Theory, Concepts and Methods in Tourism Climate Research

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Abstract
It is generally accepted that climate is an important part of the region's tourism resource base, but its role in determining the suitability of a region for tourism is often assumed to be self evident and therefore to require no elaboration. Relatively little is known, other than in very general terms, about the effects of climate on tourism or the role it plays. And even less is known about the economic impact or significance of climate on commercial prospects for tourism. The whole area involving which climate related-criteria people use to make decisions about tourism and recreation choices is largely unresearched, but highly relevant to a variety of applications. Thus far, much of the research specifically on climate reported in the journal literature has been superficial in that relationships between climate and tourism are assumed rather than observed and seldom objectively tested. Moreover, the research is largely devoid of any clearly structured conceptual framework or frameworks that embrace important theory, paradigms, processes and interactions. These theoretical frameworks are important because they provide a basis for data generation, hypothesis testing and further theory generation. Without this, it is difficult to develop a coherent set of research methods; and perhaps more importantly, develop models that constitute a bridge between the observational and theoretical levels that can assist is building a coherent knowledge base for understanding, explanation and prediction. This paper reviews the work so far on climate and tourism with a view to identifying what concepts and theoretical frameworks may already exist and looks to ways these may be drawn together in future research.

INTRODUCTION

Tourism is one of the world's biggest industries. It is also the fastest growing. For many regions tourism is the most important source of income, for others the potential economic returns from tourism development are enormous. In these places it is generally accepted that climate is an important part of the region's tourism resource base, but the role of climate in determining the suitability of a region for tourism or outdoor recreation is often assumed to be self evident and therefore to require no elaboration. Relatively little is known, other than in very general terms, about the effects of climate on tourism and outdoor recreation or the role it plays. And even less is known about the economic impact or significance of climate on commercial prospects for tourism.

The whole area involving which criteria, including climate related-criteria, people use to make decisions about tourism and recreation choices is largely unresearched, but highly

relevant to a variety of applications. Thus far, much of the research specifically on climate reported in the journal literature has been superficial, in that relationships between climate and tourism are assumed rather than observed and seldom objectively tested. Moreover, the research is largely devoid of any clearly structured conceptual framework or frameworks that embrace important theory, paradigms, processes and interactions. These theoretical frameworks are important because they provide a basis for data generation, hypothesis testing and further theory generation. Without this, it is difficult to develop a coherent set of research methods; and perhaps more importantly, develop models that constitute a bridge between the observational and theoretical levels that can assist is building a coherent knowledge base for understanding, explanation and prediction. This paper reviews the work so far on climate and tourism with a view to identifying what concepts and theoretical frameworks may already exist and looks to ways these may be drawn together in future research.

CONCEPTS AND TERMS

Definitions

The study area labelled *tourism climatology* deals with the concepts of "climate" and "tourism" in the broadest sense. Climate invokes the concept of "weather" in that it is defined as the accumulation of daily and seasonal weather events over a long period of time, where weather is the condition of the atmosphere at any particular time and place. "Tourism" embraces the concept of "recreation" in that it is the practice of travelling for recreation, where recreation is defined as an activity in which individuals voluntarily engage for personal satisfaction or pleasure. Thus, in broad terms, there are elements of equivalence in the dual terms *weather* and *climate* on the one hand, and *tourism* and *recreation* on the other. They are often used interchangeably in tourism climate research, which may be broadly defined as the study of interrelationships of tourism and recreation with climate and weather.

Weather and climate as a natural resource

Together with geographical location, topography, landscape, flora and fauna, weather and climate constitute the natural resource-base of a place for recreation and tourism. The concept of tourism climate recognises a climatically controlled resource, which along with weather, according to Hibbs (1966), can be viewed as a recreational resource which at various times and locations may be classified along a favourable-to-unfavourable spectrum. Thus climate is a resource exploited by tourism, and the resource can be measured. In this way climate can be

treated as an economic asset for tourism. The asset can be measured and the resource is capable of being assessed. But there are numerous problems.

One major problem is selection of meteorological or climatological criteria. For example, what exactly are the criteria for *ideal*, *suitable*, *acceptable*, or *unacceptable* conditions? Only after appropriate climatological criteria have been clearly identified can key questions be answered. When is the best time to visit? What clothing equipment is needed? What are the weather hazards or climate extremes likely to be?

Weather and climate as limiting factors in tourism

The characteristics of weather and climate are not necessarily determinants of tourism but constitute an important factor in both financial terms for tourism operators and the personal experiences of tourists. Various places in the world have a "tourism potential" and weather and climate set limits. For example, tourism administrators do not promote places with a little potential or appeal, as this would not be profitable. On the other hand, the tourist who chooses to visit such places would suffer inconvenience (e.g. transport costs) or discomfort (e.g. heat or cold stress). Financial loses can also result from weather variations and changes. Rainy summers or less snowy winters can have significant impacts on tourism.

