A NEW GENERATION CLIMATE INDEX FOR TOURISM

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ABSTRACT

Climate is important to tourism, but the relationship between the two is complex. This is because of the multifaceted nature of climate and the complicated way these variables come together to give meaning to a particular weather or climate condition for tourism. Researchers have attempted to tackle the problem by integrating relevant climate and tourism variables into a single index for ease of interpretation. However, these indices have been largely reliant on subjective judgements of the researcher(s) and not validated through field investigation. In the present study we aim to address this limitation by devising and then testing a theoretically informed and practically useful climatic index for tourism. The Climate Index for Tourism (CIT) can be derived using either standard climate data or, for short-time forecasts, weather variables. In either case the CIT relies on actual observations rather than on averaged data. The CIT combines three conceptual attributes of climate for tourism and recreation: the thermal, aesthetic and physical/mechanical. Unlike some existing climate indices for the tourism-recreation sector that rated the climate for broad-based "cultural tourism" or "urban tourism", the CIT rates the climate resource for activities that are highly climate/weather sensitive (e.g., beach holidays, resort tourism, water-based sporting holidays). The theoretical basis and structure of CIT are explained and the results of a preliminary validation exercise presented.

KEYWORDS: *Tourism climate index, Tourism climate, Recreation climate, Destination image*

INTRODUCTION

Climate is a dominant attribute of a tourist destination and has a major effect on tourism demand and satisfaction, but its relationship with tourism is complex. Because of this, considerable effort

has gone into devising climate indices that summarise the significance of climate for tourism. An index approach is required because of the multifaceted nature of weather and climate and the complex ways they come together in a social and cultural context to give meaning to a particular weather or climate condition for tourism.

An important limitation of most existing climate indices for tourism is that their rating schemes for individual climate variables and the weighting of climate variables in the index were largely based on the subjective opinion of the researcher(s) and not empirically tested on tourists or within the tourism marketplace. Other weaknesses of existing indices stem from their failure to address the essential requirements of an ideal index, which are discussed in detail later in this paper. In the present study we aim to address the deficiencies of past indices for tourism by devising a theoretically informed and practically useful climatic index called the Climate Index for Tourism (CIT). CIT facilitates interpretation of the integrated effects of climate and has a range of possible applications for both tourists and the tourism industry. Tourists and tour operators could use CIT to select the best time and place for a vacation travel or plan activities appropriate to the expected climate. Tourism planners could use the index to promote visitation outside the peak period and, if necessary, discourage it during the peak; or it could be used to assess the potential visitor numbers to assist in planning resort development programmes. The index, having validated the current climate preferences of tourists, could also be used to assess possible impacts of climate change on the climate resource of tourism destinations worldwide.

ESSENTIAL CHARACTERISTICS OF A NEW GENERATION INDEX

Rather than simply build on previous climate indices for the tourism, we began this study by considering the essential characteristics of a theoretically sound and practically useful index. After a detailed review of the literature and consideration of the needs of tourism stakeholders, six essential characteristics for a new generation climate index were identified:

1) Theoretically sound

A new generation index must incorporate the results of recent multi-disciplinary research (tourism, biometeorology, resource management, psychology, geography) that has contributed to an improved understanding of tourism-climate relationships.

2) Integrates the effects of all facets of climate

Tourists respond to the integrated effect of various facets of climate (1, 2). De Freitas (2) identified these facets the *thermal*, *physical* and *aesthetic* (Figure 1). Analysis of the *thermal* facet involves three steps. i) Integrate the factors that influence the body-atmosphere thermal state using a method

that takes account of both the attributes of those exposed and the functional attributes of the environment. Ideally this would include the following variables: air temperature, humidity, wind, solar radiation and nature of the physical surroundings, and for the body, level of activity and clothing. ii) Provide a rational index with sound physiological basis that adequately describes the net thermal effect on the human body. iii) Identify relationships between the thermal state of the body and the condition of mind that expresses the thermal sensation associated with this state. There are a range of methods to analyse the thermal facet. To maximize flexibility and potential application, the index should be able to accommodate input from any analysis of the thermal facet. To achieve this, the final output of the thermal facet of the index is expressed using the internationally standardised and recognised ASHRAE thermal sensation scale (see column [A] of Table 1). The physical facet covers meteorological elements such as rain and wind that directly or indirectly affect tourist satisfaction other than in a thermal sense. The occurrence of high wind, for example, can have either a direct mechanical effect, causing inconvenience (personal belongings having to be secured or weighted down) or an indirect effect such as blowing sand along the beach causing decreased staisfaction. The aesthetic facet relates to the appealing attributes of the non-thermal and non-physical components of the atmospheric environment. Included within this category are factors such as sunshine or cloud.

