REVISTA BRASILEIRA DE PESQUISA EM TURISMO
BRAZILIAN JOURNAL OF TOURISM RESEARCH
e-ISSN 1982-6125

Paper

**DOI:** http://dx.doi.org/10.7784/rbtur.v12i3.1354

# Tourism under climate change scenarios: impacts, possibilities, and challenges

## O turismo no cenário das mudanças climáticas: impactos, possibilidades e desafios

## El turismo en el escenario del cambio climático: impactos, posibilidades y desafíos

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**Abstract**: Tourism can be considered an economic sector highly sensitive to climate change and it contributes to the emission of greenhouse gases (GHG), one of the causes of global warming. To mitigate the negative effects, the concept of sustainable tourism development emerges, which should incorporate the externalities derived from climate change. Given this reality, this research aims to examine the impacts, opportunities, and challenges for sustainable tourism development under global climate change scenarios. The methodology has a descriptive/analytical, interdisciplinary, and systemic approach, based on bibliometric and documentary research, and interviews with tourism development and climate change experts. The results include the construction of scenarios that may show the possible impacts and consequences of climate change on the international tourism system, providing information for mitigation purposes, planning for adaptation actions, and minimizing impacts and vulnerability.

**Keywords**: Climate Impacts. Tourism. Adaptation. Mitigation.

**Resumo**: O turismo pode ser considerado um setor econômico altamente sensível às mudanças climáticas, e tem contribuído para a emissão de gases de efeito estufa (GEE), uma das causas do aquecimento global. Para

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* The article derives from the author's doctoral thesis (GRIMM, I.J.). The thesis was supervised by (SAMPAIO, C.A.C.). The updating of data and new theoretical contribution and revision of the article was done by (ALCANTARA, L.C.S). Thus, the networking as a way of fostering and valuing research and cooperative work should be emphasized.

*Paper received in: 02/09/2017. Paper accepted in: 12/06/2018.*

mitigar seus impactos negativos, surge a concepção do desenvolvimento do turismo sob a ótica da sustentabilidade que deverá incorporar as externalidades derivadas da mudança climática. Frente a esta realidade, este artigo analisa os impactos, oportunidades e desafios para o desenvolvimento sustentável do turismo no Brasil, a partir dos cenários projetados pela mudança climática global. A metodologia tem abordagem interdisciplinar e sistêmica, de cunho descritivo/analítico, realizada a partir de pesquisa bibliométrica, documental e entrevistas junto aos especialistas na temática do turismo, desenvolvimento e mudanças climáticas. Como resultados tem-se a construção de cenários prospectivos que mostram possíveis impactos e consequências das mudanças climáticas ao sistema turístico internacional, constituindo-se em informações para fins de mitigação, planejamento de ações de adaptação e minimização de impactos e vulnerabilidades.

**Palavras-chave:** Impactos Climáticos. Turismo. Adaptação. Mitigação.

**Resumen:** El turismo puede ser considerado un sector económico altamente sensible al cambio climático y ha contribuido a la emisión de gases de efecto invernadero (GEI), una de las causas del calentamiento global. Para mitigar sus impactos negativos, surge la concepción del desarrollo del turismo desde el punto de vista de la sostenibilidad, que debe incorporar las externalidades derivadas del cambio climático. Delante de esta realidad, este artículo analiza los impactos, oportunidades y desafíos para el desarrollo sostenible del turismo, a partir de los escenarios proyectados por el cambio climático global. La metodología tiene un enfoque interdisciplinario y sistémico, de carácter descriptivo/analítico, realizado a partir de investigación bibliometrica, documental y entrevistas junto a los especialistas en la temática del turismo, desarrollo y cambios climáticos. Como resultados se tiene la construcción de escenarios prospectivos que muestran posibles impactos y consecuencias de los cambios climáticos al sistema turístico internacional, constituyéndose en informaciones para fines de mitigación, de planificación de acciones de adaptación y de minimización de estos impactos y vulnerabilidades.

**Palabras clave:** Impactos Climáticos. Turismo. Adaptación. Mitigación.

## 1 INTRODUCTION

Manifested at various time scales and parameters such as precipitation and temperature, climate change "may be suffering expressive influence of processes derived from nature, processes that are not yet properly evaluated" (Conti, 2005, p. 71). However, since the industrial revolution, there has been a significant increase in the use of carbon (coal, oil, and natural gas), which, when burned, releases carbon dioxide ($CO_2$) into the atmosphere, increasing its power of retaining heat. This carbon burning represents more than 50% of global GHG emissions (Marengo, Mendonça, 2007; IPCC, 2013; Ambrizzi et al.; PBMC, 2014).

Tourism plays a relevant role in this debate. It is an industry affected by climate change, but it also makes a significant contribution to GHG emissions, especially due to transportation (passenger transport) and infrastructure (accommodation). The data released by the World Tourism Organization (2008) revealed $CO_2$ emissions in three tourism sectors: transportation, accommodation, and leisure tourist activities. The Organization estimates that emissions from national and international sources generated by tourism in these three sectors of the production chain, represent around 4.9% of global GHG emissions.

