Climate perceptions and preferences of French tourists: lessons for climate change impact assessment

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Abstract
Tourism has complex relationships with climate, and there is consensus that tourism could be substantially affected by climatic change. While considerable research has been presented on how climatic change is likely to affect destinations and tourism stakeholders in the future, there remains limited understanding of the climatic preferences of tourists or of their potential responses to changing climatic conditions for holiday-making. This is a research priority if the implications of climatic change for the temporal and geographic patterns of tourism demand are to be assessed with more relevance. This paper presents the results of a study of the climate preferences of French tourists, combining a quantitative survey of 1643 respondents, and a series of focus group interviews. Results show the ranking of weather and climate as a factor of destination choice and satisfaction, in particular in stays to coastal resorts, using campsites or involving outdoor activities. They also indicate the high tolerance of tourists to heat and even to heat waves, whereas rainy conditions appear to be clearly repulsive. The weight of precipitations in index like the Tourism Comfort Index should therefore be upgraded. The findings are also compared with studies in other countries. Slight differences in similar surveys can lead to a discrepancy in the appreciation of excessive heat and associated thresholds by 2-3°C, which questions the possibility to base climate change impact assessment on such fragile data.

Keywords: tourism, climate change, preferences, impact assessment, modeling

1. Introduction

Relationships between climate and tourism have been studied since the 1970s (Brunet 1970; Burnet 1970; Mieczkowski 1985; Besancenot 1989; Boyer 2005; Scott, Jones et al. 2005). Even though there is a considerable body of literature on the climate requirements of tourists (Matzarakis and De Freitas 2001; Matzarakis, de Freitas et al. 2004; Scott, Jones et al. 2005), there is also a general recognition of the lack of specific knowledge on the climate perceptions and preferences of tourists and their responses to change(Gössling, Scott et al. 2011). Furthermore, existing evidence is primarily derived from case studies (e.g. (Gössling. S., Bredberg et al. 2006; Scott, Gössling et al. 2008), the results of which may be difficult to generalize to the global tourism demand (Ceron, Dubois et al. 2009).

In recent years there has been renewed interested in tourism-climate interactions because of climate change and the expectation of significant wide-ranging changes in weather patterns (WTO 2003; UNWTO, UNEP et al. 2008). In a context of pressing climate change, there is indeed a renewed need for applications in a long term perspective, notably to estimate the economic impacts of climate change on tourism (Amelung, Nicholls et al. 2007; Amelung and Moreno 2012; ONERC 2009). It is therefore important to understand better tourists' requirements, so as to specify better range of acceptable temperatures and precipitation conditions, improve indexes like the Tourism Comfort Index (Mieczkowski 1985) and enable a modeling of tourism flows and revenues.

A wide range of methods have been used to understand the climate preferences of tourists, including expert assessments, econometric analyses, stated preferences, focus group discussions, and observed behavior (table 1).

Expert knowledge (climate indices and typologies)	Burnet 1970; Barbiere 1981; Mieczkowski 1985; Besancenot 1989; Becker 1998; Morgan, Gatell et al. 2000; Matzarakis and De Freitas 2001; Matzarakis, C.R. de Freitas et al. 2004; Moreno and Amelung 2009; Moreno, Amelung et al. submitted
Statistical correlation	Maddison 2001; Lise and Tol 2002; Hamilton, Maddison et al. 2004; Hamilton, Maddison et al. 2005; Hamilton. J. and Lau 2005; Berrittella, Bigano et al. 2006; Bigano, Hamilton et al. 2006
Questionnaire (in situ, ex situ)	Lohmann and Kaim 1999; Gomez-Martin 2006; Scott, Gössling et al. 2007; Ceron, Dubois et al. 2009; Scott, Gössling et al. 2008; Moreno 2010; Lohmann and Hübner 2012; Forland, Steen et al. 2013
Interview, focus group	Dickinson 2010
Observation/measurement	Mansfeld et al. 2004

Table 1 Overview of approaches to understand tourism and climate interrelationships

Historically, the most important approach has been the identification of links between the various components of climate/weather and the response of tourists; more recently this line of research has been extended to climate change issues. Research identifies relationships between the physical comfort of tourists and a variety of climatic variables such as sunshine, rainfall, or wind speed. Variables are combined to determine boundaries for thermal comfort/discomfort levels. These have then been used to develop indices and typologies. Climate indexes express the comfort levels of tourists, independently of location (Mieczkowski 1985; Matzarakis and De Freitas 2001; Matzarakis, C.R. de Freitas et al. 2004; de Freitas, Scott et al. 2008) or at a given location (Lin and Matzarakis 2008; Endler and