Climate data

The type of climatic data and manner it is presented in tourism climate research depends on the purpose of the work. Information can be used by 1) the tourist planner, 2) the tourist operator and 3) the individual tourist. For example, a ski facility planner needs information on the length of snow season, whereas skier wants seasonal distribution of probabilities that a skiable depth of snow will exist at a particular location and time. A planner for a tropical island resort planner needs to know the length period of acceptable weather for tourists. Prospective tourists need to know when and where conditions will be optimal, acceptable, tolerable, or unacceptable.

Climate data must be presented in a form that relates to the individuals response to weather or climate conditions. That is *events* rather than *averages*. Average have no physiological or psychological meaning. Data should give an impression of the likelihood of occurrence of the climate/weather conditions (events). Data should reflect the fact that individuals respond to the integrated, combined effects of weather elements (thermal, physical, aesthetic etc). Equal importance should be given to the nature and form of output data. It should be presented in a form that can be readily interpreted and understood by the

user. Often we have to rely on standard meteorological or climate station data, which may not be representative of the recreational area - valleys, peaks, hills, coast, beach etc. Climate station-data are intended to be representative of the bottom of atmospheric column rather than a particular microclimate or location such as beach, park or ski slope.

Weather and climate as factors in tourism and recreation 'demand'

Given that recreation is an activity in which individuals freely engage for personal satisfaction or pleasure, recreation is voluntary behaviour proceeding from one's own free choice. As a result, participation will only occur if the potential participant perceives the climate condition to be suitable. The voluntary and discretionary nature of recreation means that participation will decrease as discomfort and dissatisfaction increase. Thus satisfaction affects participation, which can be taken as a measure of demand for the climatic resource, the called "demand factor." Examples of indicators of demand in this context are visitation or attendance numbers (Paul, 1971; de Freitas, 1990) and hotel/motel occupancy or hotel "tourist nights" (Rense, 1974).

The climate or weather circumstances to which the recreationist or tourist may react or respond (i.e. those that affect decisions) are 1) conditions anticipated by the tourist (say, gleaned from weather\ climate forecasts, travel brochures etc) and 2) on-site weather. These are collectively referred to as human responses to weather and climate. They can be identified and assessed using "demand indicators".

There are two categories of methods for assembling data on human response to climate and thus the demand for the climate resource. 1) Assess conditional behaviour, such as by using questionnaires and images (e.g. Adams, 1971) to determine how people may react or think, which includes assessing influence or role of weather or climate forecasts. 2) Examine on-site experience. Since individuals are experiencing conditions first hand, the latter is more reliable. Ideally, the approach must be activity specific. And it is best not to lump all tourism together, but deal with specific categories of activities, either a) *active* or b) *passive*. Sightseeing (touring) is regarded to be the most common tourist activity.

APPLICATIONS

Potential applications of tourism climate research are diverse and sundry. They depend on what is required by planners, members of tourism industry and tourists themselves. Climatologists need to translate the technical work of researchers (climatologists) into simple

language and explain this in uncomplicated terms for use by planners, tourist operators etc. Methods used should be transparent as well as simply expressed and clearly explained. Above all, planners require climate data that is quality-checked, easy to use [i.e. well sorted]. Applications aimed directly at the tourist involve, among other things, the role of climate in considerations of destination choice - especially in relation to increasing use of the Internet.
Other applications include:

- Provide information on the length of period recreational facility will operate.
- Provide standardised climatic information to assist choice on where and when to go for a holiday, or basis for selecting an alternative activity
- Provide information for publicity campaigns to condition tourist expectations of climate at given locations.
- Describe changed opportunities because of climate change.
- Given an understanding of how weather/climate affect on-site behaviour, businesses can plan to meet demand for certain activities.
- Forecasting on-site conditions.
- Advisory services to inform travellers of what to expect (thermal conditions, cloud, rain, extremes etc).
- Provide climate information that can be used to affect the "climate image" of a destination ('destination image').
- To help tourists to bring together expectations of climate at a place and actual climate at that place.
- Guide how particular destinations are marketed to potential visitors.
- Provide information on period tourist facility will operate.

APPROACHES TO TOURISM CLIMATOLOGY

Most research on tourism climate appears to be motivated by the potential usefulness of climatological information within planning processes for tourism and recreation. The research addresses the theme of tourism climate as an adjunct to a variety of decision making processes ranging from those related to such things as the development and location appropriate recreational facilities, or determining the length of the recreation season during which a facility will operate, to those as specific as planning future activities involving personal decisions of when and where to go for a holiday.