In the ongoing debate on the causes and consequences of climate change, scientific production on tourism addresses adaptation and mitigation of climate change in developed countries (Scott et al.; Rayamajhi,

2012; Grimm et al., 2013). However, the industry is facing a phenomenon that cannot be controlled and that requires adaptation and mitigation strategies to maintain long-term tourism activities under a new climate regime.

Therefore, this article analyzes the impacts, opportunities, and challenges for the sustainable development of tourism in Brazil, under global climate change scenarios. The methodology has an interdisciplinary and systemic approach, with a descriptive/analytical character, based on bibliometric and documentary research, and interviews with tourism, development, and climate change experts. As a result, scenarios were constructed showing possible impacts and consequences of climate change on the international tourism system, providing valuable information for both mitigation purposes, as well as planning adaptation actions, and minimizing impacts and vulnerabilities.

## 2 THEORETICAL FRAMEWORK

### 2.1 Climate change and tourism: global challenges

Under a climate change scenario, it is essential to reflect on the theme in relation to the global context, its causes, and consequences. As a direct impact, climate change is related not only to the loss of biodiversity and increase in natural hazards but also to social impacts as it threatens the economic growth and political stability of nations. According to Santos (2000), "climate change can be understood as all forms of climatic inconstancy, regardless of its statistical nature or physical causes", and can be analyzed at various time and spatial scales (p. 66).

Since the Industrial Revolution, in the 18th century, the use of fossil fuels, such as coal and petroleum products, has intensified. The growing use of these elements has caused the composition of the atmosphere to change, increasing the amount of long-lived gases, especially $CO_2$.

The Intergovernmental Panel on Climate Change - IPCC (2014), in its latest report reaffirmed that climate change is happening and its causes are derived from anthropogenic activities. The report, entitled "Climate Change 2014: Impacts, Adaptation, and Vulnerability," was prepared by the IPCC Working Group II and details the impacts of climate change. The document concludes that the response to climate change involves making choices about risks in a changing world.

The contradictions between the style of development adopted by the countries and their support for nature are visible. Climate change directly affects the basic elements of life on the planet, such as access to water, food production, health, and the environment, causing increased pressure on natural resources combined with growing urbanization, industrialization, and economic development.

In this context, one of the areas affected by climate change is the tourism industry. According to the document "Climate Change and Tourism: Responding to Global Challenges", prepared by the World Tourism Organization (UNWTO), in partnership with the United Nations Environment Program (UNEP) and the World Meteorological Organization (WMO), resulting from the 2nd Inter-

national Conference on Climate Change and Tourism (Davos, Switzerland, 1-3 October 2007), climate change will affect tourism destinations, their competitiveness, and sustainability in four major areas: Direct climate impacts; Indirect impacts of environmental changes; Impacts of mobility policies and the reduction of tourism; and Indirect impacts of social change (Brasil, 2008).

The Conference brought together people from various sectors to review recent developments on the topic and prospects. The Davos Declaration (2007) recognized climate change and its strong relationship with tourism. It also acknowledged the need for a long-term strategy for the industry to reduce GHG emissions and concrete initiatives by governments, companies, consumers, and research and communication networks to raise awareness and education on climate change (OMT, 2007).

Following the Davos Conference, issues related to climate change and tourism have surfaced in the discussions at the Ministerial Summit held in London on November 13, 2007, UNWTO General Assembly in Cartagena de Indias (Colombia) from November 23 to 29, 2009 and the United Nations Conference on Climate Change (COP 21) held in Paris in 2015. The COP 21 was endorsed by 195 countries with the goal of reducing GHG emissions in the context of sustainable development. The meetings considered that tourism must find common ground on addressing climate change.

The climate is among the factors that motivate and determine much of the tourist flows and trends. However, climate change has affected many tourist destinations, where extreme events of drought, storm, large quantities of rain, and hurricanes among others, have made many regions and global communities vulnerable to these events. But just as it is influenced by climate change, tourism has contributed to global warming.

According to Peeters et al. (2017), the environmental impacts of tourism that contribute to GHG emissions derive from energy consumption, use of fossil fuels, and the transportation of tourists. Such impacts constitute the most urgent environmental problem related to tourism, imposing on the industry the challenge of finding mechanisms to reduce environmental impacts, leading countries to reduce carbon dioxide ($CO_2$) emissions, one of the elements responsible for global warming.

Despite the new challenges, until recently, both the tourism sector and the academic community, have done little research on the impacts of climate change on tourism and, conversely, on the weight tourism and related activities have had on global environmental change (Scott et al., 2009).

In any case, tourism segments[4] exposed to extreme weather events may increasingly be affected by climate change, with impacts on their infrastructure, and requiring emergency preparedness measures,

[4] Major tourist segments in Brazil: sun and beach tourism, ecotourism, social tourism, cultural, studies and exchanges, fishing, sports, nautical, adventure, gastronomic, rural, health.

increasing maintenance costs, and sometimes disrupting commercial activity (Scott et al., 2012; Fitchett et al., 2016). This means, according to the UNWTO (2007), that even under current conditions, the profitability and viability of tourist destinations are partially influenced by the climate.

