

Climate Change and Tourism

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Climate Change and Tourism
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International partner organizations:



IPCC



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Introduction

The First International Conference on Climate Change and Tourism took place, at the invitation of the Government of Tunisia and under the sponsorship of the World Tourism Organization, in Djerba, Tunisia, on 9-11 April 2003. The conference brought together over 140 delegates from some 45 countries, drawn from representatives of the scientific community, various United Nations agencies, the tourism industry, NGOs, national tourism offices, national and local governments. The conference offered a unique opportunity for tourism interests and scientists to exchange views on the consequences, opportunities and risks presented to the tourism sector as a result of changes in the world's climate.

The format of the conference comprised an official opening session, five separate working sessions - an introductory session and four round tables - a presentation of a summary of the five sessions and a debate on the issues raised, and a closing session. Twenty-six formal papers were presented during the five working sessions, at the end of each of which there was a period of open debate, questions and answers.

This Report contains the main conclusions and agenda for action derived from the presentations and debates of the Conference, as well as the Djerba Declaration on Tourism and Climate Change, as one of the main outputs of the event, plus a summary of the sessions and discussions held.

Main Conclusions and agenda for action

The two days of the 1st International Conference on Climate Change and Tourism covered a great many topics and issues. These included

- a résumé, in lay terms, of the current scientific thinking on the subject;
- details of the activities of the relevant international organisations acting in this field;
- a WTO background paper on the impact of climate change on the tourism industry;
- case studies from around the world detailing the impact of climate change on a variety of tourism activities and in a variety of locations;
- examples of adaptation and mitigation strategies;
- an examination of tourism's own contribution to the causes of climate change; and
- a full discussion among delegates following each session.

The conference provided one of the first opportunities for all interested parties to come together, and represented an important step forward in addressing this key subject. It also helped to signpost the way to the further analysis and action that is required.

The Djerba Declaration

An important output of the conference was the issuance of the *Djerba Declaration on Tourism and Climate Change*, included in this report. In brief, this declaration marks an important stage in establishing that serious international attention, under the leadership of the World Tourism Organization, is now being paid to this subject. The declaration calls upon all interested parties to continue research efforts, encourage sustainability in tourism, raise awareness of the issues involved and use the declaration as a framework for future action.

The scientific evidence

It was recognised that, within the current body of scientific analysis, research and prediction, there remain considerable uncertainties about the magnitude of the impact of many effects of a changing global climate - for example, the extent of rises in temperatures, changes in precipitation, and the extent and location of extreme events, floods and droughts. Scientific studies into climate change are on-going and, in some specific areas, are still at a relatively early stage. As such studies progress, there may well be changes in the long-term predictions for climate change which currently cover the period to the end of the present century.

Nonetheless, the conference broadly accepted, as a working hypothesis, the predictions contained in the Third Assessment Report on the Inter-Governmental Panel on Climate Change (IPCC). The IPCC in the second quarter of 2003 commenced its preparatory work for the Fourth Assessment Report, but it will be some time before that report becomes available. Such scientific studies may be expected to become increasingly sophisticated. The tourism industry, among others, should be prepared to monitor developments and adjust its planning accordingly.

From a purely ecological viewpoint, predicted changes to the world's climate give substantial cause for concern. Sea level rises threaten the viability of many coastal zones and small islands. Temperature rises are predicted to change precipitation patterns - both seasonal and absolute - which seem likely to exacerbate water supply problems. A greater risk of both flooding and drought conditions in many parts of the world stem from this. Climate change also seems likely to increase the magnitude, frequency and risk of extreme climatic events, such as storms and sea surges. The impact of predicted changes to the world's climate is expected to be especially adverse in northern latitudes, with the southern hemisphere generally expected to be less affected.

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A two-way relationship

A recurrent theme of the conference was the need to recognise a two-way relationship between tourism and climate change. On the one hand, tourism has an obligation to minimise its adverse impact on the environment and thus on the emission of greenhouse gases which in turn contribute to climate change. On the other hand, it was recognised that changes to the world's climate will have a direct impact on many tourism destinations which could have far-reaching implications, not just for the tourism industry, but for other economic sectors. The tourism industry needs to be made aware of these consequences and set in train planning processes which will enable it to adapt and adjust its activities accordingly.

The impact on tourism

In two environments which are vital for tourism activities and where tourism is an equally vital component in regional and local economies - coastal zones and mountain regions - climate change puts tourism at risk. Important market changes could result.

Seaside tourism seems likely to suffer damage from most of the effects of climate change, notably beach erosion, higher sea levels, greater damage from sea surges and storms, and reduced water supply. However, while some regions may see a diminution of demand from the leisure traveller, others - currently less important as tourism destinations - may see an increase.

In mountain regions, it seems very probable that ultimately demand for winter sports will diminish. The season will shorten, opportunities for young people to learn the sports will diminish, demand pressures on high altitude resorts will increase (which in turn could raise environmental pressures and cause further damage). Summer seasons, meanwhile, could lengthen, and generate increased demand, although this could bring further negative environmental consequences.

The balance of costs and benefits is illustrated by the situation in the Arctic, where a longer summer season might benefit cruise tourism and activities such as whale-watching, but shorter winters could reduce the range of Arctic fauna and flora which attracts some visitors.

Whatever the environmental outcome, tourism cannot be seen in isolation. Major changes in the pattern of demand will lead to wider impacts on many areas of economic and social policy - such as, for example, in employment and labour demand and in regional policy issues such as housing, transport and social infrastructure. Knock-on effects could influence other sectors, such as agriculture supplying tourism demand, handicraft industries, local small business networks and so on.

However, with the apparent exception of winter sports, unless climate change leads to a net loss in demand for leisure tourism (which the conference did not identify explicitly as a risk), a loss of demand for a given destination or type of destination may well lead to increases in demand for alternative destinations. Whether a net environmental gain or loss results from such changes will partly depend on the ability of the tourism industry to raise its sustainability - a key issue to which the conference devoted considerable time (see below).

Raising awareness

The conference felt that it is necessary to raise awareness of the inter-relationship between tourism and climate change. A number of concerns arose in this area. The first is to emphasise

the need for jargon-free, clear communication on the subject in order that tourism industry interests can see the potential implications for their sector.

The second is to understand that raising the industry's awareness is a global issue, since almost every country has a tourism sector which is of importance in the national economy and has important inter-sectoral linkages. It will be important to ensure that tourism authorities and governments understand how their own industry and economy may be affected vis-à-vis their current or potential competitors.

Third, it was acknowledged that, in raising the industry's awareness, action needs to be taken to deal with the time scales involved. While climate change predictions of necessity cover the long term, the tourism industry tends to have much shorter time horizons, even in the context of physical investment in infrastructure. It was felt that, in order to engage the attention of the tourism industry, this gap will need to be bridged, perhaps by emphasising that climate change is already having an impact on the tourism sector, and perhaps by some of the actions which it is hoped will follow this inaugural conference.

Tourism as a polluter

The conference devoted much of its final session to the issue of tourism's own responsibility for minimising pollution. While no specific calls for action emerged, a number of important issues were raised.

The principle of "the polluter pays" gave rise to an understanding that further efforts should be devoted to environmentally sustainable tourism by all concerned, and especially by the tourism industry itself. The implication was that tourism should recognise and take action to put its own environmental house in order. This is especially so since the activity of leisure tourism is primarily undertaken by the better-off, and it is in accordance with the Kyoto principles that the better-off should be the first to take action to stabilise emissions levels.

While concern about tourism's polluting effects covers all aspects of a tourist's activity, there was a consensus that the primary issue relates to **travellers' consumption of transport services**, notably road and air transport. In the former case, there is clear evidence from major tourism destinations such as France, that the use of road transport by travellers contributes significantly to greenhouse gas (GHG) emissions. The conference clearly felt that the tourism industry shares some of the responsibility for road transport pollution and thus also shares a responsibility to minimise harmful emissions by encouraging sustainable, carbon-neutral road transport solutions.

Air transport, although currently contributing substantially lower levels of GHGs than road transport, was also raised as a cause for concern. The proportionate contribution made by air transport to total GHG emissions was agreed to be rising rapidly. Schemes to achieve carbon-neutral air transport by the introduction of voluntary levies have already been described. There is evidence from countries such as the UK and New Zealand that carbon taxes of one kind or another are increasingly being placed on the political and environmental policy agenda. It seems inevitable that, at some future date, serious consideration will be given to additional environmental taxes or levies targeting the air transport sector specifically. The conference was concerned that the tourism industry acknowledge the polluting effects of air transport and take steps to minimise its impact. When considering the control of the air transport sector for its emissions, the socio-economic impacts of the control measures on destinations should also be examined, as it can affect local economies especially in long-haul destinations in developing countries.

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In the wider area of **the sustainability of tourism**, concerns were also raised about tourism's high per capita consumption of water, energy efficiency and the effects that tourism has on flora and fauna.

The conference heard evidence that tourists' water consumption was far in excess of that of local residents and that much of the resulting water stress arises in regions and areas which already suffer from inherent water shortages. Similarly, energy conservation measures need to be taken (Tunisia already offers hotels a subsidy for the use of solar power), to help to minimise tourism's environmental footprint. The concentration of tourism in certain regions of the world places stresses on the local flora and fauna which in many cases are what tourists come to see; such stresses themselves may exacerbate the adverse effects that climate change is already having on the ecology.

In all such incidences, the destination's sustainability remains a prime concern, and the conference emphasised that all stakeholders need to re-double their efforts to ensure sustainable solutions.

Further research

There will continue to be a need for further studies and research into the issues raised by the conference. Further scientific research into climate change is underway and will help to refine the implications for all sectors of economic activity. The Djerba conference has already succeeded in getting tourism more firmly onto the scientific agenda as a sector of importance whose interests will be directly affected by climate change. The conference indicated that further scientific research remained an important priority.

Beyond the scientific research, however, lies a need for further studies in which the tourism sector itself takes a more proactive position. This could arise in a number of ways.

First, there is an opportunity to pursue the interests of the sector through further studies undertaken by the World Tourism Organization, in collaboration with key United Nations agencies, such as the World Meteorological Organization (WMO) and the UN Convention to Combat Desertification (UNCCD), the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Environment Programme (UNEP), the Intergovernmental Panel on Climate Change (IPCC), and the Intergovernmental Oceanographic Commission (IOC). The WTO, having initiated an international dialogue on the topic of tourism and climate change by undertaking this conference, now needs to maintain the momentum. One way of doing so is for the WTO to forge new links for co-operative action with other international agencies and climate research bodies to ensure that the interests of the tourism industry continue to be addressed.

Second, it was suggested that further studies should be encouraged by the tourism industry on national, regional and/or local levels as appropriate. Such studies could be pursued either through the national tourism authorities (most usually, through the ministry responsible) or via the national tourism office. In either case, the objective should be for the tourism industry to treat tourism in a holistic way, which ensures that inter-sectoral implications are taken fully into account. The studies should involve all the main stakeholders in the industry, as well as the scientific community. Research should take into account the inter-relationships between tourism destinations and how changes in demand might change their relative positions.

In order to focus closely on the implications for the tourism industry - its investment decisions, marketing programmes, physical infrastructure development and so on - local studies ultimately will be needed in order to form the basis for planning suitable responses, whether these fall into the category of mitigation, adaptation or retreat. 'Macro' level studies

such as those discussed at the conference, while undoubtedly very helpful, nevertheless are of limited use in the context of local destinations.

Meetings programme

In parallel to these recommended actions, the process of informing the industry, governments and other interested parties also needs to continue. It was felt to be especially important to ensure that governments, as the primary initiators of decisions regarding appropriate responses, should be encouraged by the tourism industry to examine climate change implications specifically in the tourism context.

The conference felt that more regional meetings and pilot projects would be helpful in this regard, in order to ensure that the dissemination of information continues. The Djerba conference has clearly initiated this debate, and it was felt to be crucial that the debate continues in the future.

Role of the WTO

Finally, the conference focused on the key co-ordinating role which the World Tourism Organization should take in future. It was suggested that the WTO should act as a clearing house for information on the subject. As the Djerba Declaration makes clear, the WTO should be kept informed of all relevant studies and pilot projects, and should build a database of best international practice. There is a degree of urgency in the need for WTO to use this growing body of research to develop a blueprint for monitoring the effects of climate change on tourism. WTO should disseminate this blueprint to all interested parties in order to facilitate the planning of adaptation measures in future.



