

# The Potential Impacts of Climate Change on French Tourism

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**It is by no means original to recall that tourism is strongly conditioned by climate, be it in France or elsewhere (Harrison *et al.*, 1999). The figures showing the importance of tourism in the economy (some 8% of the GNP, 77 million foreign visitors) suggest that the climatic modifications related to the greenhouse effect could positively or adversely affect one of the major activities of the national economy.**

### Keywords:

The consciousness regarding this issue is fairly recent. In 2001 Butler and Jones could still point out that 'the tourism and hospitality industries . . . seem intent on ignoring what could be the major problem of the century', recognising that climatic change 'could have greater effect on tomorrows world and tourism and hospitality in particular than anything else' (Butler & Jones, 2001). Awareness is, however, evolving quickly: the WTO convened in April 2003 the First International Conference on Climate Change and Tourism in Djerba, and throughout the year at least three international workshops and conferences followed.

The Djerba meeting does show that some major stakeholders (mainly among tour operators, hospitality industries and governments) are still reluctant to admit the most disturbing risks or issues linked to climatic change, and tend to call for delays before acting (in the transportation field in particular): '*encore un instant monsieur le bourreau . . .*'. Tourism is both a potential victim and a definite contributor to climate change.

Regarding tourism, three different types of issues are raised by climatic change.

- (1) The effect of climate change on the climatic and non-climatic resources of tourism: changes in climatic conditions according to seasons and regions, effect of climatic change on water resources, landscape, snow for winter sports, etc.
- (2) The contribution of tourism to climate change (through transportation mainly). Tourism is affected by global warming, but it is also a major contributor to greenhouse gas emissions, by emitting CO<sub>2</sub>, and other gas (mainly CH<sub>4</sub>, N<sub>2</sub>O), and through specific phenomena (contribution to the formation of cirrus clouds by airplanes for example).
- (3) The possible effects of mitigation policies on tourism. Given the overwhelm-

ing importance of the stakes linked to global warming and a contribution by tourism, which is far from negligible, this activity is bound to be concerned by mitigation policies. This is a broad issue which is largely ignored but needs to be explored, probably under various and contrasted hypotheses.

This defines a very wide field of concerns which cannot be totally dealt with in this chapter, so we focus on the first topic; more specifically we discuss the French situation which is rather complex owing to the geographical and climatic diversity of this country.

### **Trying to Find a Reasonably Scientific Basis for the Discussion**

Generally one can read on climatic change a wide range of different forecasts, opinions or fears. For tourism, as well as for other fields, they can be simplistic, false or one-sided. For example, some will synthesise the effects of climate change into an increase of some 2° in temperatures, which would seemingly bring the climate of Paris to London (Nuttall, 1996) and thus allow the British to spend more of their holidays at home (Giles & Perry, 1998: 76–7), a pleasant and optimistic view of the future.

Discussing the future potential impacts of climate change on tourism should be based on state of the art current scientific knowledge regarding this phenomenon. Current knowledge on climate change is built through a process gathering within the International Panel on Climatic Change (IPCC or GIEC in French) thousands of scientists worldwide, belonging to the different disciplines implied in studying climate and its effects ([www.ipcc.ch](http://www.ipcc.ch)). Peers discuss the knowledge produced and present the best scientific guarantees one can expect.

The current state of the art (IPPC, 2001) highlights on a world scale the following points:

- (1) The climate is globally bound to get warmer – no existing model concludes that it could remain stable or cool down – and this is related to anthropogenic emissions of greenhouse gas.
- (2) The most recent models lead to a warming of 1.5 to 6° by the end of the century. The increase over the continents should on average be 1.5° times greater than over the oceans.
- (3) This is but 50 to 90% of the maximum, which is to be attained. The level at which this stabilisation will take place highly depends on how fast GHG emissions will be curbed.
- (4) We have no historical analogue to figure what happens with a fast warming of a few degrees over current temperatures.
- (5) We can 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 & Morel, 2000). Such a phenomenon happened several times 15,000 years back; it took only a few decades and resulted in a downfall of average temperatures in Europe by 5 to 6° (Bard, 2002).
- (6) 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 be faced with phenomena such as the hurricanes which struck at the