The increase in global temperature could shorten the winter, reducing the ice sheets and, in addition to reducing the tourism potential of ski resorts, could even make tourism unfeasible, generating an entire economic and social problem in the most affected regions. However, in the same way that climate change can impair tourism in well-known regions, it may highlight the tourism potential of regions that have not been explored. In any case, it is important to acknowledge the reciprocal relationship between tourism and climate change, how this will affect tourism, and how tourism-related pollution contributes to global warming (Scott et al*.,* 2009; Ficchett et al*.,* 2015).

Therefore, the strategy is to encourage initiatives that lead to a series of changes. These include the use of clean energy, stricter legislation on the conservation of natural ecosystems, environmental education, improvement of agricultural practices, reduction of consumption and waste, adequate environmental and tourism policy, among others, thus ensuring sustainability for future generations.

## 2.2 Consequences of climate change: observed scenarios for tourism

Scenarios, according to the IPCC, are images of the future; they are neither forecasts nor predictions. They allow establishing and assessing the socioeconomic and environmental vulnerability of pre-climate change reference, determining the impacts of those changes, and assessing vulnerability after adaptation (IPCC, 2001).

The main scenarios used in climate change research are emissions, climate, environmental, and vulnerability (Koumrouyan, 2010). In Table 1 these scenarios are identified according to Stern (2006); UNWTO (2007); Moreno (2010); Grimm et al.; IPCC (2013); and the Brazilian Panel on Climate Change - PBMC (2014), trends adopted as a reference, projections with global climatic changes from two moderate scenarios of temperature rise (+ 2 °C and + 3 °C), and incorporating the effects of the changes in different sectors including tourism.

**Table 1** – Estimates of global impacts of temperature rise

| SECTORS | IMPACTS AT 2 °C | IMPACTS AT 3 °C |
|---|---|---|
| **Agriculture Food** | A decline in crop production in tropical regions (50% of cereals, 25% of corn, and 10% of soybeans). Increased inequalities and conflicts over food and water shortages. Central-West and Northeast Brazil will suffer a drop in agricultural production. | 600 million additional people, in relation to the 2 °C scenario, may be living at risk of starvation. Rising world food prices. Northeast Brazil will be one of the most affected regions in the world. High-latitude agricultural production is likely to increase. |
| **Water** | Potential 20-30% decrease in water availability in some regions, such as southern Africa and the Mediterranean. From 600 million to 3 billion people threatened by water shortages. | 1 to 4 billion people will suffer from water shortages. Possible migrations caused by drought causing socio-economic and political instability. The Caatinga biome will become more arid and the Amazon will suffer intense periods of drought. |
| **Human Health** | From 90 to 200 million people will be at risk of contracting malaria or other diseases transmitted by insects or water. High rates of diarrhea and malnutrition in low-income countries. | More than 300 million people will run the risk of being infected by malaria and 5 to 6 million by dengue fever. |
| **Ecosystem Biodiversity** | 15 to 40% of species facing the danger of extinction. Loss of 95% of most corals, impacts on commercial and subsistence fisheries. Risk of permanent change from carbon sinks to carbon sources (Amazon). A large portion of the Tundra and half of the boreal forests may disappear. | Beginning of the collapse of the Amazon rainforest: losses of more than 10% of fish species; of 22% of wetlands in the coasts. 50% of endangered species, including 25 to 60% of mammals, 30 to 40% of birds and 15 to 70% of butterflies in southern Africa. 88% risk of transformation from forests to non-forest systems. Possible loss and extinction of ice-dependent species. |
| **Glaciers** | 60% loss of Arctic ice during the summer. Complete and irreversible melting of Greenland. A decrease of 25% or more of oceanic ice. | Total loss of oceanic ice during the summer in the Arctic. Complete loss of the ice sheet of Greenland and Antarctic glaciers with heating of 3 °C for several centuries. |
| **Seas and oceans** | Sea level rise and coastal flooding could put at risk 25 to 50 million people. High costs of recovery. | Rising sea levels, coastal flooding and water stress will put at risk 180 million people. Hundreds of thousands will have to migrate. |
| **Extreme weather events** | Increase in the frequency and intensity of floods, droughts, storms, heat waves, tropical cyclones and other extreme events. The Southern and Southeastern parts of Brazil are more vulnerable to these events. | Increase in the frequency and intensity of fires and forest fires, droughts, storms, and heat waves. Socio-economic losses mainly to the world's poorest countries and regions. |
| **Tourism** | Discomfort due to the high temperature, causing a decrease in the demand in many tourist destinations of sun and beach. New destinations may arise mainly in Conservation Units, implying overcrowding in these areas and ecological impacts. | Maximum reductions in seasons (spring and summer) in relation to humidity, and increase of insolation causing losses for certain types of tourism. Reduction of tourist areas with detriment to the winter tourism sector (snow). Declining demand meaning an economic loss to mountain (snow melting) and coastal (sea rise, and bleaching and mortality of coral reefs) destinations. |

**Source**: Stern (2006); IPCC (2013); PBMC (2014); UNWTO (2007); Moreno (2010); Grimm et al. (2013)

The causes and consequences of climate change resulting from temperature rise are global in scope (IPCC, 2007). Nevertheless, it manifests itself differently across the diverse regions of the world (Stern, 2006; Welzer, 2010). Poor countries should face the greatest consequences even if they are not responsible for most GHG emissions. Climate change could affect the most basic life-supporting elements such as access to water, food production, health, and the environment, causing increased pressure on natural resources coupled with major urbanization, industrialization, and economic development.

