Universitat de les Illes Balears

Conference GIRA 2010 Lisboa/Portugal 9 and 10 September Corporate Governance, Innovation, Social and Environmental Responsibility

Projections of the climate potential for tourism in Platja de Palma, Spain

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Introduction: tourism and climate change

- Tourism is a climate sensitive socioeconomic activity
- Key economic sector for most of the Mediterranean countries
- Climate determines tourists' flows in Europe and seasonality in the industry
- **Sun, sea and sand (3S) tourism** is largely based on well defined perceptions of warm and sunny weather conditions
- 3S tourism is especially sensitive to temperature, rainfall, relative humidity, cloudiness (i.e. hours of sunshine) and wind speed (De Freitas et al., 2008)
- Climate change could affect tourists' behaviour if altering weather perception

Mediterranean region

- rate of surface warming: 2.5–3.5 ºC /100 yrs (1979-2005)
- pace of loss in precipitation: up to 3 % per century (1979-2005; IPCC, 2007)

Balearic Islands

- Decrease in annual rainfall amounts: 16.6 mm/10 yrs (1951-2006)
- Minimum and maximum temperatures have risen at 0.51 ºC and 0.48 ºC per decade, respectively (1976-2006)
- Warming is more noticeable for springs and summers (Homar et al., 2010)

Socioeconomic features of tourism

Balearic Islands

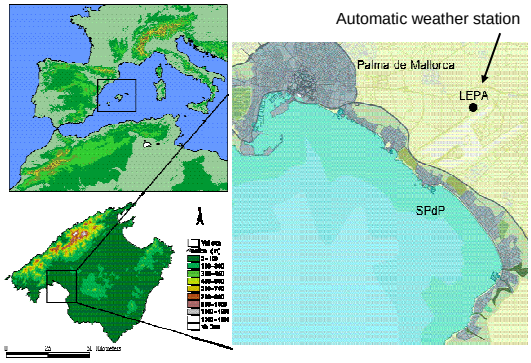
- 76,2% of the active population is directly employed within service sector
- Tertiary sector aggregates up to 72.8% of the whole inland companies

Palma Municipality

- Up to 83% of the employees in Palma municipality is directly employed by tertiary sector
- Above 81% of the companies deals with service sector
- Local employment pattern is strongly linked to the tourist demand in the county

System of Platja de Palma (SPdP)

- Main tourist resort in the Balearics
- 40000 tourist places and 34000 permanent inhabitants
- In average, 1.2 million of nights were spent per year during the 1999-2008 period
- 3S tourism is the dominant activity



System of Platja de Palma (SPdP)

The Consortium of Platja de Palma is an agreement signed by the Balearic Islands Government and the Spanish Ministry of Tourism to address the renovation of SPdP to the needs of the 21st century (further information at: http://consorcioplayadepalma.es)

Major guidelines for the Consortium are: **sustainability**, **climate and global change**, and **social and residential cohesion**

The assessment of climate change impacts and the implementation of mitigation and adaptation strategies has turned one of the key issues

Objective of this work: to assess the effects of climate change on the **tourist potential** for SPdP

The **dominance of the 3S model** over other tourist resources makes SPdP an excellent location for applying a climate index for tourism

Climate index for tourism (CIT)

CIT estimates the **satisfaction of 3S tourists** as function of daily weather conditions (De Freitas et al., 2008)

It integrates the thermal (T), aesthetical (A) and physical (P) facets of the weather

CIT expresses the integrated body-atmospheric energy balance as a thermal sensation (TSN)

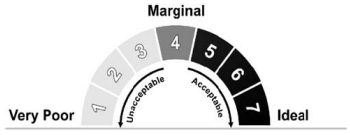
TSN has been obtained by using the RayMan model (Matzarakis and Rutz, 2007a; Matzarakis et al., 2007b)

RayMan yields the physiologically equivalent temperature (PET) as a thermal index

Thermal index is expressed as a thermal sensation by using the standard 9-point ASHRAE scale (ASHRAE, 2004)

Physical and aesthetic facets are combined with thermal facet accordingly to a weather typology matrix

