

# Tourism and Climate change : Proposals for a Research Agenda

To: The Editors, Journal of Sustainable Tourism, Channel View Publications, Frankfurt Lodge, Clevedon Hall, Victoria Road, Clevedon, BS21 7HH, UK (or by e-mail to [Marjukka@multilingual-matters.com](mailto:Marjukka@multilingual-matters.com) )

## Title

Tourism and Climate Change : Proposals for a Research Agenda

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**Keywords**

Adaptation, climate change, tourism, mitigation, research, sustainable

**Abstract**

The analysis of the interrelations between tourism and climate change is a new field of research. If the impact of climate change on tourism has been partially explored since the 1990's, the other side of the interaction – the impact of tourism on climate change, mainly through transport- is still an emerging concern for the research community. Following some research meetings held in 2003, this paper attempts to elaborate a research agenda on both of these topics. The need to open up tourism research to other fields –climatology and the International Panel on Climate Change, transport research, for instance - is obvious, so is the need to organise the research community on a global basis, to tackle the global problem of climate change. More collaborative and comparative research will help generalising the still very local existing research.

**Acknowledgments:** The authors wish to thank Mrs Christine Dodds for having helped them with the English.

**Length of the paper**

7100 words (+ 2 tables)

## **Tourism and Climate change : Proposals for a Research Agenda**

**Length of the paper : 7 100 words**

## *Introduction: the Interactions...*

In 2003, climate change (CC) has emerged on the international scene as a new field of concern for the tourism sector, started by a political mobilisation, with the first WTO Conference on tourism and climate change, and finally leading to an organisation of research, with the constitution of the Eclat group (<http://www.e-clat.org>) following two research workshops funded by NATO and the European Science Foundation (Viner and Amelung, 2003).

Research is clearly involved in this emerging debate. It produces assessments and key figures. This helps in the raising of the awareness of stakeholders and proposes evaluating strategies and instruments. Research is clearly framed by the United Nations Framework Convention on Climate Change (UNFCCC) process, and furthermore by the Kyoto Protocol. Official concepts such as “impact”, “vulnerability”, “adaptation”, “mitigation”, international negotiations with national targets on the reduction of GHG, available regulatory instruments (tradable permits, clean development mechanism...) result in a framework (Patterson 2004) which initiates research needs.

For a comprehensive view of the research that has been already accomplished, one should refer to Daniel Scott's bibliography on “Climate, Tourism and Recreation” ([Scott, Jones, Mc Boyle. 2004](#)) which is regularly updated and far more complete than the bibliography at the end of this article which aims at documenting only the points made in the paper. This bibliography compiles more than 200 references in chronological order. From the 1960's to the 1970's, the works quoted insist on the climate requirements for tourists, tourism, and outdoor leisure. During the 1980s, a few papers started analysing the potential impacts of climate change on tourist activities, particularly with case studies relating to ski resorts. The 1990s were marked by a bulk of publications on the topics of impact and adaptation, whereas the other side of the interactions – the impacts of tourism on climate change- were not stressed.

The fact that tourism covers miscellaneous activities has led, until now, to a rather neglected treatment by the International Panel and Climate Change and UNFCCC... Tourism has neither been identified as a major contributor in itself (even if the contribution of transports has been highlighted), nor as a vulnerable activity. The current thinking is still influenced by this partial and weak outlook. Since numerous stakeholders in tourism are not really conscious of the fact that they share common problems, some can wonder whether tourism should be considered as a “sector” that has to address the issue of CC, or whether its components should be treated individually ? (tourism transport within the overall transport sector, tourism accommodation within the residential sector). The following paper attempts to prove the advantages of a sector-

orientated approach, regarding the effectiveness of CC adaptation and mitigation strategies, as well as future sustainable development policies based upon more sustainable production and consumption patterns.

This is all the more complicated because the scope should be broadened, so that all substitution effects between traditional tourism and other leisure activities (day-trips, leisure near the home) can be taken into account, and their potential impacts concerning mitigation or adaptation to climate change analysed. Research should go beyond the traditional definition of tourism (at least 24 hours outside usual environments), and take into account the fact that the borders between tourism and proximity leisure are more and more blurred and porous (Ceron & Dubois, 2005).

Three different types of issues are raised by climate change.

- The effect of climate change on the climatic and the environmental resources of tourism, that is changes in climatic conditions according to seasons and regions, or effects of climate change on “environmental resources” (such as water, landscape, snow for winter sports etc.). After an evaluation of potential impacts, the question that arises is “How will tourism adapt ?”, according to the different scenarios built for climatic change, and bearing in mind that both effects require adaptation measures.
- The contribution of tourism to climate change : tourism is, through transportation mainly, a major contributor to greenhouse gas emissions, by emitting CO<sub>2</sub>, and other gases (mainly methane and nitrous oxides), and through specific phenomena (e.g. contribution to the formation of cirrus clouds by airplanes). Research questions should focus on the types of assessment needed (local, national, global, aimed at consumers or producers), on the methodologies to be used, and of the ways to mitigate emissions.
- The possible effects of greenhouse gas (GHG) mitigation policies on tourism. Given the overwhelming importance of the stakes linking to global warming and to the contribution made by tourism which is far from negligible, this activity is bound to be concerned with mitigation policies (e.g. carbon taxes) in the near future. This is a broad issue which is largely ignored but needs to be explored, probably under various and contrasted hypotheses.

## *The impact of climate change on tourism*

### **A MAJOR CONSTRAINT : THE UNCERTAINTY ABOUT REGIONAL AND LOCAL CLIMATE CHANGE**

Research on tourism and CC is very dependent on the current state of climate research, since the usefulness of any research on tourism depends on the availability and reliability of climatic scenarios, especially at a regional and local level. It is partly bound to remain so, but research in the field of tourism should also gain increasing autonomy through formulating specific questions to climate research.

Current knowledge on climate change is built through a gathering process within the International Panel on Climate Change (IPCC) involving some five thousands scientists worldwide, who belong to the different disciplines implied in studying climate and its effects ([www.ipcc.ch](http://www.ipcc.ch)). The knowledge produced is very strictly peer reviewed (see the site of the Union of concerned Scientists: [http://www.ucusa.org/global\\_environment/archive/page.cfm?pageID=801](http://www.ucusa.org/global_environment/archive/page.cfm?pageID=801)) and represents the best scientific guarantees one can expect, even if an undesired effect is, that this global consensus, leaves the door open to marginal experts who are not part of the IPCC network, contest the reality of CC, and gives them a stronger audience in the media that they would be normally granted.

