ± 15.0		60	56 ± 4.9	63 ± 4.7	67 ± 5.5
Nautical without engine	Unacceptable		0	0 ± 0.0	0 ± 0.0	0 ± 0.0		9	7 ± 1.2	5 ± 1.4	3 ± 1.2
	Good		48	27 ± 10.6	30 ± 12.7	34 ± 14.8		32	37 ± 3.9	32 ± 3.5	30 ± 4.2
	Ideal		52	73 ± 10.6	70 ± 12.7	66 ± 14.9		60	56 ± 4.8	63 ± 4.7	67 ± 4.9
Hiking	Unacceptable		42	37 ± 13.8	46 ± 17.6	55 ± 21.5		10	10 ± 1.8	12 ± 3.8	15 ± 6.2
	Good		43	37 ± 8.8	36 ± 11.1	33 ± 15.5		41	37 ± 2.0	34 ± 2.7	32 ± 3.7
	Ideal		15	26 ± 13.7	18 ± 13.3	12 ± 10.7		49	53 ± 2.2	54 ± 2.9	53 ± 4.2

unacceptable conditions dominate with 42% of days, compared to the ideal conditions (15%). As the century advanced, unacceptable conditions increased to 61%, as opposed to the ideal conditions that decrease to 27%. In the case of ideal conditions, in the early future, they improve 10%, but as the century progresses are decreasing to values lower than the present (12%). In autumn, are ideal conditions that dominate, having a slight improvement of 3% between the present and the late future. Good conditions are always over to unacceptable conditions, but as the century progresses they recede (from 40 to 30%). Finally, unacceptable conditions get benefit from climate change and move from 9% at the present to 16% at the end of the century. (Table 3)

Football

In winter are the ideal conditions that dominate in all periods. However, during the early future they fall 15% and are close to equal with the good conditions, which have increased 7% compared to the present. The same happens with unacceptable conditions which increase by 9% in the early future. As the century advanced, the situation recovers to the present values. Ideal conditions are recovered from 20 to 60%. On the other hand, the good conditions down to 28% as well as unacceptable conditions that fall till 13%. In spring, almost all conditions remain steady in all periods. The ideal conditions dominate with 82%, followed by good condition (14%) and unacceptable conditions (5%). The values are approximately. In summer, good conditions remain approximately constant at 45%. However, ideal and unacceptable conditions change along the years. Unacceptable conditions, in the early future, fall from 31% at present to 24%; the opposite happens with ideal conditions that rise from 22 to 32%, being the second more important, behind good conditions. However, as the century progresses, this situation turns and at the end of the century unacceptable conditions almost will equal to good conditions (41%) and leaving behind ideal conditions that will fall their percentage till 16%. In autumn the variability is lower. Ideal conditions dominate the situation (about 68%), followed by good and unacceptable conditions. In the case of unacceptable conditions, along the years, are being slightly increasing their percentage, from 6% at present to 10% in the late future. Good conditions have their values ranging from 22 to 26%. (Table 3)

Golf

In winter, unacceptable conditions at present are the less representative (28%), however, for the early future they increase to 47%, being the most representative. As the century progresses are reduced to 37% but remain being the most common. At present, 37% of days are good conditions, but this percentage drops to 33% for the following three periods. Ideal conditions at present have 34% but fall to 20% in the early future. As the century progresses ideal days are recovering, but in the late future this percentage is 30%, being behind to the good and unacceptable conditions. In spring, despite ideal conditions lead throughout the study period shows that there is a drop in days from 58% at present to 50% at the late future. The opposite happens for good and unacceptable conditions. Approximately both always have the same values and both have a slight growth in the future (around 25%). In summer, unacceptable conditions dominate with 46% at present, followed by good (44%) and ideal conditions (10%). As the century progresses, good conditions are the most representative with an increase of 1% every 30 years. However, in the early future, ideal conditions are more abundant than the unacceptable conditions, with 29% and 25% respectively. Throughout the years go ideal conditions recede till 16% and unacceptable conditions increase to 36%, being above ideal conditions. In autumn, nearly all conditions remain constant, being the ideal conditions that dominate with between 43% and 35%, followed by good (between 35 and 33%) and finally the unacceptable conditions (between 21 to 22%). (Table 3)

Nautical tourism (nautical tourism with/without engine)

In winter good conditions dominate in all time-slices, followed by the unacceptable conditions. It can be seen that good conditions improve with climate change and move from 44% at present to 58% for the late future. Unacceptable conditions will be decreased from 42% to 29%. Finally, ideal conditions have a sharp drop in the early future, from 14 to 5% but at the end of the century will be recovered to a value of 13%. In springtime ideal conditions dominate. At present they represent by 52%, but in the early future fall to 47%. However, during the following periods they recover to a value of 63%. The second more representative are good

conditions, but it happen the opposite process to ideal conditions; in the early future they raise from 36% to 43%, but from this time fall the percentage to reach 31% at the end of the century. Unacceptable conditions steadily declining from 12% at present to 6% in the late future. In summer, unacceptable conditions are almost 0%. Ideal conditions are the leading. At present is 52% but worth up to 73% in the early future. This value will fall to 66% in the late future. Good conditions in the present represent 48%, while in the early future down to 27%. At the end of the century the percentage will rise to 34%. In autumn the ideal conditions remain dominant, followed by good and unacceptable conditions. Ideal conditions represent the 60% at present; in the early future they fall to 56% but in the following periods they recovered to 67%. In the case of good conditions, at present represent 32%; in the early future will increase this value up to 37% but at the end of the century tends to be decreased to 30%. Unacceptable conditions will decrease from 9% at present to 3% in the late future. (Table3)

Hiking

In winter are the ideal conditions the most representative with 55% in the present; this value increases to 62% in the early future, but recovered to 55% at the end of the century. Follow by ideal conditions with 37% in the present. In the early future they fall to 20% but over the years comes back up to a rate of 35% in the late future. In the case of unacceptable conditions in the present represent 9% of the days; while in the early future double this value (18%). At the end of the century unacceptable days fall again to 10%. Spring is fairly constant in all periods. Ideal conditions dominate this season with a value of 66% in the present and a slight increase of 2% at the end of the century. The good conditions have 31% in the present but reduced to 27% in the late future. Finally, unacceptable conditions move their values between 3 and 6%. In summer unacceptable and good conditions dominate the situation with 42 and 43% respectively. However, it will be unacceptable conditions which at the end of the century lead with 55% compared to the good condition that will be decreased to 33%. In the case of ideal conditions at present represent a 15%. With climate change, ideal condition will be beneficiated and increased to 26%. As the year pass, this value will subside in favor of unacceptable conditions and will remain at 12%. Autumn is dominated by the ideal days. During the present, 50% of days are considered ideal, whose value increases along the years up to 53-54%. Good conditions are the second most abundant with 41%

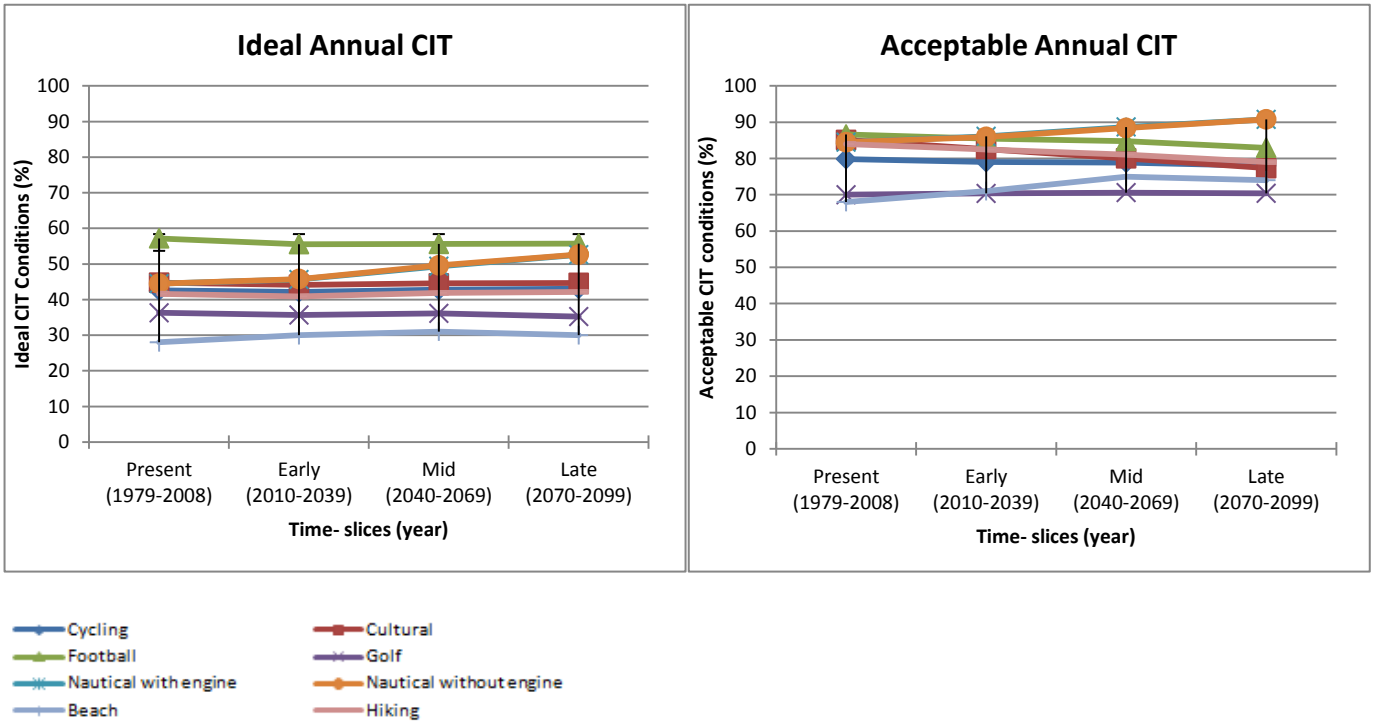


Figure 3. Relative frequencies (%) of ideal annual CIT and acceptable annual CIT for the present, early, mid and late future time-slices.