Climate change affects tourism having a direct and main relationship with water scarcity. Climate change should also affect beach tourism destinations, where sea-level rise may harm the portion of the population living in the coastal zone due to the concentration of people and services available in these regions (Kron, 2008).

Carmo and Silva (2009) assessed the portion of population exposed to the risk of sea-level rise and identified 24.3 million inhabitants living in urban coastal areas, who are most directly at risk. In relation to tourism, the authors identify that the effects should be felt in the increase of flood events and the aggravation of erosive processes (loss of beach, for example). In addition, the urban and tourist infrastructure located in the coastal zone could be damaged.

Reflecting on the magnitude of potential effects of climate change on the tourism industry, Moreno (2010) points out that the IPCC AR4 report (2007) on impacts, adaptation, and vulnerability clarifies that there is considerable diversity where tourism is treated regionally, revealing important geographical gaps in literature and research. In other words, in the IPCC report (2014), tourism receives little or no attention. Discussions on the theme would have been expected, for example, on the effect of heat waves on tourism, and competition for water between tourism and other sectors, but this has not been the case. The subject is also poorly addressed in the sustainability chapters and in the interrelationships between adaptation and mitigation.

Adaptation is understood as the possible responses of ecosystems to the current and potential impacts of climate change, seeking to minimize possible anomalies and to explore potential opportunities. Mitigation can be understood as actions that reduce the use of natural resources and implement measures that reduce GHG emissions and benefit the recovery, regeneration, and creation of sinks (Grimm, 2016).

Considering the above and observing the complexity of the impacts of climate change for all economic sectors, and considering the interactions between the social and ecological systems, interdisciplinary studies and research are necessary to consider the factors of vulnerability at multiple scales. Whereas the responses to the impacts of climate change will consist primarily of individual responses at the local scale, it is necessary that this multi-scale approach be applicable to the analysis of the adaptive capacity at the level of the communities (Dolan & Walker, 2004). In this context, tourism must be inserted in the research, as it constitutes a development alternative for nations that de-

pend on it economically.

## 3 METHODOLOGY

The data for this research were collected from the bibliometric and documentary analysis on the relationship between tourism and climate change. At this point, some gaps hindered the smooth development of research because the current literature on the subject is limited. However, for data collection and the construction of this thematic field, especially for the analysis of the possibilities and challenges that climate change may pose to the tourism industry, we sought the collaboration of a panel of experts composed of specialists and researchers from different areas of knowledge.

Thus, from January to May 2015, participants from Brazilian universities were selected and contributed to the research: Estadual de São Paulo (USP), Federal do Pará (UFPA), Federal do Ceará (UFC), Estadual da Bahia (UNEB); and foreign universities: Coimbra (Portugal), Barcelona (Spain), Austral (Chile), and King's College London (England). There were also collaborators from institutions such as the Intergovernmental Panel on Climate Change (IPCC), the Brazilian Panel for Climate Change (PBMC) and the National Institute for Space Research (INPE). A total of fifteen experts from different fields contributed: Meteorology, Physics, Sociology, Economics, Geography, Tourism, Management, Social Sciences, Biology, and Environmental Engineering.

### 3.1 Research instrument

The research instrument was a structured interview composed of questions on the relationship between tourism, climate change and sustainable development. We invited the experts and sent the questionnaires via telephone or e-mail, informing the objectives of the research. After the questionnaires were returned, data validity was checked. At this point, the return of the questionnaires was satisfactory, and it was not necessary to request clarification or further information.

Because this is a very specific research, a questionnaire was prepared and sent to the collaborators, to respond to the research objective: to analyze the impacts, opportunities, and challenges for the sustainable development of tourism in Brazil, under global climate change scenarios. The questions were: i) In the face of climate change, what are the expected impacts on the tourism industry in Brazil and in the world? ii) Is it possible to articulate mitigation and adaptation actions of the industry facing the challenges of climate change? iii) Under climate change scenarios is it possible to point out opportunities and challenges for the development of tourism? iv) To what extent does the creation or maintenance of Conservation Units become an element of regulation and mitigation of GHG emissions? v) Is it possible to promote a low GHG emission development, with tourism as an activity that contributes to this reduction?

From the collected data it was possible to organize the contributions of the experts in different fields and, together with

the data obtained in the bibliometric research, to put them into perspective and establish the theoretical construct and results.

### 3.2 Data analysis

Content analysis was conducted so that data become meaningful and valid. In this sense, the analysis categories: climate change, tourism and development, adaptation, mitigation, and low carbon served to transform the information obtained from the experts into interpretable and meaningful data according to the research objective.