World Tourism Organization

Djerba Declaration on Tourism and Climate Change

The participants gathered at the First International Conference on Climate Change and Tourism, held in Djerba, Tunisia, from 9 to 11 April 2003, convened by the World Tourism Organization, upon an invitation of the Government of Tunisia,

Having listened to the presentations by the representatives of the:

- Tunisian Government
- Intergovernmental Oceanographic Commission (IOC) – UNESCO
- Intergovernmental Panel on Climate Change (IPCC)
- United Nations Convention to Combat Desertification (UNCCD)
- United Nations Environment Programme (UNEP)
- United Nations Framework Convention on Climate Change (UNFCCC)
- World Meteorological Organization (WMO)
- World Tourism Organization (WTO)

and by representatives from the private and public sectors, as well as the points of view of a number of national governments, tourism companies, academic institutions, NGOs and experts;

Acknowledging that the objectives of this Conference are fully in line with the concerns, pursuits and activities of the United Nations system in the field of climate change, and more generally, in that of sustainable development;

Recognizing the key role of the Kyoto Protocol as a first step in the control of greenhouse gas emissions;

Taking into consideration that in convening this Conference WTO did not intend a purely science-based debate, neither to cover all the well-known social and environmental implications that climate change can have on societies, but rather to put emphasis on the relationships between climate change and tourism, given the economic importance that this sector of activity is having on many countries, especially small island and developing states, and with a view to raising awareness of these relationships and strengthening cooperation between the different actors involved;

Having carefully considered the complex relationships between tourism and climate change, and particularly the impacts that the latter are producing upon different types of tourism destinations, while not ignoring that some transport used for tourist

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movements and other components of the tourism industry, contribute in return to climate change;

Aware of the importance of water resources in the tourism industry and of its links with climate change;

Recognizing the existing and potentially worsening impact of climate change, combined with other anthropogenic factors on tourism development in sensitive ecosystems, such as the drylands, coastal and mountain areas as well as islands, and

Taking into consideration that the right to travel and the right to leisure are recognized by the international community, that tourism is now fully integrated in the consumption patterns of many countries, and that WTO forecasts indicate that it will continue to grow in the foreseeable future,

Agree the following:

1. *To urge* all governments concerned with the contribution of tourism to sustainable development, to subscribe to all relevant intergovernmental and multilateral agreements, especially the Kyoto Protocol, and other conventions and similar declarations concerning climate change and related resolutions that prevent the impacts of this phenomenon from spreading further or accelerating;
2. *To encourage* international organizations to further the study and research of the reciprocal implications between tourism and climate change, including in the case of cultural and archaeological sites, in cooperation with public authorities, academic institutions, NGOs, and local people; in particular, *to encourage* the Intergovernmental Panel on Climate Change to pay special attention to tourism in cooperation with WTO and to include tourism specifically in its Fourth Assessment Report;
3. *To call upon* UN, international, financial and bilateral agencies to support the governments of developing, and in particular of least developed countries, for which tourism represents a key economic sector, in their efforts to address and to adapt to the adverse effects of climate change and to formulate appropriate action plans;
4. *To request* international organizations, governments, NGOs and academic institutions to support local governments and destination management organizations in implementing adaptation and mitigation measures that respond to the specific climate change impacts at local destinations;
5. *To encourage* the tourism industry, including transport companies, hoteliers, tour operators, travel agents and tourist guides, to adjust their activities, using more energy-efficient and cleaner technologies and logistics, in order to minimize as much as possible their contribution to climate change;
6. *To call upon* governments, bilateral and multilateral institutions to conceive and implement sustainable management policies for water resources, and for the conservation of wetlands and other freshwater ecosystems;

7. *To call upon* governments to encourage the use of renewable energy sources in tourism and transport companies and activities, by facilitating technical assistance and using fiscal and other incentives;
8. *To encourage* consumer associations, tourism companies and the media to raise consumers' awareness at destinations and in generating markets, in order to change consumption behaviour and make more climate friendly tourism choices;
9. *To invite* public, private and non-governmental stakeholders and other institutions to inform WTO about the results of any research study relevant to climate change and tourism, in order for WTO to act as a clearing house and to create a database on the subject and disseminate know-how internationally; and
10. *To consider* this Declaration as a framework for international, regional and governmental agencies for the monitoring of their activities and of the above mentioned action plans in this field.

The participants expressed their thanks to the Tunisian Government and people for the warm hospitality and excellent facilities provided to host this Conference in the island of Djerba.

Djerba, Tunisia, 11 April 2003

WTO Background Paper on Climate Change and Tourism

Prepared for the World Tourism Organization
By Graham Todd, Travel Research International Limited

March 2003

A. INTRODUCTION

This paper is intended to be an introduction to the subject of how climate change will affect the tourism industry, a subject on which very little research has been undertaken. The purpose of this paper, and of the 1st International Conference on Climate Change and Tourism, is to set out the initial position of the World Tourism Organization (WTO) on the subject.

A priori, it is leisure travel which is most likely to be affected by climate. Climatic factors, especially those of reliable summer weather, are the prime motivation for mass leisure travel. Their impact on other forms of leisure travel varies in importance. Travel for business purposes, and to some extent, travel in order to visit friends and relatives (VFR travel), is less affected by climate.

The global climate is already changing. A key element in leisure travel demand is the degree of comfort (or discomfort) to be experienced at the traveller's destination. Subject to issues such as humidity and precipitation, human comfort becomes harder to maintain once air temperatures exceed around 31°C. This "comfort factor" is also affected by other elements such as disease risk, extended rainfall and changes in extremes. These factors all affect the choice of destination by leisure travellers.

This paper focuses at a "macro" level on the likely influences on the tourism industry of climate change. By definition, the paper can only adopt a broad approach which can hide important local or regional variations. The limitations of this approach are discussed at the end of the paper which also suggests some broad lines of action to be taken by tourism authorities in assessing the likely impact on their own tourism sector.

While climate change predictions generally cover the period to the year 2100 and may therefore seem a long way in the future, it is vital to recognise that climate change is already having an impact on tourism. Destinations should begin to consider the implications for their industry now. This paper is intended to start that process.

B. CLIMATE CHANGE PREDICTIONS

It is accepted that climate change induced by human activity is underway. Of all the effects on the world's climate, greenhouse gas (GHG) emissions are having the greatest impact. The three main GHGs are carbon dioxide (CO₂) methane (CH₄) and nitrous oxide (N₂O). By far the most important of these is CO₂. Other climatic impacts arising from human activity include additional effects of fossil fuel burning, changes to the ozone layer, sulphate emissions, aviation exhaust, and solar radiation changes. Many of these latter effects are not thoroughly understood by science but, within the current limits of scientific knowledge, it is GHGs which are at the heart of the impact.

While human-induced climate change is manifesting itself in a gradual warming of the planet, more rapid changes may arise as a result of unquantifiable surprises and shocks. Currently,

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the elements driving climate change are having and will continue to have many diverse effects, but the three most important are:-

- rising average air temperatures;
- rising sea levels (mainly due to thermal expansion - water expands as it gets hotter); and
- increased frequencies of extreme climatic events, notably storms, associated precipitation changes, sea surges etc.

Timescale

Even if it were possible to stop all human GHG emissions and stabilise GHG concentrations in the atmosphere at today's level, the effects on climate change of earlier emissions would continue to be felt for at least the next 1,000 years due to the large thermal inertia in the oceans. The Kyoto Protocol (the first step on the ladder towards stabilisation of the climate system), aimed to reduce CO₂ emissions from developed countries by 5% of their 1990 emissions. The overall target is to stabilise GHG concentrations in the atmosphere at levels that would prevent dangerous human-induced climate change. Stabilisation might possibly fall in the range of 450-750 parts per million volume (ppmv). The current atmospheric concentration of CO₂ is approximately 380 ppmv and is rising at 1% a year.

Complex three-dimensional General Circulation Models (GCMs) are used to make predictions of how the climate system will respond to changes in GHG concentrations. These models are used to make predictions as far ahead as the year 2100, and use the 2020s (2010-2039), the 2050s (2040-2069) and the 2080s (2070-2099) as dates to illustrate the likely impacts of climate change.

The central assumptions

Climate change will vary according to the rate of global economic growth, population change and other socio-economic factors. The Inter-Governmental Panel on Climate Change (IPCC) has defined four different scenarios, each having equal probability, to take account of these factors. These scenarios in turn influence the quantitative predictions of climate change, especially the variations around mean predictions.

Clearly, all sectors of the world's economy, including tourism, will be influenced by economic and social factors, and thus all long term predictions inevitably contain a degree of uncertainty.

Nonetheless, the central climate change assumptions for the period 1990-2100 can be simply stated:

- average global temperatures will rise by between 1.4°C and 5.8°C, a rate unprecedented in the past 10,000 years;
- sea levels will rise by between 9 and 88 centimetres by 2100, with a central forecast of 48 centimetres, implying a rate of increase between two and four times greater than during the 20th century;
- there will be substantial regional variations around these average changes.

Geographic summary

Temperature change

In simple terms, climate models show that, over most land areas, average temperatures will rise by an amount greater than the global average. Northern latitudes in particular will see the most rapid warming. Northern Asia (mainly the northern latitudes of Russia) and the Tibetan plateau will see the greatest rises, but northern Europe, the Mediterranean, and North America will also see above-average increases.

Precipitation change

There is perhaps less confidence about the predictions for precipitation changes than for temperature change. Globally, however, the hydrological cycle, and subsequently precipitation, will increase. The northern latitudes are predicted to see the greatest effects. The Mediterranean region is the only one where a large decrease in precipitation is predicted during the summer months, while increases are mainly predicted for the more northerly latitudes. Small summer decreases are foreseen for northern Europe, southern Africa and all of Australia, with general decreases also predicted for central America. Winter increases are expected in much of the northern hemisphere, tropical Africa and Antarctica, and summer increases also in southern Australia, southern and eastern Asia.

Other important predictions

Sea level rises are predicted for the world's oceans, with a central estimate of 48 centimetres by 2100 around variances of between 9 and 88 centimetres. Most models predict a greater than average rise in the Arctic ocean and a below average rise in the Southern Ocean. Even if emissions could be held at current levels, sea levels will rise as a result of past emissions for at least the next 1,000 years, ultimately by as much as four metres. The Greenland and Antarctic ice sheets contain enough water to raise global sea levels by 70 metres if they were to melt; thus only a small fractional change in their volume would have a significant effect.

Extreme climatic events will become more frequent. Many move from being "likely" (a 66-90% chance) in the 20th century to "very likely" (90-99% chance) during the 21st. The following are "very likely" over most land areas:- higher maximum temperatures; more hot days; higher minimum temperatures; fewer cold and frost days; reduced diurnal temperature range; increase of "heat index" (a combination of temperature and humidity that measures effects on human comfort); and more intense precipitation events. "Likely" are:- increased summer continental drying and associated drought risks; and increased peak wind and precipitation intensities associated with tropical cyclones.

Ice sheets will exhibit varying tendencies. The Antarctic ice sheet will expand due to rises in precipitation, while the Greenland ice sheet will shrink as runoff exceeds precipitation effects.

The implications for the world's major tourism regions are summarised in Chart 1.

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Chart 1: Summary of climate change predictions

	Temperature	Rainfall (precipitation)	Other key variables
Global	0.2-0.6°C rise in temperature per decade Decrease in diurnal temperature range	Increase in rainfall by 3-10% by 2050 increase in droughts over continental areas	4-10cm increase in sea-level per decade
Northern Europe	0.4-0.8°C rise in temperature per decade Increase in winter and summer temperatures Decrease in frost days	Increase in amount and intensity of winter rainfall Decrease in summer rainfall	Summers become “better” and appear “more reliable”
European Alps	Increase in winter temperatures Snowline increases in altitude by up to 100m per decade	Increase in winter snowfall	Increased risk of avalanches due to combination of higher temperatures and increase in snow Shorter ski season
Mediterranean basin	0.3-0.7°C rise in temperature per decade Increase in heat index Increase in number of days over 40°C	Decrease in summer rainfall (-15%) Increase in desertification Increase in winter rainfall Increase in erosion and runoff	Increased risk of forest fires Increased risk of flash floods Water resource pressures increase Coastal areas and infrastructure vulnerable to sea level rise
Middle East/ North Africa	0.3-0.7°C rise in temperature per decade Increase in number of very hot days	Slight decrease in annual rainfall Rainfall and convective activity become more intense	Increased pressure on water resources Increase in flash floods and erosion Sea level rise threatens beaches Increased sea surface temperatures
Sub-Saharan Africa	0.3-0.7°C rise in temperature per decade	10-15% increase in winter rainfall	Wetter warmer winters Drier more intensely hot summers
North America	0.3-0.7°C rise in temperature per decade	Slight increase in annual rainfall Rainfall and convective activity become more intense	Increased rainfall and hurricane activity over Pacific states associated with El Niño events
Caribbean	0.2-0.6° rise in temperature per decade	Slight increase in annual rainfall Rainfall and convective activity become more intense	Increased rainfall and hurricane activity associated with La Niña events
Central/South America	0.2-0.6°C rise in temperature per decade	Decrease of 3% in annual rainfall	Decrease in hurricane activity associated with El Niño events

North East Asia	0.4.-0.8°C rise in temperature Increase in winter and summer temperatures Decrease in frost days	Increase in amount and intensity of winter rainfall Decrease in summer rainfall	Summers become "better" and appear more "reliable"
South Asia	0.1-0.5°C rise in temperature per decade	Little change in rainfall	Coastal areas vulnerable to erosion
Far East/Pacific	0.1-0.5°C rise in temperature per decade	Little change in rainfall	Small island states and coastal areas vulnerable to sea-level rise

Source: Climatic Research Unit, University of East Anglia, UK

C. DEVELOPMENT OF TOURISM DEMAND HYPOTHESES

Summary of main global tourism flows

In order to consider the impact of climate change on the pattern of tourism worldwide and how tourist behaviour might change as a result of changing weather scenarios, it is first necessary to summarise global tourism patterns and the world's major tourist flows¹.

Tourism flows are unevenly distributed between the various regions of the world. Among the world's 715 million international tourist arrivals (2002), the concentration of tourism activity is heavily focussed on a relatively few markets and destinations. In terms of pure volume, three regions - Europe, North and South East Asia, and North America - account for an overwhelming proportion of both demand and supply. Around 58% of all international arrivals take place in Europe, 16% in North and South East Asia and around 12% in North America. This represents almost nine out of ten of the world's international tourist arrivals. While travel to other regions of the world may be highly significant to the destinations concerned - such as to the Pacific islands, for example - it can be negligible in terms of tourism's "big picture". Even among individual markets, tourism is highly concentrated: the top four markets - the USA, Germany, the UK and Japan - account for over one-third of all international demand, and the top ten (the previous four plus France, Italy, China, the Netherlands, Canada and Belgium/Luxembourg) for well over half.