in the present. This value will fall over the years to 32% at the end of the century. Finally, unacceptable conditions increase from 10% at present to 15% in the late future. (Table 3)

4.3. Comparative of potential climate for tourism between kinds of tourism

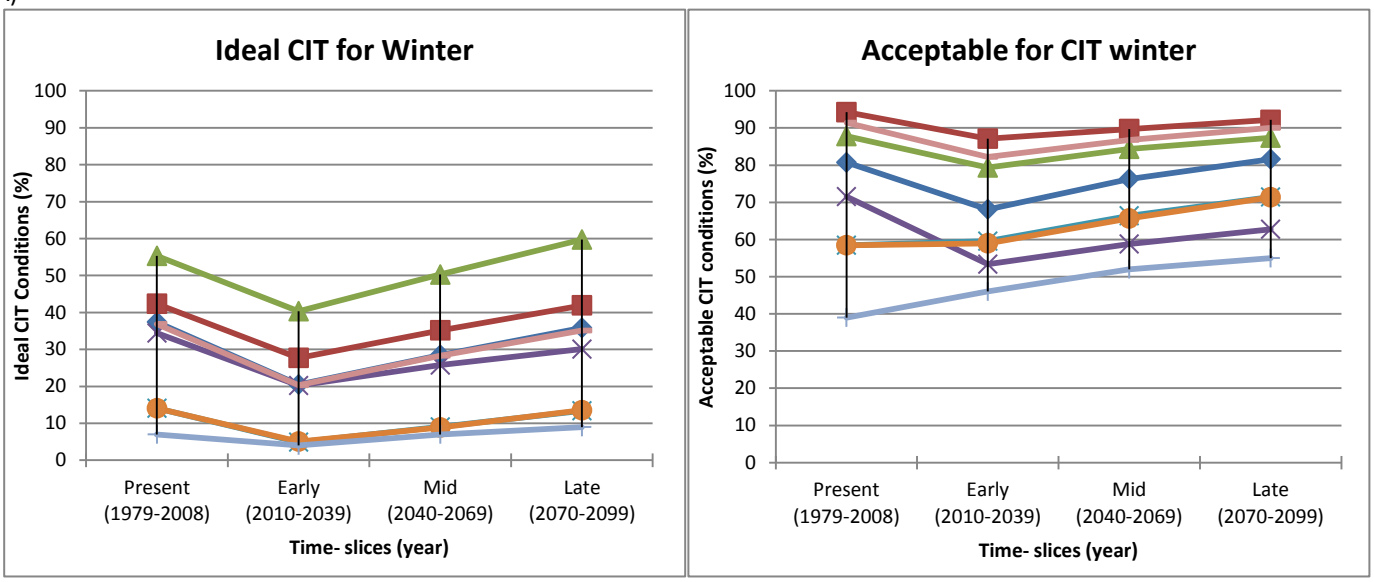
It has been added beach tourism whose data were extracted from the paper "Projections of the climate potential for tourism at local scales: Application to Platja de Palma, Spain" Amengual et al. 2011. Relative frequencies of acceptable CIT to each activity can be found in the annex C.

4.3.a. Annual comparatives

Ideal conditions

The activity with more ideal days is football. In all the time-slices is in front of other kind of tourism. At present it is far away from the rest, but at the end of the century it will approach to nautical tourism, which, with climate change improves their ideal days. It is followed by the cultural, cycling and hiking. Golf and beach are the activities which fewer ideal days have. (Figure 3)

(A)



(B)

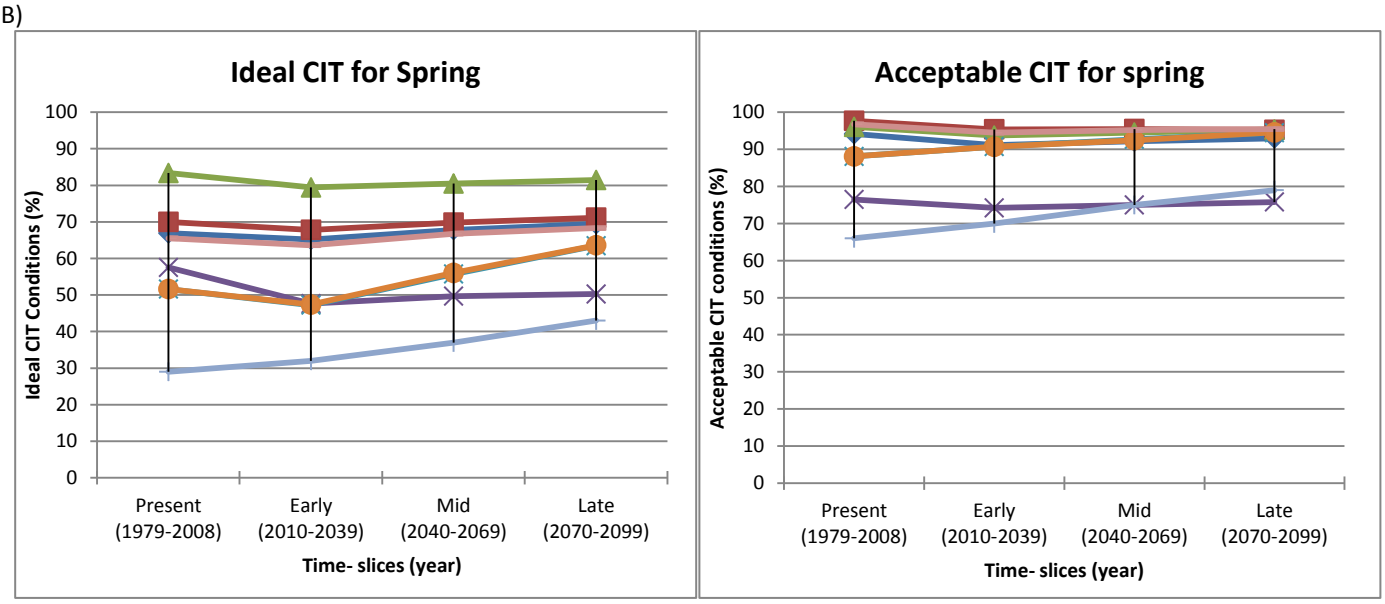


Figure 4. Relative frequencies (%) of (A) ideal and acceptable CIT for winter and (B) ideal and acceptable CIT for spring at present, early, mid and late future time-slices.

Acceptable conditions

Given good and ideals conditions, it is noted that at present the kinds of tourism that stand out are the cultural, football, hiking and nautical. However, the situation changes at the end of the century. All activities are drop in the number of days acceptable, except for nautical sports which increase markedly the percentage. It is important to note beach tourism, which despite being the activity with less ideal days, throughout the years, climate conditions are better for it, being in penultimate position at the end of the century. In the mid future it is where more efficient it can be obtained. (Figure 3)

4.3.b. Winter comparatives

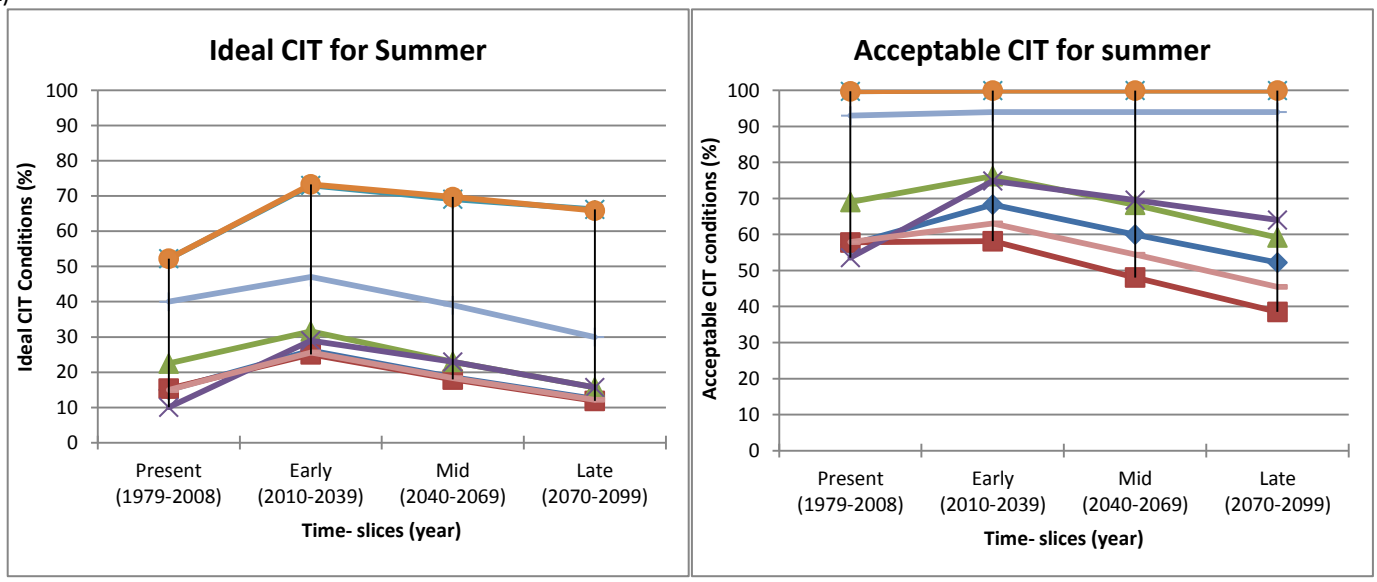
Ideal conditions

Football is the activity that best adapts to the winter, followed by far below the cultural tourism, cycling, hiking and golf. Nautical and beach tourism are less appropriate at this time of year. This pattern is the same for all periods. In the early future all tend to drop their percentage of ideal days, but in the rest of the century they are recovering. (Figure 4.A)