Cross-checking of data was organized around the categories that consisted in identifying core meanings in the experts' contributions. According to Bardin's proposal (2011), the exclusivity rule was considered, in which a quotation present in one category cannot be in another, as well as the rule of homogeneity, which defines a category as having only one dimension in the analysis. Continue re-readings of the data revealed the "results" suggesting the main implications, challenges, and possibilities of climate change to the sustainable development of tourism.

## 4 RESULTS AND DISCUSSION

### 4.1 Climate change: impacts and challenges for the development of Brazilian tourism

Recognizing the limitations of the knowledge on the relationship between tourism and climate change (Simpson et. al., 2008; Scott et al., 2009; Moreno, 2010; Grimm et al., 2013), the results presented here are based on bibliometric and documentary research, and on the opinions and knowledge of the experts consulted.

Thus, when analyzing the potential magnitude of the effects of climate change on global tourism, research indicates significant impacts. However, the lack of long-term observations is a limiting factor in the diagnosis and quantification of the role of different agents of the climate in the tourism system (demand, supply, geographical space, and agents).

In the same way, the surveys carried out correspond to specific regions (islands and ski destinations) that are not relevant to tourism in Brazil. This could be justified by the fact that despite growing attention to the relationship between tourism and climate change since the 1990s the field remains relatively unexplored, mainly due to the lack of government investment in research on environmental and social dimensions of tourism. Another limiting factor is that the interdisciplinary studies related to the subject, even among those who play a relevant role in public policies and governmental institutions, still does not seem to be very expressive.

Notably, one of the basic characteristics of Brazilian tourism is the diversity and abundance of its resources, whose exploration resulted in uneven tourism development in terms of time and space, and the creation of numerous products, giving rise to regions with unequal and qualitatively distinct tourism development. These characteristics that identify the tourism product are directly related to the geographic setting, defined by its environmental components and its territorial function. Among the geographic features,

the climate stands out, conferring peculiarity and diversity to each region, resulting in coastal, mountain, urban, and rural areas environments.

Based on these areas (coastal, mountain, urban, and rural), the aim was to identify the scenarios of climate change and its consequences for tourism in Brazil. However, the four areas presented a scale of analysis with some degree of abstraction that hides heterogeneities, specific problems, environmental contrasts, and climatic diversity. Therefore, these areas can be affected differently, since, besides the specific characteristics, the resources, products, and destinations are diverse and each has a different relationship with climate.

According to the nature and the scale of analysis carried out, the information from scientific studies, and the experts' input, it was found that the most vulnerable areas are the coast and the mountain. The vulnerability to the impacts of climate change is not particular to Brazil. According to Mello et al. (2009), this situation also occurs in other world tourist destinations.

Drawing upon the experts' contributions, we identified the impacts, consequences, and challenges posed by climate change (Table 2) to the tourism industry. We highlight that the consequences can affect differently the various components of the tourism system: geographical space, demand, supply, and agents. Regarding the tourism system, the impacts can be expected from the increase in global temperature, reduction in precipitation, an increase in its interannual variability, increase in extreme climatic events, and sea-level rise.

Among the possible impacts of climate change on Brazilian tourism, Coriolano (2015) states:

> (...) an emblematic example of the activity in the coastal zone of Ceará, where changes in the temperature of the planet according to the specialist can cause sea level to rise, and consequently increase flood events and aggravate beach erosion. In addition, the urban and tourist infrastructure located in the coastal zone can be damaged. An alternative to reduce the damage of these impacts may be the implementation of coastal engineering works, which, in turn can affect bathing waters and the scenic beauty of the coast (Expert consulted, 2015).

Other tourist destinations in Brazil may have some of their beaches affected, especially between the months of July and September, when the winds are stronger and the tides are higher. The advance of the sea is related to local effects (erosion, human activity, engineering, and occupation) and global warming. There are also temporal variations of sea level that can influence the numbers of long periods. Consequently, water invades and destroys coastal infrastructure (Marengo, 2007; PBMC, 2014).

