IN SEARCH OF WARMER CLIMATES? THE IMPACT OF CLIMATE CHANGE ON FLOWS OF BRITISH TOURISTS

by

David Maddison

CSERGE Working Paper

IN SEARCH OF WARMER CLIMATES? THE IMPACT OF CLIMATE CHANGE ON FLOWS OF BRITISH TOURISTS

By

David Maddison

Centre for Social and Economic Research
on the Global Environment
University College London
and
University of East Anglia

Acknowledgements

The Centre for Social and Economic Research on the Global Environment (CSERGE) is a designated research centre of the UK Economic and Social Research Council (ESRC).

The Author would like to acknowledge helpful comments made on an earlier version of this paper by David Pearce, Kim Swales and Peter Pearson. The usual disclaimer applies.

ISSN 0967-8875

Abstract

This paper investigates the impact of climate change on the chosen destinations of British tourists. Destinations are characterised in terms of ‘attractors’ including climate variables, travel and accommodation costs. These and other variables are used to explain the current observed pattern of overseas travel in terms of a model based upon the idea of utility maximisation. The approach permits the trade-offs between climate and holiday expenditure to be analysed and effectively identifies the ‘optimal’ climate for generating tourism. The findings are used to predict the impact of various climate change scenarios on popular tourist destinations.

1. Introduction

Insofar as British people are now, largely for the purposes of recreation, spending more time away from home than ever before the climate of other countries may be important to the welfare of the British - if only for purely selfish reasons[1]. Organised trips are now available taking people from Britain to destinations in North America, Asia, Africa and Oceania whilst package tours to the Mediterranean are now almost a quintessential part of British life. The rapid growth in international tourism whether as a part of an organised tour or independently is a reflection of greater leisure time (due in part to an ageing population) and a growth in real incomes. There is also evidence linking the growth of package holidays in the Mediterranean with reductions in cost caused by more fuel efficient planes and with a decrease in the cost of accommodation (Perry and Ashton, 1994). In addition to the relative price of different locations choice of destination is presumably influenced by a desire to visit particular landscapes or sandy beaches for recreational purposes, motivated by a desire to explore or renew cultural ties between countries or to partake of the alleged health benefits of particular locations. Poor health has often been cited as a reason for making a journey (e.g. the remedial properties of hot spas, mountain air and coastal climates). Even until quite recently a tan was considered rather a 'healthy' thing to possess. Choice of destination is also heavily influenced by the image that a country has with regards to its political stability and crime rate (e.g. the recent poor publicity surrounding Florida following the murder of several British tourists).

But a major factor in choice of both destination and time of departure is climate. Indeed, when British tourists go abroad they are often described as being 'in search of warmer climates'. Tourists might be construed as making a decision to go abroad in order to gain some short-term climatic advantage. Certainly, with regard to domestic tourism retired people in particular can be observed migrating south for the winter in America to Mexico whilst in Australia they head north to the 'Gold Coast' resorts of Queensland. Both 'push' and 'pull' factors are clearly at work. Whilst the importance of climate to both domestic and international tourism is hardly disputed there are not very many empirical studies which have explored the implications of various climate change scenarios for international tourism and welfare (for an exception see Wall, 1992).

The impact of climate change on tourism in Britain is dealt with by Smith (1991) and published in the Government's own review of the potential impacts of climate change on the United Kingdom. According to Smith, the tourist season may

[1] In 1994 UK residents made almost 40 million trips abroad (CSO, 1995).

lengthen and tourist satisfaction may increase. But here too there is no attempt to determine the changes in the overseas destinations of UK tourists, changes in the number of holidays taken (although these change are argued to be small when compared to likely changes arising from greater leisure time and higher incomes) nor to value the costs or benefits from changes in the climate insofar as international tourism is concerned. The purpose of this paper then is to assess in a quantitative fashion, probably for the first time, the importance of climate as a determinant of choice of travel destination for British residents among a number of other possible factors including travel cost.