Matzarakis 2010); they occasionally take into account activities (e.g., beach comfort index) (Becker 1998; Morgan, Gatell et al. 2000; Moreno and Amelung 2009; Perch-Nielsen 2010; Moreno, Amelung et al. submitted). Typologies combine weather types (e.g. 'nice and sunny' weather) whose relative frequencies determine the climate type of the destination (e.g. dry tropical) and its suitability for different forms of tourism (e.g. beach tourism, winter sports tourism) (Yapp and McDonald 1978; Barbiere 1981; Mounier 1981; Besancenot 1989). Climate indices and typologies are usually based on expert opinions (see Gomez-Martin 2006), but even though both concepts seek to define the climatic potentials of areas or regions for tourism (Matzarakis, Geogiadis et al. 2007; Perch-Nielsen, Amelung et al. 2009; Matzarakis, Rudel et al. 2010), they have a rather low explanatory value regarding the existing geography of tourism.

A second area of research has focused on the climate choices of tourists by econometrically analyzing destination choices (Maddison 2001; Hamilton, Maddison et al. 2004; Hamilton, Maddison et al. 2005; Hamilton and Lau 2005; Bigano, Hamilton et al. 2006; Bigano, Hamilton et al. 2007; Bigano, Bosello et al. 2008; Bujosa and Rosselló 2013). Statistical data on tourism (arrivals) are analyzed with regard to weather/climate parameters, as well as other determinants of tourist flows (level of income in source countries, transportation cost, length of coastline; (Berrittella, Bigano et al. 2006). As climate parameters are expected to change, models translate these changes into subsequent changes in tourist flows (Day, Chin et al. 2013). This approach has been criticised (cf. (Gössling, and Hall 2006), for instance because national capitals are used to represent the climate of whole countries (Lise and Tol 2002) or because 'temperature' is used to represent a wide range of climate variables (Bigano, Hamilton et al. 2006). Even more importantly, it is unknown whether observed travel behavior pretended to be explained by a given set of parameters would, under various climate change scenarios, mechanically translate into actual changes in travel flows (Gössling, Scott et al. 2011) .

Another research focus has been on the perception of weather and climate, using questionnaires and surveys, either in situ or ex situ (Lohmann and Kaim 1999; Gomez-Martin 2006; Scott, Gössling et al. 2007; Scott, Gössling et al. 2008; Ceron, Dubois et al. 2009; Buzinde, Manuel-Navarette et al. 2010; Denstadli, Jakobsen et al. 2011; Forland, Steen et al. 2013)), as well as interviews (Dickinson 2010). These studies confirm that weather and climate are important factors in tourism decision-making, and that the weather experienced at the destination has repercussions for destination perception and future destination choice (Williams, Dossa et al. 1997; Scott, Gössling et al. 2008), though Lohmann and Kaim (1999) show this relationship can be subtle, not mechanic and counter intuitive: clarifying it calls for further research.

Finally, observation and measurements of actual tourist behaviour under given weather conditions have been a research focus. De Freitas (1990) and Mansfeld et al. (2004) surveyed tourists in situ (in Australia and Israel, respectively) about their perceptions of current weather conditions in beach environments, in order to compare their satisfaction ratings with simultaneous on-site weather monitoring. Both studies confirmed the importance of multiple weather parameters in determining visitor satisfaction, with de Freitas (1990) demonstrating the overriding effect of even 30 minutes of rain. Mansfeld et al. (2004) also argued that domestic Israeli tourists were more sensitive to weather conditions, suggesting climate preferences or tolerances for marginal conditions different from those of international tourists. Limitations of in situ surveys of visitor satisfaction with current weather conditions include the small range of weather conditions that can be examined without very significant personnel

costs, and the potential for response bias. Furthermore, both studies focused on beach or 3S tourism, and cannot be generalized to other major tourism environments or destinations.

This paper concentrates on the crucial point of understanding tourists' attitudes related to weather and climate as well as their importance in decision-making. It starts by presenting the results of a study on the climate preferences of French tourists, based on the national survey *Météorologie, climat et déplacements touristiques: comportements et stratégies des tourists* (Ceron, Dubois et al. 2009). This study investigates tourists' interests for weather in general and more particularly when planning a holiday, considering various climate and weather parameters including temperature, cloudiness, rainfall, wind and extreme events. With the exception of Lohmann and Kaim (1999), this is the first study representative of a population, allowing an assessment of the robustness of results relatively to other surveys, and an attempt to explain discrepancies, which is the core of the paper's argument.

