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Research paper

Climate Change and its Influence on Tourism Fluctuation in the Araucania region of Chile

El Cambio Climático y su influencia en las fluctuaciones del turismo en Chile

Maria Nicol Rivera Merino[1*], Leslie Viviana Sepúlveda Arriagada[2], Claudia Andrea Silva Carrasco[3]

[1] Student, Ingeniería Comercial, Facultad de Ciencias Jurídicas, Económicas y Administrativas, Universidad Católica, Temuco, Chile.
mrivera2015@alu.uct.cl
[2] lsepulveda2015@alu.uct.cl
[3] claudia.silva2015@alu.uct.cl

* Corresponding author

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ABSTRACT

The increasing rates of climate change have repercussions in different sectors economics of a nations. For the tourism industry, climate change affects its destinations, since it changes the flora and fauna, relief, and vegetation of the area.
This paper analyses the impact of climate change on tourism fluctuations in the Araucanía Region of Chile. This analysis was conducted through descriptive research, of longitudinal scope and a mixed approach with a predominantly quantitative approach. Variables caused by climate change that influence tourism fluctuations in the Araucanía region were analysed.
The methodology contemplated the collection of statistical and bibliographic data. In addition, the development of a multiple linear regression model to explain the incidence of climate change on tourism, with "Overnight stays" as the study variable (y) that represents Tourism and "maximum temperatures and precipitation" as explanatory variables (x) that represent the climate change. To achieve this, data was obtained from January 2010 to December 2019. The results showed that climate change does affect in a positive way the tourism, since it has an impact on the arrival of tourists to the region, through an increase in the maximum temperature that entails an increase in overnight stays, consequently in tourism in the Araucanía Region.

Keywords: *Tourism, climate change, overnight stay, maximum temperatures, precipitation.*

RESUMEN

Los crecientes índices del cambio climático repercuten en diferentes sectores económicos de una nación. Para el sector Turismo, el cambio climático afecta sus destinos, ya que produce cambios en la flora y fauna, relieves y vegetación de la zona.
En este documento se analiza la incidencia del cambio climático en las fluctuaciones del turismo en la Región de la Araucanía, Chile. El análisis se realizó mediante una investigación descriptiva, de alcance longitudinal y de enfoque mixto con predominancia cuantitativa.
La metodología contempló recopilación de datos estadísticos y bibliográficos, además, el desarrollo de un modelo de regresión lineal múltiple para explicar la incidencia del cambio climático en el turismo con "Pernoctaciones" como la variable de estudio (y), que representa el turismo y "temperaturas máximas y precipitaciones" como variables explicativas (x) las que representan el cambio climático. Para lograrlo se obtuvieron datos desde enero 2010 hasta diciembre 2019. Los resultados demostraron que el cambio climático si afecta el turismo de manera positiva ya que existe incidencia de este en la llegada de turistas a la región, a través de un aumento de la temperatura máxima que conlleva un aumento de pernoctaciones y por ende del turismo en la Región de la Araucanía.

Palabras clave: Turismo, cambio climático, pernoctaciones, temperatura máxima, precipitaciones.

INTRODUCTION

Over the years, cimate change has gained great relevance and has been stablished has the greatest issue in the current world. Governments from different parts of the wold have promoted strategies to mitigate its effects since it impacts several of the socioeconomic areas of countries, together with the tourism industry which in the last years has stablished itself as one of the fastest growing economic sectors worlwide, as in the case of tourism in Chile. "The effects of climate change can be observed in the environmental variables that affect mainly, coastal areas mountainous places or small islands , places that are considered as the main generators of economic benefits in the tourism industry " (Tourism Environmental Staff, 2016).

This study focuses on the Araucania region of Chile.That is why it is relevant to mention that Chile is a tricontinental country, which territory is located in the western and southern areas of south America, between parallels 17° 30´ and 56° 30´ south latitude. Thus, it includes Easter Island in Oceania, and extends to the south in Antartica, in an area between the 53° and 90° meridians of west longitude and up to the South Pole (Ministry of the Environment, 2018). "The South american territory of Chile as a huge variety of climates altered by numerous environmental factors which give the country very peculiar characteristics. In general terms, the south american chilean territory presents features of a temperate climate with some essential variations that are mainly produced by latitude and altitude, giving rise to the desert, tropical, mediterranean, temperate and polar climatic systems, mainly" (Ministry of the Environment, 2017).

Due to the characteristics of its peculiar climate, Chile presents a variety of landscapes from Desert, Patagonia, National Parks, Volcanoes, to Geysers among others. It makes it position itslef within the busiest destinations in Latin America to practice tourism. According to the World Tourism Organization (UNWTO), "tourism includes activities carried out by people during their trips and stays in places other than their usual environment , for a consecutive period of less than one year , for leisure, business and other purposes" (World Tourism Organziation, 1998).

On the other hand, climate change is a worlwide issue and Chile is not excluded from the probable consequences. According to a definition by United Nations Framework Convention on Climate Change (UNFCCC), it is defined as "a change in climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is added to the natural variability of climate observed over comparable time periods" (United Nations, 1992). "Chile, according to the 4.8 article of the United Nations Framework Convention on Climate Change (UNFCCC), is considered a highly vulnerable country in the face of climate change phenomenon since it has lew-lying coastal areas, arid , semi-arid and forest areas, susceptibility to natural disasters, areas prone to drought , urban areas with air pollution problems and mountainous ecosystems such as the Coastal and Andean mountains ranges. Added to the foregoing is the strong dependance of the main socioeconomic activities on the climate, mainly on water availability " (Centro UC Cambio Global, 2014).

The Araucania region is a sector with a high tourism potential, since it offers consolidated, emerging and potential destinations (National Tourism Service, 2006). The natural environments of the region are well outlined and without great access. The coast of this region is rectilinear, very exposed to wind actions, with few bays suitable for port facilities. The coastal plains appear with little development, being able to appreciate some extensions to the Budi Lake. It is a unit of great scenic beauty, with an important area of state protected wildlife areas, a wide variety of nature attractions that allow the development of nature and adventure turism. Rivers, lakes, waterfalls, valleys and Araucarias forest are located in this zone (Ministry of Public Works, 2017).

This region constitues a transition area between Mediterranean climates with humid degradation and temperate-rainy climates with oceanic influence. The relief determines that climate factors vary both transversely and longitudinally, a fact that can be seen in the amount and distribution of rainfall. There are four sorts of climate in the region: warm temperate climate with short dry season, warm temperate rainy , cold-rainy temperate and ice climate due to height effect (SERNATUR, 2014). Hence all the mentioned characteristics in Araucania region are optimal for conducting this research on the influence of climate change in tourism industry. Furthemore, Chile is considered a highly exposed country to climate changes (UC Global Change Center, 2014).

In this regard, this research analyzes wether climate chan-

ge has any impact on tourism in the Araucania region of Chile. The main reason supporting this research is that the Araucania region , located 700 kilometers south of Santiago de Chile, has fluid connectivity by land and air, point where the intense green of southern Chile is born, watched over by huge volcanoes that draw the profile of Andes Mountain, covering themselves with forest, lakes and rivers. This amazing nature is protected in national parks and reservations easy to get into it through an important route network. The region landscapes recall The Alps, adding skii resorts located in the slopes of active volcanoes and numerous hot springs in the surrounding areas. Its volcanic geography has contribute to create ideal settings for adventurous turism such as rapids, canyons and lava fields (SERNATUR, 2021).

Another significant factor is the presence of Mapuche ethnic group in Araucania region, a culture that has remained over the years. This esential characteristic makes the region a full of identity destination. According to data obtained by CONADI, there are a total of 1.973 communities spread all over the cities in the region. Thus, the highest percentage of communities is located Padre las Casas.

This research aims to answer the following question: How does climate change affects tourism in Araucania region?, hence the main research objective is to analyze turism fluctuations in Araucania region considering variables in climate change. The foregoing will be achieved through the implementation of three specific objectives. Firstly, it is proposed to identify the exact periods where largest amounts of tourist come into the region. Secondly, to stablish the consequences of climate change in tourist destinations in the Araucania region. Finallly, to determine whether climate change has a positive or negative impact on fluctuations in tourism in the Araucania region.