The current state of the art (IPCC 2001) highlights on a world scale the following points.

- a) The climate is globally bound to get warmer –no existing model concludes that it could remain stable or cool down- and this evolution is mainly a result of anthropogenic emissions of greenhouse gases.
- b) The scenarios of the Third IPCC assessment (combining socio-economic hypotheses and climatic models) predict a warming range of 1.5 to 6 degrees Celsius by the end of the century. The increase over the continents should, on average, be 1.5 times greater than that over the oceans
- c) These figures concern the end of the century but only represent 50 to 90% of the maximum which could be attained, the long term effects of past emissions not having been taken into account. The level at which this stabilisation will take place ultimately depends on how fast GHG emissions will be curbed.
- d) We have no historical analogue and thus no means of knowing what will happen with the rapid warming of a few degrees over current temperatures.
- e) We may be faced with climatic surprises even though the models are not sophisticated enough to show this. One of the most devastating for Europe could be the disappearance of the Gulf stream (Duplessy, 1996; Duplessy and Morel 2000 ; [Schwartz, Randall, 2003](#)) Such a phenomenon happened several times 15 000 years back, it only took a few decades to appear and resulted in a downfall of average temperatures in Europe by 5 to 6° Celsius ([Bard 2002](#)).
- f) As regards the variability of climate, notably the occurrence of extreme events, the IPCC remains cautious. It seems too soon to be sure that Europe will face an increase in the occurrence of phenomena such as the hurricanes which struck at the turn of the century in France. We should,

though, remember that phenomena such as El Nino and La Nina in the Pacific are associated with changes in temperatures no greater than 2 or 3°C. Yet, an increased frequency of some types of weather extremes (floods) seems probable at west European latitudes.

g) Finally, changes in temperatures should vary according to geographic position. The models validated by the IPCC use grids that are several hundred kilometres wide and downscaling them is a hazardous exercise requiring great skill.

Given that tourism is very dependent on local features, *the lack of reliable local scenarios for climate change implies a high uncertainty in forecasting local impacts on tourism.*

## CONTRASTED SCENARIOS RATHER THAN FORECASTING

It is time however to evaluate the potential effects of climate change: precautionary measures could be useful in avoiding an expected crisis, and two or three decades could be necessary to adapt tourism products to the new conditions.

As regards this situation, the *recommended approach should be to elaborate contrasted scenarios of local climate change, and to evaluate contrasted impacts.* Research should avoid terms such as “forecast” and present results as an assessment of the “potential for change regarding tourism”, so that tourism stakeholders can assess and monitor their activities.

Some questions remain on the validity of this kind of research :

- *What should be the starting point ?* Given that IPCC is rather reluctant to publish regional scenarios, are there any existing climate scenarios which reach a sufficient degree of consensus to allow the community to work? If not, how do we deal with that difficulty? To what extent do we accept the risks on the scientific robustness of local scenarios and then be able to proceed?
- *Will the range between one extreme scenario and the other remain narrow enough to produce useful results ?* The uncertainty on climate evolution has already been mentioned : we are focusing on warming, but what happens to Europe if the Gulf stream disappears ? To this fact one must add the uncertainties impacts, reflected by statements such as “a decrease of 10% of snow cover could lead to a decrease from 10 to 30% of the availability of winter mountain tourism”. The risk could be to produce results such as “your climatic future is between 20% more snow and 30% less, and you can expect between 40% more tourists and 50% less”, which would actually be of no use for tourism stakeholders, apart from illustrating they live in an unstable world, which they probably already know, although not to the extent that climate change would imply.

Prior, therefore, to any applied research on impacts on a destination or a specific activity, a research program should include *a collective expertise of the validity of climate change hypotheses and their implications on the variability of results*, for the expected tourism case studies.

## EVALUATING THE IMPACTS: VARIOUS APPROACHES

Once this major constraint is taken into account, it is possible to imagine various perspectives.

### I. A global perspective

Destinations now increasingly compete on a world scale and there is a tendency to uniformity within mass markets, even if a sustainable development perspective, it is often argued that they should develop relying on their more specific resources, such as cultural diversity, local ecosystems.... This is, in particular, true for destinations with the same climatic resources (tropical weather and warm bathing water, warm winters).

- *A first task could be to identify to what extent climate change could redistribute climatic assets among macro-regions.* A global approach with global climate change scenarios using large regional grids (hundred of kilometres) could be sufficient to estimate, for instance, whether the Caribbean would be reinforced or weakened, compared to the South Pacific or the Indian Ocean. The main factor influencing the distribution of these competitive advantages is the climatic motivations of the tourism demand, which are quite well known, (Besancenot 1989 ; Matzarakis 2003), but which sensitivity should be analysed in the perspective of evolving climate situations.
- *These global scenarios would provide baseline information for the development of more local scenarios.* Before envisaging the future of the Costa del Sol, it would be useful to know whether tourists are more likely to concentrate in the Mediterranean as a whole, or to fly away to cooler regions.

Both of these approaches would involve a large network of researchers, using a process of scientific validation. In a context of sustainable development, a concept which emerged from a global outlook on development and environment, it is somehow surprising that the current research concentrates on local and sector-oriented surveys. An alternative approach, however, could be to downscale global results for local implementation. Will the World Tourism Organisation foster a sustainability assessment of tourism at a global level, as UNEP tried for example for issues concerning biodiversity and tourism (Conservation International, 2003) , or will it focus on developing countries, on small islands etc. leaving aside the issues concerning tourism in developed countries?

### 2. Regional and local perspectives.

Regional and local surveys -most of them quite exploratory- rather than global assessments have been produced in recent years (Elsasser and Burki 2002 ; Department of the environment 1996 ; Ceron, 2000 ; Ceron and Dubois 2002; Giles and Perry 1998; Harrison, Winterbottom and Sheppard 1999; König and Abegg 1997; Scott 2003; Wall 1998). These approaches can be based on a national scale (France, Great Britain), a geographical perspective (mountain, coastal areas) or an ecosystem approach (wetlands, deserts...). The added value and the contribution of a program prolonging these research could take various forms.