2. Method

In order to identify the potential discrepancies between actual and 'perceived' weather as well as specific climatic situations (e.g. temperature, cloudiness, rainfall, wind, or extreme events) the project investigated perceptions and attitudes to weather. Based on a questionnaire, a quantitative phase was combined with subsequent focus group interviews aimed at examining more deeply the explanatory factors underpinning some answers to the questionnaire. This paper mainly refers to the quantitative dimensions of the study. The questionnaire was sent by e-mail in February 2009 to a panel of individuals. An introductory question selected the fraction who intended to travel in 2009, since the following questionnaire was referring to a real foreseen holiday plan. The 1643 usable replies were weighted (according to age, gender, educational level and place of residence) so as to obtain a sample representative of the French population using the internet.

There are a number of limitations to the study:

- the study does not reflect the opinion of those who intended to stay at home in 2009;
- Representativeness was achieved for tourists but not for stays. In order to have more accurate answers respondents were asked to refer to a particular stay they projected. Since the survey was conducted in spring, the sample overestimates summer holidays (60% of respondents), seaside tourism (56% of respondents) and the use of merchant accommodation (68% of respondents), . As visiting friends and relatives tourists is subject to some social relationship constraints that reduce the influence of weather (Hall 2005), it was however interesting to focus on the more merchant and climate-related stays.

The questionnaire commences with a preliminary question regarding sensitivity to weather/climate when choosing a holiday destination in general. Then it focuses on a particular holiday stay the respondent intends to make in 2009, with respect to:

- description of the stay;
- sensitivity of the stay to a detailed list of weather/climate parameters (both attractive and unattractive factors);
- the use of weather information services; and
- the response to climate extremes such as a heat wave or intense bad weather.

The results allow an analysis of the sensitivity of tourism to various climate parameters, a differentiation of groups of tourists depending on their sensitivity, as well as a differentiation

of the form of tourism (sport tourism, seaside tourism). Detailed results (in French) are available (Ceron, Dubois et al. 2009) on www.tec-conseil.com

3. Results

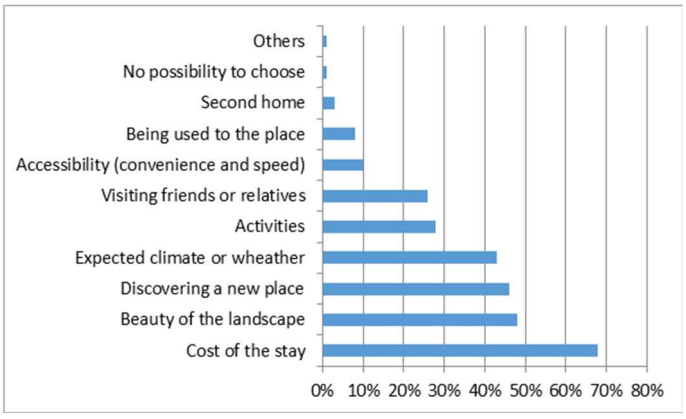
Weather and climate as a factor of destination choice

Climate and weather are considered important when a choice is to be made between destinations, ranking fourth although the level of response is far behind the most important criteria of financial cost criteria (see also (Falk 2013). However, there is some variation in response between different demographic groups. This is consistent with past surveys (Lohmann and Kaim 1999). The more sensitive include the 18-24 years old, the people having children (due to health concern or activities ?), those who live in Paris and Eastern France (characterized by a relatively humid climate: influence of climate conditions in the place of residence), and high incomes (possibly more demanding since they have greater possibilities to choose).The less sensitive include men, people in their forties and fifties, households without children, people with a monthly income less than1500...

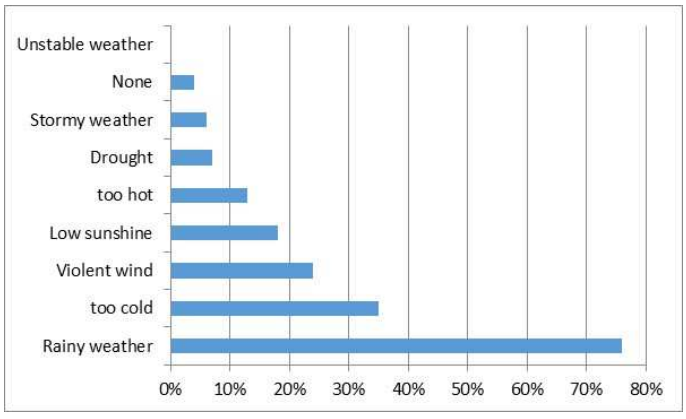
The importance of climate for the success of a stay

Less than 5% of respondents consider that adverse weather would not spoil the holiday trip they plan. The importance of weather also increases with the length of stay. Rainfall is by far seen as the most inconvenient factor (noted by 76%), before cold weather (35%)[1], windy conditions (24%) and the lack of sunshine (18%). Conversely heat (13%) and drought (7%) promote the least concern.