Climate is not only an impact factor, but also an essential resource for promoting tourism. Moreover, for most outdoor activities specially for water and snow sports in tourism. Climate variability and changes in weather patterns can directly affect the planning of tourism tours and daily operations. Unstable weather patterns in tourist destinations can significantly affect the well-being of tourists, their travel decisions even the flow of tourists (UNWTO, 2007b). Most tourists look for favorable weather conditions depending on the activities they want to do whether skiing, sunbathing, trekking, camping or sightseeing flora and fauna of the area.

This article is organized in four categories. Firstly, a theorethical framework that supports this research is presented. Secondly, the applied methodology to fullfill objectives is described . Thirdly, the results are displayed and finally, general conclusions regarding the influence of climate changes in Araucania region are presented.

THEORETHICAL FRAMEWORK

Climate change, regarding to anthropogenic influence on climate systems, has become the gratest challenge that humanity has faced. There is a scientific consensus on this phenomenon as an unequivocal fact : it has been caused by human activities, triggered by excessive emission of greenhouse gases (GHG) and other short-lived climate forcing. One of the key messages in the 5th Climate Assessment Report (AR5, 2013/14) by the Intergovernmental Panel on Climate Change (IPCC), states that "human influences on the climate system is clear and increasing, and its impacts are observed in all the continents. If left unchecked, climate change will increase the probability of threatening, widespread and irreversible impacts on people and ecosystems" (Ministry of the Environment, 2017 b).

According to United Nations, climate change refers to long term changes in temperature and weather patterns. These changes can be natural for example, thorugh variations in the solar cycle. Nevertheless, since 19th century, human activities have been the main factor in climate change. Burning fossil fuels such as coal, oil and gas generates greenhouse gas emmisions that act like a blanket around the Earth, drawing in heat from the Sun and raising temperatures (Ministry of the Environment, 2017 a). Some examples of greenhouse gases that cause climate change are: carbon dioxide and methane. These gases are emitted by the use of gasoline or by heatting a building , land and forest clearing can also release carbon dioxide, landfills are a major source of methane emission, energy industries, transportation, building , agriculture and soil uses are among the main emitters (United Nations, n.d.). There are some gases that increase the temperature of the Earth and increase the greenhouse effect. These greenhouse gases (water vapor, CO2, among others) can be added naturally or unnaturally. Throughout the history of Earth gases have been incorporated by volcanoes. Absence of CO2 the Earth's temperature would be about 33° lower than it is today. However, CO2 has been added in an artificial way as the result of human activities, mainly from the burning of fossil fuels. Therefore, it is fundamental to distinguish between the natural greenhouse event and

the enhanced greenhouse effect ever recognized as global warming (Tutii, 2011).

Global change has disastrous consequences for our planet and people. The rising in temperatures have been extremely dramatic. Severe weather patterns such as hurricanes, heavy rains and droughts, extreme colds, lack of water, storms, impacts on the exosystem (changes of habitats, animals, extinct species, new species); raising in sea level, increase of pests and diseases , agriculture troubles and consequently more hunger in the world (Tutti, 2011).

For this reason, the Meteorological Directorate of Chile, provides rates of extreme events of change climate, which it defines as: a set of indicators standardized, based on percentiles, thresholds and duration, those that allow to compare the changes that take place to global scale. The Change Detection Team of Experts Climate and Indices (ETCCDI) propose to analyze and monitor this set of rates in each country, since it has the advantage of crossing with indicators of vulnerability, related to potential impacts on different sectors, such as agriculture, health and wellness human, water resources, security, infrastructure, among others. Among the climate change rates are: Annual precipitation index, maximum daily precipitation, days with precipitation, maximum precipitation in 5 days, days with precipitation over 10 millimeters, days with precipitation over 20 millimeters, maximum length of days with rain, length maximum dry days, standardized drought index, rainy days, extremely rainy days, precipitation intensity, warm nights, cold nights, warm days, cold days, frosty days, summer days above 25°C, summer days above 30 °C, absolute maximum temperature, absolute minimum temperature, minimum maximum temperature, maximum minimum temperature, warm period, cold period, average maximum temperature, average minimum temperature, daily temperature range and heat wave (Chilean Meteorological Directorate, n.d.).

According to Águeda Esteban Talaya (2005), tourism is a complex system that is difficult to define since it comprises a set of activities of a different nature of an economic, social, geographic, cultural, sports, environmental and institutional nature. The tourism system, moreover, has a transversal and heterogeneous nature that gives it a certain singularity as an activity, since there is a strong interrelation between economic, social, natural, cultural and political factors. In addition, it points out that tourism is made up of four basic elements, the geographical-tourist space, demand, supply and agents. All the fundamental factors and elements interact in a certain institutional and legal framework and in the same location: the tourist destination, where resources are shared for a certain period of time, which, together with the services used, make up the tourist offer. Space and time are the two main components on which tourism is based (Esteban, López, & Aguiló, 2013).

Tourism demands and consumes a geographical space. This comprises a physical substrate (the natural environment), composed of geophysical elements (climate, topography, geology, fauna, flora, relief, among others) and some created by human occupation known as geohumans (Lopéz, 1944). This geographical space can be both a support and a resource for tourist activity, but it can also be a location factor. All economic activity needs a territory to take place, in this case we speak of the geographical space as a support for tourist activities, but this does not mean that the role played by the space is indifferent in relation to the processes that take place in it (Sanchez, 1985). Due to its own characteristics, it will intervene as a location factor according to the different actions carried out in it. Tourist activities are not distributed homogeneously in space, but rather have location guidelines. The factors that explain their location are economic and non-economic (assessments, environmental perceptions) (Vera, López, Machena and Antón, 1997).

Tourism is also defined as: "an activity whose progressive growth has increasingly important impacts on the cultural, social and economic sphere of a country. This is so because it produces effects on the balance of payments, on investments and construction, and on the improvement of transportation, which in turn affects employment and, ultimately, the well-being of the members of a community. " (United & Agencies, 2003). Due to the relationship that tourism has with the environment and with the climate, it is considered that, like agriculture, energy and transport, it is an economic sector that is very sensitive to climatic factors (UNWTO, 2007a). On the other hand, according to the National Geographic website, "climate refers to the average values of weather conditions for a specific place over a period of several years" (National Geographic, 2010). Likewise, Reixac indicates that "the climate is a natural tourist resource since it is an element that, through the activity of man and the means available to him, makes tourist activity possible and satisfies the needs of the demand" (Reixac, 2005).

In this context, it can be said that the climate is a very important factor for the development of tourism, as well as the weather, concepts that are usually confused instead of related. The climate is, what determines the adequacy of a certain area for tourism, it is established on a space and organizes its activities in the permanent picture of the climate of that place. On the contrary, it is the weather that determines the right time to carry out a tourist activity. The climate influences the environmental framework of the tourist activity due to the configuration of the vegetation, the morphogenetic processes, the distribution of the fauna, the flow of the rivers and the water supply. In turn, the climate exerts a great influence on the seasonality of tourist activity, long seasons allow a greater return on invested capital and infrastructure. A poor adaptation of tourist activity to weather conditions or a poor diversification of activities based on the different conditions recorded during the year enhance the problem of seasonality. This is exacerbated when the activities depend on the weather and are not only sensitive to it, as is the case of sun and beach tourism, sports winter and nautical, for example, cultural tourism does not present seasonality problems (Tutii, 2011).

Thus, Tutti (2011) points out that climate and weather influence tourism development for the following reasons:

- In the face of any tourist establishment, it is important to consider extreme weather events that are likely to put the lives of tourists and tourist facilities and infrastructures at risk. Although absolute safety in tourist activities is impossible, the non-consideration of the climatic characteristics of the tourist regions means that the tourist locations end up further enhancing the risks linked to the climate.

- The catastrophic nature of many natural episodes depends on inadequate human intervention in the geographic space. There are areas that are more vulnerable to climatic events due to lack of infrastructure.