It accounts for **beneficial and detrimental** effects on tourists' perception



	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

Database and methodology

Observed CIT is derived from daily series recorded at the LEPA weather station for the 1973-2008 period: 2 m maximum temperature, accumulated precipitation, 2 m mean relative humidity, mean cloud cover and 10 m mean wind speed

Projected CIT is obtained from daily-averaged data provided by 13 Regional Climate Models (RCMs) run within the ENSEMBLES European project under A1B SRES (1973-2100; Hewitt, C. D. and Griggs D. J., 2004)

Multimodel approach: to cope with the uncertainties arising from model error formulations and boundary conditions

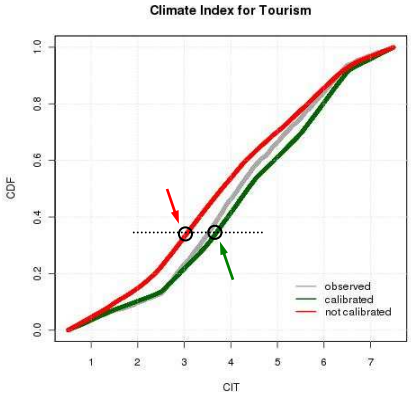
To account for local unresolved scales, a **statistical downscaling method** for each individual RCM outputs is applied to the projected CIT (Amengual et al., 2010)

Statistical downscaling (SD) and validation

SD consists of calculating the changes in the cumulative distribution functions (CDFs) of daily CIT values between a 15-year past simulated period (control; 1973-1987) and successive 15-year simulated time-slices from 1994 until 2100

These variations are corrected and transferred to the observed CDFs for the same control period, obtaining new calibrated CDFs which convey the climate signal for the subsequent time intervals

We have evaluated the performance of the method by comparing the multimodel mean raw and calibrated data percentiles against the observed ones for a 15-year validation period (1994 -2008)



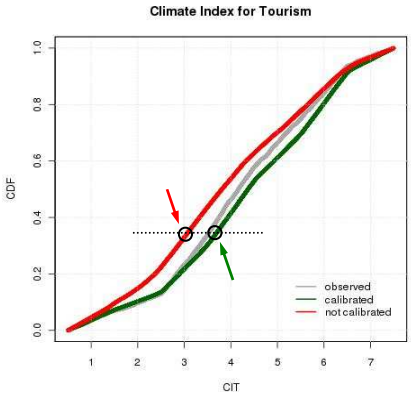
CIT CDFs	MAE cal	MAE raw	RMSE cal	RMSE raw
	0.17	0.29	0.19	0.34

Statistical downscaling (SD) and validation

Percentile-wise MAE and RMSE reveals an improvement of calibrated versus raw data for acceptable conditions (CIT=4,5)

Calibrated and observed data are fairly identical for unacceptable (CIT=1,2,3) and ideal (CIT=6,7) conditions

General improvement of the calibrated simulated perceived satisfaction of weather resource when compared against observations



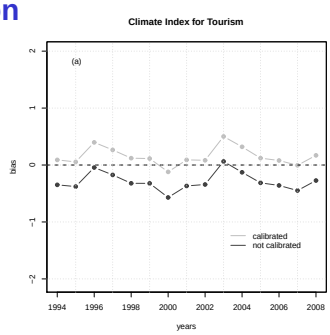
CIT CDFs	MAE cal	MAE raw	RMSE cal	RMSE raw
	0.17	0.29	0.19	0.34

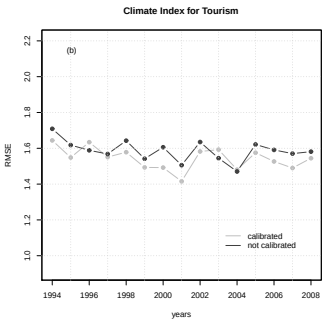
Statistical downscaling (SD) and validation

Annual scores for the validation period (1994-2008)

Annual mean bias and RMSE daily indices computed for mean multimodel raw and calibrated time series

The calibrated CIT verifies significantly better than raw values for the validation interval





	bias cal	bias raw	RMSE cal	RSME raw
CIT	0.15	-0.29	1.54	1.59

Average values over the validation period

Results: changes in annual mean regimes

Present (1973-2002)

