Climate projections for the tourist potential of the main resort in Mallorca

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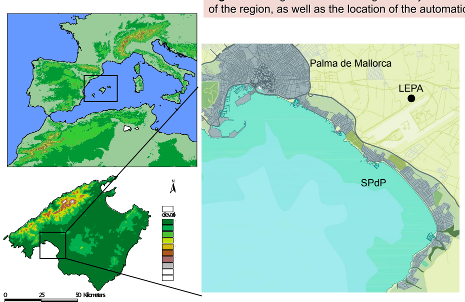
INTRODUCTION

In the framework of a collaborative agreement between IMEDEA and the Consortium of Platja de Palma –to provide scientific and technical support to the project of remodeling and adaptation of this important tourist resort to the needs of the XXI century– the effects of climate change on the tourist potential of this site are studied. The socioeconomic activities taking place within the Platja de Palma System (*PdPS*) are strongly linked to its climate. Therefore, the optimization of the tourist and residential activities on the mid-term must necessarily take into account the close dependency between the rapid change in sensible atmospheric parameters in an era of climate change and the tourist model of *Sea, Sun and Sand (3S), largely exploited in this settlement. Regional climate models (ENSEMBLES) provide the projections to analyze future tourist potential scenarios in PdPS.*

METHODOLOGY

Impact of climate change on the tourist potential of *Platja de Palma System*

Figure 1. Geografical surroundings of Platja de Palma System (PdPS). The main orographic features of the region, as well as the location of the automatic weather station, are shown (WMO code LEPA)

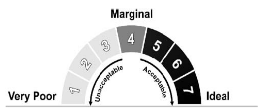


Observational records reveal an increase in the global averaged surface temperature of 2.68 ºC for the period 1979-2005. Regarding precipitation, a redistribution across climatic areas is also detected over the globe. Other important weather sensible parameters such as pressure, humidity and cloud cover have also experienced significant changes. The total global precipitation is estimated to have diminished about 3% over 197-2005 (IPCC, 2007).

Although climate change is a process of global causes and consequences, its impacts manifest locally. For the Balearic Islands, observations show a negative trend in the annual precipitation of 16.6 mm per decade for the period 1951-2006. Regarding 2 m temperatures, both maximum and minimum values increased at a rate of 0.51 ºC and 0.46 ºC per decade during 1976-2006 (Homar et al., 2009).

The socioeconomic activities developed in PdPS are closely linked to its climate. Thus, the optimization of its social, economic and environmental assets must account for the climate change impact on the tourist potential in this major European destination.

Database and the *Climate Index for Tourism* (CIT)



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

Figure 2. The thermal (T), aesthetic (A) and Physical (P) facets are combined in a matrix to derive the suitability for S3 tourist activities.

In order to quantify the analysis, a characterization of the environmental conditions favoring the leisure and 3S tourist activities outdoors becomes essential. The *second generation climate index for tourism* (*CIT*; Freitas et al., 2008) was empirically derived and allows to estimate the 3S tourist experience as a function of weather conditions. The CIT accounts for thermal, aesthetic, and physical environmental facets, and renders a quantitative measure of the satisfaction experienced by the 3S tourist.

In first place, we analyze daily time series of CIT over the period 1973-2008, for which LEPA station has available digital records (Fig. 1). In order to assess the impact of projected climate changes for the first half of the XXI century on the tourist potential of PdPS, we consider 18 Regional Climate Model results using a single scenario (SRES A1B) in the framework of the European project ENSEMBLES (www.ensembles-eu.org).

In order to compute daily series of CIT, daily series of –observed and projected- temperature, precipitation, relative humidity, cloud cover and wind were used. Regarding the body-atmosphere energy balance, the Matzarakis and Rutz (2007) model is used to compute the Physiological Equivalent Temperature (*PET*). In order to remove persistent biases in the projected daily CIT series, the calibration method of Amengual et al. (2010) is applied to the atmospheric data series.

Classification: CIT= 1,2,3: Unacceptable; CIT= 4,5: Acceptable; CIT= 6,7: Ideal.