- The climate in turn influences the creation of a certain type of infrastructure. Since tourism is movement by definition and tourists are increasingly dynamic, more efficient transport and communications are required, which depend on climatic and meteorological conditions for their proper functioning. The consideration of weather and climate conditions has been frequent in the construction projects of airports and coastal and river navigation facilities. However, the consideration of these conditions has been taken for the construction of land and railways. Since when laying out these routes, issues of temperature, frost, humidity, rain, snowfall, due to erosion and road closures must be taken into account.

- The weather influences the feelings of the tourist. In some cases positive psychic reactions develop and in others negative. The tourist therefore chooses destinations that contain climatic elements, among them, that favor the sensation of enjoyment.

- At the same time, a climate or weather conditions that are too aggressive can generate situations of discomfort and even damage health. These characteristics become more evident in certain age groups. Health tourism as a tourist modality also values the climate from the point of view of health and comfort. In this type of tourism, the climate becomes the raw material to alleviate diseases or prevent their appearance.

- A good climate makes it possible to satisfy tourist needs, promoting these spaces.

Based on some reports of the European Environment Agency, the Special Report on Sustainability of the Tourism Industry of the World Tourism Organization and a selection of articles and documents considered key to understanding the potential impacts of climate change on the tourism sector, starting with the availability of drinking water, health aspects (especially due to the increase in the area affected by tropical diseases), reduction of biodiversity (especially sensitive for destinations based on ecotourism) and damage to infrastructure (Tutii , 2011). Extreme high temperatures, heat waves and heavy precipitation events are likely to become more frequent. It is also likely that future tropical cyclones (typhoons and hurricanes) will gain in intensity, with an increase in maximum wind speeds and precipitation (Intergovernmental Panel on Climate Change, 2019).

The three major factors in choosing a tourist destination are climatic conditions together with other factors such as economic conditions and political stability, social reputation of the destination and media coverage and environmental quality, the basis of such complex interactions on these factors is difficult to separate the weight of climatic conditions on the final decision. Climate factors related to tourism should include average and extreme temperatures during the day, hours of sunshine, humidity and rainfall conditions, and the occurrence of extreme weather

events such as storms and strong winds. In general, the three tourism sectors that will be most affected by climate change are "beach tourism", "snow sports tourism" and "ecological tourism" (Tutii, 2011).

The tourism sector cannot tackle the problem of climate change on its own, so it must act within the framework of the general agenda of sustainable development on an international scale. A coherent regulatory strategy should be developed to disconnect the enormous tourism growth forecast for the coming decades from the increase in energy consumption and greenhouse gas emissions, so that tourism growth contributes to poverty reduction without ceasing to be decisive for the achievement of the United Nations Millennium Development Goals (UNWTO, 2007a).

In this regard, the Davos Declaration of October 2007, subsequently endorsed by the Assembly of the World Tourism Organization (UNWTO), affirms that the tourism sector must respond rapidly to climate change in the evolving framework of the United Nations, and progressively reduce its emission of greenhouse gases (GHG) in order to grow sustainably. To this end, measures must be taken to: mitigate their GHG emissions, derived especially from transportation and accommodation activities; adapt businesses and tourist destinations to changing weather conditions; apply existing and new techniques to increase the efficiency of energy use; collect financial resources to help poor regions and countries (United Nations, 2009).

STUDY AREA

Chile is a wealthy country in natural resources and landscape diversity, according to data from the National Tourism Service (SERNATUR). It has the driest desert in the world, 6,435 km of coastline, 15,790 lakes and lagoons, 24,093 glaciers, more than 270 hot springs, 139 active volcanoes, 1,509 peaks over 4,000 meters, 3,094 islands and islets, and 5 World Heritage Sites. Sufficient arguments to make Chile an interesting country, with great attractions, which translates into great tourism potential (Government of Chile, 2012).

According to the Tourist Competitiveness Index, prepared by the World Economic Forum, Chile is positioned at No. 52, out of a total of 140 countries. This index is a measurement that has been made every two years since 2006 to measure the factors and policies that help the sustainable development of tourism directly and closely related to the competitiveness and general development of each country. This series of indicators reflects the stability in terms of attractions and the potential that the country has to become a relevant alternative worldwide when talking about tourism (World Economic Forum, 2019).

Chile is divided in sixteen regions, where the Araucanía corresponds to the ninth. "It is located in the south of Chile, between parallels 37°35' and 39°37' south latitude and from 70° 50' west longitude to the Pacific Ocean, bounded to the north by the Biobío Region, for the south with the Los Lagos Region, to the east with Argentina and to the west with the Pacific Ocean" (National Council for Culture and the Arts, 2015). Araucanía is divided politically and administratively by 2 provinces, Cautín and Malleco, with a total of 32 communes; the last one created was Cholchol in 2004, and its regional capital corresponds to Temuco. It also constitutes the natural and proper space for settlements of the Araucanian people, where their social and cultural heritage is still preserved in some areas (Library of the National Congress of Chile, 2022b). "It has a total area of 31,842.30 square kilometers, equivalent to 4.2% of the national territory (American and Insular Chile). According to the 2017 Census, the population is 957,224 inhabitants and a density of 30.06 inhabitants per square kilometer" (Library of the National Congress of Chile, 2022b).

Its relief is determined by coastal plains, Coastal Mountain Range, Intermediate Depression, Foothills and Andes Mountains. The coastal plains are characterized by being extensive in the central zone, reaching their most significant development between the Moncul and Queule rivers, with an average width of 25 km, but in the extreme north and south they form a narrow strip. Meanwhile, the Cordillera de la Costa, which from the north to the Imperial River is called the Nahuelbuta Cordillera. This becomes a high-altitude barrier in the province of Malleco, "it is made up of metamorphic rocks with a crystalline basement and granitic rocks that outcrop in the North and South sections, where it reaches the highest altitudes" (INE, 2019). The intermediate depression, or Longitudinal Valley, has an undulating surface, interrupted by deep valleys and some island hills, such as Pidenco and Pangal. Between the mountain range and the longitudinal valley, the foothills is formed by a chain of low hills whose altitude is estimated between 600 and 1,000 meters. In the south of the region, there are foothill lakes, such as: Colico, Caburgua and Villarrica. Finally, the Andes mountain range is characterized by heights of over 2,000 meters, dominated by the volcanoes that constitute it and give it the characteristics of an active volcanic

mountain range, these are: Tolhuaca (2,780 m), Lonquimay (2,822 m) , Llaima (3,050 m) and Villarrica (2,840 m) (Library of the National Congress of Chile, 2022c).

The National Emergency Office of the Ministry of the Interior (ONEMI) indicates that; the coastal mountain range has a temperate oceanic climate characterized by abundant relative humidity and rainfall between 1,000 and 1,500 mm; while in the Cordillera de los Andes the cold high-altitude climate predominates, distinguished by an increase in precipitation of 3,000 mm per year and low temperatures throughout the year, above 1,500 meters above sea level solid precipitation and temperatures are below 0°C, dry periods last from one to two months. On the other hand, the Nahuelbuta range of hills traps the oceanic influence and the humid winds, reducing rainfall and increasing dry periods. While in the north of the region the climate is warm temperate with less precipitation (Library of the National Congress of Chile, 2022a). "The climatic characteristics of the region allowed the development of a true southern forest in the past but that was later intervened by human activities, replacing them with grasslands for livestock and crop fields" (SERNATUR, 2014). Consequently, many lands were deforested, which presented soil erosion in the Nahuelbuta Mountain Range. Nowadays efforts are being made to preserve nature and that is why 13 State Protected Wilderness Areas have been designated, among these are 5 National Parks, 6 Nature Reserves and 2 national monuments (CONAF, 2022).

In this region the predominant economic activity corresponds to agriculture. The forestry and agricultural production stands out together with the traditional cereal crops, such as wheat, barley, oats and rye, lupine and potato. Followed by livestock production, especially the bovine sector. Forestry activity has also experienced growth with a greater presence in the province of Malleco, while in the province of Cautín the activity of construction and services have stood out above the others. (Library of the National Congress of Chile, 2022b).