Unsurprisingly, most international travel takes place intra-regionally, and most of this is within sub-regions: approximately 87% of all international arrivals in Europe are from Europe itself (some 350 million arrivals), with a corresponding figure of 71% in the Americas (92 million arrivals) and 77% in the Asia Pacific region (88 million). In addition to this intra-regional activity, there are six major tourism flows that dominate international travel and account for around a quarter of total arrivals:

- Northern Europe to the Mediterranean 116 million
- North America to Europe 23 million
- Europe to North America 15 million
- North East Asia to South East Asia 10 million
- North East Asia to North America 8 million
- North America to the Caribbean 8 million

Climatic influences on tourism flows

The balance between business, leisure, VFR and other reasons for travel varies within these flows and this therefore alters the degree to which climate change will have an impact. Equally, while all leisure travel is influenced by climate to some degree, its importance clearly varies according to the type of holiday.

Among these major bilateral flows, the weather is clearly of paramount importance in much of the travel that takes place from northern Europe to the Mediterranean and from North America to the Caribbean. This mass movement of people is not only primarily leisure-based, but the intrinsic reason for travel is to visit a sunny beach destination.

The climate is a far less significant influence on travel from North America to Europe. In part there is a far higher proportion of business travel within this flow. However, even for the leisure traveller, the weather is not a major determining factor since the primary reason for

¹ The analysis of tourism flows is based on WTO tourism arrivals data as reported by national governments.

travel is more likely to be to visit the destinations' cultural attractions, rather than for the appeal of its weather.

The flow between North East Asia to South East Asia has a large sun, sand and sea component, although there is also a significant element of business and VFR travel. Equally, the composition of travel between North East Asia and North America and between Europe and North America encompasses a variety of types of traveller.

The principal regions

By far the lion's share of tourism activity takes place in **Europe**. This consists predominantly of tourist flows between the sub-regions of northern Europe (ie Northern Europe, Western Europe and Central and Eastern Europe²), plus flows within those sub-regions. Together these accounted for 162 million arrivals in 2000. However, the largest single flow is the mass transfer of tourists from the colder northern regions of Europe southwards to countries bordering the northern coast of the Mediterranean - primarily a summer sun market. This amounted to around 116 million arrivals in 2000 - about one-sixth of all tourist trips worldwide.

Europe is also a major origin market for other regions of the world, with a large number of European tourists crossing the Atlantic to North America - a flow of some 15 million in 2000. There are smaller but nonetheless significant flows of tourists to North East Asia and South East Asia (5 million in each case) and to the Caribbean (4 million).

North America is the next major centre of activity. Europe attracts a major flow of tourists from the USA and Canada - some 23 million in 2000. The Caribbean is also a major attraction for North Americans, primarily a market seeking the warm Caribbean climate during the winter months. There were around 8 million North Americans visiting the Caribbean in 2000.

The third centre of activity is **Asia**. Again, intra-regional travel predominates, with 10 million North East Asians visiting South East Asia in 2000, and 5 million South East Asians travelling in the reverse direction. There are also two relatively large flows from outside the region. North East Asia received 5 million European visits and 4 million visits from North America in 2000. Smaller numbers are recorded in South East Asia, which received 5 million Europeans and around 2 million North Americans.

In pure volume terms, other regions of the world do not feature on the map of the world's major tourism activity. While tourism is a major economic activity in parts of South America, Africa, the Middle East and Oceania, volume remains concentrated in the world's more developed nations.

Charts 2 and 3 summarise the world's main international tourism flows; the year 2000 is used as the base year.

² WTO definitions

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Chart 2: Major international tourism flows, 2000
(million arrivals)

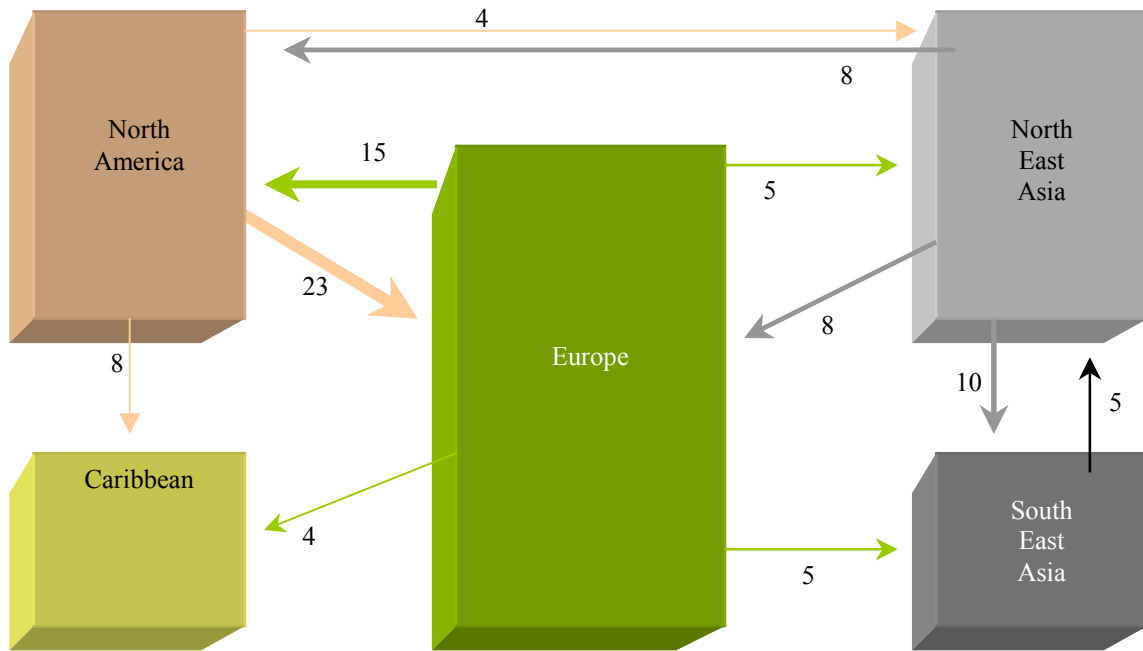
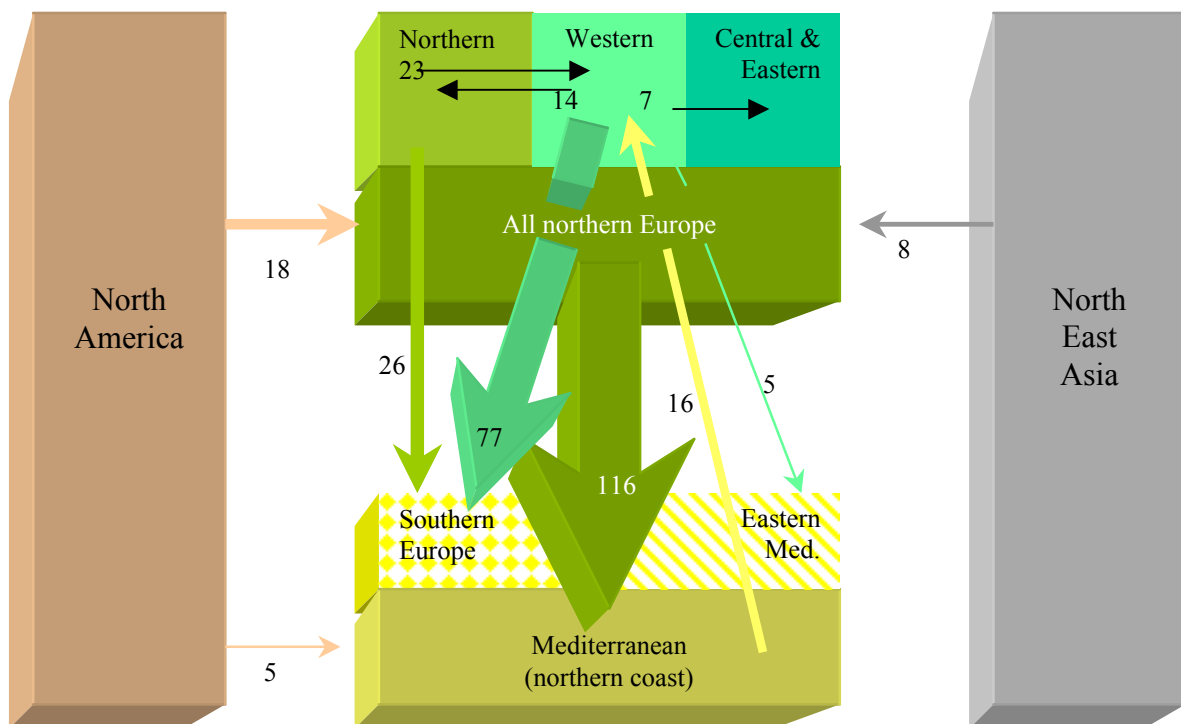


Chart 3: Major tourism flows within and into Europe, 2000
(million arrivals)



Source: Travel Research International from World Tourism Organization data

Assumptions regarding potential effects on tourism demand

Chart 4 examines the likely impact of climate change on tourism market behaviour for the six largest international tourism flows identified above. The analysis includes the effects of climate change in both origin and destination regions and suggests how tourism markets might behave as a result.

The composition of each travel market (i.e. the reason for travel), the level of climate change in a tourist's origin market and the changing weather conditions in the destination will each have a bearing on the way in which tourism behaviour alters. Looking at the main tourism flows set out in Chart 4:

Northern Europe to the Mediterranean

Broadly, this is a market with a single purpose. It leaves behind an unpredictable summer climate in northern Europe – possibly little sun, plenty of rain and cool temperatures – in search of an annual dose of certain warmth and sunshine. Altered weather patterns induced by climate change could mean that northern Europe becomes more attractive and reliable during the summer months, while the Mediterranean generally deteriorates in its appeal for the holidaymaker: the temperatures may become too hot, tropical diseases may become prevalent, there may be water shortages, the landscape may become arid, and freak events in the form of flash floods and forest fires may become more frequent. The coast may become eroded and low lying coastal amenities such as resort complexes and golf course inundated. As a result, this mass movement of tourists could gradually slow, with northern Europeans holidaying either domestically or at least increasingly within northern Europe. Equally, southern Europeans may travel north to escape uncomfortable summer conditions at home.

North America to Europe

The North American market to Europe is more cosmopolitan with 70% travelling for leisure purposes and 30% on business. The business travel component generally is unlikely to be much affected by the climatic changes. Leisure travel also is likely to be relatively unaffected since culture and sightseeing are the prime motivations for an American trip to Europe. However, cities such as Rome and Florence could become too hot during the summer peak and therefore for southern Europe there could be a greater shift to shoulder season travel. Equally, more favourable summer weather conditions in northern Europe could mean greater congestion in cities such as London, Paris and Stratford-upon-Avon, during the summer peak and again travel from North America could see a greater spread into the shoulder months.

Europe to North America

The significant business component within this market is unlikely to be greatly affected by climatic changes. The leisure sector contains a number of sub-sections, the largest of which are travel to Florida, California and New York in the USA and to the West Coast in Canada. As climate change begins to have an impact, it is likely that European travel patterns to Florida - which is largely an organised tour beach market from the UK - may shift its seasonality or location as the region suffers from coastal degradation, an increasing likelihood of tropical diseases (already malaria prevention costs are rising) and it becomes uncomfortably hot during the peak summer season. Equally, travel to the Pacific coast, though not dependent on the "sun, sea and sand" market to the same extent as Florida, may be impacted by the increasing risk of unpredictable weather. Summer travel to East Coast cities such as New York, and to California's Los Angeles and San Francisco are likely to shift to Spring and Autumn as a result of increasing temperatures. Warmer winters and summers in

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the Rockies will decrease the effective length of the skiing season, increase avalanche risk and also affect lower lying ski resorts, although summer activity holidays are likely to benefit.

North East Asia to South East Asia

Climate changes in both origin and destination region are predicted to be small relative to other regions and as a result this large flow is likely to be relatively unaffected within the time frame covered. Sea level rises and warming sea temperatures will, however, have an impact on the region's islands and coasts which attract considerable numbers of visitors from countries such as Japan and Taiwan.

North East Asia to North America

Arrivals in North America from North East Asia are predominantly from Japan, South Korea and Taiwan. The large market travelling for business purposes will remain relatively unaffected, as will the sizeable VFR component. The leisure market is predominantly visiting the USA and Canada for sightseeing purposes; again, climate change is unlikely to have a major impact. Greater storm frequency on the Pacific coast and excessive heat in cities such as New York, Los Angeles and San Francisco may well instigate seasonal alteration to travel.

North America to Caribbean

As one of the world's main sun, sea and sand playgrounds, the Caribbean's tourism offering is totally dependent on its climate and beach product. Its main market, North America, is on the one hand escaping from its own cold and grey winter climate, while on the other moving to warmth, sunshine and coastal pursuits. As a result, the Caribbean is especially vulnerable to climate change since both factors may change - parts of the USA may become warmer, thus obviating the need to escape, while rising sea levels make the islands especially vulnerable, damaging beaches and causing infrastructural damage to the predominantly low lying coastal regions. Rainfall decreases and an increased need for air conditioning will put additional pressure on the islands' water and energy resources.