Acceptable conditions dominates in the annual mean regime followed by the unsatisfactory and the optimal perceptions

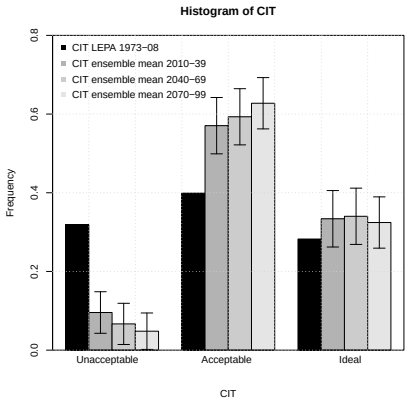
Annual relative frequencies for acceptable and ideal conditions reaches up to 68 %

Early (2010-39), mid (2040-69) and late (2070-99) 21st century projections

Redistribution of the mean annual CIT regimes for the unacceptable, acceptable and ideal conditions

Shift of displeasure weather conditions towards the acceptable ones

Relative frequency of the annual averaged number of days with optimal conditions is expected to maintain a steady evolution



Annual CIT	present	early	mid	late
Unacceptable	0.32	0.10	0.07	0.05
Acceptable	0.40	0.57	0.59	0.63
Ideal	0.28	0.33	0.34	0.32

Annual frequency distribution of the rating classes

Tourism and seasonality

In Spain, tourist sector is marked by a **strong seasonality**:

- Large differences in occupancy rates between the cold and warm seasons
- Total tourism revenues are more than 50% higher in August than in December
- More than three times hotels nights were spent in August than in December (INE, 2009)
- Peak demand for 3S tourism is also strongly influenced by state holidays

Amelung and Viner (2006) pointed out that the future summery conditions could deteriorate in the Mediterranean and improve in western and northern Europe

These latter areas are currently the major sources of tourists for the Palma municipality: Germany were the main tourist source market –over 42%–, followed by Great Britain –close to 27%– during 2008

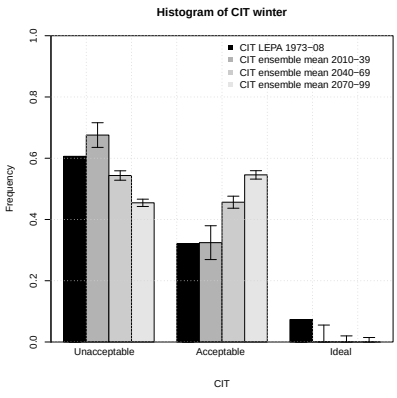
- Probable major modification in the tourist flows around Europe owing to climate change
- Imbalance between institutional and natural seasonality
- Climatic conditions for the shoulder seasons are likely to improve for the Mediterranean which could help to deseasonalise tourism industry

Results: changes in seasonal mean regimes

Winter

- Projections would indicate a small decrease in the seasonal number of days with unsatisfactory perception from the middle of the 21st century
- A moderate decrease in the relative frequencies for the current optimal conditions
- This redistribution of the climate resource in wintertime would benefit the acceptable perception, which could be noticeably increased at the end of the century, exceeding the unsatisfactory conditions

Winter CIT	present	early	mid	late
Unacceptable	0.61	0.67	0.54	0.44
Acceptable	0.32	0.33	0.46	0.56
Ideal	0.07	0.00	0.00	0.00



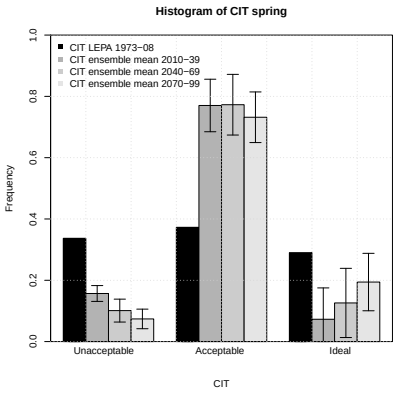
Results: changes in seasonal mean regimes

Spring

• Important growth in the relative frequencies for satisfactory conditions increasing twofold the present number of days