Acceptable conditions

Cultural tourism is more profitable to practice at

(A)



(B)

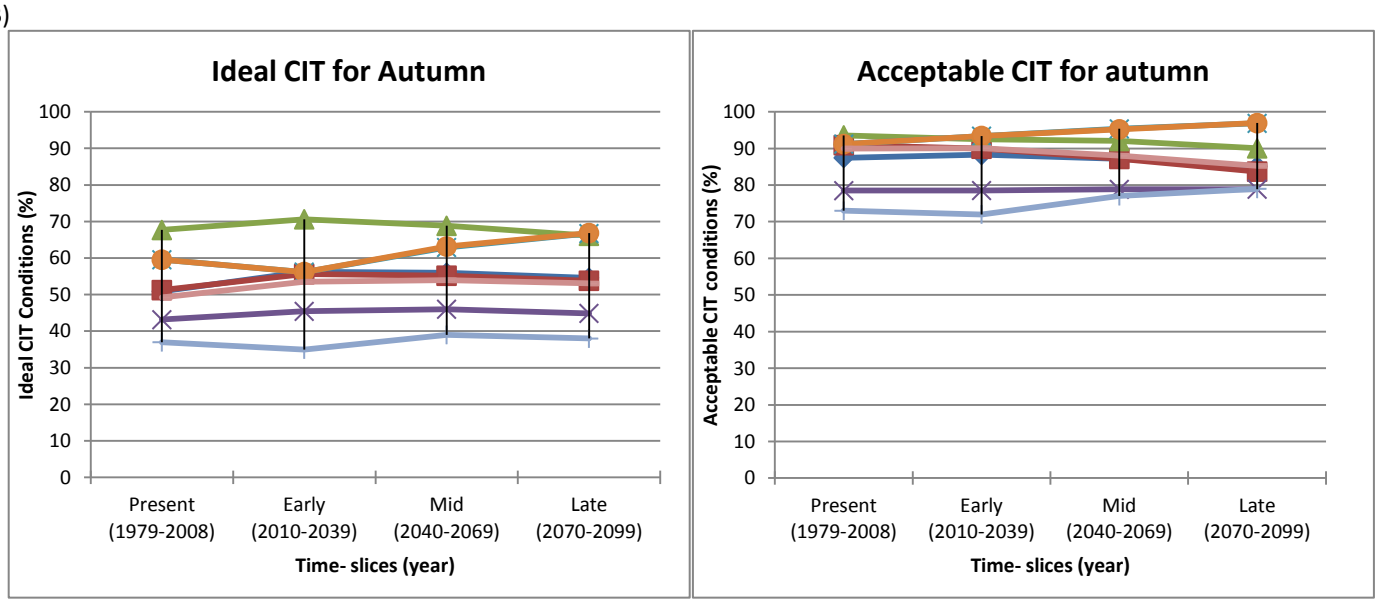


Figure 5. Relative frequencies (%) of (A) ideal and acceptable CIT for summer and (B) ideal and acceptable CIT for autumn at present, early, mid and late future time-slices.

this time. It is followed closely by hiking and football. Nautical tourism improves throughout the century which is positioned above the golf in the late future. The activity with less acceptable days is beach, but has an improvement along the century. (Figure 4.A)

4.3.c. Spring comparatives

Ideal conditions

The most favorable practice is football, followed by cultural tourism, cycling and hiking. At present, golf has more ideal days than nautical tourism. However, in the early future they are equaled but in the late future nautical tourism has more ideal days than golf. The beach tourism is still in last place, but improving his percentage with climate change. (Figure 4.B)

Acceptable conditions

At present, cultural tourism, hiking, football and cycling are the activities with more acceptable days. As the century progresses, nautical sports are joined with the other activities, even beating the cycling at the end of the century. Beach tourism is in the last position but substantially improves at the end of the century compared with the present. (Figure 4.B)

4.3.d. Summer comparatives

Ideal conditions

The most important activity in this season is the nautical tourism, especially as the century advanced. It is followed beach tourism, but it has a tendency to lose ideal days. On the other hand, football, cultural tourism, hiking and golf are the less ideal for this season. (Figure 5.A)

Acceptable conditions

Nautical tourism and beach have the best relative frequencies. Golf has a great improvement with climate change. At present, golf is in last place, but at the end of the century will be the third activity most important. All other activities will lose percentage over the century, being cultural tourism, hiking and cycling which less acceptable days have. (Figure 5.A)

4.3.e. Autumn comparatives

Ideal conditions

Football is the activity with more ideal days, followed by the nautical tourism. At the end of the century, ideal days decrease to football and they improve to nautical sports, having virtually the same value. The activity with less ideal days is the beach tourism. (Figure 5.B)

Acceptable conditions

At the present, football is the activity with a higher percentage, followed by nautical tourism, cultural, hiking and cycling. However, at the end of the century is the nautical tourism which has a higher percentage of days acceptable, moving away from football. As the century advance, football, hiking, cycling and cultural tourism have a slight drop in acceptable days. However, the percentage remains high. Beach tourism has a big improvement, equaling golf at the end of the century. (Figure 5.B)

5. Discussion

The study was done under the conditions of the A1B scenario, which emphasizes globalization and material wealth, but in an equitable balance between use of fossil and non-fossil energy (IPCC, 2000). It is a mid state between scenarios that point to further climate change (A1FI, A2) and a lower global warming (A1T, B1, B2). Therefore, there is some uncertainty on how each type of activity could evolve in another scenario.

To explore the different kinds of tourism on the island and their climate potential, it is important to know how they will evolve and which are more propitious and profitable according to the season. Obviously, the ideal conditions are interesting to be inter-compared, but the most important are the values of acceptable CIT (the sum of ideal and good CIT) because these results are those that have a practical use for decision-making. In the case of basing decisions on activities with the same relative frequencies of acceptable CIT, a discriminant index would be the amount of ideal CIT.

Once analyzed the data, it has not been observed large changes at annual level. However, depending on the season, it has been observed more variability between activities and between different time-slices.

Considering only the ideal relative frequencies, there is a strong seasonality, being the months of winter and summer the periods with fewer optimum days for the activities: relative frequencies are generally below 50%. On the other hand, considering the acceptable relative frequencies, seasonality is less marked. In effect, when

combining good and ideal CIT, conditions for the practice of the activities become highly frequent and less fluctuating throughout the year. Even so, the seasons of spring and autumn offer the most propitious conditions for a wide range of tourism possibilities, because their percentages are never lower than 70% in all time-slices (with the exception of beach tourism that in the present springs is 66%)

Comparing the activities annually, it is concluded that seasons behavior balances each other, since in all time-slices (present and the three futures) all activities range from slightly below 70% to 90%. At present, football is the activity with most ideal days (55%). Also, as a second option it is recommended promoting cultural tourism, nautical activities, hiking and cycling. However, at the end of the century nautical tourism is the one with more acceptable days as a result of having increased by more than 10% the ideal days. Therefore, for the late future, the best activity throughout the year is the nautical tourism, with a relative frequency of 90%.

It is not recommended to look only at the annual data because there is camouflaged information that can induce to errors of interpretation. It is preferable to study each activity according to the seasons.

In winter, the best activities to practice are cultural tourism, football and hiking, with over 80% in all periods studied. However, football is the activity that has more ideal days throughout the season, followed by cultural tourism. This happens at present and at late future. It is remarkable how beach tourism is benefited by climate change, which from mid-century, more than 50% of winter days are acceptable CIT (but in any time-slices it does not reach 10% of ideal days). In contrast, the practice of golf declines with climate change. Considering that 76.2% of tourists are attracted by the climate, 51.2% by the beaches and 36.4% by the prices (Amelung & Viner, 2006), the increase in the number of beach days may be favorable at the end of the century to attract tourists to this season. Basically, beach tourism is what motivates tourists to visit the island, being the other activities complementary. (Forcades & Martorell, 2003). At the same time, it could benefit the de-seasonalization of tourism.

In spring any activity can be practiced. All activities are above 87%, with the exception of golf and beach for which the relative frequency of acceptable CIT moves between 66% and 79%. To define the best activity we looked at the CIT with ideal characteristics. Thus, football is the activity with most ideal days, followed by cultural tourism, cycling and hiking. This happens in the four studied periods. It is important to note how the nautical sports improve in the distant future by 11% of ideal days compared to present. As winter, beach tourism improves considerably at the end of this century (from 29 to 43%).

Summer is the most important station for the island. Actually, in this season there is the highest number of tourists. In one hand they come motivated by the good weather (Barceló et al. 2010) but on the other hand this summer peak is the result of the institutionalization of holidays, especially for families with children whose parents match their holidays with school holidays (Amelung & Viner 2006). Nautical tourism and beach are the activities with better relative frequencies. In addition, acceptable CIT remains constant in the four study periods, with 100% in nautical tourism and 94% for beach tourism. However, the activity with has more ideal days is nautical tourism by 55% at present and 66% at late future. Despite it improves their ideal days by 20% in the early future compared to the present, as the century progresses the percentage decreases slightly. Even so, at the end of the century, their relative frequency is 14% above the current one. On the other hand, climate change brings down considerably the ideal days on the beach from the early-mid future. As a common pattern it can be seen that all activities have improved in the early future, but from this period they have a tendency to decline their ideal and acceptable CIT. At the end of the century golf and nautical sports improve the percentage of ideal CIT compared to the present, but golf is the only one that improves its acceptable CIT (nautical and beach tourism are kept constant). Golf changes from being the activity with fewest acceptable days at present, to be the third with the best percentage in the late future. The activity that adapts worse to climate change is cultural tourism, which falls by 19% of acceptable days at the end of the century compared to the present. As some studies suggest, summer in the Mediterranean will be more extreme (Moreno & Amelung, 2009; Perch-Nielsen et al. 2010; Amelung & Viner, 2006) and it is reflected in most activities studied in this article. However, as it is said in the report of Moreno & Amelung (2009) it seems that beach tourism will not be affected as much as

previously thought. It is also necessary to mention that the arrival of fewer tourists to practice an activity not only depends on the climatic conditions of the place, it also depends on climatic conditions in the countries where these tourists originate (weather improvement in the Nordic countries can influence in reducing the current demand in the Mediterranean high season) (Kimberly, M. 2009, Moreno & Amelung, 2009; Amelung & Viner, 2006). It is also dependant on tastes and fashion trends (for example, lie in the sun was considered sign of beauty and health, but now is considered a dangerous practice to the health) (Amelung & Viner, 2006), aviation (the arrival of tourists to the island is basically by plane and an increase of flight price as a result of fuel price increases, could result in a decrease in the number of visitors), political stability, technological advances, among other factors (Amelung & Viner, 2006).