From a purely strategic perspective it is of obvious interest to examine how the numbers visiting different sites change as the climate changes. Many island economies in particular are heavily dependent on tourism and if climate is what tourists are seeking then climate change may have significant consequences for these island economies. Furthermore, following the methodology outlined in this paper it is possible to compute a money-metric measure of how welfare changes as the attributes of a set of sites change (the welfare of tourists changes in the sense that more desirable climates may be brought closer to home). There is also a possibility that several low-lying island states may well become 'unavailable' in the sense that they risk being inundated by rising sea levels. The methodology employed enables monetary values to be placed on this eventuality at least in so far as 'use' values are concerned. The methodology rests on the fact that different sites are characterised by different travel costs and accommodation costs. By observing differences in visitation rates it is possible to examine the rate at which individuals are willing to trade off higher money costs against desirable 'site attributes' such as climate. The economic values of changes in both site quality and availability may be of interest to those seeking to compile an overall damage cost assessment to the effects of climate change.

The remainder of this paper is organised as follows. The next section examines the plausibility of the one of the key assumptions underlying revealed preference techniques: the existence of perfect information. The third section describes the model used to explain the pattern of observed visitation rates, the extraction of money metric measures regarding changes in site quality and availability and discusses some alternative specifications. The fourth section looks at the data sources available for the purposes of estimating the proposed model. The fifth section considers the results of the statistical exercise. The penultimate section uses the results of the exercise to illustrate the impact of climate change on particular tourist destinations and the final section concludes.

2. Climate And Tourism: The Assumption Of Perfect Information

The first information that potential holidaymakers encounter regarding the climate of a particular destination is through the travel company's brochure. The image of an attractive climate is cultivated in the mind of the consumer (usually) bounded by the requirement to remain within certain standards. There is obvious scope to be selective in the presentation of particular climate variables. The existence of warm temperatures in the Mediterranean during wintertime is pushed but the relatively higher rainfall (compared to London) occurring at that time is downplayed. Holiday tour operators frequently use the same 'blue sky' photographs in their summer and winter brochures. Even when climatic tables are given there is a concern that these raw data are not readily understood by the potential tourist and that some 'expert interpretation' is required.

The view that tourists were largely ignorant of or were purposefully deceived about the climate of their intended destinations (and therefore suffered disappointment as a result) and were moreover incapable of assessing for themselves raw climate data led to the construction of indices which purported to objectively evaluate tourist potential of the climates of different countries. In the view of the contributors to this literature the climatic resources of the world were not being fully utilised or, to put it another way, the inadequate provision of information resulted in market failure. In these indices different components of climate were subjectively weighted and placed on a labelled scale.

Perhaps as a result of the view that tourists do not have access to perfect information there are no examples of taking a revealed preference approach to tourist flows in the literature. But are tourists really so lacking in information? Do they allow themselves to be persuaded by blue-sky photographs? Tourists presumably have come to expect blue-sky photographs and discount such tricks. Furthermore the traveller has ready access to sources of high quality low cost information which is independent of the travel company he goes with in the form of countless travel guides, television programmes such as *The Travel Show*, daily weather reports for world capitals published in the newspaper as well as television and radio weather forecasts which now cater for the overseas traveller and even quite specialised weather guides such as Pearce and Smith (1993). The main source of information however is surely from people who have already visited a particular destination. They know how the climate actually felt and can describe it in terms familiar to them. Tourists are also able to take legal redress against tour operators whose holidays were for one reason or another sub-standard. Since the cost of obtaining this information is low relative to the cost of a typical package holiday the tourist has every incentive to take advantage of it (Perry, 1993). It is frankly hard then to conceive of how travel companies could consistently mislead the majority tourists with respect to what type of climate to expect and the concerns of earlier researchers appear misplaced. As such the revealed preference approach, which rests on the assumption of perfect knowledge concerning the attributes of different destinations, can be expected to work well whereas much of the earlier literature looks like an anachronism. Furthermore, the revealed preference approach is capable of expressing in monetary terms the extent to which changes in the climate of different holiday destinations changes welfare which is a fundamental objective of this paper.

3. The Pooled Travel Cost Model

The paper now turns to a theoretical model of the allocation of time and money spent visiting different destinations (or 'sites' as they are called in the travel cost literature) and the consumption of other goods. The model employed here is based largely on McConnell (1983) and Johansson (1987). Note that unlike in the majority of the travel cost literature the time spent at particular sites is modelled as being a variable of choice.