Chart 4: Summary of climate changes and their probable impact on major international travel flows

MAJOR TOURISM FLOW	ORIGIN MARKET CLIMATE CHANGE	DESTINATION REGION CLIMATE CHANGE	IMPLICATIONS FOR DESTINATION REGION	POSSIBLE MARKET REACTIONS
NORTHERN EUROPE TO MEDITERRANEAN	<ul style="list-style-type: none"> - Much warmer, wetter winters - Warmer, drier summers - More "reliable" summers 	<ul style="list-style-type: none"> - Warmer, wetter winters - Much warmer, drier summers - Changes more marked in Eastern Mediterranean - Increased heat index - More days above 40°C - More arid landscape - Small tidal range means greater sea level rise impact 	<ul style="list-style-type: none"> - Greater drought and fire risk - Increased water shortages - Greater personal heat stress - Beach degradation and habitat loss due to sea level rises - Vulnerability to more tropical diseases (eg malaria) - More flash floods - Poor urban air quality in cities 	<p><i>Overwhelmingly a leisure travel market</i></p> <ul style="list-style-type: none"> - Improvement of Northern European summers triggers more domestic holidays - Decreased incentive for Mediterranean summer holidays - Increased incentive for shoulder month Mediterranean holidays - Increased incentive for southerners to go north
NORTH AMERICA TO EUROPE	<ul style="list-style-type: none"> - Warmer winters - Warmer summers - Slight rainfall increases - S.E. USA (Florida) at risk from beach erosion, greater storm risk - Pacific coast greater storm risk and higher rainfall 	<p>Northern Europe</p> <ul style="list-style-type: none"> - Much warmer, wetter winters - Warmer, drier summers - More "reliable" summers <p>Southern Europe</p> <ul style="list-style-type: none"> - Warmer, wetter winters - Much warmer, drier summers - E. Med. esp. sharp changes - Increased heat index - More days above 40°C - Sea level rises 	<p>Northern Europe <i>(80% of flow is to this sub-region)</i></p> <ul style="list-style-type: none"> - More attractive climate for summer holidays - Possibly greater congestion at key sites and cities <p>Southern Europe <i>(20% of flow is to this sub-region)</i></p> <ul style="list-style-type: none"> - Greater drought risk - Increased water shortages - Greater fire risk - More beach degradation due to sea level rises 	<p><i>Approx. 70% leisure, 30% business</i></p> <ul style="list-style-type: none"> - Too hot for peak summer cultural visits to southern Europe; - Shoulder months travel may increase - Little change foreseen for travel to northern Europe
EUROPE TO NORTH AMERICA	<p>Northern Europe</p> <ul style="list-style-type: none"> - Much warmer, wetter winters - Warmer, drier summers - More "reliable" summers <p>Southern Europe</p> <ul style="list-style-type: none"> - Warmer, wetter winters - Much warmer, drier summers - E. Med. esp. sharp changes - Increased heat index - More days above 40°C 	<ul style="list-style-type: none"> - Warmer winters - Warmer summers - Slight rainfall increases - S.E. USA (Florida) at risk from beach erosion, greater storm risk - Pacific coast greater storm risk and higher rainfall 	<ul style="list-style-type: none"> - Sea level rise damages Florida coast and Everglades - Risk of Pacific coastal damage - Geomorphic damage to south-eastern coast - Increased heat index - Coastal erosion and storm damage risk on east coast - Rising health costs as tropical disease risk rises 	<p><i>Biggest destinations are Florida, California and New York</i></p> <ul style="list-style-type: none"> - Florida may become less attractive at peak times - Possibly greater attraction of Carolina coast? - E. coast US and Canadian cities too hot in summer - Stronger winter ski market due to reduced capacity in Europe

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MAJOR TOURISM FLOW	ORIGIN MARKET CLIMATE CHANGE	DESTINATION REGION CLIMATE CHANGE	IMPLICATIONS FOR DESTINATION REGION	POSSIBLE MARKET REACTIONS
NORTH EAST ASIA TO SOUTH EAST ASIA	<ul style="list-style-type: none"> - Warmer all year round - Small year round rainfall increase 	<ul style="list-style-type: none"> - Little change in rainfall - Relatively little change in temperatures - Coastal areas vulnerable to sea levels rises 	<ul style="list-style-type: none"> - No dramatic climatic changes foreseen - Islands and tourist coasts vulnerable - Coral bleaching 	<ul style="list-style-type: none"> - Climatic factors unlikely to influence travel patterns greatly - Possible decline in dive and beach markets
NORTH EAST ASIA TO NORTH AMERICA	<ul style="list-style-type: none"> - Warmer all year round - Small year round rainfall increase 	<ul style="list-style-type: none"> - Warmer winters - Warmer summers - Slight rainfall increases - Pacific coast greater storm risk and higher rainfall 	<ul style="list-style-type: none"> - Risk of Pacific coastal damage - Geomorphic damage to south-eastern coast - Increased heat index - Coastal erosion and storm damage risk on east coast 	<ul style="list-style-type: none"> - E. coast US and Canadian cities too hot in summer? - Sightseeing travel not likely to be greatly affected by climate change
NORTH AMERICA TO CARIBBEAN	<ul style="list-style-type: none"> - Warmer winters - Warmer summers - Slight rainfall increases - S.E. USA (Florida) at risk from beach erosion, greater storm risk - Pacific coast greater storm risk and higher rainfall 	<ul style="list-style-type: none"> - Warmer winters - Warmer summers - Small decrease in rainfall - Sea level rises 	<ul style="list-style-type: none"> - Particularly vulnerable to sea level rises - Increased beach erosion - Coral bleaching and reef damage - Salinisation of aquifers - Higher energy costs for air conditioning - Greater need for sea defences and flood control - More tropical diseases (eg malaria) - Increased pressure on natural resources and eco-systems 	<ul style="list-style-type: none"> - Beach product offering becomes less attractive (heat index, beach erosion, sea and coral quality) - Less need to escape northern climate - Loss of confidence in destination health risks

Source: Travel Research International

Other destination regions

In addition to the major international tourism flows discussed above, it is also useful to summarise the climate changes predicted for other world regions which, while not featuring among the major flows, nevertheless have important tourism sectors. Also, two types of destination in which tourism is especially important - mountain regions and small island states - need consideration. Chart 5 summarises this information. It is worth noting that, by and large, the southern hemisphere will be less affected by climate change than the north.

Chart 5: Summary of climate changes and their probable impact on other world regions

DESTINATION REGION	CLIMATE CHANGE PREDICTIONS	IMPLICATIONS/CONSEQUENCES FOR TOURISM INDUSTRY
ALPINE AND MOUNTAIN REGIONS	<ul style="list-style-type: none"> - Warmer winters - receding snow-line - Wetter winters ie more snow at high altitudes, more rain at lower levels - Shorter snow season - Warmer, drier summers 	<p><i>(Travel to mountain regions for winter sports is predominantly intra-regional)</i></p> <ul style="list-style-type: none"> - Shorter skiing season - Greater demand for high altitude resorts for skiing - Greater risk of avalanches - Extended season for non-ski mountain activities - Possibly less overall demand for skiing?
TROPICAL ISLAND STATES	<ul style="list-style-type: none"> - Relatively small temperature rises - Relatively small rainfall changes - Sea level rises critical - Storm frequency and intensity increases - Coral bleaching 	<ul style="list-style-type: none"> - Beach erosion and coastal flooding - Possible submergence - Salinisation of aquifers - Reef damage and erosion - Increasingly untenable beach resorts - Ingress of new tropical diseases - Increased energy costs for A/C - Reduced demand for holidays to worst affected islands - Reduced demand for dive holidays
MIDDLE EAST AND NORTH AFRICA	<ul style="list-style-type: none"> - Warmer winters - Much warmer summers - Drier summers in North Africa - Wetter summers in Arabian peninsula 	<ul style="list-style-type: none"> - Probable decline in peak summer visits - Stronger winter tourism market - Stronger tourism demand in shoulder months
SOUTH AMERICA	<ul style="list-style-type: none"> - Below average winter warming for Amazon region - Warmer summers in Amazon - Little change in annual rainfall in Amazon region - Warmer summers in southern cone, inconsistent predictions for winter - Inconsistent predictions for southern cone rainfall 	<ul style="list-style-type: none"> - South America likely to be among the least-affected regions globally for tourism demand - Possible rise in skiing's importance in Andean region (Chile, Argentina)?
SUB-SAHARAN AFRICA	<ul style="list-style-type: none"> - Inconsistent temperature predictions except (a) warmer winters in West Africa and (b) warmer "summers" (Jun-Aug) in Southern Africa - Increased rainfall in West and East Africa in winter - Small decrease in rainfall in "summer" (Jun-Aug) in Southern Africa - Wetter summers in Sahara 	<ul style="list-style-type: none"> - Little clear indication of climate changes affecting tourism - Hotter and drier "summer" months in Southern Africa could diminish demand slightly? - Wetter "winters" in East Africa could diminish demand for 'safari' and beach holidays?
AUSTRALIA NEW ZEALAND PACIFIC ISLANDS	<ul style="list-style-type: none"> - Inconsistent temperature predictions, except warmer "summers" (Jun-Aug) in northern Australia - Small decrease in "summer" (Jun-Aug) rainfall 	<ul style="list-style-type: none"> - Winter demand (Oct-Mar) from northern hemisphere to remain strong? - Pacific islands very vulnerable to sea level rises and greater storm activity (see 'Tourism to tropical island states' above)

Source: Travel Research International

Looking to the future

WTO's forecasts contained in *2020 Vision* are the only long-term tourism predictions that exist. Over that period, and in the longer term, the performance of the tourism sector will clearly be influenced by social change, political developments, economic growth, environmental change and demographic trends. Because there is no tourism forecast beyond 2020, no analysis has been done of the effect of these various factors on tourism growth.

In the context of climate change predictions for the whole of the 21st century, forecasts to 2020 are clearly of limited use. Nonetheless, *2020 Vision* predicts that global international arrivals will rise on average by 4.1% a year to a total of 1.56 billion arrivals in 2020, with the Middle East growing fastest (7.1% per annum) and Europe slowest (3.0% per annum). In the longer run beyond 2020, these rates seem certain to decline. (If the global growth rate of 4.1% a year were to continue to 2100, total international arrivals would reach 40,000 million, probably four times the global population at that date.)

It is nevertheless instructive to look at just two examples - the main flows from northern Europe to the Mediterranean (the world's largest tourism flow), and from North America to the Caribbean (because economically, tourism is more vital in the Caribbean than in any other region on earth).

The "base case" in Table 1 shows the effects of extrapolating tourism growth in these two regions at 3% a year on average, based broadly on WTO forecasts to 2020, for a further 30 years.

However, it is possible that climate changes may cause these rates of growth to be lower over the long-term than they would otherwise have been. Purely to illustrate the possible effects, Table 1 also shows two lower rates of growth - 2.5% and 2% a year on average.

Table 1: Hypothetical results of alternative growth rates in international tourism flows to two key regions, 2000-2050
(million arrivals)

Flow	Growth rate (% pa)	2000 (the base year for these flows)	2020	2030	2040	2050
"Base case" extrapolation						
N Europe to Mediterranean	3.0	117	211	283	382	513
N America to Caribbean	3.0	8	14	19	26	35
Half point growth rate reduction						
N Europe to Mediterranean	2.5	117	192	245	314	402
N America to Caribbean	2.5	8	13	17	21	27
Full point growth rate reduction						
N Europe to Mediterranean	2.0	117	174	212	258	315
N America to Caribbean	2.0	8	12	14	18	22

Source: Travel Research International

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WTO data show also that in 2000, on average, each international arrival in Europe generated expenditure of US\$580 excluding transport costs, and each North American arrival in the Caribbean generated US\$1,000. Thus the northern Europe-Mediterranean flow was worth around US\$70 bn in 2000, and that from North America to the Caribbean US\$8 bn. By 2050 these would be US\$300 bn and US\$35 bn respectively.

While such analysis can be no more than hypothetical, if climate change caused the decreases in growth rates shown in the table, the Mediterranean in 2050 might have foregone between 111 and 198 million arrivals, worth (in constant 2000 prices) between US\$64-110 bn in receipts. The Caribbean (from North America only) in 2050 might have forgone between 8 and 13 million arrivals worth US\$8-11 bn.

While these tourists would not necessarily be "lost" to global travel since they might simply go to other regions or convert to domestic tourism, the destination regions concerned would nevertheless have to deal with radically different economic circumstances, especially in employment, than would have been the case without these effects.

Potential effects of climate change on France

In a recent study on the world's largest tourism destination, the main points are as follows:-

- by 2050, mean temperatures in France will have risen by 2°C;
- rainfall in summer will be 15% less than current levels and in winter 20% more;
- the effects will be sharpest in southern France;
- the authors suggest that summer tourism in the southern parts of the country may well benefit from the even higher temperatures that will affect more southerly Mediterranean countries such as Spain and Italy;
- winter tourism, especially along the Atlantic coast, will see a decline in demand;
- shoulder months should benefit as warmer weather extends further into the autumn;
- changes in rainfall may cause water shortages in the south in summer;
- there will be a 10-45% reduction in the duration of winter snow, shortening the Alpine skiing season; and
- on the coasts, it will be necessary to address beach erosion from rising sea levels as well as planning issues such as moving building lines away from the beach.

D. DEVELOPMENT OF POLICY OPTIONS

Many consequences of global climate change - such as rising temperatures and sea levels, increased storm frequencies, and increasing or diminishing precipitation - cannot be influenced by any individual destination to any great extent. From the standpoint of the tourism industry, it is therefore important to recognise what is likely to happen and to lay plans to mitigate the adverse effects as far as possible.

The following text summarises some of the actions that may be open to some destinations in this regard.

The physical environment

(a) Coasts and beaches

The effects of climate change on islands, coasts and beaches - the natural playground of a significant percentage of the world's leisure tourists - probably produce the most severe repercussions for the tourism industry. There are a number of different impacts:

- **sea level rises** cause coast and beach erosion, inundation of flood plains, rising water tables, destruction of coastal eco-systems, salinisation of aquifers and, at worst, the total submersion of islands or coastal plains.
- **warmer sea temperatures** of 1-2°C cause coral bleaching and dying. This leads to a breakdown in the reef protection surrounding most tropical coastlines and an amenity loss for divers and snorkellers. It is predicted that coral bleaching will increase in intensity and frequency to the extent that in the Caribbean and South East Asia it will occur annually by 2020 and in the Pacific by 2040.
- **increasing storm frequency**, especially in conjunction with rising sea levels, leads to damage to sea defences, protective mangrove swamps and shoreline buildings, to beach erosion and causes storm-surge damage to coral reefs .