The most important elements for the choice of a destination
Read : 43% quote "climate or expected weather "as one of the most important elements in their decision



The weather features that could spoil the most a future stay
Read: 76% consider that "rainy weather" could spoil their stay



Source : (Ceron, Dubois et al. 2009)

Figure 1: The importance of climate and weather for destination choice and satisfaction

[1] Note that winter sports were practically excluded by the timing of the enquiry

The appreciation of excessive temperatures

The median day temperature above which respondents considers it too hot is on average 32°C Conversely, the temperature under which it is considered too cold is, on average, 14°C, which means that at temperatures over 15°C, almost half of the sample considers the temperature is too cold..

However, the answers to both questions differ according to age, place of residence, accommodation, the location of the destination (seaside…) the activities and the purpose of the visit,: see Figure 2 below. This shows how irrelevant it is to consider average temperatures across tourists as a whole.

« Pour ce séjour, à partir de quelle température ferait-il pour vous trop chaud ou trop froid en journée ? » (For this stay, from which diurnal temperature would you consider the weather as too hot or too cold ?)

The answers also differ according to age, place of residence, the type of accommodation, the location of the destination, the activities and the purpose of the visit.

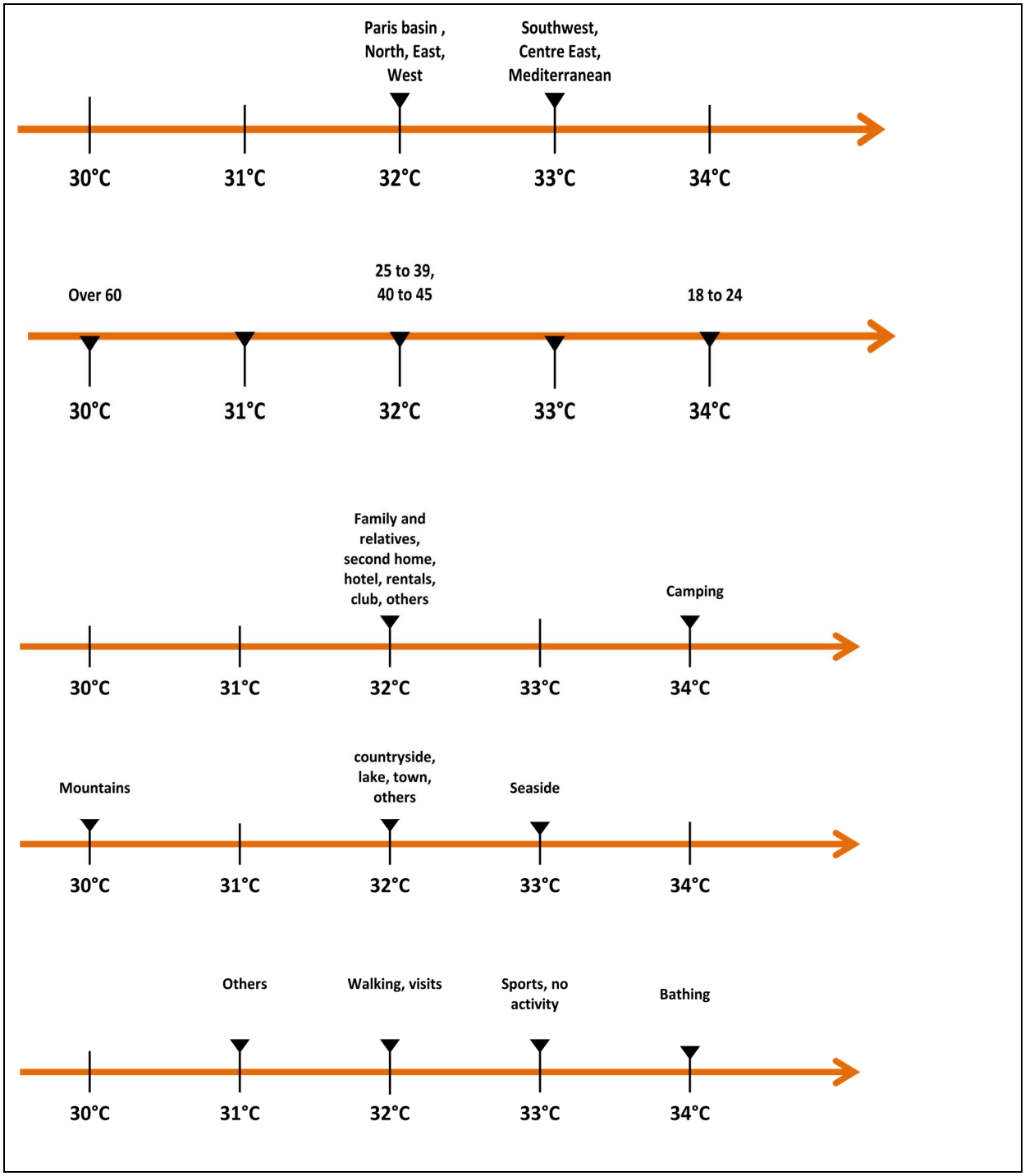


Figure 2 The temperature above which tourists consider it will be too hot during daytime, according to age , place of residence , accommodation, the environment of the stay and activities