- *Comparative research* : why are some tourism destinations more sensitive to climate change than others (diversity of the tourism supply and demand, presence of man-made and cultural attractions...), where do the more endangered ecosystems coincide with tourist destinations, what are the different methodologies used to assess the potential impact of CC ?
- *Studies of the impacts on tourism of extreme events (the high summer temperatures in 2003 in western Europe for instance)*. These could now become more frequent and the results could be used as analogues ([Giles and Perry 1998](#)).
- *Integrative research, to gather, on a same destination, research data with different disciplinary perspectives producing a more thorough evaluation of specific cases*. For example, to evaluate the future of tourism in French “Camargue” (the Rhone delta), a research project could gather specialists of wetlands, of French tourism, of Mediterranean tourism, of coastal resorts...
- *Activity-oriented research*. Some research deals with the impacts on activities, for example skiing, canoeing and other river sports, bathing activities ([Holmes, Palmquist and Steiger 2000](#); [Mc Boyle and Wall 1987](#); [Scott 2003](#)). These papers concentrate on the “non climatic resources” of tourism : water availability in rivers, landscape change, snow for winter sports...

## ADAPTATION STRATEGIES FOR TOURISM STAKEHOLDERS

Once the potential impacts of climate change on the tourism activity are better understood, it is possible to concentrate on *adaptation strategies for the tourism sector*.

The preliminary research question concerns *political science, i.e. the governance of the tourism sector in the context of climate change*. Since climate change is a long term phenomenon, the effects of which cannot yet be predicted in detail, how is it possible to involve stakeholders in adaptation strategies ? Long term precautionary measures are, generally, of minimal concern to private operators. Does it mean that only governments are likely to endorse adaptation strategies. This is a somewhat worrying diagnosis given the general weakness of tourism policies . Alternatively what kind of public-private partnerships can be imagined ?

Climate change will, indeed call for policy responses from private operators as well as from public stakeholders. *The wide range of responses has to be evaluated, with criteria such as technical feasibility (Scott , Mc Boyle and Mills 2003), profitability, capacity to cope with uncertainty, and impacts on the environment.*

Stakeholders can adopt three main responses to climate change.

### I. Waiting until the level of knowledge increase

This option assumes that short term responses will be more efficient than long term ones and precautionary measures (due to discount rates). Responses will be more accurate once the

concrete implications of climate change are known. This has, up to now, been a common attitude in all activities. Research should point out the drawbacks of this approach and the problems with which stakeholders can be confronted.

## 2. Trusting the ability of technology to face environmental change.

Since the beginning of the 1980's, for instance, French ski resorts have been engaged in a strong investment in artificial snow cover (to 2002 more than 160 resorts out of 239 have been equipped (*SEATM, 2002*), aiming to obtain a "snow insurance", considered as a strong marketing argument. *Center Parcs* with its fifteen European resorts offers a "tropical paradise" warranty: i.e. a 28°C bathing water all the year long. Natural beaches, in the same perspective, threatened by an increased coastal erosion, can be replaced by artificial ones... Several questions arise from this approach : to what extent could tourism operators endorse this additional investment to cope with climate change ? Would the profitability of the sector be maintained ? Would customers accept these man-made environments ?

## 3. Adopting a precautionary attitude,

This option insists on building flexibility within the tourism sector and improving its ability to respond to environmental changes. The two majors factors influencing the adaptability of the tourism sector are the reversibility of options and the diversity of the tourism supply. The impact assessment of the *Erika* oil spill on French coastal resorts, for instance, showed clearly that destinations with more diversified assets, customers, accommodation and facilities were more resilient than destinations only orientated towards camping and bathing activities. Developing off-ski activities (hiking trails, pathways, cultural events) in ski resorts may well be more sensible and consequently constitute a better insurance for the future than investing in artificial snow cover. This alternative at least is worth discussing. In this perspective, climate change responses could be integrated into a broader risk management policy for the tourism sector: diversification is also a way of limiting tourism sensitivity to economic crisis .

*Evaluating the relevance of these strategies, globally, locally or for specific tourism activities is a new and seldom explored field of research. These evaluations should not be limited to climate change, but be part of broader sustainability assessments of tourism strategies.*

**Table I : A Research Agenda. Adaptation**

Research gaps	Required steps	Methods	Disciplines
Improvement of regional climate models	Further develop climate models at regional scales	Modelling	Climatology. Tourism research depends on IPCC
Current climate models are imprecise	Assessing current models uncertainties on local climate	Collective expertise with climatologists	Climatology
Local studies must be replaced in their context	Global impact assessment of CC on tourism	Collaborative research project	Multidisciplinary (geography, biometeorology, economics, ecology...)

Local studies must be confronted to one another	Comparison of case studies (on products, natural environments...)	Comparative research	Multidisciplinary (geography, biometeorology, economics, ecology...)
Obstacles to long term adaptation strategies	Analysis of tourism investment and products decision making	Destination surveys, history of tourism	Political science, sociology, economics , history
Relevance of current adaptation strategies	Evaluation of strategies (technical feasibility, costs)	Development of tools for decision marking (grids)	Political science, Economics

## *The impact of tourism on climate change*

Evaluating the impact of tourism on climate change is the second facet of the “interactions”. The first evaluations underline the importance of such issues for monitoring the impacts of human activities on climate change. For example, *the overall French tourism emissions, including accommodation and equipments, represent from 9 to 10% of French Global Warming Potential. Tourism transportation represents about 80% of this contribution.* These results are not surprising, since it is well known that the transport sector as a whole has a growing contribution in the greenhouse effect : the contribution of transport in French CO<sub>2</sub> emissions jumped from 8% to 34,3% between 1960 and 1999. The emissions of ground transports increased by 16,5% between 1990 and 1999, those of aviation by 59,6% (Fontelle, Chang, Allemand and al. 1999, 2000). The modal choices (and consequently the infrastructure development policies) have a strong impact on this contribution. In that perspective, *studying the growing dependence of tourism on transports* (more passenger.kilometer travelled for the same amount of overnight stays) *seems central to research*, for environmental as well as for economic reasons. According to OECD, however, «*One source of tourism-related environmental impacts – travel - remains consistently and conspicuously absent from the general discourse on sustainable tourism*”.