There has also been interest in the indirect effects of climate. For example, Perry (1972) suggested that people leave swimming pools and golf courses on wet days and converge on nearby towns in search of amusement indoors. Therefore, depending on the weather sensitivity of the recreational activity, climatic information can help in the planning, scheduling and promoting of alternative indoor entertainment facilities. Perry (1972) also describes the use of climatic information in publicity campaigns to condition tourists' expectations of climate at a certain locations.

In this context, considerable effort has gone into devising numerical indices of climate that summarise the significance of climate for tourism (Peguy, 1961; Poulter, 1962; Fergusson, 1964; Rackliff, 1965; Hughes, 1976; Davis, 1968; Murray, 1972; Mieczkowski, 1985; Harlfinger, 1991; Becker, 1998). This is because of the multivariable nature of climate and the complex way they come together to give meaning to a particular weather or climate condition in terms of recreation or tourism. These indices facilitate interpretation of the integrated effects of various atmospheric elements and permit places to be compared. The problem is all of these is climate ratings are arbitrary as non have been empirically tested, with the exception of study by Harlfinger (1991).

It is clear, however, that if climatic information is to be useful in decision-making, it needs to be presented in a form appropriate to the problem. Tourists respond to the integrated effects of the atmospheric environment rather than to climatic averages. It is generally accepted, therefore, that standard weather data or even secondary climatic variables are not always reliable indicators of the significance of atmospheric conditions. At any given air temperature, for example, the thermal conditions experienced will vary depending on the relative influence and often offsetting effects of wind, humidity, solar radiation and level of a person's activity. Moreover, the design of a particular thermal assessment scheme will depend on the intended use as well as on the nature of the thermal climatic conditions to which the scheme is to be applied. For example, schemes have been devised for groups of runners (de Freitas et al, 1985), survival in climates of extreme cold (de Freitas and Symon, 1987) and for general purposes of human climate classification (Auliciems, de Freitas and Hare, 1973; Auliciems and Kalma, 1979; de Freitas, 1979, 1987). The importance of this has been recognised in climate-recreation research (Terjung, 1968; Bauer, 1976; Reifsnyder, 1983), but so far there have been few convincing studies aimed at to identify optimal or preferred conditions for various outdoor recreational activities. There have been even fewer that examine the sensitivity of tourism to atmospheric conditions generally.

Several writers have described tourism climate in terms of human response in preference to traditional taxonomic methods of portraying regional climates (Green, 1967; Davis, 1968; Murray, 1972; Maunder 1972; Crowe, McKay and Baker, 1973, 1977a, 1977b; Findlay, 1973; Crowe, 1976; Gates, 1975a, 1975b: Masterton, Crowe and Baker, 1976; Masterton and McNichol, 1981; Smith, 1985). In some cases, as in the work of Paul (1972), simple climatic indices such as the Thom Discomfort Index and the Wind Chill Index have been computed from climatological data and, in the case of Green (1967), generalised quantitative summations of weather variables arbitrarily weighted have been employed. Other researchers such as Terjung (1968), Danilova (1974), Bauer (1976) and Yapp and MacDonald (1978) have used more sophisticated measures of tourism climate based on the body's thermal exchanges with the environment. Mieczkowski (1985) has devised a broadly based climatic index for evaluating world climates for tourism. However, meaning attached to these measures has been secondarily derived and interpreted without field investigation.

It was with the above in mind that the work by de Freitas (1990) set out to examine, by way of a case study in Australia, methods capable of giving information that can be used to appraise and rate recreational climates in terms of user sensitivity and satisfaction. Ideally, given the complexity of the problem of addressing the amenity role of climate, the research should concentrate initially on a well-defined human activity; preferably one that is clearly linked with amenity resource attributes of the atmospheric environment. These requirements are fulfilled by a variety of outdoor recreational activities of which beach recreation appeared to be the most appropriate. There are several reasons for this. 1) Beach recreation is an activity in which the human body is usually lightly clad and therefore directly exposed to atmospheric elements. 2) Beach users in Australia are normally clustered in a relatively small area (patrolled by lifeguards). Therefore, sample populations can be readily observed, and the compact area facilitates on-site monitoring of atmospheric and associated environmental variables representative of ambient conditions. 3) For the beach user, individual recreational aims or objectives of the occasion are similar. From a research standpoint these characteristics offer a relatively controlled situation. 4) Beach use is among the most popular of outdoor recreational activities in Australia and elsewhere as measured by beach attendance figures. Thus, greater knowledge of the influence of climate on beach recreation is likely to be economically important to the coastal recreation industry.

Two broad categories of questions exist around which the investigation was built (de Freitas, 1990). Since the heat balance of the body is fundamental to assessments of human climates, the first category involves specification of the thermal environment.