The natural environments of La Araucanía are well outlined and without great access difficulties, as occurs in the extreme regions of Chile (Ministry of Public Works, 2017), which allows the development of nature and adventure tourism. According to CONAF data, the Araucania Region is characterized by having a great wealth of attractions that we can categorize into:

Main attractions:

- National Parks: Villarrica, Huerquehue, Conguillío, Tolhuaca, Nahuelbuta.
- National Reservations: Villarrica, Malalcahuello, Alto Biobío, Malleco, China Muerta y Las Nalcas.
- Volcanoes: Tolhuaca, Lonquimay, Llaima, Villarrica, Lanín y Quetrupillan.
- Lakes: Conguillío, Colico, Villarrica, Caburgua y Calafquén.
- Rivers: Biobío, Trancura, Toltén.
- Monuments Ñielol y Contulmo.

Additional Attractions

- Hot spring: Malleco, Malalcahuello, Manzanar, Huife, Montevivo, San Luis, Peumayen, Menetúe, Trancura, Sierra Nevada.
- Snow covered volcanes of Sollipulli and Quetrupillán.
- Lagoons: Quillelhue, Tinquilco, Quililo, Captrén, Galletúe, Icalma and Budi.
- Rivers: Cautín, Imperial, Trancura, Allipén, Moncul among others.

In the Araucanía region exist four border crossings, three of them are: Pino Hachado, Icalma and Mamuil Malal, which are permanently enabled, and Reigolil, which is temporarily enabled. "The region's landscapes are reminiscent of the Alps, but with ski resorts located on the slopes of active volcanoes and numerous hot springs in the surrounding area. Its geography modeled by volcanoes has created ideal settings for adventure tourism such as rapids, canyons and lava fields" (SERNATUR, 2022).

METHODOLOGY

This study follows a non-experimental design with a mixed approach with predominantly quantitative, descriptive and longitudinal scope since it is based on the observation of data in a given period of time, with the purpose of investigating how climate change affects the fluctuations of tourism in the Araucanía Region. For the collection of information and according to the mixed approach of the study, two research techniques were used: (i) Bibliographic references of experts and research already carried out to carry out the qualitative analysis to complement the research; (ii) Compilation of statistical bibliographic data for the quantitative analysis for the variables that represent tourism and variables that are indicators of climate change.

The used bibliographical references were those that demonstrate and explain the concepts to better understand the consequences and benefits that climate change has on tourist destinations in Araucanía region. In additio, the evolution of visits to protected wild areas (ASPE) was used in order to confirm the results obtained from the collection of statistical bibliographic data.

The collection of statistical bibliographic data had the goal of identify the fluctuations of tourism in the Araucanía region in the face of variations in climate change between the periods that comprise January 2010 to December 2019 based on the statistics obtained from the data repository of the National Institute of Statistics of Chile (INE) and the Meteorological Directorate of Chile. With this information, a database was created with the aforementioned period (see table 1), working these on a bimonthly basis, through a multiple linear regression, it is intended to determine if climate change has a positive or negative impact on the fluctuations of tourism in the Araucanía.

Consequently, 3 variables were defined. Firstly, tourism, maximum temperature and rainfall: (i) Tourism is measured by "Overnight stays", this consists of the total number of nights that passengers stay in tourist accommodation establishments in the region of the Araucania. Secondly, (ii) "maximum temperature" which indicates the maximum temperatures recorded in the Araucanía region, which are measured in Celsius degrees; (iii) Finally, the third variabl is the "rainfall" that corresponds to the amount millimeters of rain that fell monthly in the defined period of time, both the variable maximum temperature and rainfall are based on the Maquehue Station, Temuco Ad. (380013) of the Chilean Meteorological Directorate.

As mentioned above, the Meteorological Directorate of Chile proposes 26 rates to measure climate change, within these the maximum temperature and rainfall variables were chosen as the variables responsible for representing climate change for the purposes of this investigation. Meaning that these variables contain a large amount of relevant information associated with climate change. According to the annual report on the evolution of the climate in Chile for the year 2020, high temperatures are related to hot days, which in turn allow the analysis of impacts related to fires, human and animal comfort, and above all influences resources of water (Chilean Meteorological Directorate, 2021).

See chart 1.

Chart 1: Data Base.

Date	Overnight stays	High temperatures	Rainfall
2010 January- February	154.178	22,70	154.178
2010- March- April	19.078	19,70	19.078
2010- May-June	21.198	13,30	21.198
2010- July-August	31.033	12,10	31.033
2010- Sept.-October	33.191	16,20	33.191
2010- Nov-December	40.220	19,60	40.220
2011- January- February	145.806	25,40	145.806
2011- March-April	31.408	19,55	31.408
2011- May-June	19.973	12,95	19.973
2011- July-August	31.817	11,95	31.817
2011- Sept.-October	38.417	16,45	38.417
2011- Nov-December	41.893	22,60	41.893
2012- January- February	152.029	25,95	152.029
2012- March-April	41.862	20,35	41.862
2012- May-June	29.283	13,50	29.283
2012- July-August	45.928	12,00	45.928
2012- Sept.-October	43.807	16,80	43.807
2012- Nov-December	46.884	21,10	46.884
2013- January- February	160.010	26,50	160.010
2013- March-April	44.169	21,00	44.169
2013- May-June	29.411	13,00	29.411
2013- July-August	46.387	11,95	46.387
2013- Sept.-October	46.202	17,00	46.202
2013- Nov-December	53.643	22,55	53.643
2014- January- February	187.871	25,20	187.871
2014- March-April	46.282	19,10	46.282
2014- May-June	33.264	13,20	33.264
2014- July-August	49.078	12,40	49.078
2014- Sept.-October	48.863	16,25	48.863
2014- Nov-December	51.655	21,30	51.655
2015- January-Feb	175.008	27,10	175.008
2015- March-April	49.989	23,60	49.989
2015- May-June	43.010	14,35	43.010
2015- July -August	61.523	12,85	61.523
2015- Sept.-October	60.973	16,80	60.973
2015- Nov-December	80.009	21,50	80.009
2016- January-Feb	177.075	26,65	177.075
2016- March-April	69.127	22,25	69.127
2016- May-June	48.574	14,75	48.574
2016- July-August	108.512	12,90	108.512
2016- Sept.-October	100.567	18,10	100.567
2016- Nov- December	105.818	22,00	105.818
2017- January-Feb	240.492	25,75	240.492
2017- March-April	102.033	21,10	102.033
2017- May-June	88.790	12,55	88.790
2017- July-August	113.380	13,25	113.380
2017- Sept.- October	97.464	15,55	97.464

2018- Nov- December	101.788	21,30	101.788
2018- January-Feb	234.921	26,55	234.921
2018- March-April	94.941	19,90	94.941
2018- May-June	72.991	12,95	72.991
2018- July-August	96.918	12,45	96.918
2018- Sept.-October	88.851	16,50	88.851
2018- Nov- December	98.990	21,75	98.990
2019- January-Feb	170.226	26,25	170.226
2019- March-April	71.495	21,40	71.495
2019- May-June	58.200	14,35	58.200
2019- July- August	84.326	13,60	84.326
2019- Sept.- October	75.263	17,20	75.263
2019- Nov- December	75.718	22,35	75.718

Source: Own elaboration through Meteorología de Chile, Instituto Nacional de Estadísticas.2022

RESULTS

The main results of the study are presented below, grouped into two sections (i) qualitative analysis and (ii): multiple regression analysis

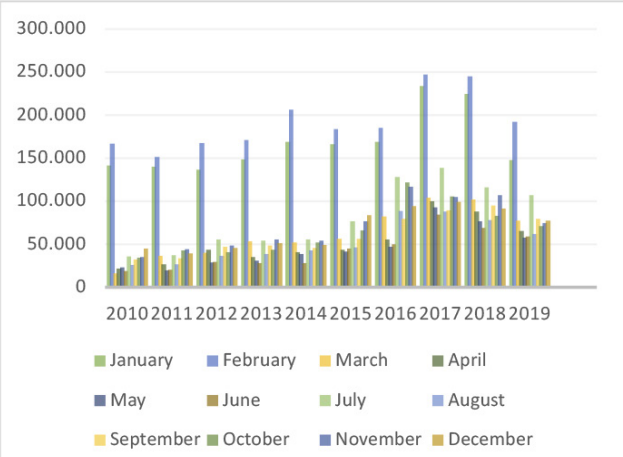
(i) Qualitative analysis.