El Niño Southern-Oscillation (ENSO)

Variations in the location of warm and cold waters within the Pacific Ocean have a cyclical effect on the global climate. In recent years, the magnitude of these variations (the oscillation between the two extremes) has been increasing. The transfer of the warm waters of the western Pacific along the equator to the eastern Pacific and to the western coasts of the Americas is now referred to as "El Niño". When the opposite happens, the phenomenon is called "La Niña". Scientists have become aware that changes associated with ENSO produce large variations in weather and climate around the world from year to year. These variations are associated with floods, heat waves, fire risks and other changes, and also influence the CO₂ balance in the atmosphere.

Extensive coral bleaching occurred as a result of El Niño in 1998 and 30 large scale incidents were reported. Coral bleaching is already evident in Central America and the Caribbean, the Pacific and Indian Ocean Islands, Asia and the Red Sea. Scientists are as yet unaware of how more frequent coral bleaching events will affect reef development and species composition.

Adaptation measures

A rise in sea level means that not only does the coast itself needs protection but also that measures may be required to protect the hinterland from flooding. It is commonly accepted that strategies for adaptation to sea level rises fall into three main categories - delineated as "protect", "accommodate" or "retreat" - and that all need to be considered in the broader context of coastal management. Measures might include:-

- the building of sea wall defences and breakwaters to protect the coast and its hinterland; this has been the traditional response, and may be the only practical option, but it has been found sometimes to create as many problems as it solves and can ultimately destroy a location's natural beauty;
- enhancement and preservation of natural defences (such as the re-planting of mangrove swamps or raising the land level of low lying islands);
- adapting to the changed conditions by building tourism infrastructure and resorts further back from the coast;
- importing sand to beaches in order to maintain their amenity value; beach re-nourishment may, however, be costly and temporary and may damage the area from which the sand is drawn;
- sand mining for building materials can exacerbate the loss of beaches; new building regulations to introduce other types of building material may be considered; and

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- dealing with degradation of coral reefs, which are not only a source of vital tourist income for island destinations but also frequently essential in protecting low-lying islands, such as those in the Pacific and Indian Oceans; when coral bleaching occurs and the reefs die, alternative man-made protection is unlikely to succeed; ultimately, abandonment may be the only option.

Climate change and lost tourism revenues

In 1998 (the warmest year ever, influenced by a strong El Niño phenomenon), coral bleaching took place on the resort of Bandos Island in the Republic of Maldives.

This island drew much of its tourism revenue from diving operations. In the year in question, the island experienced a 30% drop in its normal annual income from tourists' diving operations of some US\$ 1 mn, indicating that earnings from tourism can be affected in the very short term by climatic factors.

(b) Mountain regions

Climate change is affecting the world's mountain regions, including the popular ski regions of the Alps and across the USA, in a broadly similar way: the snow line is receding due to warmer winters (for every 1°C increase, the snowline recedes by 150 metres), the ski season is becoming shorter, and there is greater precipitation – which means more snow at higher altitudes – during the winter months. The threat to winter sports is already manifesting itself in the skiing regions of Switzerland and Austria for example, while Scotland is having to address increasingly frequent snow-deficient winters. Such climatic changes strike at the very essence of a ski resort's *raison d'être*. At the same time, mountain summers are becoming warmer and drier, presenting opportunities for extending the non-ski market.

Adaptation measures

A number of adaptation strategies for ski resorts present themselves, ranging from mitigation of the detrimental effects to a complete change in the tourism product. These include:-

- at the margin, increased use of artificial snow can help to extend and supplement natural snow-cover as temperatures rise;
- high altitude resorts are likely to become more popular and may have to adapt to greater demand;
- lower altitude resorts, with reduced snow cover, may need to introduce an increased range of alternative attractions to skiing during the winter season;
- as a result of less stable (wetter) snow, greater avalanche protection will be required;
- resorts that are no longer within the reliable winter snow belt may need to reinvent themselves and address alternative markets; and
- as mountain summers become drier and warmer, the summer tourist season may be extended into the shoulder months; changing demographic patterns, particularly an ageing population with more leisure time, may prove beneficial to attracting this market.

The built environment

Climate change is already causing planning authorities to revise many aspects of policy, such as re-defining flood plain risks and discouraging development on them. In the tourism sector there will be an increasing need to take climatic factors into account specifically in tourist areas, of which coastal areas are likely to be the most important.

Adaptation measures

Policy options will have to be considered for tourism infrastructure in a variety of areas. These may include:-

- where techniques such as sand-mining are crucial to the supply of building materials but are also exacerbating beach erosion, planners may have to insist on alternative (and perhaps a return to locally-traditional) building materials;
- similarly, traditional designs may have to be encouraged to deal with alternative methods of cooling buildings in increasingly hot climates to counteract rising energy costs;
- physical planning issues will require building lines to be moved back from eroding coasts;
- coastal infrastructure, such as drainage, waste disposal, electricity, water supply, railways and roads may also have to be moved back from eroding coastal areas;
- water supply itself will have to be re-examined for many, increasingly arid areas;
- in the financial sphere, newly-built tourism infrastructure (e.g. hotels) in vulnerable areas may have to be written off over shorter-than-usual periods which in turn could have an effect on the prices which tourists have to pay; and
- increased insurance costs will have to be factored into resort profitability.

Climate change and power consumption

Power consumption in Grenada has been observed to change by up to 25% for every 1.1°C of temperature rise. Between July and September 1999, temperatures were 0.9°C above average, causing power consumption to rise by 11%.

The Tourism Sector

While the impacts of climate change vary and are likely to manifest themselves in a variety of ways, what is certain is that the tourism sector has to show itself adaptable to changing conditions. Some changes may indeed favour an increase in tourism – such as warmer, drier summers in northern Europe leading to greater domestic travel and a reverse flow of tourists from the south – so that one destination's loss is another's gain. However, the majority of changes – rising temperatures and sea levels and increasing storm frequency, in particular – present the industry with real challenges.

Adaptation measures

Each situation calls for its own individual solution, but mitigation tactics that the industry might employ include:-

- the introduction of built attractions to replace natural attractions if the appeal of the latter diminishes - eg the installation of an ice rink, spa facilities, etc, if skiing becomes less reliable at lower altitudes;
- the development of alternative marketing strategies to cope with an expanding or a diminishing market (including stronger promotion of domestic tourism);
- adaptation to changes in the seasonality of tourist arrivals – eg the increased heat of the Mediterranean during the summer months may lead to reduced visitor numbers during the peak season but an increase during the shoulder months;
- co-operation with governments in order to deal with problems such as those associated with health, availability of water and vulnerability of infrastructure;

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- recognition of the vulnerability of some eco-systems – eg wetland areas such as the Everglades in Florida - and the adoption of measures to protect them as far as possible;
- the introduction of alternative attractions (such as the sinking of a ship to provide a focus for divers to replace lost coral dive sites); and
- the recognition that the tourism industry will be required to meet more stringent insurance conditions.

Climate change and tourism marketing strategies

A concrete example of how market focus has changed as a result of climatic influences is to be found in the resort of El Nido, located on Palawan Island in the Philippines, where coral bleaching has led to the industry targeting the honeymoon market to replace the destination's lost dive market.

Coral bleaching during the summer of 1998 led to 30-50% coral mortality. It is estimated that 80% of resort guests in the mid 1980s were divers; this has now declined to around 10%. Honeymooners now account for around 50% of the guests, but low occupancy rates suggest that it has proved impossible to replace "lost" dive guests entirely.

It is estimated that, if the coral takes ten years to recover from the bleaching, the net present value of the diving income lost during that time will amount to US\$6-7 mn for the national economy. However, if the coral fails to recover, the net present value of the loss in earnings will be in the range of US\$15-27 mn.

Issues of Government Policy

Government policies on climate change cover all sectors of the economy. The following is a suggested list of adaptation measures aimed explicitly at the tourism sector. These might include:-

- introduce fiscal incentives (e.g. accelerated depreciation) or financial assistance for changes to the built tourism infrastructure (e.g. expanding flood drainage provisions in hotel properties, or re-development further back from beaches), to deal with the consequences of climate change;
- consider changing the fiscal regime where necessary (e.g., new hotels in vulnerable coastal zones may have to be written off in a shorter-than-normal period due to sea level rises, and thus may also require accelerated depreciation provisions);
- introduce fiscal incentives to encourage use of traditional building materials and thereby discourage, for example, local sand mining;
- greater public investment in infrastructure for new tourism developments (e.g. land preparation, coastal defences or supporting infrastructure investment) to meet climate change impacts;
- passing legislation to change planning policies, zoning, land use priorities, as necessary;
- introducing changes to the school year in order to change peak holiday times (e.g. if traditional mid-summer periods become too hot or ski resorts have shorter snow seasons);
- providing direct training to the tourism sector in dealing with the consequences of climate change, including assistance with practical issues e.g the 'hazard' mapping of sites and zones;
- providing re-training for displaced tourism sector workers where market share may have been lost;

- revising policies on the financing of national tourism offices in order to ensure that promotional and marketing activities are tailored to new climatic realities (e.g. promoting 'shoulder' seasons); and
- re-casting national transport policies where, say, aviation should be given a lower priority and internal transport higher priorities.

How tourism contributes to climate change

Tourism is not only affected by climate change, it also contributes to it. The bulk of tourism's contribution to greenhouse gas emissions comes from transport activities (76.5% in the case of the USA, with the remainder derived from accommodation, restaurants, retail activities and activity-specific tourism).

Within the transport sector, the predominant source of greenhouse gas emissions is road transport. In France, for example domestic and international tourism now account for 7-8% of France's total road transport emissions (which themselves were the origin of 39% of the country's total CO₂ emissions in 1990, up from 8% 30 years earlier). Air transport has been estimated to be between two and four times more polluting per passenger carried than road transport.

Adaptation measures

In Europe and North America, the private car dominates modal choice for the leisure tourist. In most of the rest of the world, air travel is the most important mode (but is also very significant in Europe and North America). While demand for air travel for day-trip (e.g. business) purposes or air freight movements does not qualify as tourism, much of the remaining passenger demand is ascribable to tourism. In contrast, taking the French example, less than 10% of road transport derives from tourism.

While the issue of private car emissions is in the front line of pollution reduction strategies such as those enshrined in the Kyoto Protocol, air transport as a polluter is far less well-documented, is excluded from the Kyoto Protocol altogether and, until recently, has hardly featured in the debate about tourism's contribution to pollution.

This position seems unlikely to prevail indefinitely. Increasing concern is being expressed about the environmental costs of unfettered growth in air transport. IPCC studies suggest that globally, by 2050, air transport will be contributing about 5% of the total greenhouse gas effects on climate change; some commentators regard this as an under-estimate and claim that it could be twice this level. For the crucial CO₂ emissions, aviation will account for between 6% and 10% of the total by that date. The European Environment Agency points out that there was a 19% increase in greenhouse gas emissions in the EU between 1990 and 2000. Although air transport contributes only a small share of this, it is the fastest-growing source of GHG emissions, having risen by almost 29% in that decade.

Air transport's polluting effects may be able to be reduced through measures such as improved air traffic control so that in-flight delays can be minimised, and by the use of more fuel-efficient engines. However, despite such moves and also despite the highly political nature of any decision on the subject, it seems clear that, eventually, air transport will be subject to increased taxation as a means of controlling growth. There is mounting pressure to remove the duty exemption on aviation fuel but, since that would require a highly complex re-negotiation of the 1944 Chicago Convention, debate seems currently to favour a direct tax levied per ticket or per sector instead. There is already a direct call for such a tax from the UK (suggesting that the tax would have to be the equivalent of US\$55 per sector in order to have the desired effect), together with a demand that aviation should be included in the Kyoto Protocol as a matter of urgency.

While such action on civil aviation would be difficult for any nation to implement unilaterally, Europe-wide action seems far more likely and could directly affect the treatment of the sector worldwide. Whatever method is adopted, the result would be to raise the price of air travel as a means of reducing growth in demand. The consequences for short-haul air transport, on which the highly successful 'no-frills' airlines are based, for expansion in the airport infrastructure across Europe, for aircraft manufacturers and for employment would be profound.

E. SUMMARY AND INDICATIVE AGENDA FOR FUTURE WORK

The "macro" approach adopted in this paper can do no more than scratch the surface of a complex subject. In reality, the effects of changing climatic conditions on the global tourism industry will be influenced at local and sub-regional levels by factors such as:-

- the impact of individual climatic characteristics on local destinations;
- the physical environment;
- topographical characteristics;
- local geological factors;
- changing local health risks as a result of climate change;
- the nature of the tourism markets being served;
- the types of tourism facility and attractions offered.

Against this background, individual tourism destinations need first of all to interpret these global trends in the context of their own localities. Although the timescale during which climate change will have an impact may seem long, the impact on the tourism industry (and, of course, many other sectors) has already begun.

While tourism's adaptations to climate change need to be made at a local level, there are a number of conclusions that the industry as a whole must recognise. Climate change is happening now and its impact on tourism has to be taken seriously. Because of the importance of weather and environment to leisure demand, tourism is one of the sectors most likely to be affected by climate change. The greater the economic importance of tourism, the greater is the importance of understanding potential impacts and planning for appropriate action. The potential impact of climate change has very important implications for employment, investment policies, government policies and for the livelihoods of local residents.