Sensitivity to heat waves and abnormal period of rain

When asked whether they would change their plans in case of a forthcoming heat wave (several days over 35°C, with hot nights and associated drought), a vast majority of respondents answer they would not cancel the trip, change the destination or shorten the stay. More minor adaptations are preferred, such as the choice of different activities (less sport) or an air conditioned accommodation. A similar question was asked for the reactions to an abnormal period of rain, leading to much more decisions to change.

The main findings of the study, reflected in the answers to the questionnaire and confirmed and reinforced by focus groups are also useful in a climate change perspective:

- a low level of concern regarding heat waves, shown by the "too hot" threshold (32°C mean diurnal maximum temperature) and the focus group discussion (typically a "good heavy heat" i.e. "une bonne grosse chaleur " has been referred to). This is also valid for retired tourists who seem not to be aware of the degree of risk they face;
- a deep aversion to rain. Regarding this variable not only a high sensitivity exists but it also has strong effects on decisions: only 40% decide not to change their plans against 70% for a heatwave;
- this asymmetry between sun and rain, with the attractiveness of heat and the absence of concern over heat waves, was confirmed by the qualitative focus groups. This was an unexpected result as many climate change impact studies concentrate on the temperature factor. The results suggest that studies that pay attention to the risk of rain are also recommended.

4. Discussion

Results dispersion

The dispersion of results suggest that it is currently impossible to draw from the various studies on the climate requirements of tourists a reliable synthesis of benchmarks that would be usable by stakeholders to forecast the potential impacts of climate change and to adapt to such changes. Table 3 indicates some of the temperatures that have been identified in previous research and which most users usually focus on. A further difficulty with such results is that when such information is provided to stakeholders for given circumstances (place, season etc.), the variance with other studies, (though not comparable) may lead to potentially undeserved doubt on the reliability of results.

Mean	Daily		°C
	Monthly	Hamilton, Maddison et al. (2004) Lise and Tol (2002) Morgan, Gatell et al. (2000)	24 21[a] 27-30
	Quarterly		
	Annual	Hamilton. J. and Lau (2005) Bigano, Hamilton et al. (2006)	14 16
Min/Max	Diurnal max.	Gomez-Martin (2006) Ceron, Dubois et al. (2009) Rutty and Scott (2010) Clausse and Guérout (1955) Besancenot (1989)	22-28 32 37 25 33
	Daily/24h max.		
	Monthly max.		
	Quarterly max.	Maddison (2001)	30.7
	Diurnal min.	Ceron, Dubois et al. (2009) Rutty and Scott (2010) Besancenot (1989)	14 22 16-18
Optimal	Daily/24hr.	Rutty and Scott (2010) Scott, Gössling et al. (2008)	27-32 20.5[b]-26.8[c]

a – warmest month
b – urban environment
c – beach environment

Table 3: Mean, Min/Max and Optimal temperatures for tourism, as identified in the literature

Average temperatures are the most commonly found in statistical data bases, thus they are the most frequently used in models of tourism and climate change. Minimum and maximum temperatures can also be given by meteorological databases but have rarely been fed into econometric models. However, minima and maxima, as well as optimal temperatures, arguably reflect more correctly what is acceptable or what people have in mind when they answer questions on temperatures so they fit well with questionnaires and interviews.

The reason for the difference in the figures mainly lies in the methods (see Table 1) and in the type and location of the destinations covered (Table 4). The number of studies that have sufficient common points to be legitimately compared is thus restricted.