**Table 2 -** Impacts, consequences, and challenges to the tourism industry in the face of climate change

| FACTORS | IMPACTS | CONSEQUENCES | CHALLENGES |
|---|---|---|---|
| **Temperature increase** (supply and demand) | - Reduction of the appropriate period of sun exposure<br>- Thermal stress<br>- Increase in the incidence of skin cancer | - Redirection of demand to other potential destinations, such as conservation units<br>- Adaptation of the travel period<br>- Fragmentation of the holiday period with reduction in stay<br>- Poor quality of experience | - Promote a low-carbon activity<br>- Offer destinations of nature all year round<br>- Promote actions and run campaigns on sun protection issues |
| **Extreme Events** (geographical space, demand, supply, and agents) | -Destruction of tourism infrastructure<br>-Road blockades<br>- Interruption of media services<br>-Changes in the hydrologic cycle | - Real estate speculation;<br>- Contamination and spread of diseases<br>- Lack of drinking water<br>- High cost of recovery<br>- Low capacity for emergency care (rescue, evacuation, medical services)<br>- Unavailability of emergency accommodation, counseling and assistance to victims<br>- Increase in the price of trips<br>- Insecurity<br>- Poor quality of experience<br>- Consumer distrust | - Foster new, more sustainable tourist destinations<br>- Promote actions and run campaigns informing about the protection and rational use of resources<br>- New investments, technologies and marketing strategies<br>- Create plans and actions and develop strategies to deal with the consequences of extreme events<br>- Implement warning measures that anticipate occurrences of extreme events and measures to mitigate the problem and protect the local population and the tourist |
| **Sea-level rise** (geographical space, supply, and agents) | - Degradation of beaches<br>- Bleaching of corals<br>- Coastal erosion<br>- Destruction of mangroves<br>- Destruction of the waterfront infrastructure | - Decrease of sand space for leisure<br>- Impacts on the freshwater reserve<br>- High cost of the waterfront restoration | - Promote mitigation and adaptation actions and initiatives<br>- Plan and order the use and territorial occupation of the seaside<br>- Implementation of coastal engineering works |

**Source:** Grimm (2016), based on the experts' contribution

In the state of Paraná, the shore of Praia Grande (beach) in Matinhos is an example of coastal areas degraded by severe erosion, irregular occupation of the coast, rivers with waters probably contaminated by clandestine sewage connections, introduction of exotic species in the area of *restinga* (spit), execution of infrastructure works of leisure and access to the beach without criteria and with suppression of dunes and *restinga,* and constructions in publicly-owned property. Such conditions are not exclusively due to climate change, but this may exacerbate situa-

tions of coastal vulnerability due to heavy rains, rising sea levels, storms, and other phenomena that can greatly impact coastal communities and their productive activities.

Climate change is contributing to sea-level rise and causing storms resulting in sand-starved beaches, where the progressive scarcity of sand can cause some beaches in the Brazilian coast to disappear mainly in urban areas, which are at greater risk because sand is generally not replaced naturally and the shoreline suffers from great erosion. Moreover, rough sea with waves above three meters high and high tides will amplify these impacts throughout the coastal zone. There is also an occasional effect, which is the change in atmospheric circulation patterns, with changes in the wave regime (Rosman, 2007).

On the other hand, milder temperatures in the south of the country can somehow favor beach tourism outside the summer period (Ambrizzi, 2015). Climate change scenarios for coastal tourism indicate that there may be a shift in the tourist season due to the intensification of a warmer and drier summer season. On the other hand, it may favor expansion and changes in the seasons. There may be a fragmentation of the working holiday period, to better take advantage of the atypical conditions of the weather (due to excess heat out of season) and better economic conditions (promotion of more affordable trips).

Warmer summers can indirectly enhance local economies through sales of weather-related products, e.g., to protect against ultraviolet rays (sunscreens, hats, glasses, etc.), and to relieve the heat (beverages, proper foods, ice creams, air conditioning, fans etc.), that become a basic need of both residents and tourists (Marengo, 2015).

The climate projections, based on the Brazilian biomes, show that particularly in the North and part of the Northeast there will be a decrease in rainfall, causing a lack of water, while in the South there will be a significant increase in rainfall that can produce extreme flood events. For the Southeast, extreme rainfall and drought are observed, causing water shortage and floods that affect the population.

The scenarios show that the availability of potable water in the coastal zone may be further aggravated, a situation currently observed in some resorts, where the seasonal concentration of tourist demand requires supply alternatives. In this context, it is suggested, like other global tourist destinations, the desalination of seawater (Cape Verde, Africa), use of underground resources when they exist, and the use of rainwater (Palma de Mallorca, Spain). The solution to this question is key for the maintenance of coastal tourism activity, especially under climate change scenario.

In this context, we can observe the challenges tourism faces from the possible impacts of climate change. Economic, through new investments, technologies, and marketing strategies; environmental, with the protection and rational use of resources; social, promoting the reduction of poverty, the reduction of tourist vulnerability, ensuring physical security of the receiving community and tourists, in the event of an extreme climatic event; policy, promoting mitigation and adaptation actions and initiatives and;

spatial, with proper planning and land use.

The impacts of climate change may also affect tourism demand directly, interfering with the choice of destination and the period of the trip, or indirectly affecting the quality of the experience, adverse perception after some extreme event and insecurity about the destination.

Extreme events are a growing concern for tourists in terms of security and protection, putting increasing pressure on planners and managers involved in tourism, urging them to analyze the impact of disasters on the sector and to develop strategies to deal with the adverse consequences (Maditinos & Vassiliadis, 2008; Coriolano, 2015 – expert consulted).

Therefore, we verify that the tourism system is constantly adapting, responding to environmental, economic, political, demographic, and technological changes, to new demands, acting in a specific way according to the territory where the tourist destination is inserted. Therefore, Campos Filho (2015) emphasizes that:

> (...) it is important to analyze the impacts taking a temporal and spatial scale and considering the characteristics of the site to be studied. In a macro scenario, climate change has impacted negatively all rural and urban environments, including vulnerable tourist destinations (current and potential) independent of biome and other geographic features (Expert consulted, 2015).