RESULTS

Observed trends of tourist potential

Number days	1973-08 (36 yrs)	1973-90 (18 yrs)	1991-08 (18 yrs)	Δ CIT
CIT = 1	26.1	26.7	25.5	-1.2
CIT = 2	22.1	22.5	21.7	-0.8
CIT = 3	70.3	65.9	74.7	+8.8
CIT = 4	86.4	86.1	86.8	+0.7
CIT = 5	59.6	56.1	63.2	+7.1
CIT = 6	74.5	79.4	69.6	-9.8
CIT = 7	26.2	28.6	23.8	-4.8

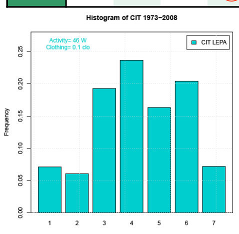


Figure 3. CIT histogram for the period 1973-2008

The table shows the annual frequency of each CIT category for the period 1973-2008. Comparing the two semi-periods (early, 1973-1990; and late, 1991-2008) it becomes apparent the decrease in the frequency of ideal conditions (-14.6 days) together with an increase in the acceptable conditions (+7.8 days). Linear trends computed over the observed period confirm this result.

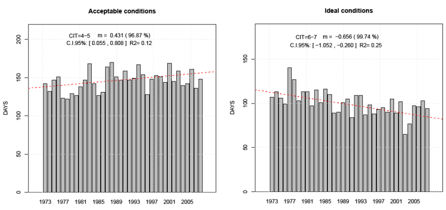


Figure 4. Time series of annual frequency of acceptable and ideal conditions. Linear trends are computed for each series and expressed in change days per year.

CIT conditions	Change in number of annual days per decade	Statistical confidence in change rate	95% interval confidence	
			Lower limit	Higher limit
Unacceptable	+1.86	Likely	-1.34	+5.06
Acceptable	+4.31	Extremely likely	+0.55	+8.08
Ideal	-6.56	Virtually certain	-10.52	-2.60

Projected trends of tourist potential

Number days	LEPA 1979-2008 (30 yrs)	Multi-model mean 2021-50 (30 yrs)	Δ variables
CIT = 1	25.2	24.7	-0.5
CIT = 2	22.5	23.4	+0.9
CIT = 3	71.7	94.6	+22.9
CIT = 4	87.4	97.5	+10.1
CIT = 5	60.6	58.7	-1.9
CIT = 6	73.1	48.9	-24.2
CIT = 7	24.7	17.3	-7.4

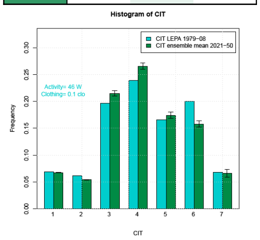


Figure 5. CIT histograms for observed and projected climates. Vertical segments indicate the 18 RCMs standard deviation

The table shows the multimodel mean annual frequency of each CIT category projected for the period 2001-2050. Comparing the late projected period (2021-2050) and the observed period (1979-2008), a significant reduction exceeding the 31 days per year of ideal conditions is obtained. In parallel, an absolute increase in frequency of 8.2 days per year is found for the acceptable S3 days.

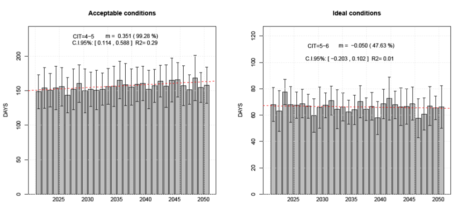


Figura 6. Time series of annual frequency of acceptable and ideal conditions for the period 2021-2050. Model dispersion among the 18 RCMs is expressed in terms of standard deviation with vertical segments.

CIT conditions	Change in number of annual days per decade	Statistical confidence in change rate	95% interval confidence	
			Lower limit	Higher limit
Unacceptable	-2.62	Likely	-5.64	+0.41
Acceptable	+3.51	Virtually certain	+1.14	+5.58
Ideal	-0.50	More unlikely than likely	-2.03	+1.02

CONCLUSIONS

Observed mean regimes (1973-1990/1991-2008)	Acceptable conditions	Ideal conditions
Annual	⇧ ⇧	⇩⇩⇩
Winter	⇧	⇩
Spring	⇧	⇔
Summer	⇧	⇩
Autumn	⇧	⇩ ⇩

Projected mean regimes (1979-2008/2021-2050)	Acceptable conditions	Ideal conditions
Annual	⇧⇧⇧	⇩⇩⇩
Winter	⇧	⇩
Spring	⇧	⇩
Summer	⇧	⇩⇩⇩
Autumn	⇧	⇩

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