Country	Maddison 2001; Lise and Tol 2002; Hamilton, Maddison et al. 2005; Berrittella, Bigano et al. 2006; Bigano, Hamilton et al. 2006
Region,miscellaneous	Mieczkowski 1985; Besancenot 1989; Lohmann and Kaim 1999; Matzarakis and De Freitas 2001; Hamilton, Maddison et al. 2004; Matzarakis, C.R. de Freitas et al. 2004; Gomez-Martin 2006; Ceron, Dubois et al. 2009
Seaside	Burnet 1970; Besancenot 1989; Becker 1998; Morgan, Gatell et al. 2000; Mansfeld, Freundlish et al. 2004; Scott, Gössling et al. 2008; Moreno and Amelung 2009; Moreno, Amelung et al. submitted
Town	Scott, Gössling et al. 2008
Countryside	
Mountain area	Williams, Dossa et al. 1997; Scott, Gössling et al. 2008

Table 4 Destination characteristics and scale

Detailed comparison

However, to further develop the arguments with respect to implications for stakeholder understanding of results we shall focus here on a comparison between our own study (Ceron, Dubois, et al. 2009) and Rutty and Scott (2010) with the aim to show the differences in results, explaining the reasons for them and suggesting where methods need to be improved. Table 5 provides a comparison of select features of Rutty and Scott (2010) and Ceron, Dubois et al. (2009).

Selected features	Rutty and Scott (2010)	Ceron, Dubois et al. (2009)
Sample		
- Population	Students <30years old	All Internet users
- Size	N = 866	N= 1600
- Countries covered	Austria, Germany, Netherlands, Sweden, Switzerland	France
Destinations	North/East Mediterranean	All
Travel period	Year	Mostly spring and summer
Temperature results	Too hot over 37°C	Too hot over 32°C
	Too cold under 22°C	Too cold under 14°C

Table 5 Comparison between Rutty and Scott (2010) and Ceron, Dubois et al. (2009).

In terms of temperatures, the two studies give quite divergent results: a difference of 5°C for the upper threshold and of 8°C for the lower one. What potential explanations are there for such differences?

The question that was asked. Ceron, Dubois et al. (2009) use the term too hot/too cold[2] whereas Rutty and Scott (2010) use "unacceptably hot/cold" which can be seen as a stronger term and thus should push the answers to upper and lower boundaries than in the Ceron, Dubois et al. (2009) study, yet this is not the case for Rutty and Scott's (2010) "cold" threshold.
The definition of temperature. Ruty and Scott (2010) correct the answers for humidity, whereas Ceron, Dubois et al. (2009) do not. The Mediterranean climate is overall dry (except in winter and spring) and tourist flows concentrate in summer. This should push the results in terms of non-corrected temperatures more towards the extremes and thus narrow the gap between the studies.

The samples used are quite different: students for Rutty and Scott, a representative sample of the French using internet. The Ceron, Dubois et al. (2009) study shows significant differences regarding the thresholds according to age (e.g. 2°C more for the 18-24 years old (average maximum temperature of 34°C)). Also, some parts of the French population are more acclimatized to heat than people from more northern countries (Besancenot 2001; Besancenot 2007). Rutty and Scott's (2010) results do not reflect this, but it can probably be simply explained by the fact that their tourists precisely come to the Mediterranean to find heat, sometimes putting themselves at risk.

The nationality. The tourists in Rutty and Scott's (2010) study originate from Austria, Germany, the Netherlands, Sweden and Switzerland. Ceron, Dubois et al. (2009) only refer to French tourists. A few studies have shown differences between nationalities whereas others, founded on statistical data consider this phenomenon as minor (Lise and Tol 2002). Scott, Gössling et al. (2008) work on three samples of students from Canada, New Zealand and Sweden shows significant differences in their preferences when referring to beach tourism (3.6°C), less for urban tourism (0.6°C). So, although no French tourists are included in Ruty and Scott (2010)[3] one can expect their preferences to be different.

The destinations. Ruty and Scott (2010) consider the Mediterranean, though excluding southern shores (Egypt, Tunisia, Morocco) which seem particularly vulnerable to climate change (Henia 2008). They also focus on beach and urban tourism. Ceron, Dubois et al. (2009) consider all types of destinations, showing, as other studies do, differences between urban, countryside, mountain and beach environments (for the Mediterranean and elsewhere) (Lohmann and Kaim 1999; Mansfeld, Freundlish et al. 2004; Scott, Gössling et al. 2008). Ceron, Dubois et al. (2009) demonstrate in particular a better acceptance of cold temperatures regarding mountains, the countryside and lake environments, which is not really a surprise. Possibly, the thresholds are higher for the Mediterranean than for holidays on average coastlines.