Therefore, regions with less precipitation should take measures to inform and educate tourists on using water wisely, promoting awareness on waste reduction. As for tourism enterprises, they should implement simple, effective, and environmentally friendly measures for water and energy use. Leisure activities or tourist destinations that depend on water (water parks, thermal baths, etc.) must pay attention to the need to diversify their activities. Likewise, tourist destinations that are vulnerable to the impacts of frequent heavy rains and its adverse effects (landslides, storms, floods, etc.) may have highways and airports affected causing delays or interrupting the movement of tourists. These destinations should be vigilant and get alert measures to anticipate the occurrence of winds, rainfall, lightning, and storms in order to take steps to ease the problem and protect the local population and tourists.

In suggesting that the tourism industry face the new challenges posed by climate change, we should consider the global/local relationship inherent to the phenomenon of climate change, and the possible articulation and actions of local movements with the international proposals on the subject. However, Marengo (2015) warns that despite the global/local articulation being possible, the cooperation between regional and global actions is advisable, since there is no point in reducing emissions locally if the "world continues to release greenhouse gases" (Expert consulted, 2015).

According to Ambrizzi (2015), a country must show the world it is doing its part in reducing GHG emissions and has a sustainable economic development. Maybe, as well, it can influence more decisively other Nations and thus be able to propose projects

and topics toward consensus, including those countries that have not signed the global reduction agreement, under the Kyoto Protocol (Expert consulted, 2015).

For actions aimed at addressing the challenges posed by climate change to reach their goals and become benefits to the receiving communities, tourists and tourism companies will require partnerships among the various segments to legitimize actions and join efforts around common objectives. Recognizing this need Redclift (2015) bets on the collective and legitimate act of civil society: “There need to be specified links between individual and collective action and the need for strong community involvement. The key is the strength and legitimacy of civil society and its institutions” (Expert consulted, 2015).

Climate change poses challenges to tourism, however, it is possible to identify opportunities for the sustainable development of the activity by observing climate change scenarios, especially for destinations more vulnerable to extreme weather events, which may affect the life of communities, their assets, and ways of life, as well as tourism infrastructure and tourists themselves.

In this case, Oliveira (2015) states that the challenge that comes with pursuing opportunities "includes all economic activities, not just tourism. It is necessary to manage the changes that the ecological order will impose through the aggravation of environmental crisis" (Expert consulted, 2015). For Ambrizzi (2015) it will be possible to "(…) generate opportunities through the knowledge of how the climate will develop in the future. Warmer and drier regions, cooler and wetter can be adapted to develop environments conducive to tourism in the region" (Expert consulted, 2015).

Opportunities arise from change. The tourism industry should seize the moment to create conditions and develop a low-carbon economy.

### 4.2 Opportunity to develop a low-carbon tourism activity

On February 16, 2005, the Kyoto Protocol[5] came into force, the document "The Economics of Climate Change," also known as the Stern Report (Stern Review on the Economics of Climate Change*)*, emphasizes the business opportunity with the global warming and the production of agrofuel.

From this report, the term low-carbon economy[6] becomes part of Government discourses. However, the current environmental crisis, makes it clear that it is not possible to reconcile growth with climate change; Al-

[5] The Kyoto Protocol is a complementary treaty to the United Nations Framework Convention on Climate Change. Created in 1997, it set emission reduction targets for developed countries, historically responsible for the current climate change (Ministry of Environment)

[6] The carbon market established under the Kyoto Protocol aims to market carbon. From the creation of Clean Development Mechanisms (CDMs) surplus carbon is generated which in turn can be traded via the carbon market. CDMs can be both carbon sequestration and emission minimization. The carbon market seeks to negotiate the reduction of carbon dioxide emissions, theoretically helping to mitigate climate change. To compose such a system, it is necessary to elaborate a series of methodologies, regulations and

though the prestigious Stern Report (2006) argues that "it's not incompatible the fight against climate change with the promotion of growth" (p. 39), this statement does not point the way toward this utopia.

As far as low-carbon economy is concerned we should highlight that using technology and processes less damaging to the environment are essential, however, this is not always a viable solution in the short term. According to Frangilli (2007), obtaining the so-called "carbon credits" is a new path companies and governments should consider carefully.

The Kyoto Protocol represents a global effort to mitigate climate change; the document states that developed countries, signatories to the agreement, should reduce their emissions by an average of 5 percent between 2008 and 2012, based on its 1990 emissions. It also established a mechanism that allowed emission reduction projects in developing countries that did not have emission reduction targets under the protocol, the Clean Development Mechanism (CDM). The CDM also helps countries with quantified GHG emissions limitation or reduction to achieve their commitments. That is, developed countries can meet part of their limitation and reduction targets for greenhouse gas emissions through the purchase of carbon credits generated in projects located in developing countries. Thus, countries like Brazil increase their chances of sustainable development. CDM projects should contemplate replacement of fossil fuels, energy efficiency, burning or use of methane, among others. For the removal of carbon, methodologies for afforestation and reforestation were approved, where voluntary actions have been carried out in the context of the neutralization or compensation of emissions. However, caution should be exercised when using this type of measure, since there are many doubts about its real effectiveness (Frangialli, 2007, p. 32).