Tourism can be considered seasonal in Chile, since it occurs in some seasons of the year, with the exception of some places such as Easter Island. In the Araucanía region, this is enhanced in two periods: summer and winter, specifically in the months of December, January, February and July. In the ninth region, the months of June, July, August and even September have a snow season, so all winter sports are enhanced in these months, since ski centers are enabled and open to the public, Pucón, Corralco and Las Araucarias ski center, located in the communes of Pucón, Curacautín and Vilcún respectively. While, in the summer, precisely in the months of December, January and February, outdoors activities carried out near the lakes from Villarrica, Caburgua, Lican Ray, Collico and Tinquilco predominate. In this way, tourists seek to alleviate the heat and have fun practicing activities such as kayaking, rafting, swimming, boat rides, catamarans, and launches. On the other hand, this area offers diverse panoramas, since it has a series of national parks enabled for camping and different trekking rout Also, it has an exquisite culture with a predominance of the original Mapuche people, so practicing ethnic tourism is one of the preferred options along with gastronomic tourism with the realization of typical gastronomic fairs of the regiones for those who like to connect with nature.

Graphic 1 "Evolution of overnight stays in tourist accommodation establishments in the IX Region". Overnight stays correspond to the total number of nights that passengers stay in the tourist accommodation establishment. The evolution of overnight stays in the Araucania Region in the corresponding period between the years 2009-2019, shows a marked seasonality in the summer months, December-February, and the winter season June-August, these peaks of visits occur in the summer and winter vacation times, taking advantage of the geographical attributes of the area.

Both national and international tourists within the region have been increasing steadily in terms of overnight stays. However, the national tourist is the most relevant at the industry level since it occupies the largest share of overnight stays in the region, reaching 80% of the total of these; therefore, the remaining 20% of the total overnight stays correspond to foreign tourists.

Graphic 1. Evolution of overnight stays in tourist accommodation establishments in the IX Region.



Source: Own elaboration data taken from INE. 2022.

In Table 2, the variations that have been seen during the years in overnight stays show an increase in comparison to the ones of 2010 to 2017, which had variations ranging from 3% to 30%, reaching a total of 1,487 in 2017. 892 overnight stays, almost doubling the overnight stays in 2010, which was equivalent to 597,793. The years 2018-2019 had negative variations, the number of overnight stays decreased by approximately 400,000 overnight stays.

Chart 2. Annual growth rate of overnight stays in the Araucania Region.

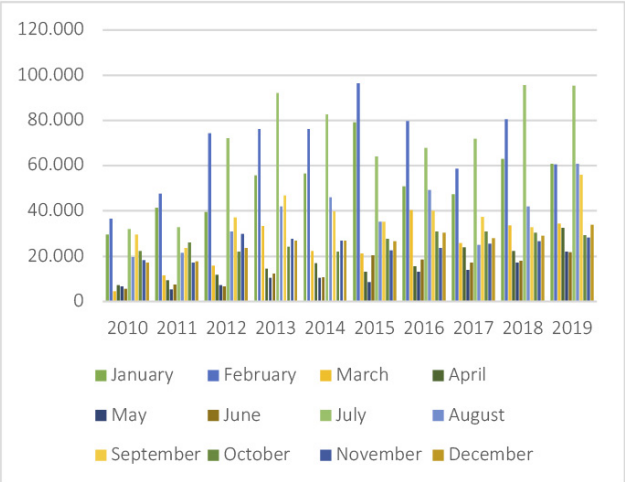
Year	Annual Total	% previous year	Year	Annual Total	% previous year
2009	514.181		2015	941.022	13%
2010	597.793	16%	2016	1.219.344	30%
2011	618.624	3%	2017	1.487.892	22%
2012	719.583	16%	2018	1.375.220	-8%
2013	759.640	6%	2019	1.070.453	-22%
2014	834.023	10%			

Own Elaboration.2022

As observed in Graph 2 "Visitors to Protected Wilderness Areas" (ASPE), each year the number of people who attend these spaces within the region increases. Visitors come for various reasons, to connect with nature, the desire for adventure, rest from the busy city life, observe biodiversity, among other reasons. In La Araucania, the protected areas include five National Reserves, these are: Villarrica, Malleco, China Muerta, Alto Biobío and Malalcahuello; five National Parks: Conguillío, Villarrica, Tolhuaca, Nahuelbuta and Huerquehue; and a National Monument: Cerro Ñielol. All of these are scenarios that offer enriched landscapes, with different climates and diverse flora and fauna, which is what makes them attractive for people who visit them.

Two periods can be distinguished with the highest increases in visitors. As in graph 1 "Evolution of Overnight Stays IX Region", these increases occur in the months of December to March and June to September, which coincide with the summer and winter seasons in the territory of Chile. These wild areas offer delight with beautiful views of hills and volcanoes, walk through ancient forests of araucarias and other native trees in the area, allows you to contemplate rivers, lakes, lagoons, waterfalls and waterfalls. Moreover, during the summer captivate with their warm colors and in winter they offer a snowy view, they also give rise to the observation of animals, amphibians and birds such as: güiña, pumas, culpeo fox, chilla fox, woodpeckers, peregrine falcon, condor, harriers, peuco nuco, short-stream duck, darwin frog, toad four-eyed, many of which can only be seen in this territory.

Graphic 2. Visitors of protected wild areas in the IX Region.



Source: Own elaboration taking data from CONAF 2022.

(ii) Multiple regression analysis.

In table 3 "Correlations between indicators of climate change (maximum temperature and rainfall) and overnight stays in the Araucanía Region, Chile" it can be interpreted that, in terms of the correlation between overnight stays and rainfall (Y, X1) , is -0.337, this indicates that there is an inverse relationship, so that before an increase in rainfall there will be a decrease in tourist overnight stays. Additionally, it could be said that when considering a large amounts of rainfall, it is most likely that the number of tourists arriving in the region will be negatively affected compared to periods in which there is less rainfall. The level of significance is 0.008, it is less than 0.05, which shows that the relationship is very significant, however, the intensity of the relationship is weak, so it is estimated that the rainfall variable by itself does not explain the variation in a good way. variable overnight stays.

The existing correlation between the variables Overnight stays and maximum temperature (Y, X2), is 0.643, it is observed that it is a moderate-high, positive and direct relationship. This indicates that when one variable increases the other also does, so it follows that, given an increase in maximum temperatures, there will be an increase in overnight stays by tourists in the region. The significance is less than 0.05, so there is a very significant relationship. The relationship is high, which indicates that the maxi-

mum temperature variable is capable of explaining the overnight stays variable to a great extent.

Finally, Rainfall and Maximum Temperature (X1, X2), with an index of -0.79, indicates that there is a high and inverse relationship, this indicates that before an increase in maximum temperature there will be a decrease in rainfall. The intensity of the negative relationship is high with a significance level of 0.000 less than 0.05, so it is significant.

Chart 3. Correlations between climate change indicators (maximum temperature and rainfall) and overnight stays in the Araucania Region, Chile.

		Overnight stays	Rainfall	Highest T°
Overnight stays	Pearson Correlation	1	-,337**	**,643****
	Sig.		,008	,000
Rainfall	Pearson Correlation	-,337**	1	-,790**
	Sig.	,000		,000
Highest temperatures	Pearson Correlation	**,643****	-,790**	1
	Sig.	,000	,000	

Source: Own elaboration - Cálculo del Análisis de Correlación de Pearson, SPSS Statics 21. 2022

Table number. 4 "Description of variables independently" shows the behavior of each variable individually. For the first variable ***Overnight stays***, it can be said that on average there are 80,197 bimonthly overnight stays, an average that is above the median, which indicates that there is a greater number of bimonthly stays where overnight stays are lower than high, the typical deviation indicates that the variable moves + 52,836 around the mean, so in short, the variable is in a range 27,361 < 80,197 < 133,033. In the measures of dispersion we find the asymmetry, which with a value over 0 with, 1.308 indicates that the data have a positive asymmetric shape, that is, that the greatest dispersion of data is to the right and the greatest concentration to the left. ; Regarding the value of kurtosis, it is 1.24> 0, graphically it takes a leptokurtic shape, that is, a shape elongated upwards.