	Rutty and Scott (2010)		Ceron, Dubois et al. (2009)	
	Too hot	Too cold	Too hot	Too cold
Beach	37	22	33[a]-34[c]	17

[2] « Pour ce séjour, à partir de quelle température ferait-il pour vous trop chaud ou trop froid en journée ? »
[3] Including a sample of French students would have allowed to compare the two studies and inform on whether the results are stable or not…

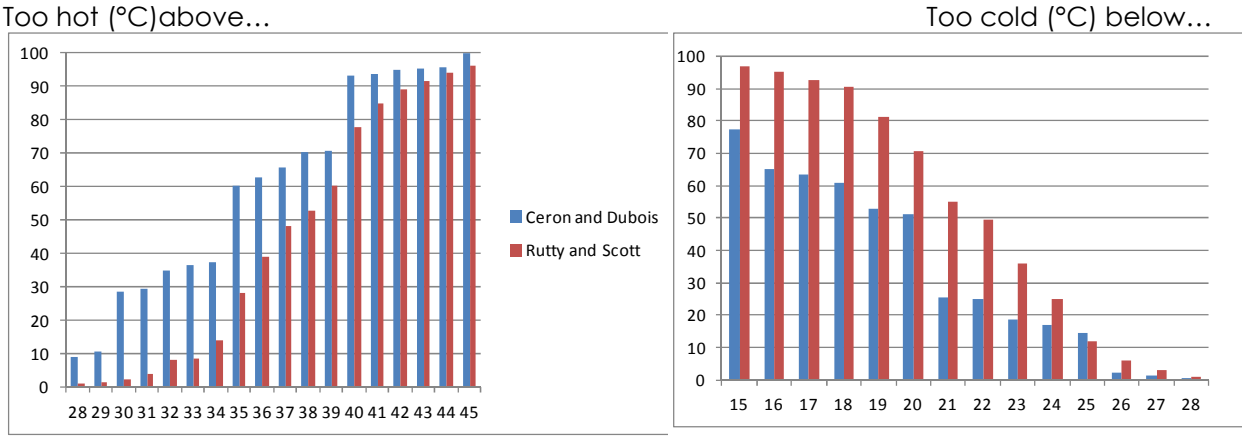
Urban	30	17	32	15
Inland lakes			32	15
Countryside			32	13
Mountain			30	9[c]

a: coastal all tourism
b: coastal, bathing
c: unreliable since the sample contains a small part of spring holidays

Table 6 Temperature thresholds (°C) according to two studies and different environments

The period of the year. The Rutty and Scott study implicitly refers to summer (beach holidays) whereas Ceron, Dubois et al also consider spring and autumn (the date of the enquiry was chosen to almost eliminate winter sports). It is possible that a larger period implies lower thresholds for cold temperatures as seen in the table above.

Figure 3 goes deeper into the comparison. The French population aged 18-24 planning a trip in a coastal resort in spring or summer is compared with the opinion of a sample of students from five Northern European countries about a potential summer trip in the Mediterranean. The differences are still very notable : the threshold of 50% of the sample is reached at 34°C with Ceron and Dubois, at 37°C with Rutty and Scott for the "too hot" question, and respectively at 20°C and 22°C for the "too cold". The French sample appears clearly less tolerant to heat (whereas it is physically better acclimated to it) and more tolerant to cold.



Source : Rutty and Scott (2010) ; Ceron, Dubois et al. (2009)

Figure 3: Share (%) of the sample declaring a temperature as too hot (or "unacceptably hot") or too cold (or "unacceptably cold")

Perception bias. The two studies (and others) share some underlying limitations, some of them inevitable when working with stated preferences. Rutty and Scott (2010) certainly heads in the right direction when they correct the temperatures given by the meteorological databases with humidity so as to render them comparable to stated preferences. Yet this probably stillfalls short of needs. Indexes such as TCI basic (Mieczkowski 1985) and improved (Harlfinger 1991; Becker 1998; Morgan, Gatell et al. 2000; Freitas, Scott et al. 2004) are more complex than the sole Humidex[4], and it is appropriate to correct for parameters other than humidity (Gates 1975; Crowe, McKay et al. 1977). For example, in considering the implications of climate change, predicting that Marseilles (France) in Spring

[4] Humidex = T + 0.555 U – 5.555, with U = vapour tension (hPa)

will cross a threshold in conditions favourable to tourism without taking into account wind conditions (the Mistral) is quite hazardous. The problem is of course the availability of the data for a multiplicity of parameters and the complexity of such exercises, should they be feasible.

The difference between perceived temperatures and those given by databases is obvious and, due to this perception bias, it is not proven that the temperatures individuals declare match those given by the databases, even if they can be corrected by taking other parameters into account. No benchmarking exercise of stated temperatures with reality has to our knowledge ever been done, whereas benchmarking in other domains is considered as a prerequisite. Whether tourists over or under estimate the actual temperatures, and to what extent, is a mystery, seemingly difficult to solve.