3*) Simple to calculate and uses readily available data*

To maximize application, the index should be designed so that it can use either standard climate data or, for short-time forecasts, weather variables. In either case, the index should rely on actual observations rather than on averaged data. The temporal resolution of climatic data must be daily, in order that the index values can be expressed as probability estimates of likelihood of occurrence (e.g., there is a 90% chance of experiencing 'ideal' conditions during each day of a specified holiday period).

4) Easy to use and understand

Importance should be placed on the nature and form of the index output, which should be presented in a form that can be readily interpreted and understood by users in the tourism-recreation sector. Much research has been done on the international application and communication of the UV index and the lessons learned about the simplicity of the rating system and messaging are highly applicable to designing a climate index for the tourism-recreation sector. The end product of the index should be a rating system with five to seven classes, with clear descriptors of the quality of the climate conditions for the tourism activities the index was specifically designed for. In the case of CIT, the highly climate/weather sensitive activities of beach holidays are the focus.

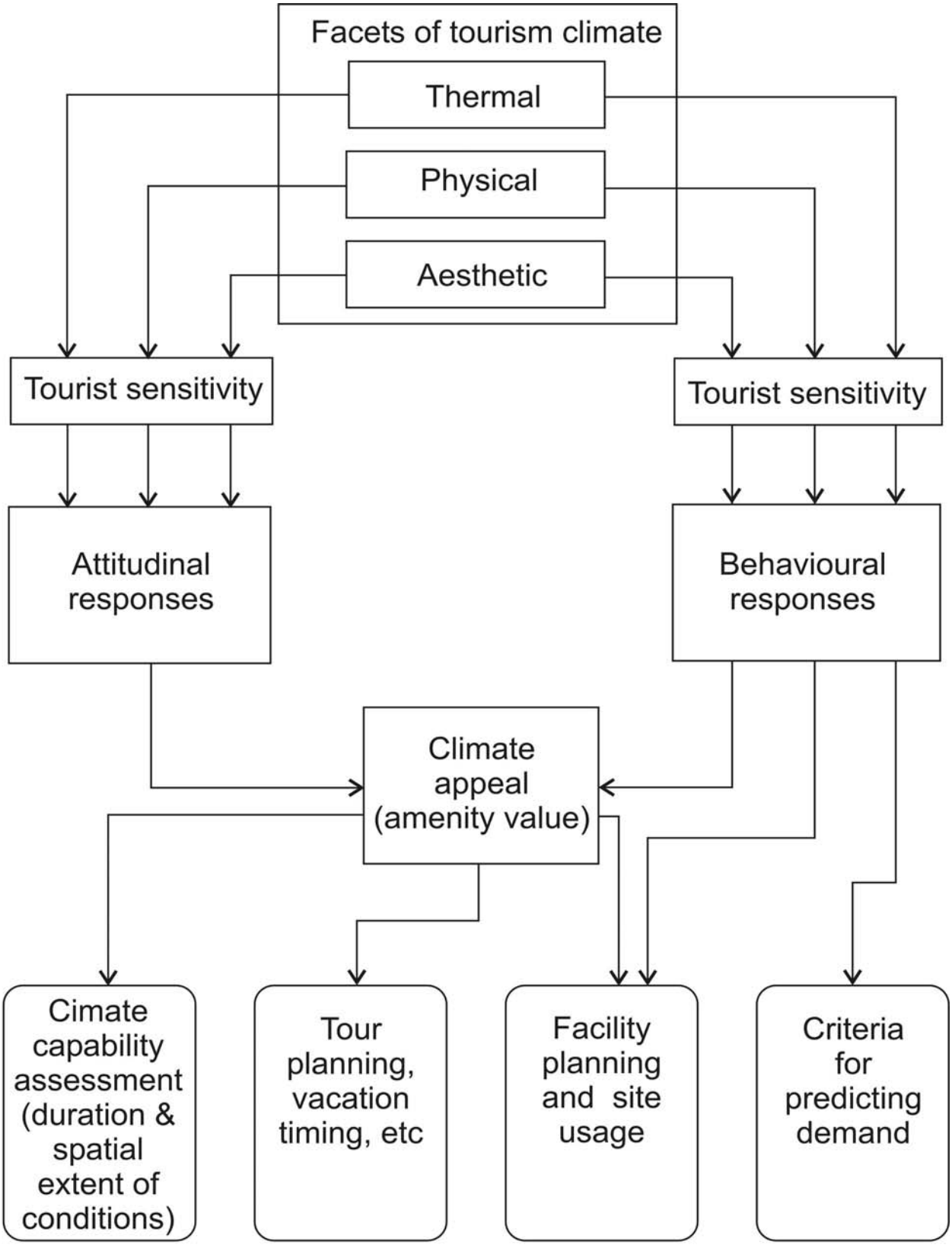

Figure 1: Various facets of tourism climate, their significance and impact (from 1)