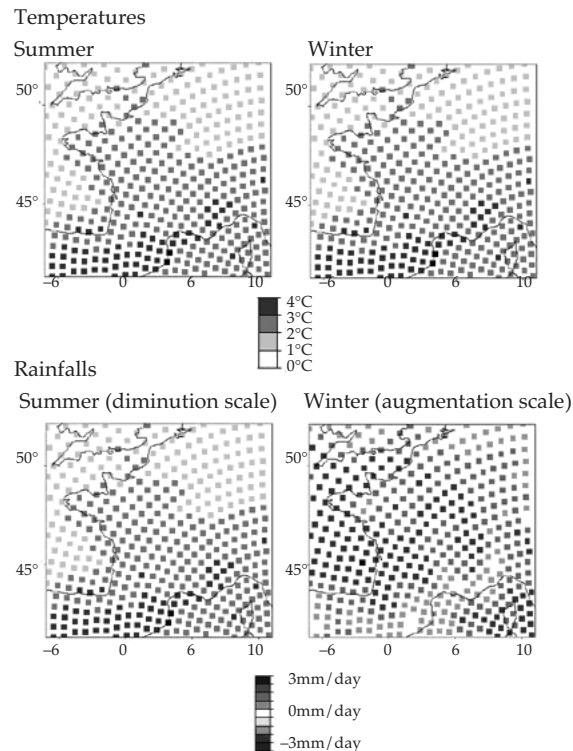
turn of the century in France. We should, though, remember that phenomena such as El Nino and La Nina are associated with changes in temperatures no greater than 2 or 3°. Yet an increased frequency of floods seems probable at our latitudes.

- (7) Last, but not least as regards our subject, changes in temperatures should vary according to places. The models validated by the IPCC use grids that are several hundred kilometres wide: roughly, the point is that, given the power of current computers, working with a tighter grid implies shortening the time horizon. This is why regional models are less reliable than global ones.

Nevertheless, the following discourse is derived from a regional model, i.e. a scenario by Météo-France built for the French Mission on Greenhouse Effect (Déqué, 2000), which uses a grid of 70 × 70 kms. The scenario considers the effects of a doubling of atmospheric CO<sub>2</sub>, which could be reached by the middle of the century. It concludes that France could have, compared to its current climate, a warming of about 2°C, more stressed in summer and in the south of the country. This warming would lead to an increase of winter rainfalls of about 20% (rainy events more frequent and more intense) and a reduction of summer rainfalls of about 15% (longer and more intense summer droughts resulting in a downfall of about 5 to 10% of groundwater reserves till autumn); these general tendencies would be more marked in the south than in the north.

Even if Météo-France is considered as a serious institution (except in local pubs . . . ) and though the reduced size of the grid can be felt coherent with a short time horizon, the model might be more questionable than global models. From a social scientist's point of view a 'short' long term of a few decades is very attractive since that kind of horizon can still make sense for forward thinking stakeholders: should we refer to J.M. Keynes' words it is the kind of long term in which we shall not all be dead . . . It should be noted that the results are not contradictory with those wider models given for France as a whole, and that indications for seasons and regions seem to fit with the more global prospects and phenomena recalled above. This is why we consider they provide a basis for a reasonable analysis of what is at stake for French tourism.