• Remarkable drop for both unsatisfactory and ideal weather perception, but the former would decrease during the whole century and the latter could steadily increase halfway through the 21st century

CIT	present	early	mid	late
Unacceptable	0.34	0.16	0.10	0.08
Acceptable	0.37	0.77	0.77	0.73
Ideal	0.29	0.07	0.13	0.19



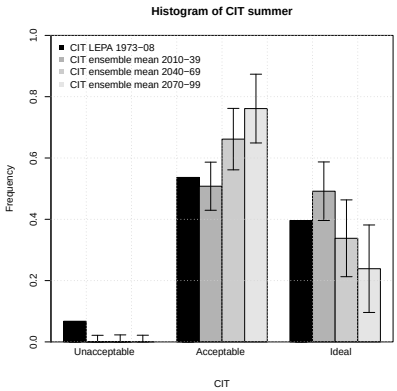
Results: changes in seasonal mean regimes

Summer

• For the peak season, the number of days comprising ideal conditions is expected to rise for the early future time-slice, and then, constantly fall for the remaining periods bellow the current relative frequency

• The satisfactory perception would evolve in the opposite way

Summer CIT	present	early	mid	late
Unacceptable	0.07	0.00	0.00	0.00
Acceptable	0.53	0.51	0.66	0.76
Ideal	0.40	0.49	0.34	0.24

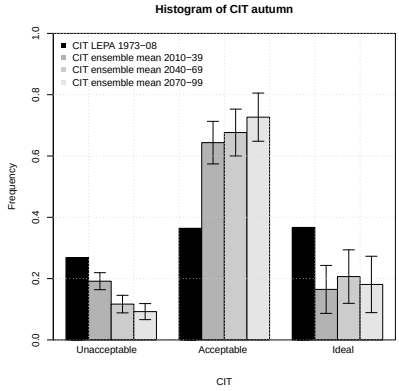


Results: changes in seasonal mean regimes

Autumn

- A remarkable shift can be expected for the agreeable perception
- The rise in the relative frequency for this subjective perception are due to the loss in the seasonal number of days with both unpleasant and ideal climatic conditions respect present

Autumn CIT	present	early	mid	late
Unacceptable	0.27	0.19	0.11	0.09
Acceptable	0.36	0.64	0.68	0.73
Ideal	0.37	0.17	0.21	0.18



Results: changes in seasonal mean regimes

- Climate change signal could produce an increase of **satisfactory** weather perceptions for the peak and shoulder seasons (i.e. spring and autumn)
- Overall fall in the relative frequencies for the **optimal** conditions is foreseen for all the seasons when compared with present perception
- Peak seasonal weather conditions would likely **shift to the shoulder seasons for 3S tourism** outdoors activities
- Higher tourism revenues in springs and autumns might partially soften the economic losses as consequence of the worsening of the optimal conditions for summers
- Since climate resource will remain as a fundamental push and pull factor for European tourism in the future, these results could imply a seasonal adjustment of tourists' flows

Results: changes in monthly mean regimes

To correlate 3S tourists' flows and climate conditions, it has been plotted monthly average visitation for the Palma municipality (1999-2008) against the present and future time-slices averaged climate index for tourism

- Point out the link between monthly average climatic conditions and visitation levels, rather than to bind weather resource and visitation levels in specific years (Amelung and Viner, 2006)

- Relate CIT scores with current tourists' perception and to explore the future evolution of tourists' flows through CIT-based projections

- Overcome some climate index for tourism limitations: test CIT for a wider tourist market sector and by accounting factors such as, diverse age or a wider spatial visitor source coverage (De Freitas et al. ,2008)

Results: changes in monthly mean regimes

Present

- Highest visitation levels are found in July and August (institutional holidays)