It therefore seems essential that the tourism industry should get involved in joint initiatives - with governments, local authorities or the international agencies - in assessing the implications of climate change.

Central governments and tourism ministries will always have a key role to play in defining and promoting action in the tourism sector in response to climate change. However, it is likely that such initiatives will need to be implemented at a sub-regional or local level in order to take into account local conditions and needs. The precise content of local initiatives will depend on local circumstances of course, but among those that the tourism industry can take might be:-

- form local bodies comprising the main stakeholders specifically to investigate the impact of climate change and make preparations for action;

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- establish what research material, if any, is available on the potential effects of climate change in the country or region concerned, identify the major gaps in that research and seek action to fill those gaps;
- initiate, participate in or undertake local studies to:
 - assess whether/how climate change has already begun to have an impact on tourism;
 - prepare physical plans and "hazard maps" of vulnerabilities due to climate change (e.g. impending rises in sea level or growing water shortages in peak summer periods) which will affect the industry directly;
 - co-operate with scientists, physical planners, public authorities and other appropriate specialists to prepare outline plans of the potential impact;
 - define and cost whatever mitigation measures and actions may be appropriate in local circumstances;
 - assess the issue of whether additional/new products need to be introduced to cope with changing circumstances;
 - define and cost the benefits to the tourism industry that might be gained from appropriate remedial measures and from new opportunities that may arise for the industry;
- act as a focal point for lobbying actions to bring to the attention of policymakers the issues which will affect the tourism sector arising from the potential impact of climate change;
- adopt an integrated approach to tourism management in order to accommodate medium and long term concerns (such as rising sea levels) and current needs, as well as the interests of different stakeholders;
- initiate discussions with tourism planners, national tourism offices and tourism ministries on the changes to tourism policy and promotional efforts which may be required as the effects of climate change become more pronounced;
- undertake an ongoing monitoring of changes that may be emerging as a result of climate change - eg physical changes to destination, visitor health, changing markets, changing product.

LIST OF PRINCIPAL REFERENCES

Agnew M. and Viner D., *Potential impacts of climate change on international tourism*, The Surrey Quarterly Review, Volume Three, Number One, University of Surrey 2001

Australian Greenhouse Office, *Australia's third national communication on climate change*, 2002

Ceron, Jean-Paul and Dubois, Ghislain, *Why should French tourism pay attention to climate change?*

Cesar, Herman, *Impacts of the 1998 Coral Bleaching Event on Tourism in El Nido, Philippines*, Coastal Resources Center, University of Rhode Island, December 2000

Coastal Resources Center, University of Rhode Island, *Socio-economic Implications of Mass Coral Bleaching*.

European Environment Agency, Indicator Fact Sheet, *Transport emissions of greenhouse gases*, October 2002, Term 2002 02 AC and Term 2002 02 EU

Hadley Centre, UK, *Stabilisation and commitment to future climate change*, 2002

Hoegh-Guldberg, Ove, *Climate Change, Coral Bleaching, and the Future of the World's Coral Reefs*, Greenpeace USA

Inter-Governmental Panel on Climate Change, *Aviation and the Global Atmosphere*, 1999

Inter-Governmental Panel on Climate Change, *Special Report on the Regional Impact of Climate Change. An Assessment of Vulnerability*, 2001

Maddison, David, *In search of warmer climates? The impact of climate change on flows of British tourists*, Kluwer Academic Publishers, 2001

Royal Commission on Environmental Pollution, UK, *The environmental effects of civil aircraft in flight*, 2002

UK Meteorological Office and the UK Department for the Environment, Food and Rural Affairs *Stabilisation and commitment to future climate change; scientific results from the Hadley Centre, October 2002*

UNEP World Conservation Monitoring Centre, *The 1998 Coral Bleaching Incident*

United Nations Framework Convention on Climate Change (UNFCCC), *Impact of climate change on tourism in developing countries*

World Meteorological Organization and United Nations Environment Programme *Climate Change 2001 - The Scientific Basis*

Summary of Conference Sessions and Discussions

Official opening statements of welcome were made by HE Mr. Mondher Znaidi, Minister of Tourism, Commerce and Handicrafts, Government of Tunisia and Mr. Francesco Frangialli, Secretary General of the World Tourism Organization. The main conference sessions then commenced.

Introductory session - Tourism and climate change

The first working session of the conference dealt with the general subjects of climate change and its broad potential impact on tourism. There were four papers presented.

Dr. Geoff Love of the Intergovernmental Panel on Climate Change (IPCC) summarised the current assumptions regarding climate change. The IPCC, is jointly sponsored by the World Meteorological Organization and the United Nations Environment Programme, relies on the voluntary contributions of the world's scientific community and undertakes only assessment work itself. It responds primarily to requests from the United Nations Framework Convention on Climate Change (UNFCCC) but also works with other UN conventions as appropriate.

The current position on climate change is embodied in the IPCC's Third Assessment Report which contains the results of the latest scientific climate models. Having sketched out the causes of climate change, Dr. Love acknowledged that there remain areas of considerable scientific uncertainty in the study and prediction of climate change, especially in the highly complex area of the carbon cycle. Nonetheless, science is certain that the earth's average surface temperature has risen to unprecedented heights, and that current rates of temperature rise are the fastest ever. Science is also certain that precipitation patterns are changing, although there is less certainty about the regional relationships between climate change and the incidence of both floods and droughts.

Carbon dioxide in the atmosphere is the principal "greenhouse gas". In pre-industrial times, there were 280 parts per million (ppm) in the atmosphere. The current level is 380 ppm. There is uncertainty about how much higher the level may go before stabilisation measures, such as those set out in the Kyoto Protocol, are reached. Current modelling is based on stabilisation at 550 ppm or 750 ppm, while predictions also exist for a 'no stabilisation' outturn.

The four most striking effects of climate change are sea level rises, changes (increases) in surface temperatures, a more intensive hydrological cycle and the probable variation in regional impacts. Models allow for considerable variances of prediction and reflect the need for further scientific research. However, firm conclusions already show that the earth's climate will change, that emissions levels already achieved will ensure that climate change continues for many years (even if hypothetically emissions were to cease now entirely), and that the consequences for the world's regions will be marked - especially in northern latitudes and over the main continental land masses.

Dr. Youssef Nassef of the UN Framework Convention for Climate Change (UNFCCC) addressed the issue of global mitigation strategies, especially in the context of the Kyoto Protocol, adopted in 1997. A total of 186 countries are Parties to the UNFCCC, and 96 are Parties to the Kyoto Protocol, including some developed countries which, in 1990, accounted for 37.4% of carbon dioxide emissions. The Kyoto Protocol is not yet in force, however. It requires the ratification of enough countries which, together, account for 55% of global carbon dioxide emissions. This has not yet been achieved.

The central objective of the UNFCCC is to stabilise the atmospheric concentration of greenhouse gases at a level which would prevent dangerous interference with the world's

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climate system, and to do so soon enough to allow ecosystems to adapt naturally, to avoid threatening global food security and to enable economic development to proceed in a sustainable manner. An important principle is that developed countries should be the first to take action.

Two priority areas for action are identified. The first is to mitigate the impacts of climate change, and the second is to adapt to them (the effectiveness of adaptation measures depends on the location's capacity to adapt - and thus poor countries are the most vulnerable). UNFCCC's national enquiries reveal that in many countries tourism is seen as an important and fast-growing sector which is also very vulnerable to climate change and is linked to other vulnerable sectors. There is thus a strong case for synergistic action, as well as for identifying the impact that climate change will have on the tourism sector and reinforcing national capacities to deal with the consequences.

On behalf of the World Tourism Organization, **Mr. Graham Todd** of Travel Research International presented a paper co-authored with Ms. Sue Mather, also of Travel Research International, with the assistance of Dr. David Viner of the Climatic Research Unit, University of East Anglia. Having summarised the IPCC's predicted temperature, sea level and other relevant changes in each of the world's main regions, the paper related these to the major international tourism flows on a global basis.

A large proportion of all international trips are made between a few of the world's major regions and between their constituent sub-regions. Notable among these flows are the (absolutely) large flows to the Mediterranean from northern regions of Europe, and the (relatively) large flows into the Caribbean from North America. There are also important intra-European, trans-Atlantic, trans-Pacific and intra-Asian flows.

Climate is perhaps the most important influence on the choice of a leisure travel destination. To generalise, the majority of leisure travellers seek reliable, warm (or, for winter sports, reliably snowy), destinations in exchange for their normal place of residence. Just as climate is a powerful influence on leisure travel demand, it follows that climate change has the capacity radically to change the nature, pattern and seasonality of international travel.

While no formal forecasts of leisure travel exist beyond 2020, long-term projections of tourism demand indicate that international travel flows could grow very substantially. The potential impact of climate change, when translated into a shift in demand from one region to another, has the potential to make very major impacts on leisure travel destinations. Ultimately the economic sustainability and viability of some destinations could change.

The paper sets out policy options for coastal zones, mountain regions, the built environment, the tourism industry and for governments. Tourism's contribution to climate change, largely derived from tourists' use of the transport sector, is summarised, and the paper concludes with a suggested plan of action for the tourism sector. In essence, destinations are encouraged to undertake close studies of their own circumstances and to prepare appropriate action plans. As in Dr. Nassef's paper, synergistic action with other sectors is advocated.

Finally in this first session, **Mr. Ahmed Slouma**, Director General of the Tunisian National Tourist Office, summarised the key role played by the country's climatic characteristics in the development of the current tourism industry. For centuries, Tunisia has been known as a tourism destination based on its climatic attractions. With a warm summer, mild winter and pure air, the country attracts visitors who seek relaxation and reliable weather. In recent times the Tunisian government has promoted spa tourism, developing resorts offering thalassotherapy and thermal facilities.

Tunisia was one of the first countries to prepare a framework for sustainable tourism and is aware of the need for flexibility in its tourism policies to reflect the needs both of international markets and of the domestic market. With the dual aims of sustainability and quality, tourism in Tunisia is clearly vulnerable to climate change and, as subsequent papers presented by Tunisian experts pointed out, has in hand a number of adaptation strategies to deal with these trends.

Round Table No 1 - Tourism and water resources

Water resources, the most crucial element for all forms of human activity, clearly has a critical position in the tourism sector. Seven papers were presented on this subject.

Dr. Jean-Marie Fritsch of the World Meteorological Organization summarised the key issues relating to the effects of climate change on global water resources, emphasising that, for the tourism industry as for all human activities, water is a key resource. Tourism is also a large consumer of water per capita - well above the global average. Furthermore, tourists' demand for water especially arises in dry, sunny holiday destinations where, by definition, water resources are often relatively scarce. Of the planet's 35 million km³ of fresh water, only 40,000 km³ (approximately 1%) is 'renewable', defined as being subject to the hydrological cycle of evaporation and rainfall. The remainder is stored as a fossil resource (as ice - 70% - and groundwater) which, if drawn on, cannot be replaced.

As the global climate warms, the hydrological cycle becomes more intense, increasing rainfall and raising the chances of flooding. However, the increase in rainfall will not be evenly spread, but will be concentrated in northern continental latitudes, increasing the probability of extremes such as the flooding in central Europe in 2002 which caused so much damage to tourism in cities such as Prague. Evidence of the growing risk was provided by data from Munich Re, the insurance group, which showed that, in the period 1950-2000 the value of economic loss due to natural disasters had risen from circa US\$3 bn a year to circa US\$68 bn a year (in constant prices), with insured losses rising similarly; in both cases, most of this increase took place in the past 20 years.

In conclusion, Dr. Fritsch called for action in the face of climate change to improve monitoring services and the understanding of hydrological processes, and to adopt increasingly integrated approaches to water management in order to evaluate more clearly the impact of climate change on the water environment and thus, *inter alia*, on the tourism sector.

Mr. Grégoire de Kalbermatten of the UN Convention to Combat Desertification (UNCCD) dealt with desertification and the inter-relationship between tourism and dryland regions. Tourism exerts both negative and positive influences on such regions - negative in the context of competition for scarce water resources, land degradation and the creation of pollution, positive in areas such as income generation at a local level, protection of biodiversity and overall ecosystems and the enhancement of economic potential.

The net effect of tourism is thus a question of balance. In small islands such as St Vincent and the Grenadines in the West Indian Windward Islands for example, water resources are entirely rainfall-dependent. There is evidence that absorptive capacities are being reached for the tourism sector in some of the smallest islands in terms of building activities, waste disposal and the detrimental effects of inadequate sewage treatment on coral reefs and the marine environment. On the positive side for example, the opening up of the Dana Reserve at Wadi Dana in Jordan after three years had created 55 jobs and provided financial benefits to 1,000 people. Tourism revenues covered 60% of the reserve's running costs; 70% of tourism receipts came from domestic tourists.

In order to enable tourism to continue in a sustainable manner, it is necessary to carry out environmental impact assessments, monitor the processes leading to land degradation and desertification, and encourage the tourism industry to promote sustainability in all aspects of its activities.

Regional and national examples of water resource issues in the context of tourism were presented for the Great Horn of Africa region (by **Ms. Warue Virginia Ngugi** of the World Meteorological Office), Tunisia (**Mr. Yadh Labane**, Tunisia National Meteorological Institute and **Mr. Yadh Zahar**, Tunisian National Institute of Rural Engineering and Forestry), Lake Balaton (**Ms. Tamara Ratz**, Kodolanyi Janos College, Hungary) and the circumpolar (Arctic) region (**Ms. Jeanne Pagnan** Twin Dolphins, Canada).