Some additional limitations of the scenario should nevertheless be pointed out. It gives for each season results for average temperatures, rainfalls and water reserves held in the ground. It does not provide results for a certain number of factors conditioning as much as the previous one's tourism (cloudiness for example), nor does it give the results in the most relevant form for the matter we deal with (it is not so much the quantity of rain that is important but rather the rhythm with which it falls: see tropical destinations for instance).<sup>1</sup> In fact, one cannot think only in terms of long-term average climate change. It seems useful to insist on the difference between 'climate' and 'weather' (Department of the Environment, 1996: 200; Giles & Perry 1998: 75): the coming climate changes might be accompanied by a more frequent occurrence of extreme weather events and greater standard deviations to average conditions. The weather forecasts, now fairly reliable from one weekend to the next, allow short-term departure decisions taking into account these deviations (Department of the Environment, 1996: 207). This faces some sectors of the tourism industry with a new challenge, in particular in Northern Europe where tour operators manage an important



**Figure 1** Impact of a doubling of CO<sub>2</sub> on French climate

percentage of travel, but can be more easily coped with in a country such as France where the major part of tourism activity is external to the market economy (Commissariat général du Plan, 1998: 48).<sup>2</sup> In such a context, domestic tourism might reveal itself more resilient than vacations abroad.

Finally climate change will interact with the benefits tourists expect from climatic conditions and these in the forthcoming decades are quite uncertain. It is already known they vary largely according to historical periods and to the populations concerned (Besancenot, 1989: 16). One can for example recall that the climatic requirements of the populations of the north of Europe are not the same as those of French people: the climate of Brittany will be better accepted by a British tourist than by a Frenchman for holidays, which does not mean, however, that the former will not prefer a sunnier destination. It is also known that the quest for sunshine is a recent phenomenon: Mediterranean people traditionally seek for shade, so did the British, developing summer hill stations in India. In France, a tanned skin was not until recently much appreciated. Over one century the benefits expected from sea bathing completely changed and along with them the requirements relating to the temperature of water. It is thus not unthinkable that new considerations, linked in particular to health (an increase of the number of skin cancers, on which TV and other media would undoubtedly dwell) could modify in a few decades the climatic expectations of tourists and question the heliotropism of our societies. On the French Riviera, for instance, changes can

already be seen in the bathing habits of tourists, who tend to go to the beach sooner in the morning and later in the afternoon.

### **Climate Requirements of Tourists and Greenhouse Effect**

A climate adequate for tourism should provide:

- **Safety.** It is important that tourists be sheltered from climatic accidents and the natural catastrophes which they generate, which is not always the case, since they are often more endangered than local inhabitants because of the proximity of water they seek and in reason of the fragility of some lodgings they use. Some concern can arise since models that try to work on variability (not all do) predict that Greenland would stay cool while Europe would get warmer (Hadley Centre, Institut Pierre Simon Laplace), thus generating the conditions for violent storms and floods.
- **Amenities, which include several aspects:**
  - *sunshine periods.* Which refer both to duration and regularity;
  - the absence of daily rainfalls. It is not the quantity of rain that falls which matters the most, but the frequency of the falls. The limits of what is acceptable are subject to debates. These debates relate first to a higher limit which, if one looks at the scenario of Météo-France, can cause worry for the winter season: the upper limit for winter should be one hour rainfall between 6 am and 6 pm. Secondly, they point to a lower limit which concerns mainly the summer period: too dry weather also presents disadvantages through its impact on landscapes: for example 4 days' rainfalls is considered by some specialists as an optimum (Burnet, 1970);
  - *comfort*, which can be defined as a situation in which man does not have to strive to maintain the internal equilibrium of his body, comprises two aspects.
    - (a) **Thermal comfort.** Considering the prospects the scenario points out, the higher temperatures can be a problem, in summer and for the hottest destinations. There does not seem to be a general agreement as to the maximum temperatures a tourist can accept. Some authors deny their existence or situate maxima at a very high level (40° for Viner & Agnew, 1999: 21). Other authors, using statistical models, point to an 'optimal maximum daytime temperature for tourism of around 30.7°C' (Maddison, 2001: 200), or to an 'optimal holiday temperature' of 21°C worldwide (Weitze & Richards, 2002: 437). According to Besancenot (1989: 35) a fall of comfort starts to be felt beyond a daily maximum temperature of 31°C with a very significant aggravation beyond 33°C. On the other side, one could hope that an appreciably more significant part of the country could remain most of the year over the acceptable minima (16 to 18°C: the temperature at which an individual at rest starts to feel coolness) and thus see its appeal for tourists enhanced. This might happen, but the diagnosis is much more complex and cannot be limited to taking into account temperatures since they interact with wind patterns and moisture of the air. Moreover, for the forms of tourism centred on bathing, the