1) Given methods of body-environment energy budgeting, how are outdoor thermal conditions best quantified?
2) How should thermal index values be interpreted?

The second category of questions centres on assessing the atmospheric resource generally in terms of recreation.

1) What thermal atmospheric conditions are those most preferred for (beach) recreation?
2) To what extent is the level of (beach) user satisfaction influenced by non-thermal atmospheric conditions?
3) What are the relationships between atmospheric conditions and participant satisfaction?

CONCEPTUAL FRAMEWORKS

Human response to climate is largely a matter of perception, with the exception of the thermal component. Thus some climate variables are entirely *physical* (e.g. rain), some are *physiological* (e.g. air temperature), some are *psychological* (e.g. clear blue skies) and some are *combinations of all three*. Many writers on the subject of tourism climate single out the thermal component of climate as the most important element. But within a broad range of moderate or "non-extreme" thermal conditions, other factors assume relatively greater importance in determining the pleasantness rating of a given weather or climate condition.

The nature of the relationship between the atmospheric environment and the enjoyable pursuit of outdoor recreational activity may be seen to be a function of facets of on-site atmospheric conditions. A conceptual framework for this is shown schematically in Figure 1. The *facets of tourism climate* given at the top of Figure 1 are 1) *thermal*, 2) *physical*, and 3) *aesthetic*.

1) Treatment of the *thermal* characteristics of on-site conditions involves four steps.

    a) Integrate the physical factors influencing the body-atmosphere thermal state. The method used must include both the attributes of those exposed and the functional attributes of the environment as well as the complete range of atmospheric variables. For the atmospheric environment these include air

temperature, humidity, wind, solar and longwave radiation and nature of the physical surroundings, and for the body, metabolic rate, posture and clothing.

b) Provide a rational index with sound physiological bases that adequately describes the net thermal effect on the human body.

c) Identify relationships between the thermal state of the body and the condition of mind that expresses the thermal sensation associated with this state.

d) Provide a rating of the perceived thermal sensation and corresponding calorific index according to the level of satisfaction experienced. This means identifying subjective reaction classified on a favourable-to-unfavourable spectrum as a measure of desirability of conditions.

2) The *physical* category shown in Figure 1 is identified in recognition of the existence of specific meteorological elements such as rain and high wind that directly or indirectly affect participant satisfaction other than in a thermal sense. The occurrence of high wind, for example, can have either a direct mechanical effect on the vacationer, causing inconvenience (personal belongings having to be secured or weighted down) or an indirect effect such as blowing sand causing annoyance. Others things that fall into physical category are rain (duration), rain days (frequency), ice, snow, severe weather, air quality and ultraviolet radiation.

3) The aesthetic aspects relate to the climatically controlled resource attributes of the recreation environment, which Crowe, McKay and Baker (1973) have termed the atmospheric component of the `aesthetic natural milieu'. Included within this category are `weather' factors such as visibility, sunshine or cloud associated with the prevailing synoptic condition (for example, `a nice, clear, sunny day'), day length and visibility.

The above factors are summarised in Table1.