Investigating through ex situ questionnaires has the advantage of easing the access to large and potentially representative samples compared to in situ studies through interviews. The drawback is that the researchers have a poor cognition (if any) of the contextual conditions the tourists have in mind (consciously or unconsciously) when they answer. Moreover in ex situ studies tourists are questioned in very abstract conditions (distance and time), possibly on destinations they have never experienced. Referring to a trip they plan (as in Ceron, Dubois et al. (2009)) certainly renders the prospects more concrete but is far from solving the problem. All the more that the "average daily temperature" is a constructed abstract notion as individuals perceive a series of temperature during the day (e.g., fresh in the morning, hot on the beach, then more acceptable in the shade). A possible option may be that surveys more explicitly refer to weather forecasts, with questions like "from which temperature as announced by your weather service would you consider the situation as too hot?"

5. Conclusion

From a substantial representative sample of the French population (using Internet), coupled with some focus groups allowing a more in-depth understanding of motivations, this research has provided some robust evidences of the climate perceptions and preferences of tourists. Results highlight the asymmetry between heat, generally perceived as positive or neutral, and rain, clearly repulsive for tourism. They also allow a better understanding of factors (age, type of tourism stay, accommodation, place of usual residence) affecting this sensitivity to weather and climate. Recommendations concern further research on climate preferences, but also the use of this knowledge in the modelling of the economic consequences of climate change.

First, when comparing recent studies dealing with the temperature thresholds for tourism, the clear conclusions are that

- their findings cannot be conveniently extended to other populations, destinations and environments;
- in order to adequately generalise, in studies of stated climate preferences, an international study using strictly common methodologies and representative samples across destinations and populations would be needed;
- it is preferable to account for a set of factors (temperature, precipitations, etc.) rather than on the sole temperature parameter to express climate preferences. The use of complex indexes such as the Tourism Comfort Indexes and the new generation of derived indexes is useful, all the more if these indexes are adapted to different forms of tourism;

- methods to define such indexes should combine stated preferences and expert knowledge.

Second, having shown the shortcomings of our knowledge, the pending question is whether the scenarios that can be built for the future (Amengual, Homar et al. 2012; Amelung and Viner 2006; Cavan, Handley et al. 2006; Forland, Steen et al. 2013) make enough sense and are useful to stakeholders. Naturally this does not question the large agreement on the idea that climate change will deeply impact tourism (UNWTO, UNEP et al. 2008), but it does question to some extent the utility and validity of the information that can be provided (Gössling & Hall 2006).

As explained above, the difference regarding the "too hot" threshold is of 3°C, for similar surveys and similar samples (e.g. 18-24 years people in seaside tourist stays by the coast), can be explained by slight differences in samples, in the way questions are formulated or in the interview protocol. Are any of the two estimates reliable enough to be fed into scenarios? The 3°C uncertainty is actually of the same order of magnitude as the increase in temperature in the climate change scenarios (e.g. for A1B used by Rutty and Scott (2010): 2.5°C for 2046-2065, 4.5 to 6.5°C according to seasons for 2080-2099). Rutty and Scott (2010) deal with the modelling of climate conditions in five beach destinations in the Mediterranean: Lanarca (Cyprus), Milos, Antalya, Nice and Gerona. Out of these, two are already "unacceptably hot" in July and August; four become so by the end of the century. Reducing by 3°C the level of the threshold would suggest that also Nice and Milos are already too hot in July and August (Rutty and Scott 2010). All five destinations would be "too hot" by the end of the century (some being perceived probably as "far too hot"). This also extends the period of unacceptability by one or three months in the east Mediterranean (Rutty and Scott 2010). Considering such a degree of uncertainty would lead to a shift in conclusions: they would rather be that the Mediterranean is already too hot for beach holidays in the peak period, but the sample of tourists (if they care) accept it. Whether the increase in temperatures will lead to some future tipping point or whether such a tipping point will be related to factors other than temperatures remains a question no mechanistic modelling can answer.

The above discussion reminds there is a difference between the assessment of the modifications of natural ecosystems under climate change and that of the affects of climate change on human activities, among which tourism can be considered as an iconic example (Scott et al. 2012). The reactions of elements of an ecosystem (e.g. birds) can, at least at first glance, be seen as more predictable: at a macro-temporal and spatial scale when the climatic conditions change, the boundaries of the species will follow (as far as they can) (Dormann 2007). However, complex the process may be, it remains mechanical in nature because of the incapacity of birds to change their immediate habitat and environment. In contrast, the reaction of tourists depends not only on climatic conditions that are not limited to the temperatures and on which they can act (the generation of artificial environments: e.g. snowmaking). The response also depends on the representations they have of climatic items and how they translate such representations into decisions and behaviours. This explains that physical conditions and expert judgment are less apt to be fed directly into scenarios than they are in other domains. We need sufficient information on the representations and on their translation into decisions to proceed.

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