relationship between the temperature of the air and that of water is a crucial factor.

- (b) Hydrous comfort. Heat will be better accepted if the air is dry. From this point of view the scenarios associating a rise of the temperature of summer with diminishing rainfalls are rather reassuring. On the other hand the increase in moisture in winter could degrade the assets of France in this season and push tourists towards other destinations.

Tourists generally tend to accept conditions beyond what is considered as comfortable in other circumstances, but there are some limits especially when health is at stake.

- *The minimisation of the major health risks associated to climate.* It is known that the exhibition to sunrays causes skin cancer, that the association of cold temperatures and violent winds increases the risks of heart attacks, and that moist winds increase cerebral and vascular accidents frequency (over a certain degree of moisture, water tends to pass into blood). In this respect over-heated summers and more disturbed winters are not welcome. Some categories of the population are particularly concerned (young children through dehydration) but the main fact to take into account is the ageing of the population. Besancenot (1989: 40) recalls that 20 to 30% of emergency returns home by tourists originate from a climatic aggression of some sort. More unexpected health hazards affecting tourism might arise. Malaria cases have been reported around French airports: a warmer climate would favour this kind of disease which in the previous centuries was frequent in some parts of France, but the risk is more dependent on the sanitary level of the country than on its climate: it therefore can be considered as limited. Various other risks, perhaps more serious, can be quoted: mosquitoes such as *Aedes albopictus* or nearby species who carry yellow fever, dandy fever or Rift fever, or the West Nile virus could be disseminated by travel and find a welcoming climate in some parts of France ([http://www.x-environnement.org/Jaune\\_Rouge/JR00/besancenot.html](http://www.x-environnement.org/Jaune_Rouge/JR00/besancenot.html)).

One is thus far from a simplistic vision of the consequences of a climatic change, according to which one would consider that two degrees more, and a sunnier situation, would reinforce the assets of France, or Britain (Nuttall, 1996), for tourism. The situation is more complex and the results provided by the scenarios make it difficult to reach a clear diagnosis. A vision of the temperatures and rainfalls is not sufficient: data, or assumptions if building scenarios is the aim, are necessary in the fields of nebulosity, the rainfall and winds pattern, etc.

Main points:

- Tourism destinations might be particularly endangered by extreme climatic events.
- Comfort might be questioned both by too hot summers around the Mediterranean and by rainy and windy winters.
- Health risks related to temperature and diseases might increase.

## **Climate change, seasons and regions**

- **Summer**

The western regions of Europe profit from an oceanic climate which answers tourists' expectations during 30% of the summer to 70% as one moves southwards. One could think that a warming climate could at the same time lengthen the season and allow tourist practices to expand towards the north. One can recall that the difference of average temperatures on the Atlantic coast between the 48th parallel (Brest) and the 46th (Oléron) is about 3°C in August, that is to say a little more than the rise of the summer temperatures in the scenario. More generally, at our latitudes, the IPCC (GIEC, 2001: 13) estimates that a rise in temperatures from 1.5 to 5° over a century would result in a shift of isotherms from 150 to 500 kms north (from Biarritz to Brest or from Plymouth to the Scottish border), or from 150 to 500 m in height, which in the latter case would offset much of the altitude effect of Massif Central or of Scottish highlands.