Autumn is very similar to the spring. Given the high rate of acceptable days (between 72% and 97%), any of the activities can be practiced. At present, the activities with highest percentage include football, nautical tourism, cultural, cycling and hiking with values between 87% and 94%. However, football will be the activity with highest number of ideal days (68%), followed by the nautical tourism (60%). At the end of the century, the situation changes and activities tend to move away from each other slightly, being the nautical tourism the activity with a higher percentage of ideal (67%) and acceptable days (97%). During the autumn, climate change will improve significantly nautical and beach tourism. Cultural tourism, football, hiking and cycling will have a slight decrease of ideal and acceptable days.

Some specialists think that the product of sun and beach is losing strength in mature destinations as a result of the emergence of new tourism products and to a change in demand (Aguiló et al. 2006). So, it is essential to bet on a new type of tourism, developed and diversified, which added value to the island (Barceló et al. 2010). In addition, given that tourism sport (cycling, golf, football, nautical, hiking) and cultural tourism are having a boom and a greater importance when choosing a tourist destination (Marchena & Repiso, 1999; Forcades & Martorell 2003; Aguiló et al. 2006; Barceló et al. 2010), Mallorca could be an ideal tourist destination. We found that throughout the year there are always activities with relative frequencies high enough to enable their practice and be complementary to beach tourism. This also increases the possibility of de-seasonalizing the tourist sector of the island, which is one of the main factors threatening the tertiary sector (Forcades & Martorell, 2003; Barceló et al. 2010, Amengual et al. 2011b). Also, from mid-century, it appears that the worst period for alternative activities is the summer season. Therefore, if exploitation of the other types of tourism is effectively achieved, climate change will favor the reduction of the seasonality of tourism industry, increasing the chances of other seasons besides the summer to attract tourists.

6. Conclusions

Mallorca is a mature tourist destination, which has begun to see signs of strength loss as a result of emergence of new tourist destinations and the change of demand by the tourist, who has become more exigent when choosing a destination. In addition, Mallorca has an added problem, the high seasonality of tourism which strongly conditions the region's economy. The island has been characterized by a market of sun and beach in the last decades, but now it is starting to sell other kinds of complementary tourism in order to remain one of the major tourist destinations. In addition, the expansion to a market with new products makes it possible that the island will capture the attention of new tourists throughout the year, enabling its de-seasonalization.

To manage tourism and tourism products, it is needed an assessment of the climate potential for tourism in the present, and a study of a possible future evolution of climate potential over a period in which climate change is a reality. To do this, it has been used the Climate Index for Tourism (CIT), which gives us an index of daily perception that the tourist has of this activity.

Projections indicate that annually there is not a large variation in percentages. Beach and nautical tourism are the activities that have an improvement owing to climate change, while other activities remain constant. Summer and winter seasons are the most significant in terms of changes. In summer, although in the early future all the activities improve, at the end of the century all of them have a tendency to get worse and reduce the ideal and acceptable days. It is important to emphasize the case of golf and nautical tourism: although the trend

throughout the century is also negative, in the last time-slice they have a percentage of acceptable and ideal CIT higher than at present. Cultural tourism is the activity that decreases the most compared to the present. At winter it happens the opposite than in summer. In the first time-slice, tourism activities get worse respect to the present, but in next time-slices they follow a tendency to improve, especially in the case of the of sun and beach product. In spring and autumn there are no sudden changes. In spring, beach and nautical tourism improve significantly, while the rest remain almost constant. In autumn, beach and nautical tourism improve, cultural tourism has a slight drop in acceptable days and all other activities remain approximately like the present.

In recommending the best activity, projections indicate that the activity that has more acceptable and ideals days throughout the year is football at present, and nautical tourism in the late future. In winter, cultural tourism, hiking, football and cycling are the activities with higher acceptable CIT. Spring follows the trend of winter, but with higher percentages of CIT, moreover nautical sports are added as one of the best activities. In summer, nautical and beach tourism are basically the best options. In autumn, the best activities are football, cultural tourism, nautical tourism, hiking and cycling in the present; in the late future the most important activity will be nautical tourism, but followed closely by the other activities. Despite this, in spring and autumn any activity is ideal to advertise given the very high rates of acceptable CIT.

The increase of acceptable and ideal days of beach in winter, spring and autumn with climate change, is a positive aspect to reach the de-seasonalization of tourism in the island. It is essential to promote new tourist products which for most tourists are complementary to the beach. Therefore, the product of sun and beach may be used as an attractive force to tourists in other seasons apart from summer, at the same time that it completes the offer with the most appropriate activities for each season. Other factors play against the wanted de-seasonalization, as it is the case of institutional vacation that tends to coincide with the summer. On the other hand, there is a risk that the summers will be too hot to attract tourists to the islands at future, and thus we face the possibility that they will prefer new destinations where temperatures will be milder.

Numerous studies exist in the literature about the relationship between beach and climate, but not with other activities. The importance of this study lies in the fact it is the first time it has been examined the relationship between potential climate and activities like cycling, football, golf, nautical sports and hiking. In addition, the use of CIT indicator for activities other than the beach tourism is a genuine innovation of this project. The generalization of the matrix for the calculation of CIT is a contribution and an added value to the original version created by de Freitas et al. 2008. Despite this, one weakness of the study is that the matrices have been adjusted only theoretically but not empirically. Future projects are needed to increase the accuracy of CIT definition in the new matrix for each tourism, in which a field work with surveys to the users and subsequent contrast of answers with observed weather data are needed.

There are still many unknowns about how tourism in Mallorca can evolve in the future. Only with the climate potential factor it can not be explained an increase or decrease of tourism demand. Transportation, fuel prices, water resources, fashions, trends and a long list of factors are involved with tourism. Further studies in other fields of research are needed to understand these processes of transition.

Acknowledgement

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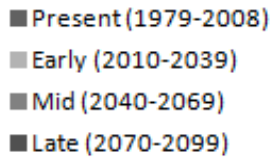
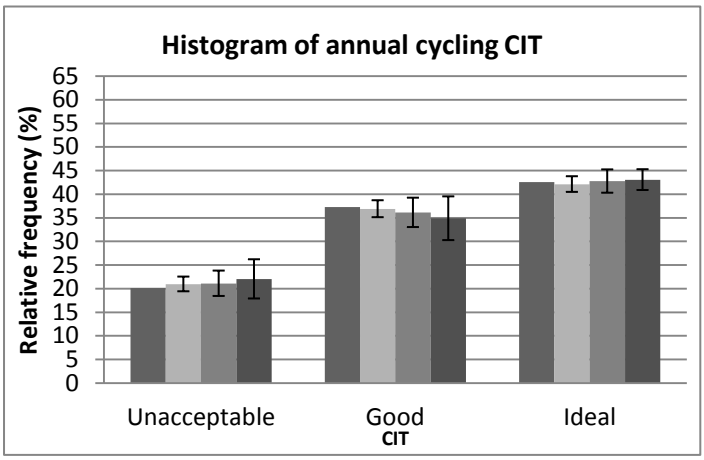
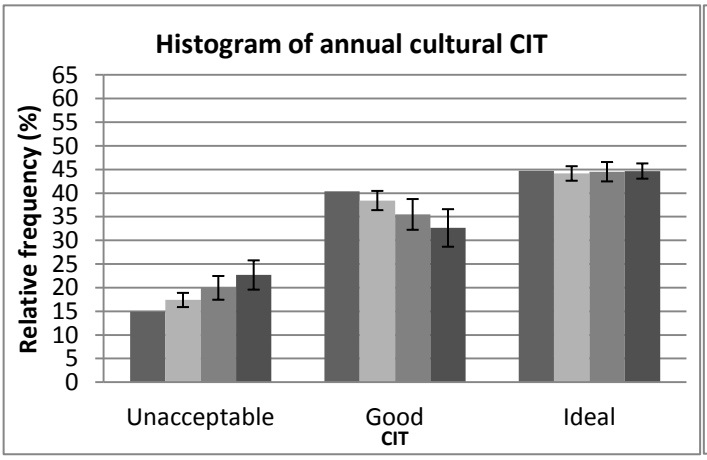
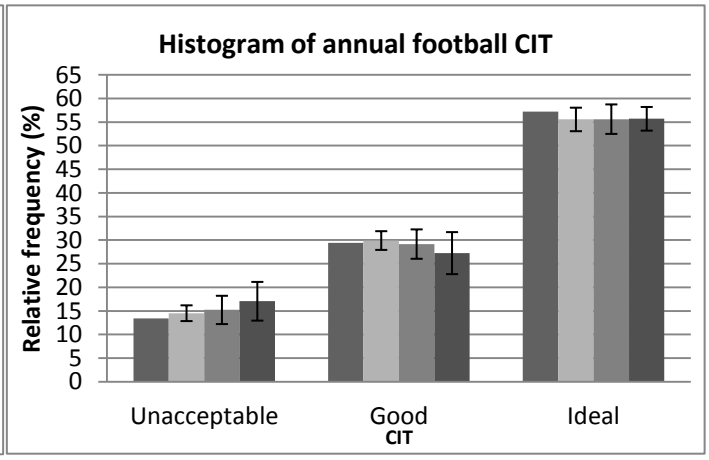
ANNEX A: HISTOGRAM OF ANNUAL CIT