Assume that the individual derives utility from the number of visits to different destinations, the time spent on each visit, as well as from the consumption of a vector of other goods. The individual's utility function can be written as:

$$u = u(q, x, t, z)$$

where u is utility, q is a vector of consumption goods, x is a vector containing the number of visits made to each site, t is the time spent on each visit to site j and z is a vector of site quality. The constraint attached to the choices made is as follows:

$$q p_q + xp = m + l p_w - t p_w - ax p_w$$

where p_q is a vector of prices, p is the (ticket) price of travel, m is unearned income, l is the amount of time available for work, p_w is the wage rate and 'a' is the time required to visit a site. Thus the final term of the right-hand side of the equation represents the economic cost of time spent travelling. Associated with the solution to this problem of constrained maximisation is the indirect utility function V (in which some constants are suppressed in order to simplify the notation):

$$V = V(p, z)$$

Employing Roy's theorem yields a set of demand equations for among other things the number of visits to each site:

$$\frac{V_p}{\lambda} = - x(p, z)$$

where λ is the marginal utility of money (which is treated as a constant). Let p^0 represent the current price of travel and p^c a price so high that no trips are taken at all (p^c may be infinity and is often referred to as the 'choke' price). Integrating both sides with respect to p between the limits of p^c and p^0 gives the Consumer Surplus (CS) obtained from the site:

$$CS = \frac{V(p^c, z^0)}{\lambda} - \frac{V(p^0, z^0)}{\lambda} = -\int_{p^o}^{p^c} x(p, z^0)dp$$

Next, differentiating both sides with respect to z gives:

$$\frac{V_z(p^c, z^0)}{\lambda} - \frac{V_z(p^0, z^0)}{\lambda} = -\int_{p^o}^{p^c} x_z\big(p, z^0\big)dp$$

But given the assumption of weak complementarity between x and z (see Freeman, 1993):

$$\frac{V_z(p^c, z^0)}{\lambda} = 0$$

In other words, if it can be assumed that there exists a price so high at which the number of trips taken to the site falls to zero, then changes in the level of the site attribute z do not affect utility. Integration of this equation with respect to z gives the change in CS following a change in the level of site attribute z:

$$\Delta CS = -\int_{p_0}^{p_c} [x(p, z^0) - x(p, z^1)]\, dp$$

where z_0 and z_1 are the pre and post change level of site attribute. Note that even though several commodities may exhibit weak complementarity with environmental quality (e.g. flight costs, accommodation costs etc.) all that is required in order to measure the value of changes in environmental quality is the demand curve for one of those commodities.

When many alternative sites are being studied there may be substantial variation in qualities across sites. But whilst travel costs to the same site may or may not differ between individuals (in the empirical application of the model described below they do not) the site quality is the same for everyone. Therefore all empirical models which attempt to incorporate site quality have involved some kind of simplification and as a consequence suffer limitations in their ability to characterise recreation demand accurately (Freeman, 1993). One approach (see for example Smith et al, 1986 or Caulkins et al, 1986) has been to pool all of the observed visitation rates for the different sites and to estimate a single demand function in which the observed visitation rates are solely a function of the own price and quality variables:

$$x_j = x(p_j, z_j) \quad j$$

This model is referred to as the Pooled Travel Cost Model (PTCM) and is the model employed in this paper. The fundamental weakness of the PTCM is that it predicts changes in the overall number of visits to a group of sites but does not allow for a reallocation of visits between different sites following a change in the price or quality attributes of alternatives. Moreover it assumes that the coefficients on the own price and quality variables are the same across all sites. By contrast, reallocation effects are dealt with explicitly by the Random Utility Model (RUM) of choice approach to valuing site attributes[2].

[2] With the RUM an individual chooses from a set of alternatives according to the utility which they provide. The indirect utility function (V) associated with a particular site j and choice-occasion is:

$$V_j(z_j,\ y - p_j)$$

where z_j is a vector of site attributes, y is income and p_j is the price of visiting the site. The indirect utility function contains a random error term which means that the choices made cannot be predicted with certainty but only with a given probability. The random error term reflects the existence of unobserved site characteristics and/or variations in taste between individuals. An individual visits a particular site k provided that:

$$V_k(z_k,\ y - p_k) + e_k > V_j(z_j,\ y - p_j) + e_j$$

$$sites\ j \neq k$$

If the random error terms are distributed as type I extreme value variates then the probability of an individual i making choice j is given by:

$$Prob\ (Y_i = j) = \frac{e^{V_{ij}}}{\sum_{j=1}^{j=n} e^{V_{ij}}}$$

This is referred to as the Conditional Logit model. This model however has well known shortcomings of its own. One shortcoming the assumption of the Independence of Irrelevant Alternatives (IIA). A further defect of the RUM is that it is incapable of predicting any possible change in the total number of tourist trips made following a change in site attributes: all that is predicted is how an exogenously determined number of trips are allocated between different destinations (e.g. see Bockstael et al, 1986).

4. Data And Specification

Having outlined its theoretical underpinnings, this section describes the data sources for the variables used to estimate the PTCM. There is little in the way of existing literature to act as a guide to the appropriate specification of the model (at least in terms of what quality attributes are the important ones). Accordingly the analysis should be looked upon as a probationary one.

For the dependent variable quarterly data on international travel by British residents is taken from the International Passenger Survey (IPS) for 1994. Visits abroad for reasons other than holidaymaking (e.g. business trips) are excluded since they are not as responsive to climatic factors. The data set also contains the average return fare paid per person to each destination, average spending on items other than fares and the average duration of the stay. From the latter two variables it is possible to determine daily expenditure. Whilst this is not the same thing as having a sterling price index for the cost of living relevant to tourists it is quite clear that things such as accommodation costs are an important consideration to the potential tourist and also that some countries are considerably more expensive to stay in than others. It was argued in the theoretical model that the amount of time required to travel to the country of interest had an opportunity cost attached to it such that other things being equal nearby resorts are preferred. The average time spent in transit is not available so as a proxy the 'great circles' distance from London is used instead. The great circles distance is the shortest distance which an aircraft could fly to reach a particular destination. Ordinary rectangular (mercator projection) maps found in most atlases obviously cannot be used to measure the great circles distance and instead an azimuthal equidistant projection map is required (see figure 1)[3].

[3] A computer program made available through the University of Michigan to measure the great circles distance between the world's capital cities can be found on the following internet site: http://www.indo.com/distance/.

Figure 1: An Azimuthal Equidistant Projection Map Based on London

Source: The Times Atlas.

GDP per capita in US dollars converted using purchasing power parity exchange rates is taken from the UNDP (1995). Its inclusion in the data set reflects the belief that countries with higher GDP possess better tourist infrastructure (hotels, restaurants, visitor centres etc.). Furthermore some tourists might be upset by visions of poverty and squalor which would greet them in many low income countries. Population and population density are taken from the Times Atlas (1992). Population proxies for the quantity of what might be called the 'cultural capital' that a particular country possesses (e.g. notable museums, sites of historical significance, buildings of architectural interest). Population density proxies for what might be referred to as 'natural capital' (e.g. unspoilt areas, environmental quality). These are unashamedly broad terms. It is anticipated that whereas the former will be positively related to tourism flows, the latter will negatively affect them.

The attraction of some countries clearly lies in the fact that they possess unspoilt sandy beaches fit for recreation. The total length of beaches found in different countries is available from a report by Delft Hydraulics (1990) and is added to the data set. Climate variables are taken from Pearce and Smith (1994). The climate of the country's capital city is taken since this is arguably the most relevant for tourists (although there are arguments for producing a weighted average of several records to represent the climate of the larger climatically more diverse countries). Two variables are included as a description of the climate: averaged maximum daytime temperature and precipitation on a quarterly basis. The former is included in both a linear and quadratic fashion. Including both linear and quadratic terms allows temperature to exert both a positive and negative influence on visitation rates depending upon the current temperature. Finally, three dummy variables are included to represent the different quarters. The role of these variables is to demonstrate that differences in visitation rates can ascribed to climate rather than any other seasonal factors such as statutory holidays. Among the many other variables which might be expected to have an important influence on holiday destinations but which are not included in the data set foremost among these are variables related to the degree of personal safety. This might in some future study be satisfactorily proxied by the inclusion of countries' respective murder rates. Sunshine too is omitted since it is not collected on a consistent basis for very many capitals. This is unfortunate in that many tourist destinations (such as Cyprus) are renown for their sunny climate.