The Mediterranean climate is currently unquestionably favourable to tourism during the four summer months. It is in fact rather adapted to a mass tourism, which is more sensitive to sunshine than to real comfort. The changes envisaged by the scenario could accentuate this vocation of Mediterranean France to accommodate a population in good health, ready to accept excessive heat (in the Costal del Sol current model). As a tourist destination, the Mediterranean coast of France would undoubtedly be rather less affected than Spain or Greece, already hotter (Viner & Agnew, 1999: 21–3); for this reason it might profit from a comparative advantage compared to nearby destinations of the same type. Greater heat is also likely to repel at the same time the important old age population and the residents of Mediterranean regions, in France, Italy or Spain. Thus, mountain regions could become appreciated for their relative coolness, the shade of their forests.

- **Winter**

There is serious uncertainty as to whether the rise in winter temperatures would improve holiday conditions. For instance, in the same document referring to the British context (Department of the Environment, 1996) one can find the following quotations: 'milder winter conditions could provide less cold stress to older people in Britain and mean that vacations currently taken in the Mediterranean . . . could become less compelling' (Department of the environment, 1996: 204) and 'in the north of the UK any significant increase in rain fall, wind speed or cloud cover are likely to offset the more general advantages associated with higher temperatures' (Department of the environment, 1996: 199).

Currently, in France, one can express serious doubts on the winter tourist vocation of the Atlantic coast, not so much because of the temperatures than of the constant lack of weather stability. This point is all the more important since the customers available at that time are essentially old age pensioners. Looking at the local intensities of winter rainfalls of the Météo-France scenario, it does not seem that the situation should improve on the coast, nor inside the country: the average temperate climate could

become less favourable to winter holidays than it is now. Some places are favourable to winter holidays on the south Atlantic coast, but that is due to microclimatic conditions, and one can wonder whether they will resist the announced variations. Even if these privileged sites are rather small, from the economic point of view the stakes are important: what will be the winter like in Biarritz in 2030?

One can also doubt that the Mediterranean coast sees its situation as a winter vacation resort improve radically. The reputation of the gulf of Genoa and its backcountry is well established, but a glance on its climatic data shows that it is really privileged compared to other Mediterranean areas (strong homogeneity of the fresh season). In France itself, the climate becomes more disturbed and windy in Western Provence and in Low Languedoc, which are not so well suited for winter holidays. Even if rainfalls are expected to increase less here than on the Atlantic coast, it does not appear likely to improve the situation.

Consequently one can wonder whether large cities, where climatic environments are controlled, will not see their attraction increasing in winter. In the same way the completely artificial resorts such as tropical leisure parks could expand.

- **Shoulder seasons**

The tourist potentialities of spring and autumn could at a first glance be largely increased. This could meet with current phenomena like the development of short vacations, insofar as this trend continues. In fact the future prospects are not so clear. For the Atlantic coast and its inland regions, the Météo-France scenario forecasts milder springs but increased rainfalls. If that means more disturbed weather, one does not see what tourism will gain from it. On the other hand, one can expect excellent dry autumns. Logically the tourist season should last longer, rather than start sooner, unless gloomier winters and contrasted springs result in massive departures with the first sunny days. In fact, this can be seen nowadays for the Mediterranean area: objectively the autumn climate appears more favourable to tourism than spring and yet spring-time seems more appreciated by tourists. In addition one can wonder whether the landscape of a dry autumn, consecutive to the strong hydrous deficits of summer will not spoil the end of the season: a country such as Greece has the reputation to be appreciated more in spring than in autumn.

Ultimately, the evolutions envisaged by the Météo-France scenario could reveal a divide between regions/seasons favourable for a type of tourism adapted to people in good health, which can deal with some climatic stress, and others, more adapted to an older and more fragile population. The reaction of the various categories of customers to these modifications of climatic conditions possibly will not be immediate nor mechanical. In addition, the climatic trends will undoubtedly modify the comparative advantages between France and neighbouring countries; it is an important issue that the scenario, which deals solely with France, does not point out.