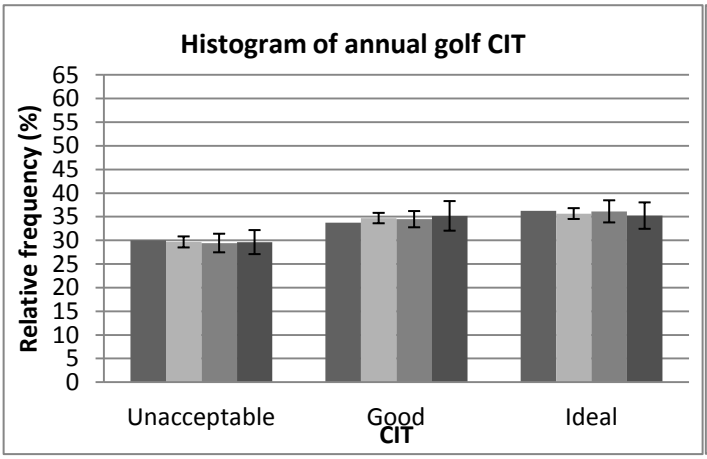
Figure A. Relative frequency (%) of the annual mean regimes for the unacceptable, good and ideal conditions of the climate resource for the present (CIT LEPA), early, mid and late (CIT multimodel) time-slices. Also displayed Is the standard deviation of the model ensemble.

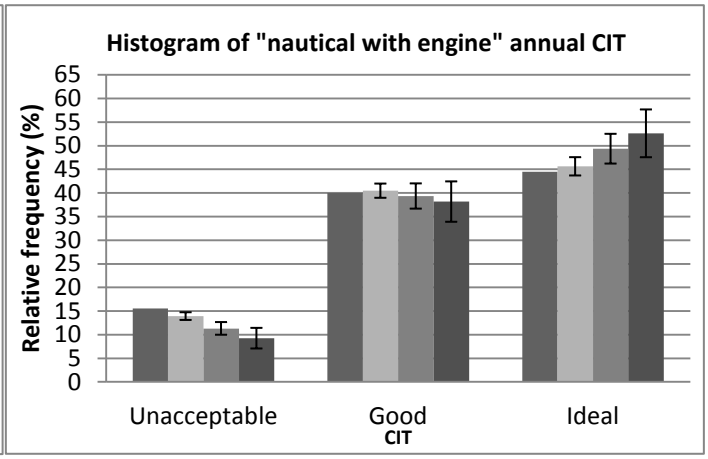


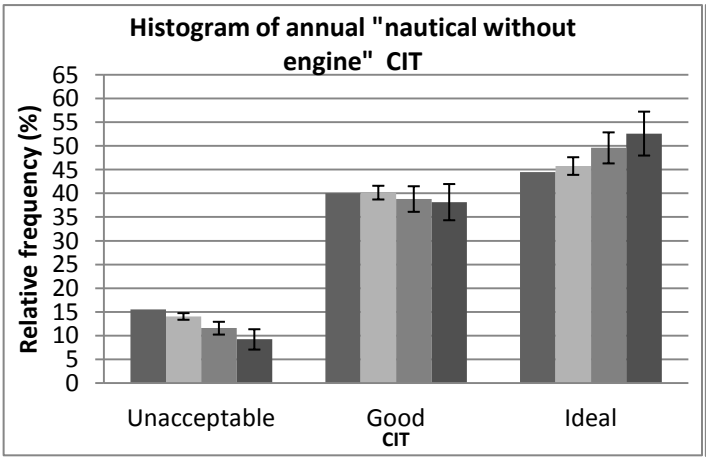


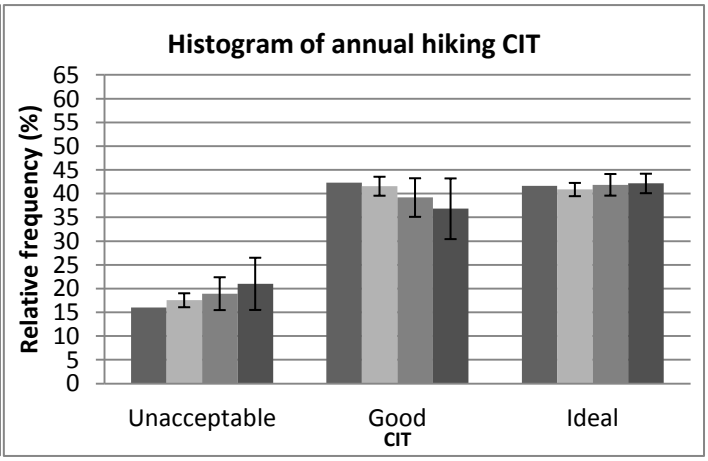






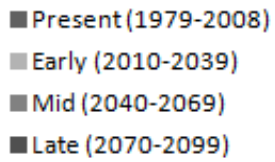


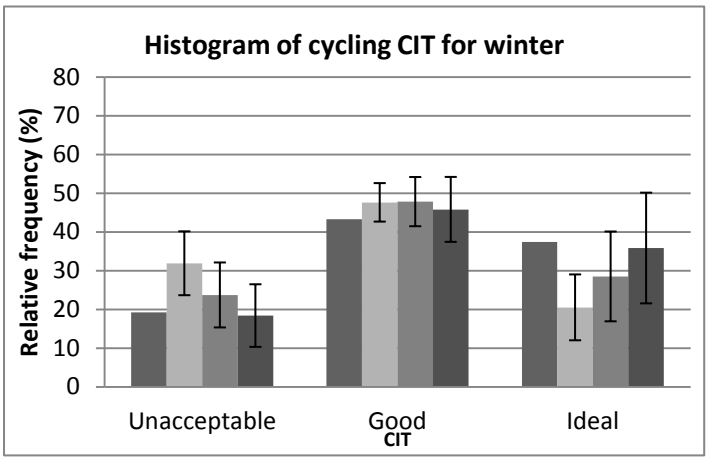


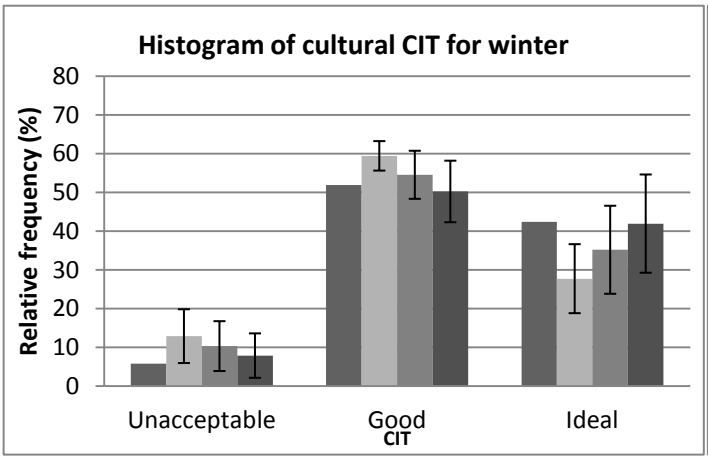


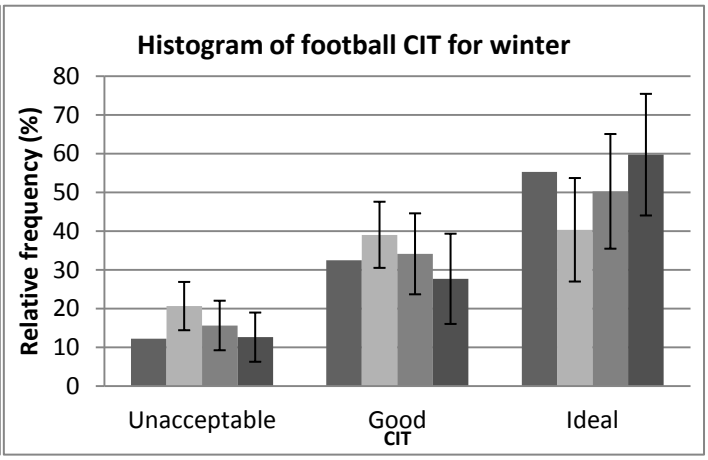
ANNEX B: HISTOGRAM OF CIT FOR WINTER, SPRING, SUMMER AND AUTUMN

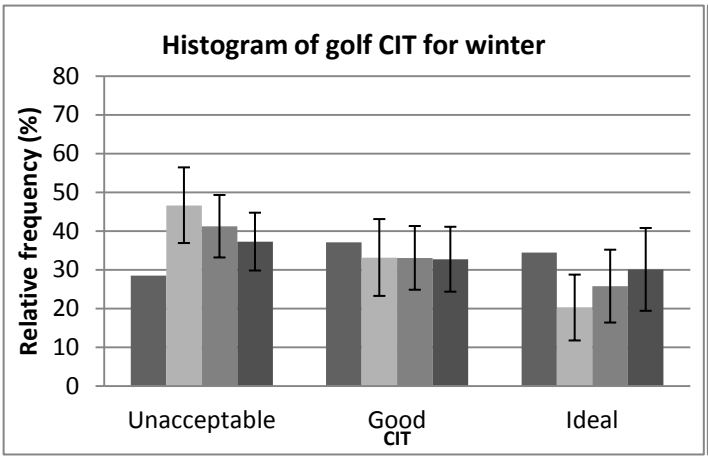
Figure B.1. Relative frequency (%) of winter mean regimes for the unacceptable, good and ideal conditions of the climate resource for the present (CIT LEPA), early, mid and late (CIT multimodel) time-slices. Also displayed Is the standard deviation of the model ensemble.