Although, for some time, transport research has been addressing the issue of transport impact on climate change, research dedicated to *tourism travel* only started comparatively recently (Ceron and Dubois 2002 ; [Hoyer 2000, 2001](#) ; [Peeters 2003](#) ; [Becken 2002](#) ; Becken, Simmons and Frampton, 2003; [Gössling, 2000, 2002](#)). The first assessments concerning tourism were produced by public institutions in charge of the Environment rather than by academics: for example by the French Institute of the Environment (IFEN 2000), the Environment Protection Agency of the US (EPA 2000), or the Environment Directorate of OECD (OECD 2001).

## AGREEING UPON A COMMON SET OF METHODOLOGIES

The framework of the UNFCCC GHG mitigation policies relies on an inventory of emissions harmonised on a common basis, in order to set policy targets. Each negotiation round of the Kyoto Protocol reveals strong debates about what should be evaluated and how it should be accomplished. As a major economic activity, tourism should be included in these debates.

*Collective methodological work, in order to reach a consensus of experts on evaluating the impacts of tourism on climate change* (Gössling, Ceron, Dubois, Patterson, Peeters, Richardson 2004) *appears to be a priority.*

A few assessments have, currently, been conducted for local destinations, (Ajuntamento de Calvia, no date), private operators or individual travellers, (Garrod, Wilson and Bruce, 2002), but priority should now be given to sector-based national evaluations. Since UNCCC negotiations take place between governments, inventories of GHG emissions consider national entities. An assessment on a national scale is thus a priority allowing tourism to be taken into consideration within broader discussions on climate change. Indeed, tourism is not readily extractible from those national inventories, and additional analyses are required, similar to Tourism Satellite Accounts, that assess economic impacts.

This opens several fields for research.

- *Who is responsible for the impact of international tourism on the atmosphere ?* Should it be emitting countries (Gössling 2002), in a consumption approach, receiving countries, in a production approach (since they benefit from tourism), or airline companies, whose nationality is harder and harder to determine ? The inclusion of air transport, like maritime freight transport, poses difficult methodological and ethical problems (Godard, 2003) in the evaluation of GHG emissions, and both of them have been so far excluded from the Kyoto protocol. Future research should discuss these questions and introduce ground rooted ethics into the debate. Are, for instance, remote destinations more legitimate in their use of air transport because they have no possibilities of substitution ? What priority should be given to developing countries ? Are there differentiated responsibilities among countries and to what extent are they asymmetric ?
- *Improving methods for estimating travel impacts.* Coarse evaluations based upon a number of passengers-kilometer travelled, multiplied by average GHG emissions factors for each mode of transport, seem insufficient in presenting an accurate picture of the impacts. Real emissions depend on factors such as the load factor of vehicles, age, motorisation, air conditioning of cars, types of travel (speed, altitude, charter or regular flights for air transport...), technologies (does the propulsion of trains rely on renewable or non renewable primary energies, and/or on carbon neutral energies?). The objective is to reach more rigorous and less questionable evaluations, by

taking into account, for instance, the impact of ongoing research into the environmental impact of air transport, still discussed, for instance concerning the impacts of contrails and the contributions to exhaust gases on cirrus clouds formation (IPCC, 1999). IFEN's experience (IFEN 2000) showed that, within the EU, data often exists, but that using it requires a serious effort in collection and processing. Transport surveys are variable between countries, and this makes standard requirements for assessment of tourism impacts difficult to define.

- *Producing data for accommodation and facilities*, which is often missing in spite of some attempts (EPA 2000 ; Gossling 2002 ; Becken & Simmons 2002 ; IFEN 2000) presents difficulties. That is why the calculation of the total contribution of the overall tourism sector, be it at an international, national or local level, remains uncertain (Dubois and Ceron, 2005). The methodology for accommodation and facilities would require a knowledge of the number of overnight stays (or visitors) for each type of accommodation and facility, allowing the multiplication by ratios, such as the average use of energy per overnight stay (or visitor). The breaking down between the different energy sources used (electricity, fuel, gas....) should be known in order to calculate greenhouse gas emissions. For accommodation, these ratios depend on the standard of comfort, the age of accommodation, the climate of the location (implying air conditioning, heaters...) etc.. This is why the existing data on local energy intensity is not very helpful : only a few surveys provide such ratios for hotels, camp sites, secondary homes on a national basis...Current work on eco-labelling and its forthcoming monitoring will provide more ratios in the near future. There is also a serious lack of data concerning activities and facilities : theme parks, water parks, ski lifts... EPA (2000) clearly pointed out the lack of emissions factors, while several varieties of high-impacting facilities develop rapidly (snowmaking, boating, theme parks...).
- Further, when accommodation, catering and facilities are included in an overall evaluation, *it seems necessary to consider both total impacts and net impacts on climate change* since tourists do not consume energy at home while they are on vacation. The net emissions may be positive or negative depending on the style of vacation as well as the lifestyle in the home environment. It would not be fair to the tourism sector to just consider the *total* estimate. The focus should rather be on the incremental emissions caused by tourism and on the way of reducing them. This requires referring to baseline data on household daily emissions. Different types of holiday - for instance beach versus ecotourism or touring holidays- should be compared. The difference in behaviour between home and holiday for different types of tourists should also be considered.

## LINKING TOURISM AND TRANSPORT RESEARCH

With regards to climate change, *the evaluation of transportation impacts should be considered as a priority*. The Environment Protection Agency (EPA, 2000), estimated that for the United States 76,5% of CO<sub>2</sub> emissions from the tourism and recreation sector are caused by transportation

(against 15% for lodging, 2,7% for restaurants, 1% for retail, and 4,8% which are activity-specific). In New Zealand the share of transport in the emissions by tourism reaches 90%, if on-site transportation is added. In Calvia (Balearic Islands) on-site tourist movements represented 73 000 tons of CO<sub>2</sub> in 1995, whereas air transport to the destination contributed eight times more to greenhouse gas emissions (534 000 tonnes) (Ajuntament de Calvia, no date). It is also clear that a minority of tourists (long distance and by plane) account for the larger part of emissions, especially if one considers the non gaseous effects of aviation on radiative forcing (contrails and cirrus clouds formations) (Gössling et al. 2004).