In the **Great Horn of Africa** (GHA) region, the inter-relationship between water and tourism is complex. Water is required to grow the plants on which herbivores, birds and so on depend; this in turn creates opportunities for carnivores, which, together with the general flora and fauna, are a key attraction for tourists. The sustainability of this type of wildlife tourism is thus directly dependent on water; changes to water supply, whether seasonal or geographic, affect the abundance and location of flora and fauna which influences the sustainability of various types of tourism. Tourism is thus fully integrated within the issue of water supply, and changes to precipitation caused by climate change will have a direct effect on tourism demand. At the same time, tourism is placing demands on (often water-scarce) drylands which reinforces the symbiotic relationship.

In **Tunisia**, the evidence of changes in precipitation over a lengthy historical period is inconclusive, and care should be taken to avoid rash conclusions and hasty judgements. Despite such reservations, however, Tunisia is accepting the broad predictions relating to the effects of climate change and is seeking to plan its response accordingly.

Tunisia is relatively a water-scarce country, especially in the tourism zones along the eastern seaboard and the offshore islands. Water is already having to be transferred to some of the best known tourist resort areas such as Sfax and the island of Kerkena. Within perhaps ten years, it may also be necessary to do so to Djerba. While in absolute terms, tourists in Tunisia consume only 1% of national water resources, per head they consume nine times as much as nationals, partly because the use of water by tourists in hotels and resorts is typically very wasteful. Extensive treatment of this water is required before it can be re-used. In Tunisia, it is predicted that, even without the effects of climate change, water rationing may ultimately be required because of regional water demand conflicts to which tourism contributes.

In Hungary, **Lake Balaton** is one of the largest bodies of freshwater in Europe and the country's second largest tourist attraction, drawing up to 2.25 million visitors annually, 55% of whom come in just three summer months. Lakeside tourism depends crucially on climatic resources and the quality and depth of the water in the lake. At present, the depth is just one centimetre above the minimum of 70 cm at key monitoring points; if the depth falls seriously below that, re-nourishment by means of river diversions may be required. At 28 beaches around the lake, water quality is monitored and the government has a responsibility to maintain the lake as a key tourism attraction, not least because of the local economic dependence on the tourism sector. The direct and indirect impacts of global climate change may significantly alter the current tourism system of the Lake Balaton region.

In the **Arctic**, encompassing land ranging from Alaska, across Canada, Greenland, northern Scandinavia and much of Russia, tourism is a relatively new activity which has yet to achieve high volume. Nonetheless, for some regions and communities it is seen as having important potential. Evidence of the effects of temperature rises on the ice-cap and tundra is already

available. In tourism terms, it is having some beneficial effects (such as extending the season for whale-watching and cruise-ship tourism, since access is improved if the ice-pack freezes later in the season), and some detrimental effects (such as a lack of ice-dependent fauna - seals, polar bears - and the opportunity to have the "Arctic experience" where the ice season is shorter than in the past). The key messages for the circumpolar region from the point of view of tourism, however, are that the infant tourism industry is unprepared for the effects of climate change on its business, that the Arctic tourism product itself is likely to change, and that better co-ordinated monitoring of the effects and implications of climate change will be required on an international scale, taking the region as a whole into account and involving all the affected countries.

Round Table No 2 - Tourism in small islands and coastal zones

The second round table of the conference focused on a segment of the tourism industry that is likely to be one of the most affected by climate change – tourism to small islands and coastal regions. Four speakers addressed this issue.

Mr. Terry Jones, on behalf of the Intergovernmental Oceanographic Commission, outlined some of the specific difficulties faced by coastal and marine areas through the impacts of climate change. An increase in the world's coastal population – 20% live within 30 kilometres of the coast – means that greater pressures are already being exerted on coastal eco-systems. The global mean sea level rose by between 10cm and 20cm during the twentieth century and current predictions suggest a rise of 20cm to 100cm, with a mid-estimate of 50cm, during the twenty first. Impacts on coastal communities include migration, flooding, rising water tables, increased soil erosion as farms are moved to steeper slopes, loss of coral protection, reduction of the fish stocks necessary for subsistence and income, and changes to protective coastal vegetation. These impacts impose heavy financial burdens on the economies of small island states (SIS). At the same time, tourism, the mainstay of many SIS economies, may become less attractive through a degraded environment and damaged infrastructure.

Mr. Jones provided examples of how low lying islands and coastal zones are already feeling the impact of climate change. The El Niño event in 1997-98 in the Seychelles, Kenya and Tanzania, for example, caused severe coral bleaching. Sea level rise in the Maldives, (in which tourism provides 18% of GDP, 60% of foreign exchange earnings and 90% of government tax revenue), will mean, at best, severe coastal erosion and could mean that a large proportion of the land mass will disappear over the next 30 years; salt water intrusion could make the islands uninhabitable. Extreme weather events are also taking their toll. The Seychelles, for example, suffered the most extreme rainfall conditions in 100 years in 1997, causing extensive damage to housing and roads. A storm in Praslin in 2002 destroyed a large number of endemic trees, damaged infrastructure and paralysed tourism services, causing a total loss of US\$86.7 mn.

Mr. Jones reiterated the particular impacts of climate change - sea surface temperature change, sea level change, increased wave height and precipitation change (flooding or drought) - which have a significant effect on tourism to SISs and stressed the need for policy responses which address mitigation and adaptation strategies. He noted the need to raise public awareness and to ensure that all stakeholders participate in the formulation and implementation of adaptation policies. Decision-making should include monitoring, vulnerability assessments, economic evaluation and economic and regulatory proposals. It is important for national tourism associations to be involved in such activities.

Mr. Suresh Boodhoo, Expert of the World Meteorological Organization, noted that many small island states are also developing regions, whose development is hampered by having to devote precious resources to mitigating the damaging impact of climate change. Tourist infrastructure – particularly hotels which are frequently in the 100 metres of coastline most at

risk – is becoming increasingly threatened by extreme weather and associated events such as storm surges, tropical cyclones and sea level rises. This vulnerability makes the supply of timely weather forecasts and accurate predictions a vital tool for enabling the tourism industry to be prepared. Tourists need to be informed of weather conditions – such as the apparent temperature (the combination of temperature and humidity), radiation, and imminent cyclones – for reasons of safety. At the same time, the industry needs to be informed in order to plan for a tourist's comfort and safety and take pre-emptive action when extreme events occur. Some SISs, such as Mauritius, are already working closely with national hydrometeorological services to provide weather and climate forecasts. This enables the industry to be better informed, to use such information to help develop an appropriate marketing strategy and to disseminate warnings of weather events to the media when required.

Mr. Terry Jones presented a paper on behalf of **Mr. Patricio Bernal**, Executive Secretary of the Intergovernmental Oceanographic Commission. He described how data for the Global Ocean Observing System (GOOS) is collected through a system of buoys, ships, floats and via satellite. The marine observations contribute to a better knowledge of environmental information which can be used for the forecasting and management of air quality, climate and weather predictions, ocean conditions, and the management of weather conditions. The information is used in a variety of industries, including leisure and tourism. Uses include the planning and construction of infrastructure, seasonal planning for resort load capacity, hazard and risk management preparation and cruise ship route planning. Such uses relate to long term planning, such as for infrastructure and landscape design, new hotel capacity plans, building codes, and mitigation strategy design, as well as for short term use such as staff scheduling, "conditions" forecasts, daily guest information and the need for snowmaking in mountain resorts.

Mr. Rafik Ben Charrada of the Tunisian Agency of Coastal Protection and Management outlined the steps being taken to address the impact of sea level rises on the coastline of Tunisia. This phenomenon is not new and there is archaeological evidence around Tunisia's coast of sea level encroachment. The country's 1,300 km coastline is divided into five tourism zones and includes 60 islands and islets. Some 35% of beaches are regressing. The vulnerability of the coastline manifests itself in different ways; cliffs are being eroded, beaches are disappearing, wetlands are getting wetter and may turn into lagoons, lagoons become part of the sea and lowlands may become saline through sea incursions.

The mountainous islands are little affected but low lying islands such as the Kuriates islands are particularly vulnerable, with sea level rises having an influence on the islands' biodiversity. A further rise would totally submerge the marsh areas of the Kneiss archipelago in the south of the country where 70 sq. km. are vulnerable. The island of Djerba presents a different problem; hotels are diminishing coastal land, beaches are regressing and the littoral "sebkhas" might vanish. The island's 25 kms of coastal hotels may find themselves without a natural beach.

Some measures to mitigate the effects of a sea level rise are in place. A decree now protects 1,123 km of the total 1,300 km of coastline. Some 21,000 hectares of dunes have been stabilised through planting, and beaches have been re-nourished. In a project in Djerba, 60,000 cubic metres of sand have been used to rehabilitate Aghire beach while at Mahdia, sand traps to stop sand moving have been utilised so that the dunes are reconstituted and vegetation can grow naturally.

Six sections of coastline - Rafraf, regions north and south of Tunis, north Sousse and two sites at Djerba - are now being studied for protection adjustment and development projects are taking place at the marina at Hammamet and at a lake south of Tunis.

Action is required on two fronts: firstly through preventive measures, which include monitoring sea level rise and taking its potential impact into account in project planning and secondly through adaptation measures, which include dune stabilisation programmes, beach re-nourishment and undertaking protective work.

Round Table No 3 - Tourism in mountainous regions

The third session of the conference examined the effect of climate change on the world's mountain regions and, in particular, its impact on the winter sports and summer tourism industries. Five speakers addressed the subject and focused specifically on the Alps in Europe, the ski fields of Australia, one individual resort area in France - Morzine Avoriaz -and the mountain regions of North America.

Winter tourism to mountain areas is particularly sensitive to climate change since inadequate snow cover over several seasons means that a destination's winter sports industry ceases to become viable. IPCC predictions indicate that the effects of climate change will be stronger on land surfaces, in the northern hemisphere and in winter - the very location and timing of winter sports tourism. **Mr. Rolf Buerki** of the University of Zurich, Switzerland, described how climate change can already be seen to be manifesting itself through less snow, receding glaciers, melting permafrost and more extreme events such as landslides or avalanches. The changes bring about alterations to flora and fauna and the pattern of agriculture, hydropower and tourism is affected.

If the conditions predicted for the Swiss Alps over the period 2030-2050 hold true, the Swiss winter tourism industry is under threat. Only ski areas above 1,600-2,000 metres will offer snow-reliable conditions (broadly equating to a snow covering of at least 30-50 cms on at least 100 days between December 1 and April 15 in seven out of ten winters). As a result, the number of snow-reliable resorts in Switzerland would be reduced to 44% of the total, compared with the current 84%. Research suggests that less reliable winters would in turn change the behaviour of skiers, who would be likely to move to higher resorts (45%) or ski less often (32%). Some regions may be able to maintain their winter tourism through adaptation strategies, such as through the use of snow-making machines, but changes involve significant costs.

Fewer snow-reliable resorts suggests that the market for winter sports tourism will change. In particular, the opportunities for families and for young people to learn skiing and snowboarding at lower (cheaper) resorts will be reduced, indicating fewer new recruits to winter sports in the future. With the increasing tendency among tourists to book later, weather forecasts, too, will influence demand from weekend and day guests.

Mr. Francesco Frangioli, Secretary General of the World Tourism Organization and **Mr. Francois Passaquin**, who are respectively Municipal Councillor and Mayor of Morzine-Avoriaz, a commune in the northern French Alps, examined the recent experience of a typical ski resort region. They described how the commune's two resorts are being affected by climate change in different ways. Morzine, a lower level resort (1,000 metres) catering to a family clientele, is facing snow cover problems, while the newer, high altitude resort of Avoriaz (1,800 metres) which attracts a younger, sports-minded market, can suffer from severe overcrowding at peak times.

Generally, destinations need to address the problems of a shortening of the winter season, an increase in arrivals and a growth in short-stay travel by car; differing solutions - such as diversifying attractions, new ways of piste management, and electric shuttle buses (such as those to be introduced in Morzine-Avoriaz) - are required. It was noted that a particular problem for Morzine-Avoriaz is that it is accessed by road, which causes severe traffic and parking congestion and also highlights one of tourism's own contributions to pollution. The

speakers noted that destinations need to adopt Agenda 21 in the context of their own local communities, and that by examining the consequences of climate change from a local perspective, they can address the heart of the issue of sustainable tourism development.

Mr. Frangialli also emphasised the inter-relationship of climate change with the broader issues of sustainable development. Echoing the commitments of the "Earth Summit" in Rio de Janeiro, the Johannesburg Summit ten years later and the report of the UN's Brundtland Committee, he reiterated the need for a sustainability which goes hand in hand with economic development, social justice and environmental protection and renewal. This implies addressing the major problems of poverty, water supply, energy and climate. Poverty, with its corollaries of illness, famine, illiteracy, infant mortality and the deterioration of the environment, affects 23% of the earth's population; the aim of the Millennium Declaration is to reduce the number by half by 2015. Other challenges such as access to water and energy, desertification and primary forest reduction are also inextricably linked to the need to reduce greenhouse gas emissions. The WTO's Secretary General reiterated the fact that if the developed world (notably the USA, Europe and Japan) and developing world (which does not yet create pollution at the same level as the developed economies but which, in some cases, is exhibiting a faster rate of growth) do not curb the emission of greenhouse gases, devastating consequences for the whole planet will result.

Dr. Daniel Scott from the University of Waterloo in Canada examined the potential impact of climate change on nature-based and winter tourism in the mountain regions of North America. As one of the fastest-growing tourism segments, nature-based tourism is especially dependent on the quality of a destination's natural surroundings; climate-induced changes to flora and fauna, the loss of glaciers, and forests damaged by fire or disease all affect the quality of the tourism product.