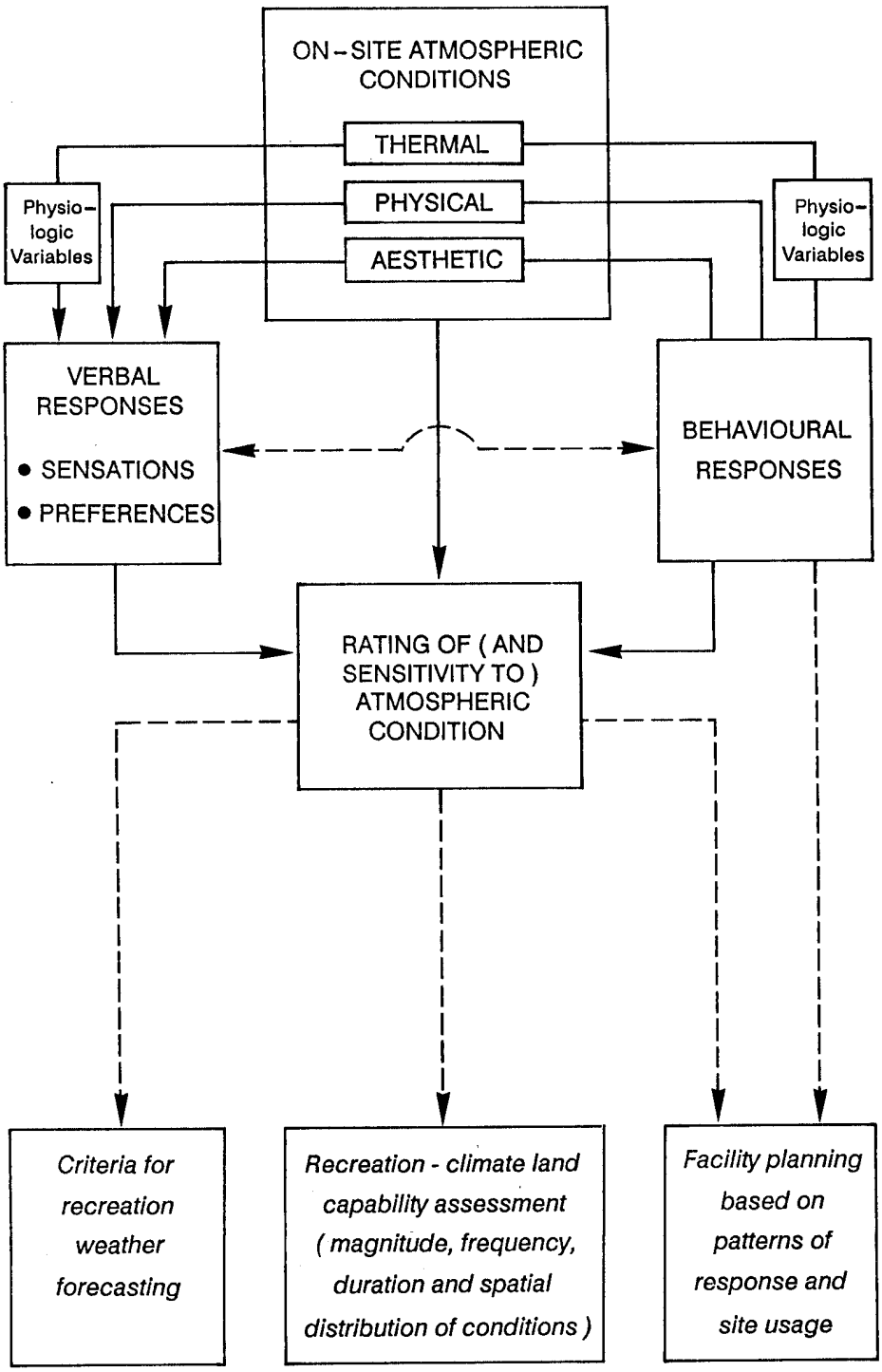

Figure 1. Conceptual framework for the study of tourism climate showing the make-up of on-site climate conditions and two independent methods for assessing human response or reaction. These can be used for rating weather and climate in terms participant sensitivity and satisfaction to conditions.

Table 1. Various facets of tourism climate and their significance and impact.

Facet of climate	Significance	Impact
Aesthetic		
Sunshine/cloudiness	Quality of experience	Enjoyment, attractiveness of site
Visibility	Quality of experience	Enjoyment, attractiveness of site
Day length	Convenience	Hours of daylight available
Physical		
Wind	Annoyance	Blown belongings, sand, dust…
Rain	Annoyance, charm	Wetting, reduced visibility, enjoyment
Snow	Winter sports/activities	Participation in sports/activities
Ice	Danger	Personal injury, damage to property
Severe weather	Annoyance, danger	All of above
Air quality	Annoyance, danger	Health, physical wellbeing, allergies
Ultraviolet radiation	Danger, attraction	Health, suntan, sunburn
Thermal		
Integrated effects of air temperature, wind, solar radiation, humidity, longwave radiation, metabolic rate.	Thermal comfort	Environmental stress Physiological strain Hypothermia Hyperthermia
	Therapeutic, restorative	Potential for recuperation

To identify and describe the experience of on-site atmospheric conditions, de Freitas (1990) used two separate forms of user response, shown in Figure 1:

1) Sensory perception of the immediate atmospheric surrounds expressed verbally;
2) Behavioural responses that modify or enhance effects of the atmosphere.

By employing, independently, separate indicators of the on-site experience, the reliability of each was examined and interpreted by comparison and apparent threshold conditions verified.

Little is known about the effects of climate on human behaviour, but it is clear that in some cases behaviour is a response that modifies or enhances the effects of the atmosphere. Behaviour can be used as a measure of human sensitivity and satisfaction. Role and significance of behaviour is that an individual can adapt/adjust in five ways:

1) Passive acceptance;
2) Avoid of areas of unfavourable weather or climate determined condition (for example: move from sun to shade, or vice versa; select vacation destination according to climate condition etc);
3) Change activity to suit weather condition so as to maximise enjoyment of outdoor experience (for example: swim more\less, drive rather than walk, extend\reduce length of stay etc);
4) Use structural or mechanical aids (for example, use of: umbrellas, wind breaks, hats, shelters etc); and
5) Adjust thermal insulation of body (clothing).