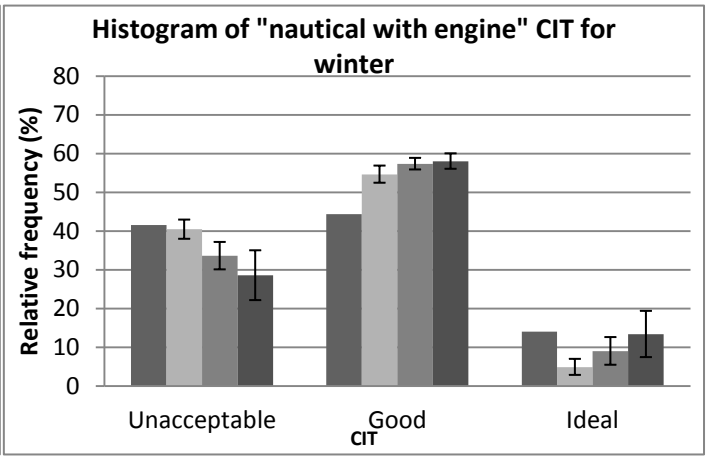


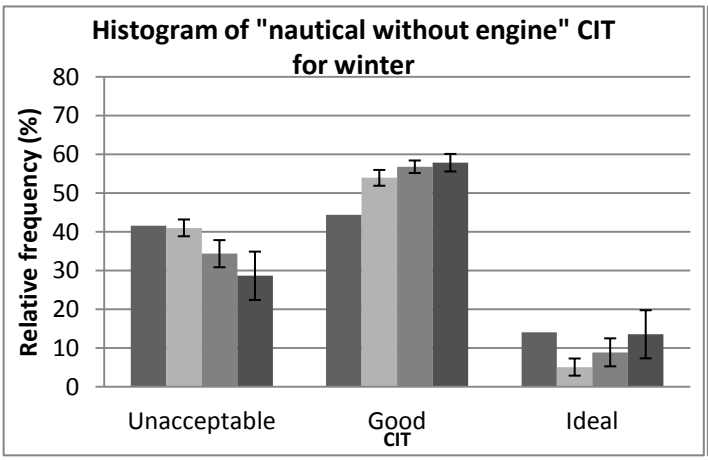












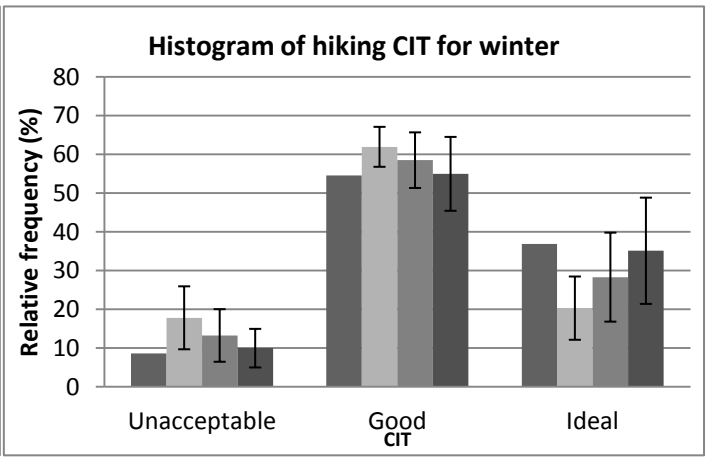
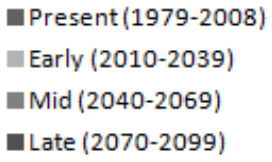
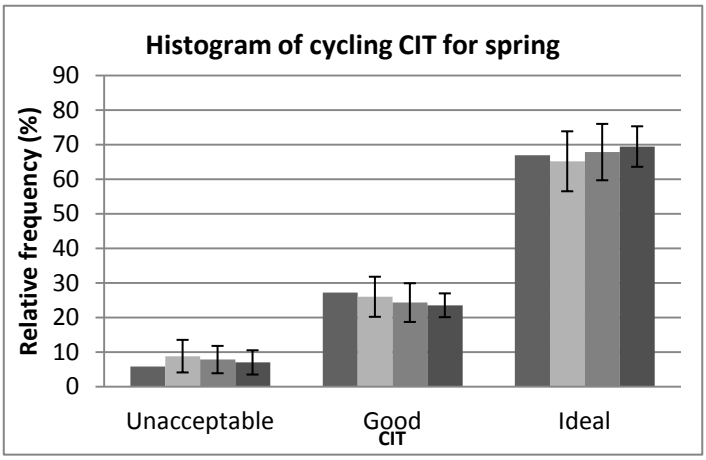
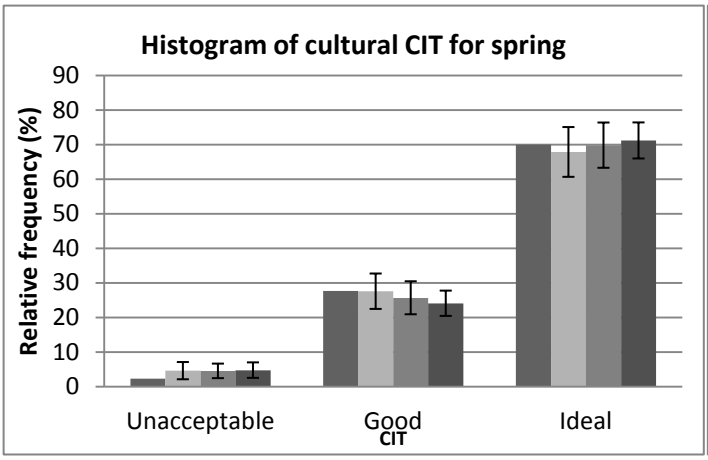
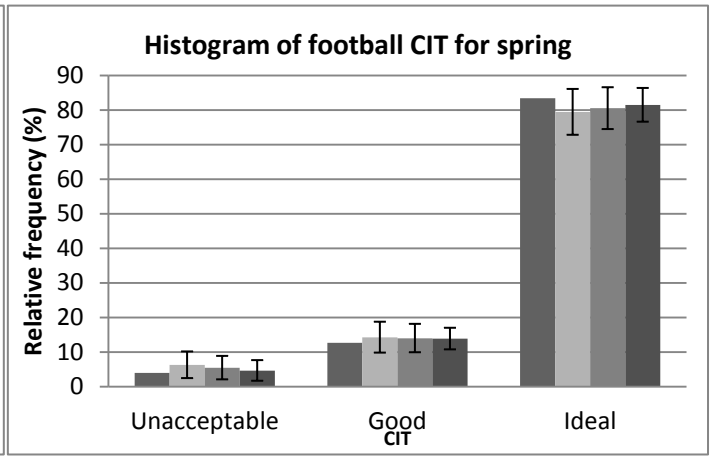


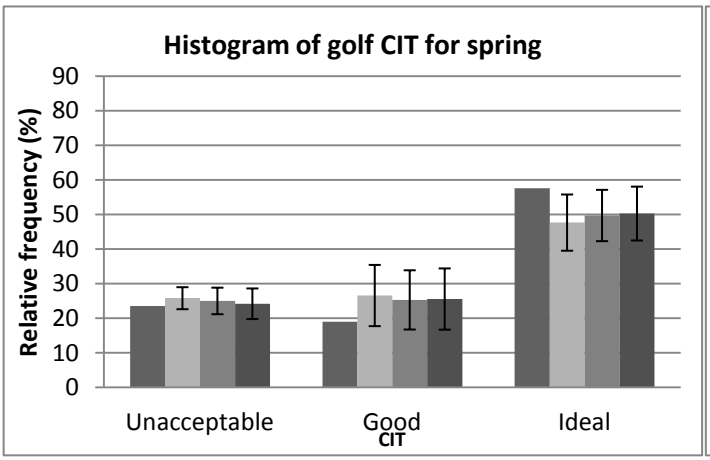
Figure B.2. Relative frequency (%) of spring mean regimes for the unacceptable, good and ideal conditions of the climate resource for the present (CIT LEPA), early, mid and late (CIT multimodel) time-slices. Also displayed Is the standard deviation of the model ensemble.