**Main points:**

- French Mediterranean tourism could find competitive advantages over its already hotter nearby competitors.
- Mediterranean hinterlands could become more attractive due to their relative coolness.
- The Atlantic Coast could be negatively affected by an increase of winter rainfalls.
- Artificial resorts with controlled environment could be favoured.
- Autumns would be more attractive, but spring could more favoured by customers.

**Impact of global warming on the non-climatic resources of tourism**

• **The energy consumption of lodgings**

The climatic conditions can strongly influence the building and maintenance conditions of lodgings and tourist infrastructures. It is known for example that hot and wet climates damage buildings. In a country such as France one can think that the future climatic conditions could facilitate the use of light lodgings in season: campsites and intermediate forms of lodging, provided that these types of accommodation are reasonably comfortable even under excessive heat. Moreover the rise of the temperatures could foster a request for air-conditioning<sup>3</sup> – which is already increasing dramatically – the more as it meets the interests of supply-side stakeholders (surpluses of electric production from nuclear power stations in summer). Generally a change in climatic conditions could push towards the creation of artificial environments minimising the stress; as a result the energy consumption of tourist activities could be deeply modified.

• **Beaches and sea level**

It is not the rise in the sea level which is the most worrying: the concern is far from being of the same importance as for the tourist destinations in the Pacific (Maldives and others: Viner & Agnew, 1999: 17). However, it must be remembered that France faces a slow increase of the sea level, from 1.2 to 1.5 mm a year owing to long-term phenomena (Simon, 2001: 8); the greenhouse effect should accelerate this phenomenon which contributes to coastal erosion (Paskoff, 2001: 14–15). Out of 5500 km of coasts 850 are subject to an average withdrawal of more than one metre a year; the sand beaches roll back or disappear in certain places (30 m withdrawal in Flandres and 450 m at Saintes Maries de la Mer in a half century) (Ifen, 1994: 27), and 20% of the French coastal communes currently have their beaches attacked by erosion (Thorette & Marchand, 1996: 93). Really dramatic problems could arise in the very long term; to 2100 the rise should be at most one metre but more probably within the range of a few decimetres. However, the warming of oceans has a considerable inertia: a world increase of temperatures of 2 or 2.5° in 2100 would lead to a 6 m increase of ocean levels by the year 3000 (IPCC, 2001).

Within the foreseeable future, a reasonable option is to do with the phenomenon, which implies not to build, too near the coastline, commodities that will call for further protection. It must also be remembered that sand beaches might move back without disappearing, which is the case for the shoreline south of Bordeaux since Roman times. The other option, which is to resist, includes two possibilities:

- building protections along the shore (already 400 kms in France);
- compensating the diminishing sand volume, which maintains the landscape and is not so costly as one may fear. The Dutch bring back each year to the shoreline some 6 or 7 million cubic metres of sand for a cost of 35–40 million dollars. The quantity forecasted for 2100 should increase by 50%. It remains that currently the maintenance of a kilometre of sand beach costs less than the maintenance of a kilometre of motorway (Paskoff, 2001: 18).

- **Water resources**

The scenario of Météo-France provides charts concerning the water reserves of the ground. It points to a strong contrast between spring (capitalising the rains of winter) and the rest of the year. It is not possible, in this paper, to appreciate the impacts on the vegetation and the landscapes of France, and consequently on numerous amenities on which tourism is based.<sup>4</sup> However, one should remember that vegetation is much more sensitive to changes in rainfall than to temperatures. Species can follow climatic changes and migrate but at a rhythm which is specific to each of them and ranges from 4 to 200 kms per century, which is far below some of the modifications IPCC suggests (+3° implies a shift of the area favourable to specie 500 kms north).