The results of the research (de Freitas, 1990) showed that body-atmosphere energy balance indices are reliable indicators of on-site thermal conditions. Thermal component is main factor determining the desirability of weather Behaviour is a reliable indicator of the significance of weather conditions. Use of shade and clothing are best indicators of heat and cold stress, respectively. Change of posture related to on-site conditions, to a greater degree than expected. Duration of visit is best behavioural indicator of overall significance of recreation climate.

Certain behavioural adjustments (use of shade umbrellas, windbreaks and possibly increased frequency of swims) serve to reduce the beach user's sensitivity to on-site atmospheric conditions, although stated preferences as regards beach weather remain the same. In the absence of ideal conditions, an individual can create, to a point, a personal microclimate that is acceptable. Surprisingly, attendance is a poor measure of demand (i.e. user response to varying on-site atmospheric conditions). Attendance only reflects the outer

limits of acceptability. The work suggested that time spent on site per visit (duration of visit) is a more accurate measure of user response and preferences. Furthermore the findings of the research indicated that atmospheric conditions within the broad zone of acceptability are those that the beach user can readily cope with or effectively modify. Optimum thermal conditions are those requiring no specific adjustment or behavioural fine-tuning.

FUTURE DIRECTIONS

Thus far, most work in tourism climatology has been based on subjective criteria and unverified perceptions of tourists. More field studies are required along with work that assembles observational data to determine the actual responses, perceptions, needs, reactions and expectations of vacationers. Anderssen and Colberg (1973) have shown that of factors that affect tourism demand, the dominant attributes of a tourist destination are cost, climate and scenery. Research is needed to assess the relative importance and role of the climate attribute as a component of the tourist destination image.

There a number of studies are in the tourism climatology literature that identify potentially useful areas for future research. For example, Ross (1992) has shown that climate, as a component of destination image, does strongly influence tourist behaviour. Hunt (1975) pointed out that images and expectations of a destination may have as much as, or more, to do with an area's tourist image projection than the more tangible recreation resources. Publicity about climate to be expected in an area can also modify a tourist's expectations and thus their degree of satisfaction with the outcome of the experience. There is the often-quoted example of the Irish Tourist Board, which shrewdly promoted the delights of a cool and rainy Irish summer. It was thought to have influenced the expectations of tourists, thus reducing their disappointment.

Ross (1992) has also explored the influence of a variety of climatic conditions on both ideal holiday destinations and on perceptions of the wet tropics area of Far North Queensland. Given that distinct patterns were found, these results have implications for those involved in the tourism/hospitality industry, as it should influence the way the area is marketed to potential visitors to Far North Queensland as a holiday destination.

There is also the question of forecasting tourist travel overseas based on climate. Palutikof (1999) and Agnew and Palutikof (2001) have explored this area. They found that: a) outward and inward visitor movement is a response to both weather during the year and travel and weather the previous year; b) rainfall is a better indicator of outward travel than inward,

with wetter conditions encouraging more visits abroad; and c) autumn temperatures and sunshine have the greatest influence on inward travel. Predictions of tourist travel based on these findings could be important to the travel industry and justify further research.

There are costs to both tourists and tourism operators resulting from the occurrence of unexpected less than satisfactory climate. These need to be fully documented and methods and approaches to studying these require attention. Even now tourists and tourist operators can take out insurance on likelihood of "bad" weather conditions occurring while on vacation. The question arises as to how insurance companies define "bad weather" and the extent to which this is accurate or appropriate, and how this compares to perceptions of the "quality" of conditions experienced by tourists themselves on the one hand, and how it varies with different recreational activities on the other.

The popularity of Mieczkowski's Tourism Climate Index (TCI) shows that there is demand for this type of unitary indicator of climate. What is now required is research that tests the accuracy of such an index or devises a similar index using systematic surveys to interpret it, rather than relying on arbitrary and subjective value judgements of the researcher, as in the case of TCI. An ideal tourism climate model would:

- Rely only on standard climate data.
- Minimise use of average values and maximises use of actual (real) observations.
- Use as input all attributes of the atmospheric environment.
- Use an integrated body-atmosphere energy balance assessment of the thermal component of climate
- Includes all three attributes of tourism climate: thermal, aesthetic and physical/mechanical
- As an added feature, recognise the notion of climate as a limiting factor, or climate limits to tourism, with focus on thresholds or limitations; for example, times when climate unsuitable or unappealing to the vacationer.

In all of this, the aim should be to adopt standard methods and indices as far as possible. There is also a need to provide potential tourists with probabilistic information on climate to be expected at various destinations. This will lead to improved information and improved choice. Clearly, much work remains to be done.

REFERENCES

Adams, D.L., 1973: Uncertainty in nature ... weather forecasts and New England beach trip decision. *Economic Geographer,* 49, 287-297.