In total 305 complete observations are available from 88 different countries. The variables contained in the data set are listed in table 1, and the characteristics of the data set are examined in table 2. The different countries represented in the data set are listed in table 3.

Turning now to the functional specification of the model, the demand equation for the PTCM is modelled as:

$$\frac{VISITS_j^{\lambda}-1}{\lambda} = \alpha_0 + \beta_1 FARE_j + \beta_2 GDP_j + \beta_3 POP_j + \beta_4 POPDEN_j +$$

$$\beta_5 BEACH_j + \beta_6 PDAY_j + \beta_7 DIST_j + \beta_8 TEMP_j + \beta_9 TEMP_j^2 +$$

$$\beta_{10} PRECIP_j + \beta_{11} Q1_j + \beta_{12} Q2_j + \beta_{13} Q3_j + e_j$$

where the subscript j refers to each different observation in the data set. Two special cases were considered: $\lambda = 1$ and $\lambda \rightarrow 0$. These refer to the linear and semi-log models respectively[4]. In the linear model the impact on visitation rates of a change in the level of any variable is independent of the level of any other variable whereas in the somewhat more plausible semi-log model this is not the case. β_1, being the coefficient on the own-price variable is expected to be negative, as are the coefficients β_4, β_6, β_7, β_9 and β_{10}. In contrast the coefficients β_2, β_3, β_5 and β_8 are expected to be positive. There are no prior expectations regarding the sign of the coefficients β_{11}, β_{12} and β_{13}.

[4] The left-hand side variables are not transformed into logarithms since some of them take negative values.

Table 1: Definition of Variables Contained in the Travel Cost Data Set

Variable	Definition
VISITS	Number of visits from the UK
FARE	Average cost of a return fare (£s)
GDP	GDP per capita (1992 USD)
POP	Population
POPDEN	Population density (persons per km^2)
BEACH	Beach length (km)
PDAY	Cost of an extra day's stay (£s)
DIST	Great circles distance from London to the capital (miles)
TEMP	Quarterly averaged maximum daytime temperature of the capital city (°C)
PRECIP	Quarterly precipitation in the capital city (mm)
Q1	Takes the value unity for the first quarter, zero otherwise
Q2	Takes the value unity for the second quarter, zero otherwise
Q3	Takes the value unity for the third quarter, zero otherwise

Source: *See text.*

Table 2: Characteristics of the Travel Cost Data Set

Number of observations = 305

Variable	Mean	Std. Dev.	Minimum	Maximum
VISITS	85134.	0.26600E+06	235.0	0.2332E+07
FARE	225.58	148.47	17.00	818.0
GDP	10015.	6950.7	620.0	0.2376E+05
POP	0.4948E+08	0.1570E+09	6700.	0.1100E+10
POPDEN	395.83	1378.5	0.2455E-01	0.1350E+05
BEACH	131.03	368.09	0.0000	2970.
PDAY	37.397	15.774	9.287	181.0
DIST	3565.9	2523.3	199.0	0.1168E+05
TEMP	22.496	8.5632	-3.667	38.67
PRECIP	83.404	69.773	0.0000	403.3
Q1	0.23279	0.42330	0.0000	1.000
Q2	0.25902	0.43881	0.0000	1.000
Q3	0.26557	0.44236	0.0000	1.000

Source: See text.

Table 3 Countries included in the travel cost data set

Anguilla
Antigua
Argentina
Australia
Austria
Azores/Madeira
Bahamas
Barbados
Belgium
Bermuda
Bolivia
Brazil
Brunei
Canada
Canaries
Cayman Islands
Chile
China
Columbia
Cuba
Cyprus
Denmark
Djibouti
Dominican Republic
Ecuador
Egypt
Fiji
Finland
France
French Polynesia
Gabon
Gambia
Germany
Gibraltar
Greece
Greenland
Grenada
Hong Kong
Hungary
Iceland

India
Indonesia
Iran
Israel
Italy
Jamaica
Japan
Jordan
Kenya
Lebanon
Luxembourg
Malaysia
Malta
Mauritius
Mexico
Monaco
Morocco
Nepal
Netherlands
New Caledonia
New Zealand
Norway
Pakistan
Philippines
Poland
Portugal
Puerto Rica
Romania
South Korea
Seychelles
Singapore
Slovenia
South Africa
Spain
Sri Lanka
St Lucia
Sweden
Switzerland
Syria
Tanzania
Thailand
Trinidad

Tunisia
Turkey
UAE
Uganda
USA
Venezuela

5. Results

Using the method described by Maddala (1977) it was found that the semi-log model (corresponding to the case $\lambda \rightarrow 0$) was indeed most likely to have generated the observed data. The results of the semi-log regression analysis are displayed in table 4.