It remains to be seen up to what point the new situation would modify the comparative assets of the various regions by giving advantage to those that remain relatively green in the summer and in the autumn, for example the north-east of France (Jura, Vosges) where the impact would seem to be lower. In addition, it is probable that in the whole territory the water supply for tourist activities and leisure will be harmed (for instance angling: Holmes et al., 2000), and that one will see more and more frequent restriction measures such as have appeared these last years and which can adversely affect family tourism and even second homes (watering of the lawns, swimming pools, etc.).

It is of course for the Mediterranean part of France that one can be most anxious. Among Mediterranean countries, French river basins enjoy a privileged position (Margat, 1990). Whether one considers the part of resources that are used or net consumption, France is in a good situation, compared to its developed neighbours (the situation of south Mediterranean countries is by far worse); in addition, expected demand for 2025 still leaves a margin for additional use. The water demand related to tourism is, however, not well known: the demand of tourist activities is considered as part of that of communities, of which it would represent about 10%. For Mediterranean France, communities themselves account for 10% approximately of the total use. In terms of use, the industrial sector comes first (cooling of power

stations which returns water after use) whereas in terms of consumption agriculture accounts for 85% of the total. It should, however, be specified that consumption related to tourism is concentrated within the period when water is scarce (as is also the case for agriculture). This leads to the necessity of over-sizing the storage facilities (at some economic cost) and possibly in the future to choices between uses for tourism and irrigation (roughly the consumption of a square metre of lawn is of the same order as that of a square metre of corn). Choices within tourist activities might also have to be made (see for example the questioning of water consumption by golf courses). Important savings potentials exist as well for irrigation as for tourist activities.

Lastly, it goes without saying that drier summers will increase the risks of forest fires in the Mediterranean regions (Viner & Agnew, 1999: 24) and elsewhere, causing safety problems and spoiling much appreciated landscapes.

- **Snow for winter sports**

Winter sports can disappear. Who would remember that canal skating was common in Holland a few centuries ago if some famous paintings did not remind us of the fact? More recently, in the first half of the 20th century, ice-skating was frequent on the lakes of Parisian parks. This is no longer the case.

The issue of skiing has been frequently studied in France and abroad (Elsasser & Burki, 2002; König & Abegg, 1997; McBoyle & Wall, 1987; Scott 2003; Scott et al., 2003). We shall just briefly point out the conclusions of Eric Martin for the French mountains (Martin, 1996). This author assesses the impacts of a rise of 1.8°C, without taking into account any change in the total of rain and snow falls.<sup>5</sup> At an altitude of 1500 m, Martin evaluates the reduction of the duration of the snow cover from 20 to 25% in northern Alps, of 30% in the part of the southern Alps staging from Dévoluy to High Tarentaise and Queyras, of over 40% for the more southern part of the Alps and up to 45% for certain regions of Pyrenees. At higher altitudes the reduction in the time the snow cover lasts would be only 10%. One can easily imagine to what point the conditions of winter sports would be upset. Skiing could migrate to higher altitudes, which would surely become overcrowded, and this could lead to developing snowfields in colder countries, for instance in Canada.

**Main points:**

- The lack of snow for winter sports is the major direct constraint related to climate change that French tourism would have to face.
- The changes in sea level also have a high impact but they are far from being related only to climate change.
- Indirect impacts on landscapes, biodiversity and water resources are too variable to be assessed at a national scale, though they could have a long-term impact of destinations assets and attractiveness.

## **Conclusion**

The main limitation of forecasting the impacts of climate change on tourism is the remaining uncertainty on the extent of global warming and also on its local effects. Future climatic research should provide step-by-step more detailed and reliable scenarios.

However, it is already important to analyse the potential effects of climate change since the time of response of the tourism industry to environmental change is directly related to the life time cycle of the tourism product (20–30 years).

The first message to be addressed to tourism stakeholders is that in the three or four coming decades, climate change will seriously impact on tourism, sometimes dramatically (winter sports) sometimes in the margins. As it is still impossible to predict what will happen, the most adapted technique to forward the message seems to be the development of contrasted scenarios, so that operators can benchmark the expected effects of climate change.