Agnew, M.D. and Palutikof, J.P, 2001: Impacts of climate on the demand for tourism. In *Proceedings of the First International Workshop on Climate, Tourism and Recreation*. A. Matzarakis and C. R. de Freitas (eds). International Society of Biometeorology, Commission on Climate Tourism and Recreation, Porto Carras, Halkidiki, Greece, December 2001, WP4, 1-10.

Anderssen, P. and Colberg, R., 1973: Multivariate analysis in travel research: A tool for travel package design and market segmentation. *Proceedings of the Fourth Annual Travel Conference of the Travel Research Association*, 225-240.

Auliciems, A., de Freitas, C. R. and Hare, F.K., 1973: Winter Clothing Requirements for Canada. Atmospheric Environment Service, Canada Department of the Environment, *Climatological Studies*, No. 22, Toronto, 80 pp.

Auliciems, A. and Kalma, J.D., 1979, 'A climatic classification of human thermal stress in Australia', *Journal of Applied Meteorology,* 18, 616-626.

Bauer, D.J., 1976: The Climate of Prince Albert National Park, Saskatchewan. Meteorological Applications Branch, Atmospheric Environment Service, Canada, Dept. of the Environment, Toronto, Project Report No. 28, 166 pp.

Becker, S., 1998: Beach comfort index: a new approach to evaluate the thermal conditions of beach holiday resort using a South Africa example. *GeoJournal*, 44 (4), 297-307.

Cabanac, M., 1971: Physiological role of pleasure. *Science*, 173, 1103-1107.

Clawson, M., 1966: The influence of weather on outdoor recreation. In W. Sewell (ed.), Human Dimensions of Weather modification, Department of Geography, University of Chicago, Research Paper No. 105, 183-193.

Crowe, R.B., 1975: Recreation, tourism and climate: a Canadian perspective. *Weather*, 30, 248-253.

Crowe, R.B., 1976. 'A Climatic Classification of the Northwest Territories for Recreation and Tourism', Meteorological Applications Branch, Atmospheric Environment Service, Canada, Dept of the Environment, Toronto, Project Report No. 25, 232 pp.

Crowe, R.B., McKay G.A. and Baker W.M, 1973: The Tourist and Outdoor Recreation Climate of Ontario. Volume I, Objectives and Definitions of Seasons, Publications in Applied Meteorology, REC-1-73, Meteorological Applications Branch, Atmospheric Environment Service, Canada, Dept of the Environment, Toronto, 70 pp.

Crowe, R.B., McKay G.A. and Baker W.M., 1977a: The Tourist and Outdoor Recreation Climate of Ontario. Volume II, The Summer Season, Publications in Applied Meteorology,

REC-1-73, Meteorological Applications Branch, Atmospheric Environment Service and Dept. of Fisheries and Environment Canada, Toronto, 421 pp.

Crowe, R.B., McKay G.A. and Baker W.M., 1977b. 'The Tourist and Outdoor Recreation Climate of Ontario. Volume III, The Winter Season', Publications in Applied Meteorology, REC-1-73, Meteorological Applications Branch, Atmospheric Environment Service and Dept. of Fisheries and Environment Canada, Toronto, 249 pp.

Danilova, N.A., 1974: A recreational evaluation of the climate of the Black Sea Coast. *Meteorological Translations*, No. 25, Atmospheric Environment Service, Canada, Dept. of the Environment, Toronto, 17-31.

Davis, N.E., 1968: An optimum weather index. *Weather*, 23, 305-317.

De Freitas, C.R., 1979: Human climates of northern China. *Atmospheric Environment*, 13, 71-77.

De Freitas, C.R., Dawson N.J., Young A.A. and Mackey W.J., 1985. 'Microclimate and heat stress of runners in mass participation events. *Journal of Climate and Applied Meteorology*, 24, 184-191.

De Freitas, C.R., 1985. 'Assessment of human bioclimate based on thermal response. *International Journal of Biometeorology*, 29, 97-119.

De Freitas, C.R. and Symon L.V., 1987: A bioclimatic index of human survival times in the Antarctic. *Polar Record*, 23 (147), 651-659.

De Freitas, C.R., 1987: Bioclimates of heat and cold stress in New Zealand. *Weather and Climate*, 7, 55-60.

De Freitas, C.R. 1990: Recreation climate assessment. *International Journal of Climatology*, 10, 89-103.

Fergusson, P., 1964: Summer weather at the English seaside. *Weather*, 19, 144-6.

Findlay, B., 1973: Climatography of Pukaskwa National Park, Ontario. Meteorological Applications Branch, Project Report REC-2-73, Atmospheric Environment Service, Canada, Dept of the Environment, Toronto, 95 pp.