Acceptable conditions

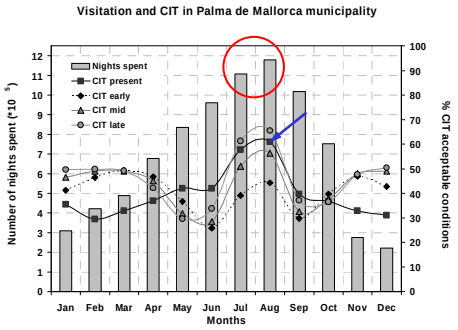
- Current tourist potential distribution presents a **peak distribution** with its maximum in August
- Highest percentages from May to October
- Coincides with the high visitation period which is defined as the six months comprising the greatest rates of accommodation (from May to October)

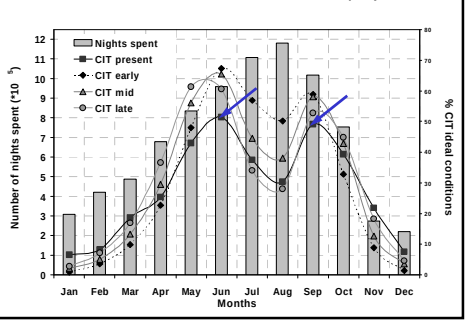
Ideal conditions

- **Bimodal distribution**
- Highest scores from May to October as well
- State holidays are not the best period to carry out 3S leisure activities with optimal conditions

High visitation period spans over the six month period that rates above 75% of the whole number of days with acceptable or ideal conditions

During this period, more than 70% of the annual overnight stays are spent in Palma municipality





Results: changes in monthly mean regimes

Projections

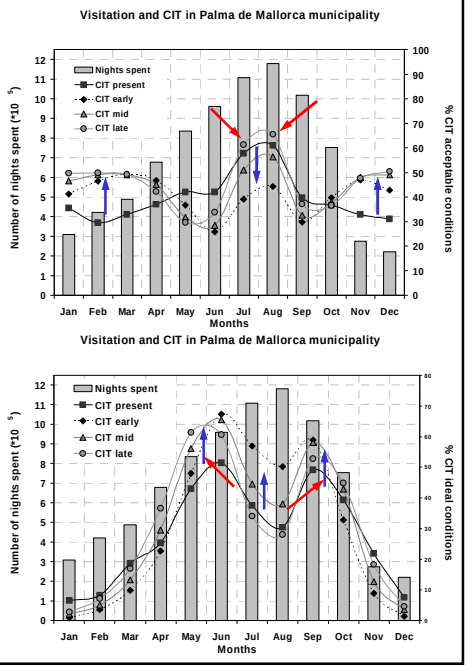
Weather resource will remain as a fundamental push and pull factor for European tourists' flows in the future

Acceptable conditions

- Decrease in the relative frequency with acceptable conditions for the high visitation period (May-Oct) until the late 21st century
- Increment for the remaining months
- The peak distribution is expected to be more marked at the end of 21st century

Ideal conditions

- Maintaining of the bimodal distribution
- Rise in relative frequencies for the high visitation season until the late period of the 21st century, when it could be found a drop in the summer and a growth in the shoulder seasons



Conclusions and further remarks

- The performance of the statistical downscaling shows an improvement in reproducing the present climate baseline (i.e. 1994-2008) when using CIT calibrated series
- Results have pointed out that highest visitation levels coincide with acceptable or optimal perceptions of the weather resource for 3S tourism
- Out of the high season, the satisfactory and ideal conditions decay remarkably
- The impact of climate change on the tourist potential suggests a probable future change on the seasonally adjusted tourist sector
- Weather subjective perception for beach holidays will remain as a major push and pull factor for tourism in the future: policymakers should address the possible consequences upon tertiary sector

Conclusions and further remarks

• Climate change could offer new opportunities for expansion of tourist sector towards the shoulder seasons

• An adequate adaptation to the likely future change in the present peak season could help to alleviate the stress produced by a resort based in a mass tourism model upon its social and economic structures

• Current seasonally adjusted of the incoming tourist fluxes can be also ascribed to other factors as the temporal coincidence with the institutional seasonality

• Policymakers should be aware of a probable future imbalance between climatic and institutional factors: increase in the flexibility of the institutions and companies to favour tourists' holidays and spare time

• They should also take into account the projected improvement of the summery weather resource for north and western European countries: diversification of the tourist supply by introducing new leisure activities not so strongly dependent on the peak season

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