Overall the regression is highly significant and manages to explain almost 50% of the variation in the log of observed visitation rates. Furthermore the hypotheses put forward in the preceding section are all upheld. Nonetheless not all visitation rates are well predicted which is unsurprising given the importance of country-specific factors in determining choice of destination. As expected, the coefficient on the own-price variable 'FARE' is negative and highly significant indicating that, other things being equal, more expensive destinations generate fewer trips. It is also observed that countries with a higher GDP per capita are likely to generate more trips as are more populous countries but that countries with a lower population density are preferred. Countries with greater numbers of beaches are well-liked. The variable indicating the cost per day of visiting the different sites is negative and highly significant indicating that the more expensive a country is to stay in, the more infrequently it is visited. The variable describing the great circles distance from London has the correct sign but has only marginal significance. In part this may be because of the relatively high correlation between distance travelled and fare price[5].

Turning to the climate variables, the variables describing quarterly averaged maximum daytime temperature the coefficients on the linear and quadratic terms are positive and negative respectively pointing to the existence of an 'optimal' maximum daytime temperature for tourism of around 29°C. Precipitation on the other hand has a negative coefficient indicating that greater rainfall deters tourists although not significantly so. This suggests that perhaps a different measurement concept other than precipitation such as rain-days might have been more appropriate or else that other omitted climate variables like hours of sunshine have biased the coefficient on rainfall. None of the dummy variables describing the time of departure are significant implying that it is climate rather than other seasonal factors which explain observed visitation rates.

[5] The correlation coefficient is 0.81.

Table 4: The Estimated Pooled Travel Cost Model

Ordinary least squares regression.	Dep. Variable = Log VISITS
Observations = 305	Weights = ONE
Mean of LHS = 0.9244884E+01	Std. Dev of LHS = 0.1987143E+01
Std. Dev of residuals = 0.1438978E+01	Sum of squares = 0.6025611E+03
R-squared = 0.4980400E+00	Adj. R-squared = 0.4756157E+00
F [13, 291] = 0.2220981E+02	Prob value = 0.0000000E+00
Log-likelihood = -0.5366101E+03	Restr.(ß=0) Log-l = -0.6417184E+03
Amemiya Pr. Criter. = 0.3610558E+01	Akaike Info. Crit. = 0.2165703E+01

ANOVA

Source	Variation	Degrees of Freedom	Mean Square
Regression	0.5978556E+03	13	0.4598889E+02
Residual	0.6025611E+03	291	0.2070657E+01
Total	0.1200417E+04	304	0.3948739E+01

Variable	Coefficient	Std. Error	t-ratio	Prob
Constant	8.3472	0.5370	15.545	0.00000
FARE	-0.56164E-02	0.1003E-02	-5.602	0.00000
GDP	0.73447E-04	0.1539E-04	4.772	0.00000
POP	0.13699E-08	0.5751E-09	2.382	0.01785
POPDEN	-0.20062E-03	0.6318E-04	-3.175	0.00166
BEACH	0.14725E-02	0.2569E-03	5.732	0.00000
PDAY	-0.12633E-01	0.5436E-02	-2.324	0.02082
DIST	-0.76482E-04	0.5964E-04	-1.282	0.20069
TEMP	0.17252	0.4205E-01	4.103	0.00005
TEMPSQ	-0.29564E-02	0.1022E-02	-2.893	0.00410
PRECIP	-0.11087E-02	0.1342E-02	-0.826	0.40954
Q1	0.10804	0.2466	0.438	0.66162
Q2	-0.28269	0.2390	-1.183	0.23792
Q3	-0.13340	0.2448	-0.545	0.58617