Studies have shown that the length and quality of the summer tourism season in Canada's western mountain parks and in Rocky Mountain National Park in the USA would improve under climate change, increasing visitor numbers, local economic output and tourism employment. Nevertheless, it is predicted that these increases will cause ecological stress in 24 of Canada's 38 National Parks. More important than the length of the season, climate change will affect the ecosystems of mountain environments - with, for example, an upward shift of the treeline and a loss of alpine habitat, animal species and glaciers - and at the same time change the natural beauty on which tourism depends.

Dr. Scott described the retreat of glaciers in western North America over the past century. Glacier National Park in Montana, for example, has lost 115 of its 150 glaciers and scientists predict that all the remaining glaciers will have disappeared within 30 years. The loss of this park could serve as an important educational tool to illustrate the impact of climate change.

In North America, little research on winter tourism has been undertaken in the north west. In the east, however, snowmaking has become an important adaptation strategy. Under a variety of scenarios, there could be a 7% to 32% reduction in the length of the ski season by the 2050s using current snowmaking capabilities. Improved capabilities could reduce this to a 1% to 21% reduction, but to do so would have significant cost implications. The snowmobile industry - estimated to be worth over US\$10 bn in North America - is more vulnerable to climate change than alpine skiing because snowmaking is not viable for the large areas involved. As an example, climate change scenarios for southern Ontario project a season reduction of about 50% by the 2050s and of between 70% and 79% by the 2080s.

The varied impacts of climate change on different destinations alter competitive relationships between those destinations. If, for example, the ski market from the North East USA were to move to Canada, Canadian tourism could thrive even with a reduced season. Studies of tourism examining these inter-relationships are therefore required.

Dr. Robert Richardson of the University of Vermont in the USA described the results of a study undertaken to assess the effects of changes of climate and resources on nature-based tourism demand in Rocky Mountain National Park. The Park receives around 3 million visitors annually, with 87% visiting during the May to October period. A visitor survey included descriptions of hypothetical climate scenarios which depicted both weather-related (temperature levels, precipitation and snow depth) and resource-related (wildlife and vegetation composition) variables. Respondents were asked to estimate how the number and duration of their visits would change under the hypothetical regimes. For the two scenarios, a relatively small proportion of respondents indicated that their behaviour would change and generally the effect on visitation was positive as a result of the warmer summers. The results under the two models suggested a 10%-14% visitation increase by 2020, as well as a longer summer season. Both direct (weather-related) and indirect (resource-related) climate scenario variables were significant behaviour determinants. The increased visitation would add some US\$32 mn-US\$44 mn and between 700-1,000 jobs to the economy of the local gateway community. Under an “extreme heat climate” scenario, however, visitation levels would decline, reducing employment by some 600 jobs and income by US\$25 mn.

Round Table No. 4 - Policy issues and mitigation of the effects of climate change

The final round table of the conference concentrated on the two-way relationship between tourism and climate change. On the one hand, tourism contributes to climate change and thus creates a need for mitigating actions. On the other hand, climate change has influenced, and will increasingly influence, tourism and the behaviour of tourism markets. Seven papers were presented during this session.

Ms Njeri Wamukonya of the United Nations Environment Programme (UNEP) summarised the work that UNEP is doing in the tourism field. UNEP primarily disseminates information on international best practice. It is engaged on research and project development in areas such as eco-tourism, the mapping of tourism's footprints, the pursuit of demonstration projects at World Heritage Sites, mainly in central America, and co-operative action with tour operators and tourism destinations in Latin America and the Caribbean. The main purpose is to provide material for UNEP to publish practical guidance manuals, handbooks and similar reference works, available ultimately in many languages, that will help to guide sustainable practices on the part of the consumer, industry and governments in the field of tourism activities.

In the first of three national examples, **Mr. Jean-Paul Ceron** of the University of Limoges, France, presented a paper co-authored by himself and Ghislain Dubois, covering the two-way relationship between tourism and climate change in the case of France - the world's largest tourism destination in terms of international tourism arrivals. Acknowledging the large margin of error in current estimates, it seems that tourism in France could contribute up to 10% of France's current greenhouse gas emissions. The great majority of tourism's contribution to climate change derives from transport, and although air transport currently contributes a relatively small amount of France's total emissions, it is predicted that it will surpass road transport in importance by 2020. Since tourism in France is pre-eminently transport-dependent, it follows that it is vital that sustainable transport should be a priority in the tourism sector.

On the other side of the coin, tourism is influenced by climate change, specifically in the regional choice of destination, the season of travel and the specific climatic aspects of tourism such as the availability of snow suitable for skiing in the Alpine regions. Thus the interdependence of climate change and the tourism industry is again emphasised and the importance of prosecuting sustainable tourism solutions further underlined.

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As Executive Director of Environmental Management at TUI AG, **Dr. Wolf Michael Iwand** presented a view from a major private sector operator. Changes in the climate are already affecting tourism, but it is important to remember the priorities of both the tourism industry and the consumer. The former's main concerns are the security of its travellers, its corporate capacities and the costs involved in looking after its customers. The latter's concerns relate to issues of safety, added value, health and price. While it is right to acknowledge the danger of emissions from air transport, it should also be remembered that these account for only 2.5% of carbon dioxide emissions; it would be wrong to over-stress the need to control this sector alone.

TUI has taken many steps to enhance its own environmental standards - from technological innovations minimising aircraft fuel consumption to the pursuit of low energy solutions throughout its distribution, transport, destination and resort networks. As a leading travel group, TUI believes that actions to mitigate tourism's impact on climate change should comprise the promotion of energy efficiency across all aspects of the industry, the promotion of renewable energy resources and research into more sustainable tourism models. UN agencies need to mediate between the many interested parties and ensure that communication is not hampered by inappropriate terminology. The World Tourism Organization should act as an information clearing house on the subject and the promoter of debate on the mutual benefits of sustainable tourism solutions.

Tunisian mitigation policy experience was summarised by **Mr. Nejib Osmane** from the Tunisian Agency for Renewable Energy, and **Mr. Nouredine Ben Aissa** from the Ministry of Agriculture, Environment and Water Resources. Tunisia also underlines the two-way relationship between tourism and climate change and the need to find two-way solutions. Some 47 measures had been identified in Tunisia to mitigate the effects of climate change in general, embracing national environmental policy across all sectors. Strong emphasis is given to the subject of energy which contributes 55% of Tunisia's greenhouse gas emissions.

In the tourism sector, it is compulsory to undertake an environmental impact assessment of any new hotel development. The authorities focus tourism concerns on three strategic areas - forests and eco-tourism, water conservation and the protection of the coastline. Integrated into national energy policies, the hotel sector receives a subsidy of 20% for the costs of using solar energy, and also for the execution of an energy audit. 50 hotels have undertaken the former, and 120 the latter. In eco-tourism, a variety of reforestation projects have been implemented to raise the capacity of carbon sinks, and eco-tourism development programmes undertaken. On the coasts, measures have been taken to protect both the beaches and archaeological sites. Nonetheless, it is acknowledged that much of Tunisia is arid or semi-arid; rising temperatures and sea levels will exacerbate many of these water supply and coastal protection problems.

Two programmes designed to counteract the polluting effects of tourism, and especially of travel, were described in papers by **Mr. Tom Morton** of Climate Care UK, and **Mr. Steve Godeke** of Business Enterprises for Sustainable Travel (BEST) of the USA. Climate Care dealt mainly with emissions from the transport sector. Aviation, although accounting for only 3.5% of total emissions, is set to see its emissions rise five-fold by 2050. Climate Care deals in carbon offsets in order to achieve carbon-neutral travel. By paying a small levy - around Euro 0.90 - 1.20 per hour of flight on short- and long-haul journeys respectively - travellers can offset their emissions directly. Climate Care uses these levies to invest in carbon-reducing projects, such as the provision of low-energy light bulbs or reforestation projects. Major organisations have participated in this scheme, such as the Association of British Travel Agents which met the emissions costs of flying 1,500 delegates to their annual conference in Egypt.

In the USA, BEST pursues a similar agenda focused on corporate travel policies, seeking to make companies aware of their environmental footprint. For example, the insurance company,

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Swiss Reinsurance, found that 70% of its total emissions arose from its use of air travel. It now encourages its employees to use video- or tele-conferencing instead. Nike co-operates with Delta Airlines to donate a proportion of the ticket price for use in carbon-offset programmes which, as with Climate Care, are used to fund sustainable energy and similar projects. BEST argues that the adoption of such programmes enables companies to demonstrate that they take their corporate social responsibilities seriously and also stimulates demand for sustainable travel products.

Ms Susanne Becken, Tourism Expert with Landcare Research in New Zealand, completed this session with a paper describing the experience of New Zealand. Tourism here is highly transport-dependent, given both the "touring" nature of the sector and the extreme reliance on air transport for all international visitors. Once in the country, international visitors drive on average 1,950 km, and domestic tourists 640 km. Transport comprises 69% of an international tourist's energy consumption in the country, and 85% of that consumed by domestic tourists. The country has set the ambitious target of making tourism carbon-neutral by 2010. A carbon tax is on the way, and government research is focused both on a 'top down' approach, using environmental accounting techniques, and 'bottom up' analyses of the environmental impact of both tourists themselves and of tourism businesses.

Closing session

The conference was formally closed by HE Mr. Habib Haddad, Minister of Agriculture, Environment and Hydrological Resources, Government of Tunisia. Mr Francesco Frangialli, Secretary General of the World Tourism Organization acknowledged the Minister's encouragement and thanked the Government and people of Tunisia for the warm hospitality and excellent facilities provided to host the conference.

List of presentation documents in CD-ROM

The phenomena, origin and evolution of climate change

Dr. Geoff Love, Secretary of the Intergovernmental Panel on Climate Change (IPCC)

The climate change negotiating process

Dr. Youssef Nassef, Head, Adaptation/LDC Unit, United Nations Framework Convention on Climate Change (UNFCCC)

The interrelations between tourism and climate change

Mr. Graham Todd, Expert of the World Tourism Organization (WTO), Travel Research International, United Kingdom

Climate change implications on tourism in Tunisia

Mr. Ahmed Slouma, Director General, Tunisian National Tourism Office

Climate change and tourism: What may change in relation with water resources and water-related disasters?

Dr. Jean Marie Fritsch, Senior Scientific Officer, World Meteorological Organization (WMO), Department of Hydrology and Water Resources

Application of climate information and predictions in mitigating the impacts of droughts on tourism

Ms. Warue Virginia Ngugi, Expert of WMO, Tourist Officer, Ministry of Tourism and Information, Kenya

Tourism in regions prone to drought and desertification

Mr. Gregoire De Kalbermatten, Principal Coordinator of the United Nations Convention to Combat Desertification (UNCCD)

Evolution of the climate in Tunisia during the past century

Mr. Yadh Labane, Tunisian National Meteorological Institute (INM)

The impact of climate change on hydrological resources

Mr. Yadh Zahar, National Expert and Ms. Raoudha Mougou, National Institute of Rural Engineering and Forestry (INGREF), Tunisia

Climate implications on tourism at Lake Balaton, Hungary

Ms. Tamara Ratz, Associate Professor, Department of Tourism, Kodolanyi Janos College, Hungary

Climate Change Impacts on Arctic tourism

Ms Jeanne Pagnan, Vice-President, Twin Dolphins, Canada

Impacts of climate change in coastal and marine areas

Mr. Terry Jones, Expert of the Intergovernmental Oceanographic Commission (IOC)

The value of weather, climate information and predictions to the tourism industry in small island states and low lying coastal zones

Mr. Suresh Boodhoo, Expert of WMO, Head of Division, Meteorological Services, Mauritius

Use of observing system information in the coastal tourism industry

Mr. Patricio Bernal, Executive Secretary of IOC

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Impact of climate change at the coasts of Tunisia: The case of Karken Island

Mr. Rafik Ben Charrada, National Expert and Mr. Fadhel Baccar, Tunisian Agency of Coastal Protection and Management (APAL)

Climate Change - Impacts on the Tourism Industry in Mountain Areas

Mr. Rolf Buerki, Expert of WTO, Department of Economic Geography, University of Zurich, Switzerland

Sustainable tourism and climate change: an example in the French Alps - the case of Morzine-Avoriaz, France

Mr. Francesco Frangialli, Secretary-General of WTO, and Mr. François Passaquin, Mayor of Morzine-Avoriaz, France

Climate change and tourism in the mountain regions of North America

Dr. Daniel Scott, Adaptation & Impacts Research Group, Environment Canada at the Faculty of Environmental Studies, University of Waterloo, Canada

The effects of climate change on mountain tourism: a contingent behaviour methodology

Mr. Robert Richardson, PhD, School of Natural Resources, University of Vermont, United States of America

Managing Climate change: Strategies for Governments, Private sector and consumers

Presentation by Mrs. Njeri Wamukonya, United Nations Environment Programme, Collaborating Center on Energy and Environment

Tourism and climate change: a relation with double sense - The case of France

Mr. Jean-Paul Ceron, Centre de recherche interdisciplinaire en droit de l'environnement, de l'aménagement et de l'urbanisme (CRIDEAU), University of Limoges – CNRS - INRA, France

TUI policies, programmes and actions related to climate impact

Dr. Wolf Michael Iwand, Executive Director, Environmental Management, TUI AG

Possibilities of reduction of the negative effects caused by climate change

Mr. Nejib Osmane, National Agency of Renewable Energy (ANER) and Mr. Noureddine Ben Aissa, Ministry of Agriculture, Environment and Water Resources, Tunisia

Carbon offsetting programme

Mr. Tom Morton, Climate Care, United Kingdom

Climate change mitigation by carbon offsetting measures

Mr. Steve Godeke, Conference Board, Business Enterprises for Sustainable Travel (BEST)

Tourism and climate change – New Zealand response

Ms. Susanne Becken, Tourism Scientist, Landcare Research, New Zealand