### **Why should tourism research pay attention to transport research ?**

It could be argued that since transport research is already addressing the issue of climate change, tourism research would be redundant in that field. The purpose here is, however, to evaluate the *share* of tourism in transport impacts, so as to distinguish, for example between freight transport and passenger transport, and within passenger transport, between different motivations (work, shopping, leisure, tourism...). The objective is to link data on tourism demand and flows with the information on emissions of GHG, so that transport policies and mitigation policies can distinguish between the different responsibilities regarding climate change, and so target different sources of transport more effectively. Tourism and leisure relate to issues such as quality of life or freedom to travel, and tourists can not be treated simply like freight. *The objective is to go one step beyond macro-sector evaluations (transports, housing, industry), and to insist on the impacts of consumption patterns on emissions profiles, as a contribution to the definition of more sustainable way of life.*

### **Linking tourism and leisure mobility.**

What is the impact of leisure, with or without overnight stays ? Even if tourism is defined by WTO as including at least one overnight stay outside permanent residence, with regards to climate change, this definition of the field of research appears too narrow. The border between leisure and tourism is increasingly blurred and porous (Viard, 2002a, 2002b). Some clear substitution effects exist between tourism and leisure which can both strongly impact on greenhouse gas emissions : the intensity of the tourism demand depends on the quality of life at the place of residence, and on the possibility of leisure near the home (Ceron and Dubois, 2003). *The initial question should be "how do the uses of spare time impact on the atmosphere, what are the respective shares of tourism and leisure near the home, and how do they interrelate ?"*

### **Modal shifts**

At present, almost 80% of the French travel by car for their holidays. Road transport is responsible for more than 60% of French domestic tourism transport GHG emissions (IFEN, 2000).

International air transport is not included in the Kyoto protocol. It should, however, become more

impacted by mitigation policies in a nearby future (Commission des communautés européennes, 2001). According to Schaefer and Victor (1997) and the OECD, worldwide there would be five times more passenger.km travelled in 2050 than in 1990. The *air transport share* should then more or less equal road transport and, given higher radiative forcing, its contribution to climate change *should exceed road transport emissions around 2030*. The future of tourism using road transport appears clearer (the staggering of domestic tourism departures, the technological improvements of cars, the perspective of European norms for cars emissions...), when compared to air transport, which depends on a more uncertain context (reluctance to submit to environmental regulation and taxation, profitability of airline companies, sensitivity to global crises ...).

## **BEYOND NATIONAL FIGURES : UNDERSTANDING TOURISM PRODUCTION AND CONSUMPTION PATTERNS**

The impact of tourism on the environment can be divided between the on-site impact (including on-site transport) and transportation to the destination impact. It is most important to monitor the full extent of the impact that the different sub sectors (accommodation, transports, facilities, travel agencies) do not always consider themselves as part of the tourism sector (i.e. as part of the problem and potential contributors to its solution). “Tourism”, however, seems a relevant category in any debate on the impact of economic activities on climate change: at least as relevant as “services”, “hospitality and catering”, or “transports”. In a sustainable development perspective, where “needs” and their satisfaction are the starting point for tackling issues, it cannot be denied that leisure needs imply transport, accommodation, facilities... which should be comprehensively evaluated.

Beyond the production of national assessments, the objective should be to reach an in depth understanding of the tourism product, with regards to GHG emissions, and to “unpack” the demand of tourism/ leisure travel. This will help identifying and ranking the potential solutions : reducing speed on highways, improving load factors of aircrafts, taxing kerosene etc.

- *Confronting country profiles would be useful in comparing patterns of tourism/ leisure mobility.*  
What are the factors explaining high-impact situations ? The distance from emitting markets (Australia), infrastructure choices (what is the impact of high speed trains on overall emissions ?), driving forces of the tourism demand (the schedule of school vacations throughout the year), consumers tastes and behaviour (the propensity of Germans to travel abroad, the Spanish reluctance to do so, the popularity of short stays...) ?
- *Some more specific and localised research could help raising the awareness of stakeholders and understanding the factors involved in increasing the impact :* comparison of modes of transports ([Hoyer 2000, 2001](#), IFEN 2000), of tourism products (Garrod, Wilson and Bruce 2002), of destinations policies, of tour-operators and airline companies (impacts of hubs on air travel emissions)...

## LESSONS FROM THE LONG TERM (PAST AND FUTURE)

*Forecasting the evolution of tourism/ leisure mobility demand* and its impact on climate change would be complementary to the evaluation of current impacts. It should set out to integrate the findings of the *sociology of leisure, tourism and travel*. Indeed, the issues of behaviour towards travel (propensity to travel, articulation between tourism and leisure times) seem central. This could involve several types of research

### **Research on the history of tourism.**

History shows that mobility patterns, attitudes to transport (the addiction to speed) and modal splits have evolved quickly. For instance, in Greece, in 1954, 31% of international tourist arrivals used the plane, 30% the train, 31% the boat, and 8% the car. In 1999, this came to 76% by plane, 0,2% by train, 11,8% by boat, and 12% by road (Tsartas 1998). The lessons learnt from history could help in identifying the potential for change in tourism in the future.

### **Mobility patterns prospects and scenarios for tourism/ leisure mobility demand**

Mobility patterns are likely to be more and more diverse, individualised and maybe contrasted in the future, owing to changes in the organisation of times (diminution of working time), demography (retired people without time constraints) etc.. Referring to these trends, *scenarios of overall tourism/ leisure mobility demand* could help having a clearer understanding of the future. In that perspective, even extreme or quite unrealistic utopia should be tested: what would happen if all inhabitants of the earth adopted the mobility patterns of Americans and Australians ? What if each inhabitant treated himself to one cruise trip around the world in his life ?

## GHG MITIGATIONS POLICIES AND TOURISM

Tourism contributes significantly to the anthropogenic greenhouse effect, and relies more and more on transport. These two statements reveal the sensitivity of tourism to future transport policies directed at reducing greenhouse gas emissions under the Kyoto protocol.

In that perspective, tourism is not only questioned with regards to its own priorities (how to cope with an increasing mobility demand, and how to secure the activity given that transport prices might increase), but also with regards to its ability to comply with global environmental constraints.

Even if CC is at most an emerging concern for the tourism sector, there is already a need for research expressed by governments in that field. The European Union, for instance, issued in summer 2003 a call for tender on a "Feasibility and preparatory study regarding a Multi-Stakeholder European Targeted Action for Sustainable Tourism and Transport", the purpose of which was to identify ways of uncoupling tourism and transport growth within the Union (which is seriously challenging given the current trends).



The role of research could be a) to evaluate the regulation context of the tourism sector and the need of a regulation beyond a “business as usual” scenario, b) to analyse the stakeholders’ awareness and mobilise them into debate, and c) to help integrate the resulting answers into policy scenarios.