Source: *See text.*

6. Discussion

Using these results it is possible to examine the change in consumer surplus following a change in site attributes. The PTCM is also capable of answering the question "do British tourists have measurable use values for the low lying islands". The future facing these particular tourist destinations may not be a change in 'site quality' but instead elimination through inundation under some climate change scenarios. These benefits are of course estimated only for British residents and many caveats apply, not least the assumptions made about the unimportance of the price and quality of substitute sites. The effect of this particular assumption is to make it appear that changes in the price and quality of alternative sites have no effect anywhere else whilst in reality of course, significant substitution between sites can be expected. Nevertheless, in the absence of anything better it is possible to use the model to predict the percentage change in the number of tourists visiting each country following a change in the attributes of the choice set as well as the ensuing change in consumer surplus and the overall worth of the site itself in terms of use values. These uses are illustrated for three different countries: Greece, Spain and the Seychelles. The first two are of particular interest since they are among the most popular tourist destinations for British people whilst the latter consists of a group of islands *some* of whose very existence is threatened by rising sea levels[6]. The impact of climate change on Greece and Spain is investigated inputting assumptions for the change in climate taken from the United Kingdom Meteorological Office's (UKMO) General Circulation Model as reported in the Houghton et al (1990). This model predicts a uniform increase of around 2°C for Southern Europe (30°N - 50°N) by the year 2030 complete with changes in seasonal precipitation patterns following 'business as usual' emission assumptions.

Table 5 illustrating the situation for Greece indicates that there is a lengthening and a flattening of the tourist season with tourist numbers almost unchanged. The first, second and fourth quarters show an increase in consumer surplus whereas the third quarter marks a sharp decline as maximum daytime temperatures pass well beyond their optimum level of 29°C. Overall however there is a small increase in consumer surplus of just over £2.5 million. Table 6 illustrates the situation for Spain; a country whose attraction lies in its climate, low population density and many miles of beaches. The results of climate change for Spain are qualitatively similar to those for Greece, but given Spain's lower prices and

[6] In fact the Seychelles consists of over 90 small islands situated in the Indian Ocean. They have a tropical climate and have recently become well known as a tourist resort. Most of the islands are low-lying but the largest island, Mahé, has hills rising to 3000 ft. Hence the complete elimination of the Seychelles is unlikely.

slightly cooler climate the beneficial effects of climate change on tourism are more pronounced. There are large gains for both tourist numbers and consumer surplus in the first, second and fourth quarters. In the third quarter there is a small decline in tourist numbers but overall consumer surplus for trips to Spain increases by almost £55.5 million and the number of tourists visiting Spain goes up by more than 6%.

Finally, in table 7 the total consumer surplus arising from trips to the Seychelles is estimated as being slightly more than £2 million pounds for quarters 1-3. This is the 'use' value for this group of islands and the amount which would be lost if the whole group were inundated (as explained earlier this is a rather exaggerated proposition). In comparison with the gains from Spanish tourism this sum seems very small, as it would be for most of the island in the Indian and Pacific Oceans. The reason is that these islands are very small and quite distant (therefore expensive) and not visited much as a consequence. As a result they generate little consumer surplus. What this means is not that these low-lying islands are without value, but rather that their main value is likely to be in the form of existence rather than use values. The benefits from preserving these islands lie in the vicarious consumption of their services through films, literature and the appreciation of their cultural heritage. These services are not estimated through the travel cost technique.

Table 5: The Impact of Global Climate Change on British Tourism: the Effects of the UKMO's 2030 Scenario for Greece

Quarter	Temperature	Precipitation	Change in British tourists	Change in CS
1	+2°C	+5%	+16.0%	+£189,429
2	+2°C	-5%	+3.9%	+£3,992,970
3	+2°C	-15%	-2.8%	-£6,325,774
4	+2°C	-5%	+11.1%	+£4,691,700
Total			+0.7%	+£2,548,325

Source: See text.

Table 6: The impact of Global Climate Change on British Tourism: the Effects of the UKMO's 2030 Scenario for Spain

Quarter	Temperature	Precipitation	Change in British tourists	Change in CS
1	+2°C	+5%	+19.4%	+£13,610,068
2	+2°C	-5%	+6.3%	+£16,541,888
3	+2°C	-15%	-0.5%	-£1,972,685
4	+2°C	-5%	+16.7%	+£27,258,392
Total			+6.3%	+£55,437,663

Source: See text.