As for the ***Rainfall*** variable, it can be noted that on average the amount of bimonthly rainfall is equivalent to 83.13 mm. This average is above the median, which suggests that, like the previous variable, there is a greater number of bimonthly with low numbers than high. Within the measures of dispersion is the standard deviation, which indicates that the variable moves + 57.4 mm. around the mean, so the variable is in a range of 25.73 mm. < 83.13mm. < 140.53mm. Regarding the asymmetry index, it has a value of 0.747, which indicates a positive asymmetry, in terms of kurtosis, the index is -0.496, which graphically tends to a mesokurtic shape, that is, the curve has a normal degree of pointing.

Finally, in the ***Highest temperature*** variable, it is observed that on average bimonthly it rises to 18.48 ° C and this average is very close to the median, which means that the average of the variable is representative, in terms of its standard deviation whch indicates that the variable moves + 5 ° C approximately around the mean, so the variable is in a range of 13.48° < 18.48° < 23.48°. The Asymmetry has a value of 0.198, which rectifies that the mean of the variable is representative, since the value of the asymmetry is very close to 0; Regarding kurtosis, this measure has a value less than 0>-1.249, which graphically demonstrates a platykurtic shape, that is, a flattened shape, a slightly pronounced curve and without noticeable variations.

Chart 4. Description of variables independently.

	Overnight stays	Highest Temperatures	Rainfall
Mean	80196,6167	18,4875	83,1308
Typical error	6821,15636	0,62242	7,41707
Median	61248	18,6	59,15
Variance	2791690443	23,2446	3300,774838
Typical description	52836,45	4,8213	57,4524
Minimum	19077,5	11,95	0,35
Maximum	240492	27,10	221,95
Asymmetry	1,308	0,198	0,747
Kurtosis	1,242	-1,248	-0,496

Source: Own elaboration. Measures of central tendency of the variables. SPSS Statistics 21. 2022

The coefficient of determination R2, is a measure of goodness of fit, which explains the variability of the dependent variable that is explained by the model, manifests with a 95% accuracy the association of the variables. In other words, for the proposed regression model, with the explanatory variables, maximum temperature and rainfall,

49.2% of the variance of the overnight stays variable is explained, it is an intermediate impact coefficient, that is, moderately low, but considering that the rest of the overnight stays variable could be explained by many other variables and that, since there are no more studies on the same, it is considered valid to continue with the model, in order to allow the existence of a base model for possible future studies .

Regarding the Durbin-Watson indicator, it helps us to verify autocorrelation. This analysis is necessary to verify that one variable is not contained in another, since this situation brings with it an oversizing or inflation of the R2, Ra2 and Anova indicators, which would finally result in a loss of reliability in the model, that is, under this framework the estimates will not be true and/or will not be close to reality. This coefficient takes as measurement scale the following ranges; Dw. = 2 there is no autocorrelation; 1.5≤Dw. ≤ 2.5 exists, but does not damage the model; 3≥Dw. there is autocorrelation. Based on the above, the Durbin-Watson statistic applied to the model has a magnitude of 1.947, that is, it is in the range where there is no autocorrelation between the variables. See chart 5.

Chart 5. Summary of the model.

R	0.701
R squared	0.492
R corrected square	0.474
Estimacion error	38315,105273
Durbin-Watson	1,947

Source: Own elaboration, SPSS Statistics 21. 2022

Table 6 shows the ANOVA, this through significance measures the sensitivity of the variables, for the regression model studied. In this case, it indicates that it significantly improves the prediction of the dependent variable overnight stays, with a p-value of 0.000 less than 0.05, so when executing the hypothesis test: H0= The variables are independent and H1= The variables are not independent, H0 is rejected and H1 is accepted, with Sig. 0.000 < 0.05, it is estimated that the variables explanatory maximum temperature and rainfall are linearly related to the dependent variable overnight stays and therefore the model can be continued.

Chart 6. ANOVA

	Suma de cuadrados	gl	Media cuadrática	F	Sig.
Regression	810310404844,817200	2	40515520242,408600	27,59823	0,00
Residual	836786956407,866120	57	1468047292,067827		
Total	164709736132,683320	29			

Source: Own elaboration, SPSS Statistics 21. 2022

In Table 7 "Model coefficients, part 1", the non-standardized coefficients will help us to formulate the model equation (see figure 1. Model equation). The standardized coefficients indicate that the most powerful variable for the model corresponds to the maximum temperature and then the precipitation variable.
For the coefficients of the regression model, the "t" scores indicate that the variables considered contribute significantly to the model, since there is statistical evidence that the maximum temperature and rainfall influence overnight stays, since H0 is rejected in each situation, with significances 0.005 and 0.000 respectively, which are lower than the alpha of 0.05.
Regarding beta, it indicates the behavior of the variables as a whole. Therefore, the most important variable for the model is "maximum temperature", which has a beta of 1.002890 while the second variable "precipitations has a beta of 0.455045, therefore, it shows us that the variable temperature maximum does not have a good relationship with the other variable as a whole.

Chart 7. Model coefficients, part 1

	Not standardized coef		Typified coef.	t	Sig.
	B	**Error**	**Beta**		
Constant	-157782,97053	41416,13361		-3,8096	0,000
Rainfall	418,484718	141,560615	0,455045	2,9562	0,005
Highest temperature	10990,702034	1686,898996	1,002890	6,51532	0,000

Source: Own elaboration, SPSS Statistics 21. 2022

The zero-order correlation states the relationship that each explanatory variable "X" (rainfall and maximum temperature) has on its own with respect to the study variable "Y" (overnight stays). Table 8 "Coefficients of the model, part 2" indicates that maximum temperature has a relationship strength of 64.3%. Consequently, it is the one that has the greatest relationship with overnight stays and below it is followed by rainfall with -33.7%. . See table 8.

It is known that the order of entry of the variables generates a modification in the relationship that each of them has, this order can affect the behavior by increasing or decreasing. In addition, in the partial correlations, the correlation between two variables is interpreted, keeping the third constant, that is, with fixed data to remove the effects of that third variable on the model, but without eliminating it. In this case, as maximum temperature, it is the one that has the greatest relationship with overnight stays, it is the first strong variable that enters the model. Then, in the presence of maximum temperature, the model in general is affected, increasing from 64.3% to 65.3% in the presence of the other variable (rainfall), although it is not such a significant increase, it indicates that the method works correctly. The same happens with rainfall, if this variable entered first, counting on the presence of the maximum temperature variable, the strength of the relationship with overnight stays increases from -33.7% to 36.4%, however, in this way It is verified that the best option is to introduce the maximum temperature variable into the model first, since although there is a significant increase in the relationship, the explanatory percentage is still higher when the maximum temperature variable enters the model first.

Finally, the semi-partial correlation explains the behavior of the model and the percentage that manages to interpret the second variable in the presence of the first. In this case, we have already defined that maximum temperature was the first variable to be introduced into the model, so that, with the entry into the model of the second rainfall variable, the relationships with overnight stays were modified as follows: maximum temperature decreases its relationship with overnight stays at 61.5%, while rainfall decreases to 27.9%. With these data, it is again demonstrated that there is a greater relationship between the variables when the maximum temperature variable enters the model first, since that is when the relationship of all the variables with respect to overnight stays is higher, recognizing that this is the best model, since with the presence of both explanatory variables it is possible to better explain the study variable.

Tabla 8. Coeficientes del modelo, parte 2.

Modelo	Correlaciones		
	Orden cero	Parcial	Semiparcial
Constante			
Temperatura	0,643483	0,653334	0,615101
Máxima			
Precipitaciones	-0,337065	0,364607	0,279092

Fuente: Elaboración propia, SPSS Statistics 21. 2022

Figure 1 "Equation of the model", shows the equation of the multiple linear regression model, in which, mathematically speaking, when rainfall and maximum temperature tend to zero, it can be deduced that overnight stays in Araucanía would be zero, since the constant is -15.7823. For the case of b1= 418.48 rainfall, when rainfall is increased by one millimeter, keeping everything constant, the overnight stays increase by 418 and for b2= 10,990.70 maximum temperature, if the temperature increases by one unit, overnight stays will increase by 10,991 overnight stays, keeping everything else constant.