The main policy question that follows is: what can we do in this context of uncertainty?

- The first option can be to wait until the level of knowledge increases, considering that short-term responses will be more efficient than long-term precautionary measures. Given the rigidity of the tourism supply and the irreversibility of the environmental process involved (dwindling of beaches), it seems that this option involves a high level of risk, and that long-term costs should exceed short-term benefits.
- The second option could be to trust the ability of technology to face environmental change. Since the beginning of the 1980s, for instance, French ski resorts are engaged into a strong investment in artificial snow cover (more than 160 resorts equipped), so as to reach a 'snow insurance', considered as a strong marketing argument. Center Parcs is about to build a third resort (the 15th in Europe), with a 'tropical paradise' warranty of a 28°C bathing water all year long. Artificial ones can replace natural beaches. Two arguments limit this option. The first is environmental: an increased artificialisation of tourism resorts will undoubtedly increase the impacts of tourism on natural environments, on water resources and biodiversity (for artificial snow cover), but also on energy consumption and, indirectly on greenhouse gas emissions of the tourism sector: the response would indirectly increase the problem. However, it is not certain that tourism operators might be sensitive to this environmental argument, which is an externality of the tourism business. The second argument, somehow stronger and more accurate, is economic. The capitalistic intensity of the tourism sector is dramatically increasing in industrialised countries (CDC, 2002). The profitability of the tourism sector, already quite low, is likely to decrease with these additional investments, all the more as a lack of confidence of investors in tourism (CDC, 2002) leads to a low availability of investment in this sector. A majority of French ski resorts, for example, have never been and will never be profitable: they are strongly indebted and have to be strongly supported by public institutions, which might be reluctant in the near future to go on wasting money

in such an uncertain business. More precisely, only major destinations can afford such a 'climate insurance': ski resorts like Les 3 Vallées or Monaco, whose tourism is increasingly disconnected from environmental and climatic assets and more and more related to cultural events and gambling motivations. Moreover, natural assets will not disappear but will be redistributed among European and global destinations: it is not sure that customers will prefer the Mediterranean with artificial sandy beaches to tropical natural shores.

- A more balanced option could be a precautionary attitude, which would encourage a flexibility of the tourism sector and improve its delay of response to environmental changes. The two major factors influencing the adaptability of the tourism sector are the reversibility of planning and the diversity of the tourism supply. The Erika oil spill, for instance, clearly showed that destinations with more diversified assets, customers, accommodations and equipments resisted better than destinations only oriented to camp sites accommodations and bathing activities. Developing off-ski activities (hiking trails, pathways, cultural events) in ski resorts could be more sensible and constitute a better insurance for the future than investing in artificial snow cover, which will never replace a white natural mountain in winter. In that perspective, climate change responses can be integrated in a broader risk management policy of the tourism sector (diversification is a way of limiting tourism sensitivity to economic crisis as well). Promoting natural high quality campsites and light accommodations, developing hotels, which can be easily transformed in main residences drive the situation more reversible. Climatic uncertainty should be introduced into evaluation criteria of the opportunity of tourism investment.

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### **Notes**

1. The fact that the climatic variables acting on tourism cannot be reasonably limited to temperatures and rain quantities questions some current econometric models (Maddison, 2001: 198).
2. Nearly two-thirds of the accommodation for the French taking holidays in France is provided by the family, friends or second homes (Secretariat d'Etat au tourisme, 2000)
3. The air-conditioning of a hotel requires from 90 to 150 kWh/sq metre: source ACCOR quoted by Ifen (2000: 81).
4. A detailed analysis of this issue can be found in Wall (1998), though the author refers to a North American context.
5. This is somewhat in contradiction to the Météo-rance scénario, which expects more snow/rainfall in winter or in spring on the mountains.

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