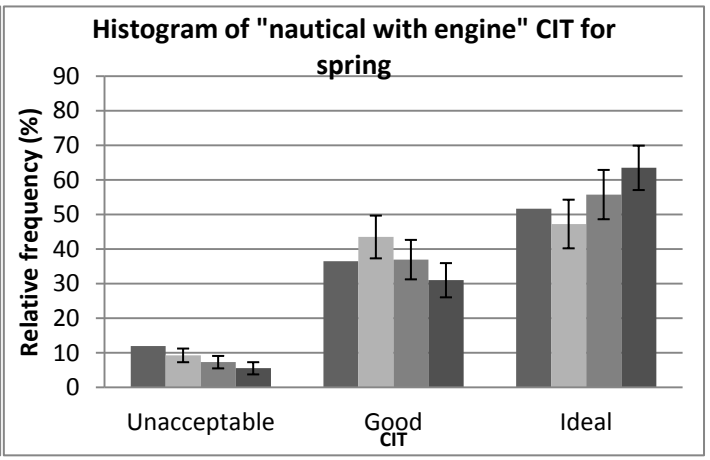


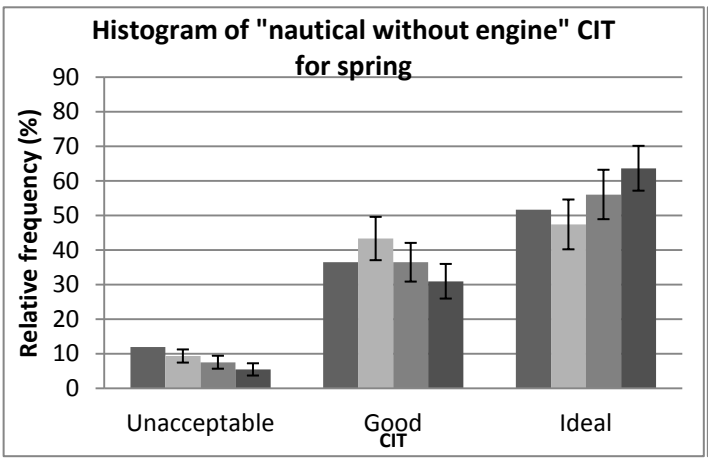












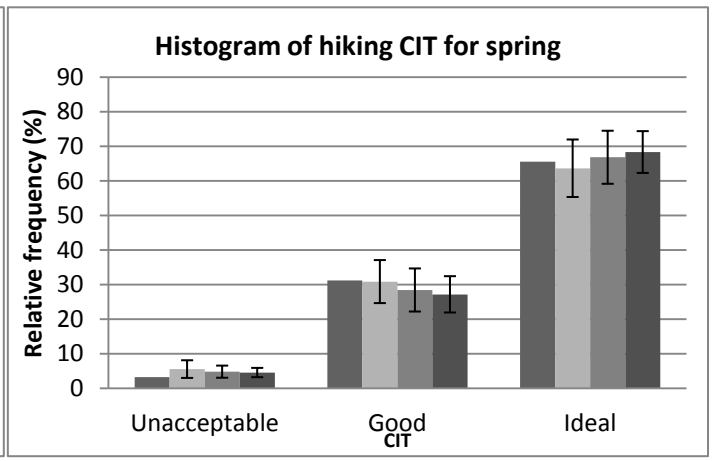
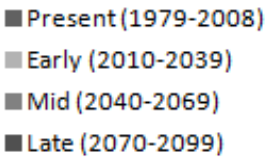
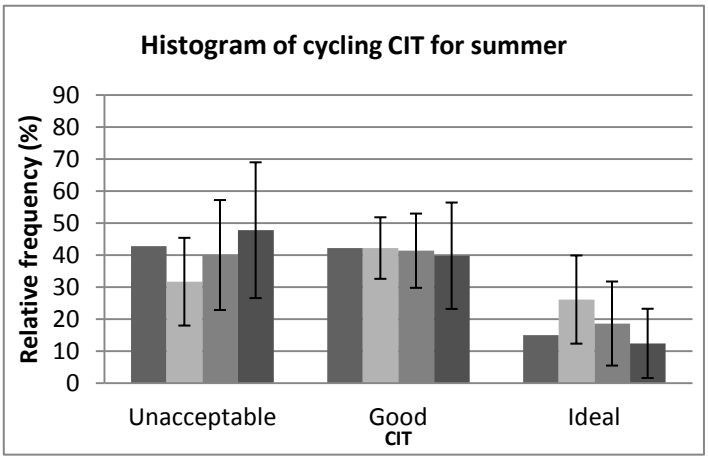
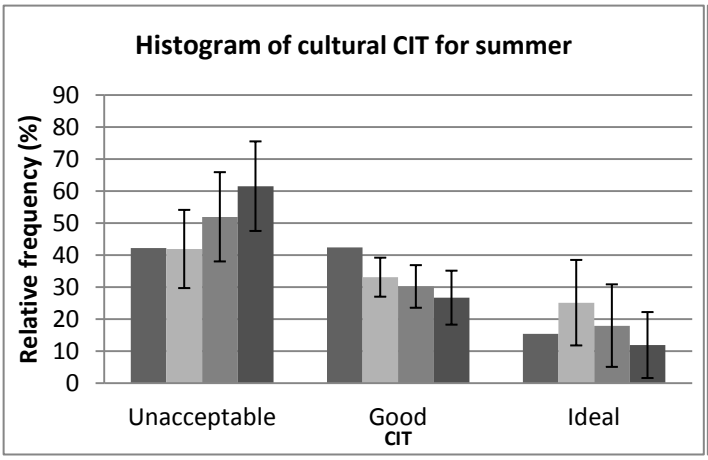
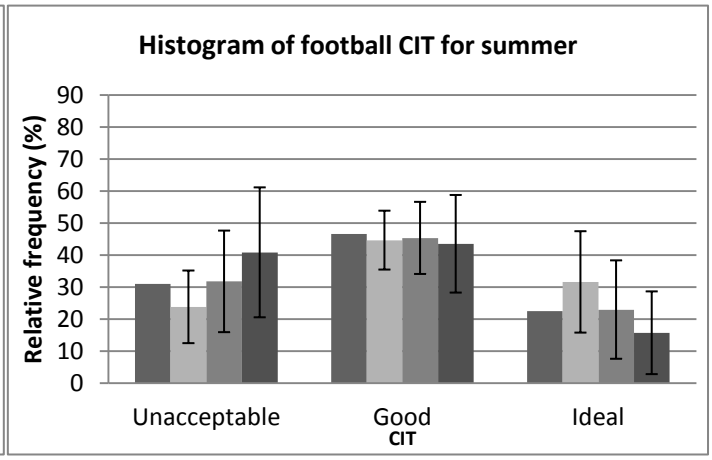


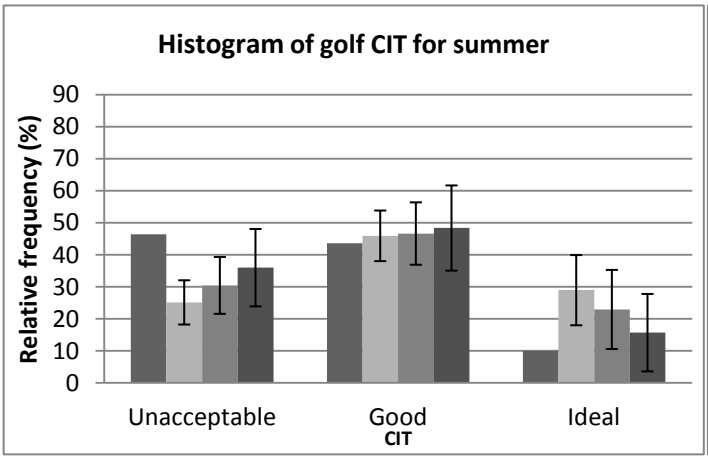
Figure B.3. Relative frequency (%) of summer mean regimes for the unacceptable, good and ideal conditions of the climate resource for the present (CIT LEPA), early, mid and late (CIT multimodel) time-slices. Also displayed Is the standard deviation of the model ensemble.