5) Recognise overriding effect of certain weather facets

This requirement takes into account that the combined effect of a given weather or climate condition is not necessarily the sum total of its various facets. Under certain conditions and at certain thresholds, the physical facet has an overriding influence on the thermal and aesthetic facets. For example, heavy rain or high winds will cause people to leave the beach even if the thermal conditions are excellent and the sun is shining. No previous climate index for tourism and recreation recognized this overriding characteristic of the physical facet and thus tended to overrate days when rain or wind dominated.

6) Empirically tested

Unlike most previous climate indices for the tourism-recreation sector, the performance of the index and its thresholds should be validated against measures of tourist satisfaction with weather climate conditions. Index validation presents several challenges. Use of the usual 'demand' indicators such as attendance/visitation numbers, traffic flows, or campsite / motel occupancy rates can be inappropriate. This is because these are not necessarily a measure of tourist satisfaction with climate conditions. For example, peak demand is strongly influenced by state holidays (institutional seasonality), not just climate (natural seasonality). In fact, peak demand is observed to sometimes occur outside of the period when optimal climate occurs (2, 3). This means statistical models of climate and tourism demand can be calibrated to non-optimal climate and thus may not predict 'optimal climate for generating tourism' as claimed. Self-reported tourist satisfaction with climate is a more reliable 'validator' for a tourism climate index. It is also important that a climate index for tourism be cross-culturally validated, as climatic preferences might differ.

STRUCTURE OF CIT

CIT is an integrated index for tourism and recreation that rates climate and weather along a favourable-to-unfavourable spectrum. It is defined as:

$$CIT = f\,[(T, A) * P]$$

where T is a measure of thermal sensation using the ASHRAE scale (column [A] in Table 1), A is the aesthetic appeal of the sky condition ranging from clear to overcast (column [B+C] in Table 1), and P is the physical thresholds of high wind and rain (column [D+E] in Table 1). Thermal and aesthetic states are combined in a holiday weather typology matrix to produce a climate satisfaction rating class, ranging from 1 to 7 (Table 2). If either physical threshold is exceeded, then P over-rides T and A to reduce the satisfaction rating.

Table 1: CIT ratings (1 to 7) based on thermal state of the human body expressed as thermal sensation (TSN) on the standard ASHRAE scale, the aesthetic quality (cloud/sun), and physical factors (wind and rain). Bold values are theoretical ratings based on the work of de Freitas (2). Bracket values are ratings based on a limited validation exercise from an interview survey using the questionnaire shown as Table 3

ASHRAE TSN [A]	Cloud ≤ 0.4 (n/N ≤ 0.4) [B]	Cloud ≥0.5 (n/N ≥ 0.5) [C]	Rain (>3mm, or >1hr duration) [D]	Wind ≥ 6 m s^{-1} at ground [E]
Very hot	**4** (3.8)	**3** (3.1)	**2**	**2**
Hot	**5** (5.4)	**3** (4.2)	**2**	**2**
Warm	**6** (6.2)	**4** (4.6)	**2**	**2**
Sl. Warm	**7** (5.8)	**5** (4.0)	**2**	**2**
Indifferent	**6** (5.0)	**4** (3.2)	**2**	**2**
Sl. Cool	**4** (3.4)	**3** (2.2)	**2**	**2**
Cool	**3**	**2**	**1**	**1**
Cold	**2**	**1**	**1**	**1**
Very cold	**1**	**1**	**1**	**1**

Table 2: CIT rating scale and interpretation for holiday travel or tourism development

Satisfaction Class		
1	Very poor	Unacceptable
2	Poor	Unacceptable
3	Fairly poor	Marginal
4	Okay	Suitable
5	Fairly good	Good
6	Good	Excellent
7	Very good	Ideal