Table 7: The Impact of Climate Change on British Tourism: the Effects of the Inundation of the Seychelles

Quarter	Change in British tourists	Change in CS
1	-100%	-£623,887
2	-100%	-£1,204,152
3	-100%	-£191,938
4	-100%	n.a.
Total	-100%	> -£2,019,977

Source: *See text. Note that the change in consumer surplus is evaluated with unchanged temperatures.*

7. Conclusions

It has been demonstrated that quarterly climate variables are able to explain differences in flows of tourists. In particular, it is shown that British tourists are attracted to climates which deviate little from an averaged daytime maximum of 29°C. Furthermore; as the attributes of low cost (i.e. nearby) destinations are likely to improve following climate change this is likely to result in a sizeable welfare gain to British tourists, even in the case of Southern European countries like Spain and Greece. Both these countries however, experience a lengthening and a flattening of the tourist season. In contrast, the losses experienced by the possible inundation of low-lying islands in the Indian and Pacific Oceans are likely to be small because these destinations are, at least to British residents, very expensive and consequently not much visited. But it is important to stress that the values which this paper seeks to estimate are use values and not total economic values which may be much greater.

At an empirical level there is also further work to be done in terms of specifying the demand equation: including alternative measures for precipitation (such as rain days), including variables representing hours of sunshine and variables representing the degree of personal security. It would be interesting to examine the role of socio-economic factors such as age and income in explaining travel patterns. At a theoretical level reallocation effects are not dealt with well in the PTCM in the sense that the effect of changes in the quality (and price) of substitute sites are set to zero. This is most unlikely to be a fair representation of what would in fact happen. In the RUM set-up by contrast, the number of holidays remains unchanged irrespective of the quality of the experience provided by different destinations so neither approach is entirely satisfactory.

References

The Times World Atlas. (1992) Times Books: London.

Bockstael, N., McConnell, K. and Strand, I. (1991) Recreation. In Braden, J. and C. Kolstadt (eds.) *Measuring the Demand for Environmental Quality*. Elsevier: North Holland.

Caulkins, P., Bishop, R. and Bouwes, N. (1986) The Travel Cost Model for Lake Recreation: A Comparison of Two Methods for Incorporating Site Quality and Substitution Effects. *American Journal of Agricultural Economics,* 68: 291-297.

Central Statistical Office (1995) *Travel Trends.* HMSO: London.

Delft Hydraulics (1990) *Strategies for Adaptation to Sea Level Rise.* Report of the Coastal Management Zone Subgroup for WMO and UNEP: Geneva.

Freeman, A. (1993) *The Measurement of Environmental and Resource Values*. Resources For the Future: Washington DC.

Houghton, J., Jenkins, G. and Ephraums, J. (1990) *Climate Change: The IPCC Scientific* Assessment. Cambridge University Press: Cambridge.

Johansson, P-O. (1987) *The Economic Theory and Measurement of Environmental Benefits.* Cambridge University Press: Cambridge.

Maddala, G., (1977) Econometrics. McGraw-Hill: Singapore.

McConnell, K. (1992) On-Site Time in the Demand for Recreation. *American Journal of Agricultural Economics*, 74: 918-925.

Pearce, E. and Smith, C. (1994) *The World Weather Guide*. Helicon: Oxford.

Perry, A. (1993) Weather and Climate Information for the Package Holiday Maker. *Weather,* 48: 410-414.

Perry, A. and Ashton, S. (1994) Recent Developments in the UKs Outbound Package Tourism Market. *Geography,* 79: 313-321.

Smith, K. (1991) Recreation and Tourism. In Parry, M. (ed) *The Potential Effects of Climate Change in the United Kingdom*. HMSO: London.

Smith, V., Desvouges, W. and Fisher, A. (1986) A Comparison of Direct and Indirect Methods for Estimating Environmental Benefits. *American Journal of Agricultural Economics,* 68: 280-290.

United Nations Development Programme (1995) *Human Development Report 1995.* Oxford University Press: Oxford.

Wall, G. (1992) Tourism Alternatives in an Era of Global Climate Change. In Smith, V. and Eadington, W. (eds.) *Tourism Alternatives.* University of Pennsylvania Press: Philadelphia.