Finkelstein, J., 1971: Climate and comfort in the tropical South Pacific Islands. *New Zealand Geographer*, 27(1), 56-64.

Gates, A.D., 1975a: The Tourism and Outdoor Recreation Climate of the Maritime Provinces. Publications in Applied Meteorology, REC-3-73, Meteorological Applications Branch, Atmospheric Environment Service, Canada, Dept of the Environment, Toronto, 133 pp.

Gates, A.D., 1975b: The tourism and outdoor recreation climate of the Prairie Provinces. Toronto, Atmospheric Environment Service.

Gaumnitz, J.E., Swinth R.L. and Tollefson J.O., 1973. Simulation of water recreation users' decisions. *Land Economics*, 49 (3), 269-277.

Green, J.S.A., 1967: Holiday meteorology: reflections on weather and outdoor comfort. *Weather*, 22, 128-253.

Harlfinger, O., 1991: Holiday bioclimatology: A study of Palma de Majorca, Spain. *GeoJournal*, 25 (4), 377-381.

Hunt, J.D., 1975: Image as a factor in tourist development. *Journal of Travel Research*, 13, 1-7.

Kevan, S. M., 1993: Quest for cures: A History of tourism for climate and health. *International Journal of Biometeorology*, 37, 113-124.

Masterton, J.M., Crowe R.B. and Baker W.M., 1976: The Tourism and Outdoor Recreation Climate of the Prairie Provinces. Publications in Applied Meteorology, REC-1-75, Meteorological Applications Branch, Atmospheric Environment Service, Canada, Dept of the Environment, 221 pp.

Masterton, J.M. and McNichol, D.W., 1981: A Recreation Climatology of the National Capital Region. Atmospheric Environment Service, Canada, Dept of the Environment, *Climatological Studies* No.34, 120 pp.

Maunder, W.J., 1972: The formulation of weather indices for use in climatic-economic studies: a New Zealand Example. *New Zealand Geographer,* 28, 130-150.

Mercer, D., 1971. 'The role of perception in the recreation experience: A review and discussion. *Journal of Leisure Research*, 3 (4), 261-276.

Mercer, D., 1972: Beach usage in the Melbourne region. *Australian Geographer*, 12, 123-129.

Mieczkowski, Z., 1985: The tourism climatic index: a method of evaluating world climates for tourism. *Canadian Geographer*, 29(3), 220-233.

Murray, R., 1972: A simple summer index with an illustration for summer 1971. *Weather*, 27, 161-169.

Paul, A.H., 1972: Weather and the daily use of outdoor recreation areas in Canada. In J.A. Taylor (ed.), *Weather Forecasting for Agriculture and Industry*, David and Charles, 132-146.

Perry, A.H., 1972: Weather, climate and tourism. *Weather*, 27, 199-203.

Perry, A.H., 1997: Recreation and tourism. In: *Applied Climatology: Principles and Practice*. R.D. Thompson and Allen Perry (eds), Routledge, London, 240-248.

Perry, A.H., 1997: Recreation and tourism. In: Applied Climatology: Principles and Practice. R.D. Thompson and Allen Perry (eds), Routledge, London, 240-248.

Peterson, G.L. and Neumann E.S., 1969: Modelling and predicting human response to the visual recreation environment. *Journal of Leisure Research*, 1 (3), 219-237.

Palutikof J.P. (ed.), 1999: Weather Impacts on Natural Social and Economic Systems (WISE). Final Report of work undertaken for the European Commission Directorate-General Research under contract ENV4-CT97-0448, 1 November 1997 – 31 October 1999, 560 pp.

Reifsnyder, W.E., 1983: A climatic analysis for backcountry recreation. *Biometeorology 8*, Overdieck D., Muller J., Schnitzler H. and Lieth H. (eds.), Swets and Zeitlinger, Lisse, 87-99.

Rense, W.C., 1974: Weather as an influencing factor in the use of Oregon's coastal recreation areas. Ph.D. thesis, Dept of Geography, Oregon State University, 217 pp.

Ross, G. F., 1992: Climate as component of tourist destination image. Paper presented at the Australia New Zealand Climate Forum Meeting, Cairns, 28 pp.

Smith, K., 1975: *Principles of Applied Climatology*, McGraw-Hill, London (pp 182-191).

Smith, C.G., 1985: Holiday Weather: Southeast Asia. *Weather*, 40, 21-23.

Terjung, W.H., 1968: Some thoughts in recreation geography in Alaska from a physio-climatic viewpoint. *California Geographer*, 9, 27-39.

Thornes, J.E., 1977: The effect of weather on sport. *Weather*, 7, 258-268.

Yapp, G.A. and N.S. McDonald, 1978: A recreation climate model. *Journal of Environmental Management*, 7, 235-252.