### **Evaluating the regulation context of the tourism and travel sector**

Given the foreseeable GHG emissions of the tourism sector, the expected improvements through mitigation plans in other sectors emissions, (the energy efficiency of industry is continuously improving) and given the economic growth and social welfare conveyed by the tourism activity, is there really a need to curb tourism flows, and to what extent ? This dilemma is not so obvious, and should probably be explored through various ways.

The latest assessment of greenhouse gas emissions for example shows that at present France complies with the Kyoto objective, releasing 2,1% less (in terms of Global Warming potential) than in 1990. As long as this satisfactory situation continues, tourism might not be questioned, and it seems therefore hardly relevant to discuss how to mitigate its impact. The context appears to change completely however if one looks at the long term, especially when international travel is included in the inventory. If the most ambitious national strategies (UK) are to be applied in other countries, then it is obvious that tourism will have to seriously diminish its impact.

Such a background leads to questions such as “what is the range of impacts in the future?”, “what are the variables which act on impacts (technology, spatial organisation, awareness: cultural change, stakeholders awareness...?)”, “what are the policy instruments at hand: incentives, new types of instruments (tradable permits...) ?” What follows just illustrates a few of these issues.

- Implications of sustainable development for the tourism sector. From equalitarian perspectives (in which the right to emit greenhouse gases should be equally shared between all inhabitants of the planet), to more pragmatic ones (complying with the Kyoto protocol), tourism will in the future be embedded in a policy context that might impact on its developments. In the next 20-30 years, this context will evolve: societies and lifestyles will change, so will technology and regulation instruments (following international commitments and national policies in the environmental field). The objective of research, within this evolving context, should be to evaluate to what extent tourism will have to change in the coming years, owing to a confrontation of the future environmental impact of tourism/leisure mobility and the forecasted environmental constraints. The potential for emissions reduction in other sectors should be assessed, to evaluate to what extent tourism would be compelled to offset its own emissions. *Here again, scenarios could contribute to assess the implications of various hypotheses.*
- Prospects of technological change. To what extent can productivity gains, which diminish the quantity of energy used per unit of service, help in mitigating the impact ? Tourism research could benefit from transport research on this topic : International Panel on Climate Change prospects

on aviation, MEET project (Methodologies for Estimating Air Pollutants Emissions from Transport), prospects for technology change within the transport sector...

### **Analysing the awareness level of tourism stakeholders**

In recent years, the awareness of tourism stakeholders regarding the impact of tourism on climate change, was upgraded by NGO campaigns (International Friends of Nature's "Red card for air transport" campaign, "Carbon neutral initiative" of the Rain Forest Alliance), conferences (WTO conference in Djerba) or the creation of web sites ([www.chooseclimate.org](http://www.chooseclimate.org)). The nature of the response of the tourism sector and its capacity to adapt partly relies on such initiatives.

*Specific sociology and political science research could insist on the evolution of these issues in stakeholders discourses and representations, for instance by analyzing the content and evolution of the environmental reporting of airlines companies and tour operators, the opinions and preferences of business leaders etc.. A good deal can be learnt from tracking the ideas and discourses legitimizing the growth of tourism and its need to be preserved from the effects of climate change, or, on the contrary, insisting on its growing responsibility in greenhouse gas (GHG) emissions.*

*We also need to know far more about the awareness of tourists and their reactions (people might know and be reluctant to act or wanting to shut their ears to bad news ([Dupuy 2004](#))). Work is also needed on the perception of weather parameters, since changes in weather can hint as to what could be expected from the effects of changes in climate.*

### **Combining and articulating the answers: policy scenarios**

A wide range of responses and instruments are available for governments, as well as for tourism operators to curb tourism emissions. They need to be evaluated with regards to criteria such as cost, efficiency in the reduction of impacts, technical feasibility, impact on the freedom to travel, political feasibility. They need then to be assembled in likely "policy scenarios", articulating compatible instruments.

These responses are of different types.

- *Technical responses*, such as improved energy efficiency of vehicles, better landing and take off procedures or tools to improve the load factors.
- *Taxation and "carbon neutral" initiatives*. Are carbon offsetting initiatives through tree planting and carbon sinks (such as "Carbon neutral" campaigns) really efficient tools in the long term (Lohmann, no date). To what extent a kerosene or carbon tax would change the price/ demand elasticity of air and road transport, or would generate financial resources to offset other sectors emissions.
- *Carbon trading schemes*. Given that tourism is supposed to be a high value added activity, could it afford exchanging rights to emit GHG with less profitable activities ? Tradable permits allowing

more or less environmentally efficient industries to exchange emission rights are to be set up for the European industry. It would be realistic on the part of tourism operators to buy in extra emission quotas from other sectors in order to maintain their activity, or to manage tradeoffs within the tourism market, or between tourism and other forms of mobility. In that perspective, *research on eco-efficiency* could help in clarifying the debate : some forms of tourism and leisure, with regards to economic benefits, social welfare and environmental impacts, seem more efficient than others.

- *Spatial Planning*, especially the relationships between infrastructure choices and tourism. In the context of the European Union's enlargement, for example, with higher access to travel following the economic growth of new members countries, one could assess the alternative of a high speed train line to Istanbul versus the spreading to the east of the highway network... At the destination level, how could a continuous chain of collective ground transport, from the main place of residence to the tourist destinations, and then within the destinations, be supplied in order to prevent tourists from taking their cars ?
- *Actions on travel demand*. What would be the impact of incentives for longer stays, etc. To what extent would the modification of competitive advantages and comparative costs between destinations impact on the tourism demand, with a special consideration on developing countries.
- *Cultural change*. Can a low impact tourism utopia be imagined : a preference given to "slow" tourism (train transport), to soft mobility (biking, walking), an enhancement of leisure and quality of life policies within the cities... Is the propensity to travel likely to change, under which conditions ?