The initial development of the climatic thresholds and satisfaction ratings (bold font in Table 1) for the CIT were based on the work of de Freitas (2, 4). In this detailed work, beach users were interviewed on-site over a period of 18 months and their responses compared with detailed climate data monitored on-site. De Freitas (2) showed that ideal atmospheric conditions are those producing "slightly warm" conditions in the presence of scattered cloud (0.3 cover) and with wind speeds of less than 6 m s^{-1}, and that rain of greater than 30 minutes duration or wind speeds of over 6 m s^{-1} had an overriding effect on reducing tourist satisfaction. Cloud cover greater than about 0.4 had the effect of reducing the aesthetic appeal of the weather condition for the beach user by 30%. The occurrence of wind greater than or equal to 0.6 m s^{-1}, or the occurrence of more than half an hour of rain or 1 mm had an overriding effect on CIT.

The work by de Freitas (2, 4) identified the contribution of the thermal component to the overall climate rating by first using a detailed body-atmosphere energy balance model to describe the net thermal state in calorific terms, which, in turn, were correlated with the standardised ASHRAE scale thermal sensation responses (TSN). Based on these findings, the contribution of the thermal component of CIT (CIT_{TSN}) is given by:

$$CIT_{TSN} = 6.4 + 0.4\ TSN - 0.281\ TSN^2$$

The effect of cloud cover greater than about 0.4 reduces the aesthetic appeal of the weather condition for the beach user by 30%. The occurrence of wind great than or equal to 0.6 m s^{-1}, or the occurrence of more than half an hour of rain or 1 mm had an overriding effect. The thermal, aesthetic and physical states are combined in holiday weather typology matrix to produce CIT index rating in classes 1 to 7 shown in Table 1.

Table 3: Beach weather questionnaire

The aim of this questionnaire is to identify levels of satisfaction with beach weather.
Assume you are at the beach, how would you rate each of the following weather scenarios using the scale:

1 = Very poor; **2** = Poor, **3** = Fairly poor; **4** Just OK; **5** = Fairly good; **6** = Good; **7** = Very good

Slightly cool weather	Lots of blue sky visible	Rating: 1..2..3..4..5..6..7
Indifferent	Lots of blue sky visible	Rating: 1..2..3..4..5..6..7
Slightly warm weather	Lots of blue sky visible	Rating: 1..2..3..4..5..6..7
Warm weather	Lots of blue sky visible	Rating: 1..2..3..4..5..6..7
Hot weather	Lots of blue sky visible	Rating: 1..2..3..4..5..6..7
Very hot weather	Lots of blue sky visible	Rating: 1..2..3..4..5..6..7
Slightly cool weather	Most of sky cloud covered	Rating: 1..2..3..4..5..6..7
Indifferent	Most of sky cloud covered	Rating: 1..2..3..4..5..6..7
Slightly warm weather	Most of sky cloud covered	Rating: 1..2..3..4..5..6..7
Warm weather	Most of sky cloud covered	Rating: 1..2..3..4..5..6..7
Hot weather	Most of sky cloud covered	Rating: 1..2..3..4..5..6..7
Very hot weather	Most of sky cloud covered	Rating: 1..2..3..4..5..6..7

You are at the beach and it rains for about an hour and you do not know when or if it will stop, are you likely to leave the beach? Yes / No

You are at the beach and wind is a nuisance. For example, it blows personal belongs away, blows sand onto your beach towel, into your clothing, food and drink. Are you likely to leave the beach? Yes / No

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VALIDATION OF CIT

The work of de Freitas (2) reported on the results of empirical field data to identify the main components of tourism climate and climatic thresholds that affect tourist satisfaction for beach activities. To build on these results and examine how tourists discriminate between the finer

amenity attributes of weather types, questionnaire surveys in controlled settings were used to measure satisfaction for a range of hypothetical atmospheric environmental conditions. A prototype questionnaire was developed and tested on 20 respondents for clarity, ease of use and timing. The final version of this survey is shown in Table 3. A preliminary survey of 34 adults was conducted in Southern Ontario, Canada during May 2004. The results of this preliminary analysis are shown in Table 1. While very preliminary, the findings were positive, as the stated satisfaction ratings of the sample group (brackets in Table 1) approximated the theoretical satisfaction ratings (bold font in Table 1) based on the field work of de Freitas (2). Further cross-cultural testing is underway with surveys being conducted in Australia, Canada, Germany, Hungary, Italy, New Zealand, Portugal and the United Kingdom as part of a collaborative project by members of the International Society of Biometeorology's, Commission on Climate, Tourism and Recreation.

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