Figure 1. Model equation:

$$Y_{(Turismo/cc)} = -157782,97 + 418,48 + 10990,70tm + \mu$$

According to Table 9 "Collinearity statistics" the inflation factors of the variance of each variable are less than 10, so there is statistical evidence that there is no multicollinearity. For collinearity to exist, the tolerance must be close to zero and VIF ≥ 10.

With this assumption it can be seen that there is no collinearity between the maximum temperature and rainfall variables since the maximum temperature variable has a tolerance of 0.376173 far from zero with a VIF of 2.6583 less than 10 and the rainfall variable has a tolerance of 0.37617 far from zero with a VIF of 2.6583.

Chart 9. Collinearity statistic.

	Confidence intervals of 95%		Collinearity statistics	
	Lower limit	Upper limit	Tol.	VIF
ConstaNT	-240717,347559	- 74848,59350		
Rainfall	135,014476	701,954960	0,37617	2,6583
Highest tempera ture	7612,745062	14368,65900	0,37617	2,6583

Source: Own elaboration, SPSS Statistics 21. 2022

A Kolmogorov-Smirnov test is performed, which belongs to the group of goodness-of-fit tests, applied to the residuals and is a test that allows to verify whether the sample scores follow a normal distribution or not, that is, that corroborate the existence of normality in the sample.
For this, two hypotheses are established:
- H0: the distribution is normal.
- H1: the distribution is not normal.

Chart 10. Normality tests

Kolmogorov-Smirnov		
Estatistics	**gl**	**Sig.**
0,091	**60**	**0,20**

Source : Own elaboration, SPSS Statistics 21. 2022

To verify this, statistically the p-value, must be greater than the alpha, that is, greater than 0.005. In this case 0.020 > 0.005 for which H0 is not rejected, from this it is inferred that there is statistical evidence that the sample and the residuals are normal. See table 10.

DISCUSSION

According to the obtained data the impact of climate change in the tourism sector is manifested in the loss of natural tourist attractions and the increase in extreme events, which dissuade tourists from visiting the country taking into account that nature is the main travel reason why tourists decide to visit Chile. Therefore, the variation in temperatures and rainfall, the loss of biodiversity and the occurrence of extreme weather events are considered threats of climate change that affect the tourism sector.

In words of the Study Center of the Pontificia Universidad Catolica of Chile, "Climate change represents one of the greatest threats facing modern society. However, our ability to perceive the signals of environmental changes and their impacts on the functioning of complex systems is quite limited, which usually results in late and incomplete responses that ultimately, in the case of climate change, they allow the most pessimistic scenarios of greenhouse gas emissions to become feasible, as well as their worst consequences" (UC Global Change Center, 2014). These consequences can be presented in various ways, such as; a rise in sea level, ocean acidification, accelerated melting of glaciers, polar ice caps, and continental ice sheets; the migration and extinction of species of flora and fauna; changes in the climate system, especially in precipitation regimes, changes in flow regimes and freshwater terrestrial systems, changes in the frequency and intensity of extreme weather events, changes in crop productivity, among others (Center UC Global Change, 2014).

For Chile, a country with high tourist attractiveness both nationally and internationally, recognized by the World Travel Awards as the Best Adventure Tourism Destination in the world continuously since 2016 (World Travel Awards, 2022). The weather is an important factor for the development of the tourism industry. The climate is a determining condition of this type of heritage, since its characteristics give life to the offer and tourist attractions of nature, as well as conditioning the seasonality of tourism throughout the country. Undoubtedly, climate change entails impacts on nature, where its correlation with the behavior of local and receptive tourists is a great unknown, which will generate a geographic and seasonal redistribution of visitor flows, putting the national tourism industry at risk " (Ministry of the Environment, 2020). The way in which climate change manifests itself will have repercussions on tourism, both in tourist destinations and in tourists, because some activities are especially sensitive to climate, such as skiing (lack of snow), going to the beach (cold), fishing (wind). Climate is the support for tourism and the most important element in the tourism product. At the same time, the climate contains a factor of risk since it can prevent tourists from carrying out any activity or simply stop going to a tourist destination (Ivanova, 2010).

In fact, climate change, far from stalking tourism as a remote future threat, is already beginning to leave its mark in different ways on destinations around the world and is influencing current decisions in the tourism sector (UNWTO, 2007a). The Intergovernmental Panel on Climate

Change (IPCC) in 2007 concluded that there will also be changes in extreme events as a result of climate change. This will include higher maximum temperatures, more hot days, greater intensity of cyclones and hurricanes, changes in precipitation, as well as longer and more severe droughts in various regions worldwide (Ivanova, 2010).

The Ministry of the Environment, together with other national and international organizations, developed an Atlas of Climate Risks for Chile (ARClim), which consists of a platform that allows observing a set of risk maps related to climate change for Chile, considering the impact of climate change between historical periods (1981-2010) and future periods (2035-2060). In this way, for the tourism sector, 4 impact chains are expected: loss of winter tourist attractions in high mountain centers, loss of tourist attractions due to forest fires, erosion on beaches and loss of tourist attraction in sun and beach destinations. (Ministry of the Environment, 2020). All these are scenarios that are already manifesting in the area.

The Araucanía region "is one of the rainiest regions in Chile; however, in ten years the reality for the inhabitants of La Araucanía has had a substantial change" (Navarro, 2017), that one of the rainiest regions of Chile is in rainfall deficit can only mean that what is affecting the planet it is already something serious, due to the absence of water it can cause the lakes and rivers to begin to dry up along with all the abundant vegetation that, precisely, is what makes the region attractive. This in the future may mean a decrease in the arrival of tourists to the area.

A clear example corresponds to the decrease in the waters of Lake Caburgua in the commune of Pucón. Lake Caburgua is one of the most desired beaches by tourists, in 2017 the low level of water in its flow became evident, for which the mayor of the area promised to conduct an investigation in order to find its origin, which later remained unspecified. In 2021, the investigation was resumed by an Agreement between the Association for the Protection and Conservation of Lake Caburgua and the Austral University, which showed that "the hydroclimatic variables show downward trends in recent years, an issue that supports the decrease in level of Lake Caburgua. However, the diversion of the waters of the Trafampulli, which until 2009 discharged part of its waters into the lake, exacerbates the climatic effect in the lowering of the lake's level" (Ulloa & Iroumé, 2021). If this situation continues, it will bring with it very serious consequences for the entire environment, beginning with alterations to the ecosystem of the flora and fauna that resides and directly affecting the economy of the people who are dedicated to the marketing of tourism in the commune.

On the other hand, "in Chile the increase over the average temperature trend has been constant mainly in recent years, a linear trend of +0.14 °C per decade has been observed" (Dirección Meteorológica de Chile, 2021). Since 2011 the years have been consecutively warmer than normal. The historical data record increases in temperatures in the central valley and the mountain range, while the coastal stations indicate a slight cooling, although without statistical significance. (Chilean Meteorological Directorate, 2021). In this sense, Chile and therefore the Araucania region, has been tremendously affected by these rises in temperature. Although it is true, tourism is an area that benefits from high temperatures in summer, this is because at this time the tourist seeks good weather to be able to choose their destinations and practice activities. In addition, there are other effects of the rise of temperatures in tourist destinations that negatively affect tourism, translating these effects into the progressive decrease of snow resources and water resources available to the population and the ecosystems dependent on it.