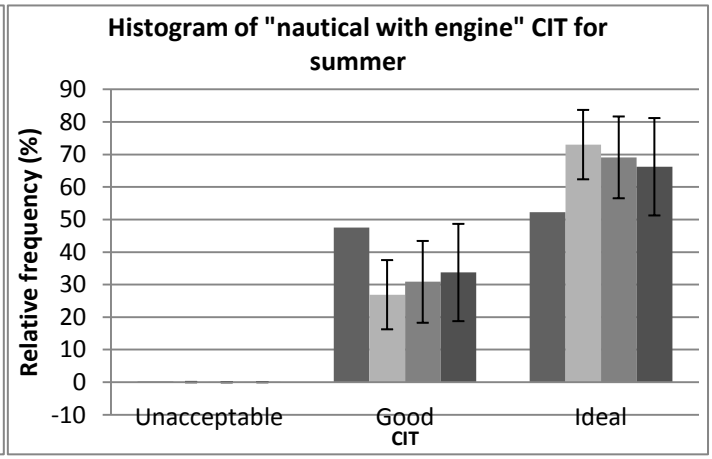


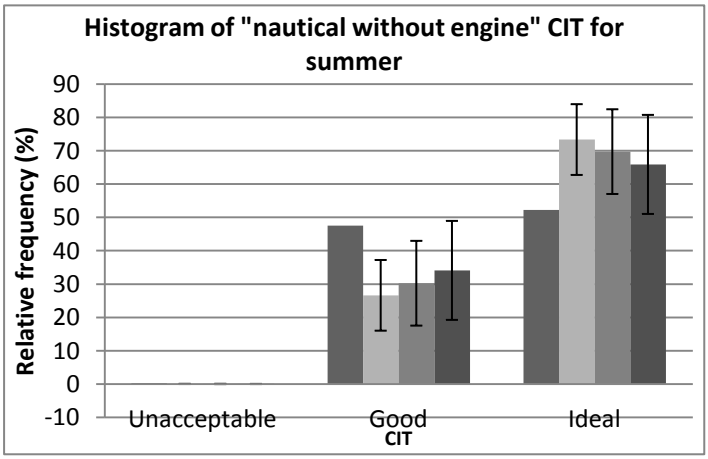












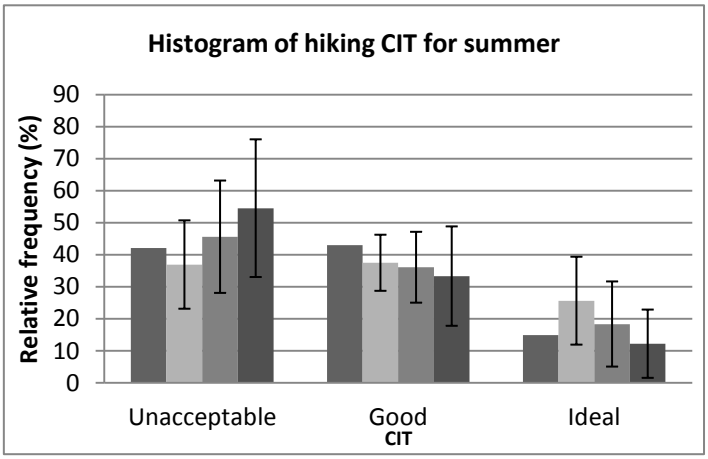
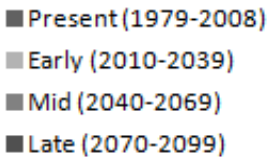
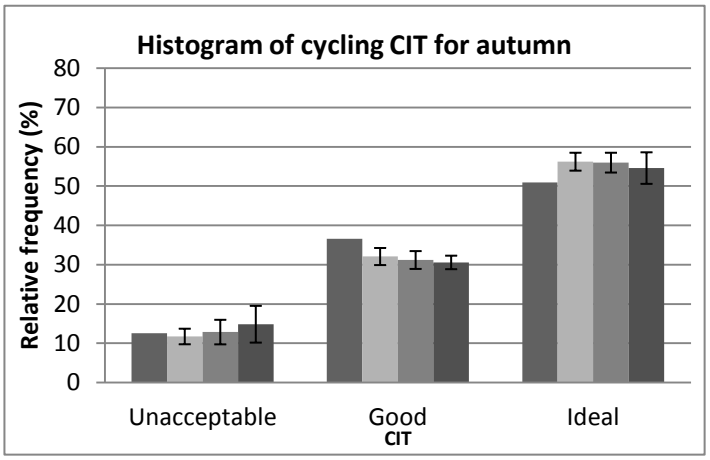
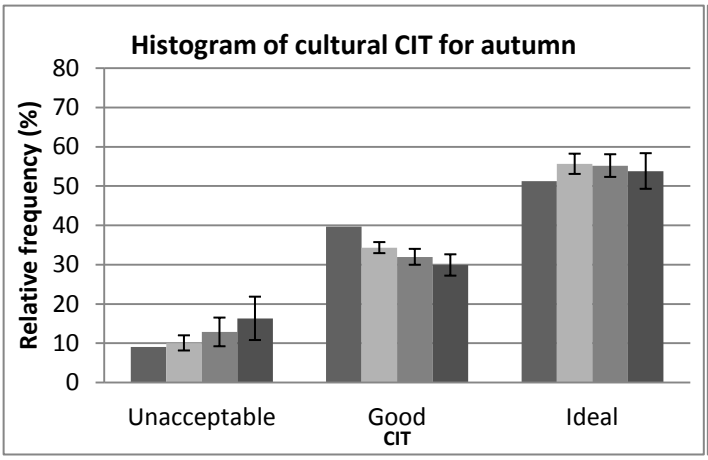
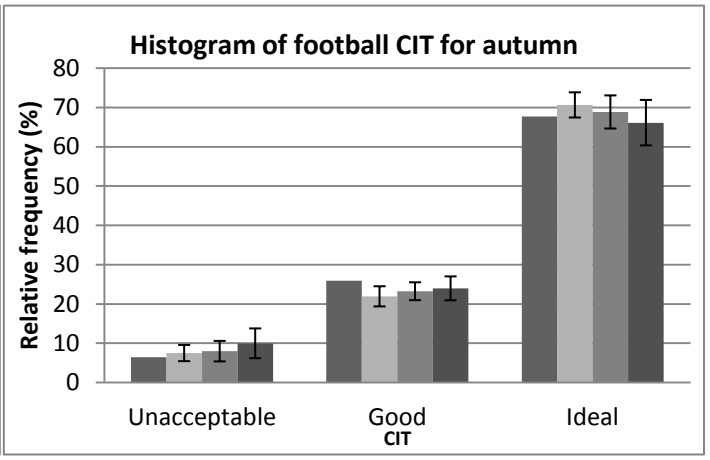


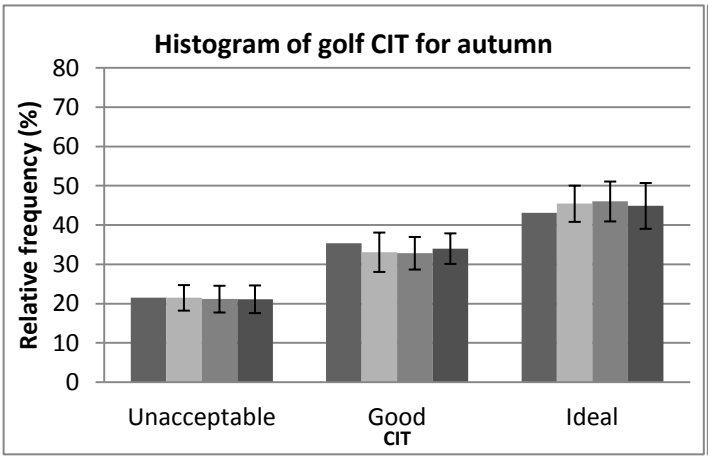
Figure B.4. Relative frequency (%) of autumn mean regimes for the unacceptable, good and ideal conditions of the climate resource for the present (CIT LEPA), early, mid and late (CIT multimodel) time-slices. Also displayed Is the standard deviation of the model ensemble.

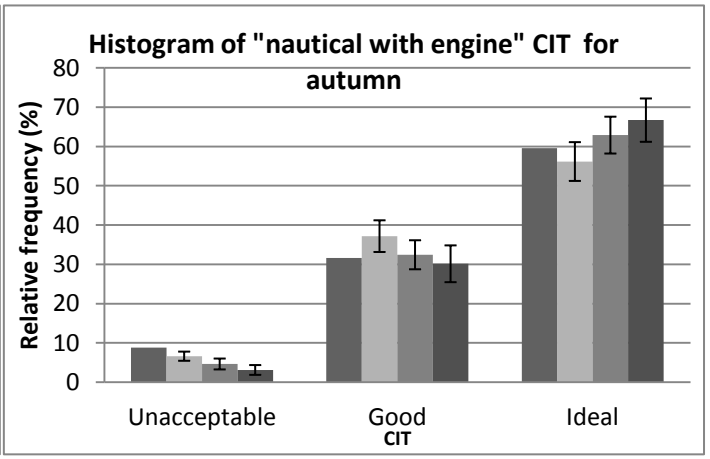


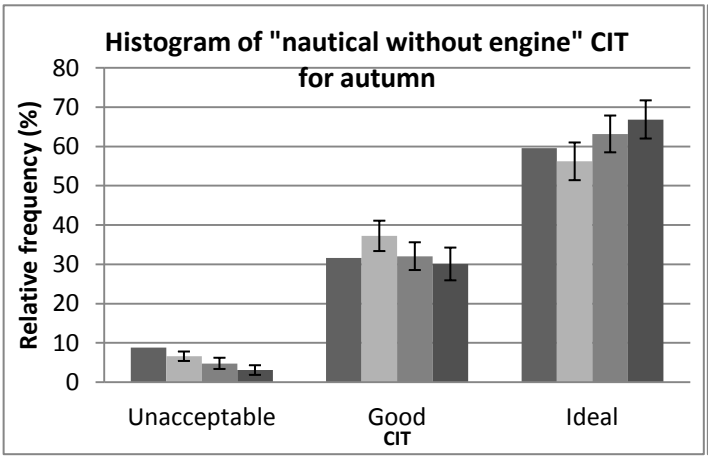


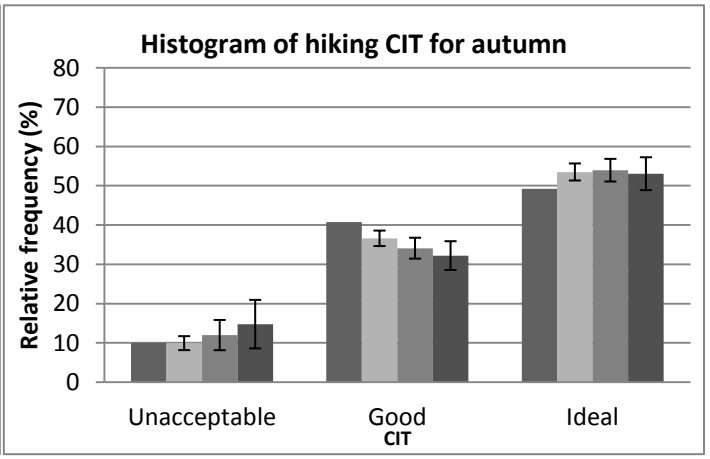












ANNEX C: RELATIVE FREQUENCIES OF ACCEPTABLE CIT

Table C. Relative frequencies (%) of (a) acceptable annual CIT, (b) acceptable CIT for winter, (c) acceptable CIT for spring, (d) acceptable CIT for summer and (e) acceptable CIT for autumn.

(a)

Acceptable annual CIT	Cycling	Cultural	Football	Golf	Nautical with engine	Nautical without engine	Beach	Hiking
Present (1979-2008)	80	85	87	70	84	84	68	84
Early (2010-2039)	79	83	85	70	86	86	71	82
Mid (2040-2069)	79	80	85	71	89	88	75	81
Late (2070-2099)	78	77	83	70	91	91	74	79

(b)

Acceptable CIT for winter	Cycling	Cultural	Football	Golf	Nautical with engine	Nautical without engine	Beach	Hiking
Present (1979-2008)	81	94	88	72	58	58	39	91
Early (2010-2039)	68	87	79	53	60	59	46	82
Mid (2040-2069)	76	90	84	59	66	66	52	87
Late (2070-2099)	82	92	87	63	71	71	55	90

(c)

Acceptable CIT for spring	Cycling	Cultural	Football	Golf	Nautical with engine	Nautical without engine	Beach	Hiking
Present (1979-2008)	94	98	96	76	88	88	66	97
Early (2010-2039)	91	95	94	74	91	91	70	94
Mid (2040-2069)	92	95	95	75	93	92	75	95
Late (2070-2099)	93	95	95	76	94	95	79	95

(d)

Acceptable CIT for summer	Cycling	Cultural	Football	Golf	Nautical with engine	Nautical without engine	Beach	Hiking
Present (1979-2008)	57	58	69	54	100	100	93	58
Early (2010-2039)	68	58	76	75	100	100	94	63
Mid (2040-2069)	60	48	68	70	100	100	94	54
Late (2070-2099)	52	39	59	64	100	100	94	45

(e)

Acceptable CIT for autumn	Cycling	Cultural	Football	Golf	Nautical with engine	Nautical without engine	Beach	Hiking
Present (1979-2008)	87	91	94	78	91	91	73	90
Early (2010-2039)	88	90	93	79	93	93	72	90
Mid (2040-2069)	87	87	92	79	95	95	77	88
Late (2070-2099)	85	84	90	79	97	97	79	85