Viola (2010), assessing the advantages and disadvantages of Brazil in the transition to a low-carbon economy, highlights the importance of reflecting on the potential of the various sectors of the economy, as many demonstrate the potential and interest of their leaders in the transition to a low-economy carbon, among them the author emphasizes ecotourism.

Specifically, in the tourism sector, the low-carbon economy can be translated as the provision of lodging, transportation, food, and recreation services that meet the needs of the demand, that seeks a better quality of life of the local community and promotes the progressive reduction of the environmental impacts of services throughout the life cycle of the product. In other words, a low-carbon economy for tourism must enhance products with lower ecological impact, meeting the growing environmental awareness of consumers, and preserving the culture of host communities (Grimm, 2016).

The initiatives for low-carbon tourism should involve the entire tourism system (de-

structures for monitoring and trading 'credits' to reduce emissions.

mand, local population, private initiative, public authorities, and NGOs), promoting measures to address climate change in the short and medium term. Among the main objectives to achieve a low-carbon economy in the sector Grimm (2016, p. 66) highlights:

- ✓ To create a platform for tourism companies to calculate their GHG emissions and present their reduction commitments;
- ✓ To bring together these reduction commitments and disseminate the progress and impacts achieved to different stakeholders;
- ✓ To promote training and information campaigns on the low-carbon economy in the tourism industry;
- ✓ To promote partnerships between tourism companies aiming at the reduction of GHG emissions;
- ✓ To promote scientific events on priority topics on climate change and tourism.

In the light of these principles, the tourism industry from the ecological efficiency (or eco-efficiency) outlook, presents itself as a perspective that can provide initiatives that are considered more sustainable.

Eco-efficiency is a term coined by the World Business Council for Sustainable Development, created in 1995, based on the life cycle of the product, whose analytical approach seeks to reduce the use of resources and minimize environmental impacts. It has been used mainly in the context of the industrial economy to reduce costs and create market opportunities while reducing the impact on the environment (Cramer, 2000).

In tourism, eco-efficiency can help decision-making in carbon trading, however, Gossling et al. (2005) warn that some issues must be considered in applying the concept of eco-efficiency. Among them, the need to collect detailed data on transportation, accommodation, and leisure activities, as well as revenues generated for different markets. This can often prove to be difficult, but nonetheless, eco-efficiency can become a more widely used instrument for sustainable tourism (Gossling et al*.,* 2005).

Also, destinations that are more vulnerable to extreme events (lack of water, heat waves, hurricanes, floods, landslides, sea level rise, etc.) should try to adapt to new environmental and climate scenarios. From this adaptation, new forms of tourism can emerge, such as community-based tourism, which seeks an alternative to mass tourism, favoring low environmental impact activities.

Developing countries, as suggested by the scenarios pointed out by the experts consulted, are the most vulnerable to the impacts of climate change and those least able to cope with them. Thus, efforts to expand research and production of knowledge that can help decision-makers in planning and creating public policies that include the tourism industry in approaches to climate change, become essential.

## 5 CONCLUDING REMARKS

In general, the results describe the average behavior of the present climate and, although shrouded in uncertainties, projections of climate change throughout the twenty-first century constitute valuable information both for mitigation purposes, as planning of adaptation actions and minimiza-

tion of impacts and vulnerabilities. Considering the different estimates that imply potential socio-economic and environmental impacts, it is advisable to plan and make decisions now, and in the future, especially in the tourism industry that depends intrinsically on the climate and the natural environment for its development.

All projections agree on a temperature increase from 3 °C in the South of Brazil to 5 °C in the North/Northeast. Within this framework, tourism, as well as other important sectors of the Brazilian economy (agriculture, livestock farming, power generation, etc.), will have to adapt to the new climate regime. In this way, impacts can be minimized.

We emphasize that the impacts of climate change and its direct and indirect effects may also lead to changes in the interests of agents towards activities that take advantage of the opportunities offered by the new scenarios, such as the expansion of tourism in conservation areas. Likewise, the promotion of tourism in rural and inland areas can progressively decongest areas that are more vulnerable, saturated, fragile, and whose sustainability is conditioned by climate change.

There is no set of unique mitigation and adaptation measures. The entire tourism system can and should take steps to reduce GHG emissions associated with its activities. For tourists, the choice of less polluting means of transport, search for products and activities with zero carbon footprint and compensation of their emissions when using air transport. For agents, the promotion of lengthier stays, destinations closer to source markets, and the development of eco-efficient products and activities. In the sphere of public policy, Governments and communities should seek to develop a normative framework that promotes energy efficiency and education and awareness programs on the subject. In the transport and accommodation sectors, water and energy efficiency can be the most appropriate alternative.

In order to achieve these objectives, the tourism industry should focus its action on the application of technologies and the adaptation of tourism businesses and destinations to new environmental conditions (adaptation may be in terms of seasonality, diversification of supply, among others).

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