Commentaire :

**Table 2 : A Research Agenda. Mitigation**

Research gaps	Required steps	Methods	Disciplines
Need for national inventories	Assessment of national GHG emissions of tourism	Develop satellite accounts for tourism	Economics, Environmental Science
International air travel is not accounted in national inventories	Discuss benefits of air travel for emitting and receiving countries	Analysis of tourism products (distribution of benefits ). Comparative research	Economics
Insufficient knowledge of impact of transport on CC	Improve assessment of non gaseous impacts of air travel on radiative forcing; simulate impact of all modes in real conditions	Monitoring, modelling	Transport research
The impacts of accommodation, equipments and activities are badly known	Develop emissions inventory of tourist activities and equipment	Extensive surveys, on national or international basis	Environmental science
Leisure, beyond tourism	Improvement of the knowledge of tourism AND leisure flows	Data processing on tourism and transport survey, new surveys, monitoring all passenger travel	Tourism and transport research
Better understanding of past and present tourism travel patterns	Studies of individual and household behaviour; studies of tourism products	Case studies and comparative research	Anthropology, Sociology, History, Economics; Geography
How will tourism GHG		Models, scenarios and	Future studies

emissions evolve ?		forecasts	
Will tourism have to mitigate its impacts ?	Assessment of the present and future regulation context (other activities, prospects for emissions targets and technological change, eco-efficiency of tourism)	Scenarios	Multidisciplinary, political science
Which mitigation instruments are adapted to the tourism sector ?	Relevance, efficiency of various instruments, integration of instruments, impact assessment on the tourists and the industry	Modelling, sensitivity analysis, extensive surveys	Multidisciplinary, Economics

## Conclusion

Climate change adaptation and mitigation are two sides of the same coin for the tourism sector. Tourist operators should be concerned with the mitigation of their impact on the climate. Their activities appear highly vulnerable to climate change though this concern has not emerged until very recently. Research must help in assessing the issues and elaborating relevant solutions.

Assessing and monitoring these research needs calls for some organisation and networking within the scientific community. It seems clear that, after the various meetings held in 2003, a sufficient degree of awareness has been reached. Some research was initiated more than ten years ago (Scott, Jones, Mc Boyle. 2004) and the issues detailed in this paper have been taken up more recently by a significant number of young academics. The novelty is that the recognition of the relevance of this subject by organisations such as the European Science Foundation, WTO, UNEP, NATO has now presented an opportunity for collaborative research.

As soon as this started, it became apparent that bridges needed to be built between different approaches and disciplines. The same difficulties are met here as in other domains : it is not any easier to cross-fertilise econometrics and sociology here than in other areas of research. Some confrontations are more original : for example, how do socio-economists establish a link with the meteorologists and biometricians who hold the main information on weather, climate, physiological constraints of tourists ?

The second requirement for the community is to articulate with the IPCC network. There is a need to integrate the IPCC findings. Are the various IPCC socio-economic scenarios sufficiently well known to allow for logically robust conclusions to be drawn for tourism ? This step has certainly to be made if tourism is to be taken into account as a whole and not only through subsectors (accommodation, travel...).

The last challenge is to network a global representative research community adapted to the global issue of climate change, with scientists from peripheral countries (developing countries, eastern

Europe...) as well as from Asian countries, that will be increasingly important both in term of destination and origin of tourism. The most active part of the community, at present, comes from western Europe, New Zealand and Canada. Identifying existing research for other countries, including non-English speakers in the process, and adapting the research agenda to other regions' issues and context (rural tourism in Eastern Europe, extreme climatic events in Southeast Asia..), without "rediscovering America" (as we say in French, i.e. repeating research already done), presents serious challenges.

## References

Ajuntamento de Calvia (no date) *Calvia Local Agenda 21. The sustainability of a tourist municipality. Plan of action*. Electronic report

Bard, E. (2002) Abrupt climate change over millennium time scales : climate shock. *Physics today* 55, 32-37.

Becken, S. and Simmons, D.G. (2002) Understanding energy consumption patterns of tourist attractions and activities in New Zealand. *Tourism Management* 23 343-354.

Becken, S. Simmons, D. and Frampton, C. (2003) Segmenting tourists by their travel pattern for insights into achieving energy efficiency, *Journal of Travel Research*. 1-9.

Becken, S. (2002) Analysing international tourist flows to estimate energy use associated with air travel. *Journal of Sustainable Tourism* 10 (2), 114-131.

Becken, S. Simmons, D. Frampton, C. (2003) Energy use associated with different travel choices, *Tourism Management*

Besancenot, J. P. (1989) *Climat et tourisme*. Paris : Masson. 223p.

Ceron, J.P. (2000) Tourisme et changement climatique. in *Impacts potentiels du changement climatique en France au XXIème siècle*. Premier ministre. Ministère de l'aménagement du territoire et de l'environnement. 104-111.

Ceron, J.P. Dubois, G (2003), Changes in tourism/leisure mobility patterns facing the stake of global warming: the case of France, presented at the IGU Globility conference, Palma de Mallorca, April 2003

Ceron J.P and Dubois G. (2005), More mobility means more impacts on climate change : prospects for household leisure mobility in France. *Belgeo*. 2005- 1-2. 103-119

Ceron, J.P. Dubois, G. (2002) Why should French tourism pay attention to climate change, Paper presented at the international Symposium “*Tourism and the natural environment*”, Eastbourne, September 2002

Commission des Communautés Européennes (2001) *Livre Blanc. La politique européenne des transports à l'horizon 2010 : l'heure des choix*. COM(2001) 370, Bruxelles : Commission européenne

Conservation International (2003), *Tourism and Biodiversity : mapping tourism footprint*. UNEP/ Conservation International, 53p.

Department of the Environment (1996) *Recreation and tourism In Review of the potential effects of climate change in the United Kingdom*. Second report, London: HMSO, pp.199-209.

Dubois G. and Ceron J.P. (2005) Greenhouse Gas Emissions from Tourism under the Light of Equity issue, in Hall C.M. and Higham J. (Eds.), *Tourism, Recreation and Climate Change*. Clevedon : Channel view publications. 97-115

Duplessy, J.C (1996) *Quand l'océan se fâche*. Paris : Odile Jacob

Duplessy, J.C. and Morel, P. (2000) *Gros temps sur la planète*. Paris : Odile Jacob. 304p.

Dupuy, J.P. (2004) *Pour un catastrophisme éclairé, quand l'impossible est certain* Paris : Le Seuil, 214p.

Elsasser, H. Burki, R. (2002) Climate change as a threat to tourism in the Alps. *Climate research*, 20, pp.253-257

EPA (2000) *A method for quantifying environmental indicators of selected leisure activities in the United States*. EPA-231-R-00-001. 92 p.