Protected wilderness areas in the region have been affected by climate change. In recent times, different forest fires have been witnessed at the regional level, which completely modify the tourist attractions of these areas. These fires are not only caused by the action of the human being, since it has been proved that in 2015, Tolhuaca National Park was affected by electrical storms that attacked the region, phenomena that are not common in this area, causing a large-scale fire. In addition to these events, there are other factors that affect wetlands, flowering processes, flora and fauna. These areas are undergoing very gigantic transformation processes, which will generate in the medium term that tourism will be much more affected by these situations. Undubtedly, the diversity of landscapes that it offers, from mountains with volcanoes, streams and lakes, to the great vegetation and varied fauna, which will clearly be modified. In addition, as high temperatures create the right environment for the initiation and subsequent spread of fires, this means that each summer season the ONEMI must declare preventive alerts. All of the above is due to the fact that the earth's temperature has been increasing uncontrollably over the last few years, in fact, the annual global land and ocean temperature has

increased by 0 0.08°C per decade since 1880, while since 1981 the rate has increased to 0.18°C per decade, according to the annual climate change reports prepared by the Climate Change Office of the Climatology Section of the Chilean Meteorological Directorate .

It is essential to mention that these relevant facts regarding the climate affect water resources. In 2011, the MOP (Ministry of Public Works) published the ENRH (National Strategy for Water Resources 2012-2025) since, within the global context, Chile is considered a privileged country in terms of water resources. There are 1,251 rivers, more than 15,000 lakes and lagoons, which contain good quality water and are regulators of the flows in the basins, it also has great availability of groundwater, which as a whole, exceeds 8 times the world average per available capita, however, according to a study by the OECD (Organization for Economic Cooperation and Development) Chile is the country with the greatest diversity of administrative authorities involved in the management of this resource, so it is necessary to regulate in some way and considering that economically, Chile projected a growth rate of between 4% and 5% for the year 2013, it was inevitable to carry out an action that would mitigate the effects produced by the growth of productive sectors dependent on water.

The effects that the advance of climate change has caused in the world are varied and clearly the Araucania region is not exempt from this, the increase in temperature has caused that in winter times, all week rains and snow, sunny and warm days are given, which are convenient for economic sectors such as tourism. On the contrary, a negative scenery for forestry, agricultural and livestock sectors, even more perjudicial for the ecosystem and biodiversity that inhabits the area. Perfect scenarios are developed for severe climatic events to occur, such as: droughts and the start of forest fires due to heat waves. Therefore, it is necessary that the authorities concern themselves with developing ecological awareness in society and inculcate respect for nature, promoting measures that seek preservation and conservation in all that this encompasses.

To face this situation, several countries, including Chile, have agreed to work together through international assemblies, such as; The United Nations Framework Convention on Climate Change, this consists of a treaty that establishes the basic obligations to combat climate change, in which 196 countries participated plus the countries that make up the European Union, it was signed at the Earth Summit in 1992 and entered into force in 1994, where Chile joined the same year. Another instance, corresponds to the Paris Agreement, signed in December 2015 and adopted by 195 countries, where it aims to limit the increase in temperature below 2 ° C compared to the pre-industrial era, and ideally limit this increase to a maximum of 1.5°C., Chile ratified the Paris Agreement in February 2017. Likewise, the Conference of the Parties (COP) is held, which is a supreme decision-making body of the Convention, the countries meet annually to review the progress in the implementation of the Convention where other instruments are proposed, evaluated and approved. support its establishment.

All the guidelines set out in international assemblies to curb climate change are adopted by the Chilean Ministry of the Environment, created in 2012, which "is the State body in charge of collaborating with the President of the Republic in the design and application of policies, plans and programs in environmental matters, as well as in the protection and conservation of biological diversity and renewable natural and water resources, promoting sustainable development, the integrity of environmental policy and its normative regulation" (Ministry of Environment, 2014). This is how, through this body, mitigation and adaptation plans have been implemented. The first, with actions, measures or activities that seek to reduce the sources of greenhouse gas emissions and the second with actions, measures or activities that seek to reduce the vulnerability of natural and human systems, moderating the negative impacts and/or taking advantage of the beneficial effects.

Nowadays, climate evolution reports are made annually, which have been developed within the framework of the National Climate Change Action Plan 2017-2022, committed by Chile before the United Nations Framework Convention on Climate Change, to comply with with the specific objective "Improve the monitoring system of the main climatic variables at the national level as an information base for the monitoring of climatic evolution in Chile" (Ministry of the Environment, 2017a).

CONCLUSION

Araucanía is a rich country in diversity of attractive natural areas for people, due to its type of climate, geography and lakes. In this region you can see the sea and the mountain range in a few hours, ski looking at a lake, enjoy the

hot springs, attend the various charms of the cities: such as museums, casinos, churches, among others, access a wide range of restaurants , visit the Italian colonizing experience and get to know the culture of the Mapuche people, the activities that can be carried out are varied and at any time of the year.

In the present study, the proposed model showed as a result that climate change does have an impact on tourism in the Araucanía region with a corrected R square of 47.4% and that this turns out to be positive, that is, more people arrive due to high temperatures caused by climate change. This can be understood because the region is very abundant in lakes, making it the ideal place to cool off. Although the R-squared corrected for the model is not that good, it is effective for performing the analysis thanks to an anova with a significance level of 0.000 rejecting H0= the variables are independent and accepting H1= the variables are dependent. This indicates that the X variables are sensitive to the increase in overnight stays (Y) and, in turn, are the variables that best explain the model. As for beta, it indicates the behavior of the variables as a whole. Therefore, the most important variable for the model is "maximum temperature", which has a beta of 1.002890 while the second variable "precipitations" has a beta of 0.455045 which again indicates that temperatures high are the factor that most influences tourism in a positive way.

Regarding the variables x and y, their level of collinearity can be said that, although it exists, with a Durbin-Watson of 1.947 and a significance between the variables of 0.000, it does not affect the model and this can be corroborated with the tolerance level and VIF of the variables. For maximum temperature the tolerance is = 0.522 and VIF=1.914, in the same way for rainfall with a tolerance= 0.376173 and VIF=2.65835. Staying in the ranges where there is no collinearity. Therefore, accurate or close to reality estimates can be expected when the model is applied, since the analysis shows that there are no variables that contain another, so it is not necessary to eliminate variables, make measurement changes in them or modify the sample section.

On the other hand, in the region, according to the data collected, the greatest arrival of tourists occurs in the summer months, December-February and winter season June-August, they occur in the summer and winter vacation season, it is shown a marked seasonality in the years corresponding to 2010-2019; it can be attributed to the tourist attributes and multiple tourist services of the region. This, today, generates a positive impact for the tourism industry and the economy, generating a greater presence of people in the various attractions of the area (volcano, lakes, parks, reserves, etc.) and in turn generates work, since it is labor intensive, especially for women and young people, it encourages entrepreneurship and innovation, promoting local development.

Based on the previous studies and bibliographic sources, it can also be concluded that climate change has affected tourism in the region of La Araucanía, due to the fact that its natural attractions have intervened, as is the case of forest fires which are considered extreme events of climate change and have affected national parks such as the P.N. Tolhuaca. Similarly, Lake Caburgua waters decrease , which is attributed to rainfall, to the intervention of the human being to the increase in temperatures in the region, which has caused changes in the biodiversity of the area. All these effects cause a chain of events that begin with the change in the ecosystem, with an associated decrease in the attractiveness of the area, therefore a decrease in the attendance to these places.

According to the statistical results, there is no effect of climate change on the fluctuations of tourism in the selected period in La Araucanía, this is possibly due to the fact that there is no effect of the maximum temperature variable on overnight stays (tourism) , or to the fact that temperatures do not have a relationship in the fluctuations of tourism. This can be explained by causality, since in the times when there is a greater fluctuation of tourists it is also where the vacation period exists, which generates in itself an increase in tourist demand in the region. Whether in summer or winter, so it would be more related to a cause and effect situation.

Tourism in 2019 contributed 3.3% of GDP to the Chilean economy, which is equivalent to $6,489 billion according to SERNATUR data. Tourism for Chile, may become one of the main economic activities in the future, as is the exploitation of copper today, but with relevant difference, since it grows with a strong added value and generates dynamic effects at all levels of the country. If it is not maintained and continues to develop in a sustainable way, a great opportunity would be wasted, since the impacts that climate change can generate can be serious, generalized and irreversible in people and ecosystems. However, today they are working on options to mitigate its effects in

Chile and several countries worldwide, so that the impacts of climate change remain controllable, creating a clearer and more sustainable future.

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