Fontelle, J.P., Chang, J.P. Allemand, N. (1999) *Inventaire des émissions dans l'air en France*. Paris : Citepa, août 1999.

Fontelle, J.P., Chang, J.P. ,Allemand, N. et al. (2000), *Inventaire des émissions de gaz à effet de serre en France au cours de la période 1990-1999*. CITEPA Report 430, Paris : Citepa, 274 p.

Garrod, B. Wilson, J. Bruce, D. (2002) *Planning for Marine Ecotourism in the EU Atlantic Area. Good Practice Guide*, University of the West of England, Bristol.

Giles, R. Perry, A. (1998) The use of a temporal analogue to investigate the possible impact of projected global warming on the UK tourism industry. *Tourism management* 19 (1), 75-80.

Godard, O. (2003) *L'équité dans les négociations post-Kyoto : critères d'équité et approches procédurales in D4E-MEDD, Les engagements futurs dans les négociations sur le changement climatique*. Paris : La Documentation Française.

Gössling, S. (2000) Sustainable tourism development in developing countries: some aspects of energy-use, *Journal of Sustainable Tourism* 8(5): 410-425;

Gössling, S. (2002). Global environmental consequences of tourism. *Global Environmental Change* 12(4): 283-302;

- Gössling, S. Peeters, P. Ceron, J.P. Dubois, G. Patterson, T. Richardson, R. (2004). The eco-efficiency of tourism. 2<sup>nd</sup> International workshop on climate, tourism and recreation. Kolimbari, Crete, Greece 8-11 June 2004 20p.
- Harrison, S.J., Winterbottom, S.J. and Sheppard, C. (1999) The potential effects of climate change on the Scottish tourist industry. *Tourism Management* 20, 203-211.
- Holmes, T. Palmquist, J. Steiger, S. (2000) Economic analysis of the potential impact of climate change on recreational trout fishing in the southern Appalachian mountains *Climatic Change*, 45, 493-509.
- Hoyer, K. G. (2000) Sustainable tourism or sustainable mobility *Journal of Sustainable Tourism* 8 (2) pp147-160
- Hoyer, KG (2001) Conference tourism: a problem for the environment, as well as for Research *Journal of sustainable tourism* 9(6) pp.451-470
- IFEN (2000), *Tourisme, Environnement, Territoires : les Indicateurs*. Orléans: Ifen 262 p..
- IPCC (1999), *IPCC Special report. Aviation and the global atmosphere. Summary for policymakers*, 23 p.
- IPCC (2001) *Climate change 2001. IPCC third assessment report*.  
[http://www.grida.no/climate/ipcc\\_tar/](http://www.grida.no/climate/ipcc_tar/)
- König, U. Abegg, B. (1997) Impacts of climate change in the Swiss Alps. *Journal of sustainable tourism* 5 (1) pp. 46-58
- Lise, W. Tol, R.S.J. Impacts of climate on tourism demand *Climatic Change* 55, pp. 429-449
- Lohmann L. (no date). *The carbon shop : planting new problems*. Briefing paper. Plantation campaign. World Rainforest Movement, 14p.
- Maddison, D. (2001) In search of warmer climates? The impact of climate change on flows of British tourists. *Climatic Change* 49, pp.193-208.
- Matzarakis, A. (2003). Climate, human comfort and tourism. NATO advanced research workshop . Warsaw 6-8 nov 2003
- Mc Boyle, G. Wall, G. (1987) Impact of CO2 induced warming on downhill skiing in the Laurentians *Cahiers de géographie du Québec*, 31, 39-50
- OECD (2001) *Household tourism travel : trends, environmental impacts and policy responses*- Report n°ENV/EPOC/WPNEP(2001)14 Paris: OCDE, 57 p.



- Patterson, T. (2004) Knowledge management for tourism, recreation and bioclimatology: mapping the interactions. In Matzarakis, A., de Freitas, C.R., Scott, D. (eds.) 2004: Advances in Tourism Climatology. Ber. Meteor. Inst. Univ. Freiburg Nr. 12
- Peeters P. (2003) *The tourist, the trip and the earth* Presentation of the NHTV lectureship Sustainable Transport and Tourism, Breda, April 2003
- Schaefer and Victor (1997) The Past and Future of Global Mobility, *Scientific American*, October 1997
- Schaefer and Victor (1999), "Global Passenger Travel: Implications for Carbon Dioxide Emissions" *Energy* 24: 657-679
- Scott, D. Jones, B. Mc Boyle, G. (2004) *Climate, Tourism, and Recreation: a bibliography* University of Waterloo ( <http://www.fes.uwaterloo.ca/u/dj2cott/> )
- Scott, D. (2003) Climate change and tourism and the mountain regions of north America. First international conference on climate change and tourism. Djerba, Tunisia 9-11 April 2003 10p.
- Scott, D., Mc Boyle, G. Mills, B. (2003) Climate change and the skiing industry in Southern Ontario (Canada) Exploring the importance of snow making as a technical adaptation, *Climate research*, 3, pp.171-181.
- Schwartz P., Randall D. (2003) *An abrupt climate change scenario and its implications for United States national security*. [http://www.ems.org/climate/pentagon\\_climate\\_change.html#report](http://www.ems.org/climate/pentagon_climate_change.html#report)
- SEATM (2002), *Les chiffres clés du tourisme de montagne*. 3<sup>ème</sup> édition, Coll. Les Dossiers, Challes-les-Eaux : Seatm
- Tsartas, P. (1998), *La Grèce : du tourisme de masse au tourisme alternatif*, Paris : L'Harmattan, Coll. Tourisimes et Sociétés, 237 p.
- Viard, J. (2002 a) *Le sacre du temps libre. La société des 35 heures*. La Tour d'Aigues : Editions de l'Aube. 215p.
- Viard, J. (2002 b) Temps libre, vacances, et art de vivre : le triangle des Bermudes des sociétés modernes. In Viard J. ed. *La France des temps libres et des vacances*. La Tour d'Aigues : Editions de l'Aube. 226p
- Viner, D. Amelung, B. (2003), Climate change, the Environment and Tourism :The Interactions. Proceedings of the ESF-LESC Workshop, Milan 4-6th June Publ. eCLAT, Climatic Research Unit, Norwich: UK, 63pp
- Wall, G. (1998) Implications of global climate change for tourism and recreation in wetland areas. *Climatic Change* , 40, pp. 371-389.

