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The carbon footprint of tourism in Bolivia

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Summary: The tourism sector generates greenhouse gas emissions in the atmosphere, impacting climate change, and at the same time, it is the sector most vulnerable to climate change. This study estimates the greenhouse gas emissions by activities associated with tourism in Bolivia during 2019. The goal is to provide a baseline and a diagnostic that identifies better opportunities and actions for all parties involved (hotels, travel agencies, tourists, service providers, etc). The results show that in 2019, 338,008 tons of CO_2eq were generated, emissions equivalent to those generated by the deforestation of 749 hectares of tropical forest in Bolivia. The primary source of emissions is air transport, at 63%, followed by land transport at 22%, hotels and lodging at 8%, food at 7%, and waste generation at 0.24%. This document provides actions to reduce emissions, to be applied at different levels and by different parties.

Key terms: climate change, greenhouse gas emissions, carbon footprint, tourism
JEL Classification: Q54, Q56, L83

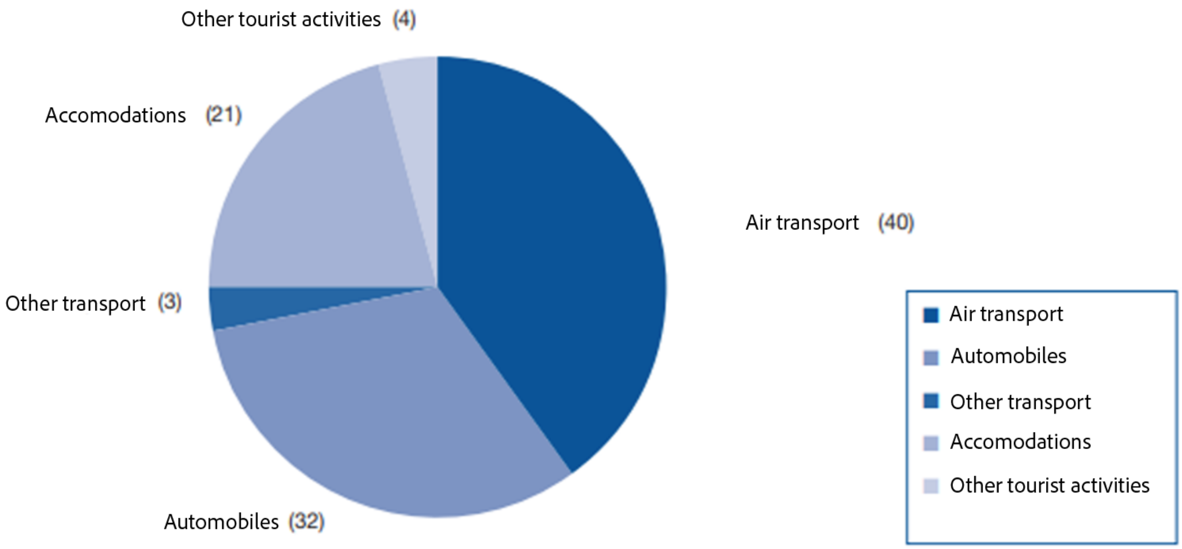
1. Introduction

According to the World Organization of Tourism in 2020, before the global effects of the COVID-19 pandemic, the growth in tourism represented 10% of employment worldwide, and 10% of global GDP in 2019, generating 9.6 trillion USD. The growth of tourism will have an environmental impact and raise new challenges in the optimal use of the natural resources and the reduction of greenhouse gas emissions (World Organization of Tourism, 2020).

In 2015, with the adoption of the 2030 Agenda, many countries have promised to maintain an average world temperature of less than 2ºC above the preindustrial levels, and to make an effort to not exceed a 1.5ºC increase in temperature. At the same time, an ever-increasing number of actors, from governments, organizations in civil society, and even the private sector, are intertwined in the debate with the promise of mitigating the effects of climate change and applying adaptation measures. The tourism sector has the potential and responsibility of being a driving force that allows the achievement of these goals.

As cited in (OMT, 2022), the tourism sector contributed approximately 5% of total CO_2 emissions caused by humans in 2005, with the largest contribution to emissions due to transportation which was responsible for 75% of total emissions from humans.

Figure 1. Contribution to total CO_2 emissions from tourism in 2005 (%)



Source: WTO (2008)

On the other hand, for tourism, the effects of climate change represent an important threat, especially due to natural disasters that are becoming more frequent, increasing the costs of trip safety and health, and affecting the security of tourism. Likewise, the shortage of water, the loss of wildlife, and the degradation of goods and tourist attractions are other factors that affect the development and growth of the tourism sector. The continuous degradation of the natural environment due to climate change and the disruption of cultural and natural patrimony also negatively affects the tourism sector, minimizing the attractiveness of local tourist destinations and reducing the economic opportunities for the local communities.

For this reason, the tourist agencies of the world have undertaken diverse actions, but the public information about the CO_2 emissions is still limited, which is why the integration of climate strategies in tourism policies is low (OMT, 2020). For this, it is fundamental to increase the participation of the tourism sector in the measures and strategies of adaptation and mitigation that combat global warming and guarantee the sustainability of a large part of the sector.

In Bolivia, in particular, the deterioration of Andean glaciers is creating profound problems in the supply of water to the western region, while the eastern region is more affected by flooding. On the other hand, droughts, including extreme droughts that cause forest fires such as the 2019 Chiquitania fire, continue to deteriorate the productivity of the land (Center for Documentation and Information, 2020). There exists undeniable scientific evidence that these are some of the impacts caused by the increase in the concentration of greenhouse gases in the atmosphere, caused by human activity (Intergovernmental Panel on Climate Change, 2013). On the other hand, the limited availability of water in quantity and quality, due to bad management or unsustainable use, could be a limitation on industrial and commercial growth, including the tourism sector.

In Bolivia, the climate crisis has created high risks for the human, economic, social, productive and natural systems. The Index of Global Climate Risk 2021 (IRC) ranks Bolivia as the tenth most vulnerable country in the world, taking into account the impacts of natural disasters and the associated socioeconomic data (Germanwatch, 2021). Bolivia has proposed a structural solution for global climate change, the "paradigm of Good Living in harmonic equilibrium with Mother Earth." The proposal is based on the principles of equality and shared responsibility, the strengthening of internal development for Good Living and the promotion of the economy of Mother Earth.

For Bolivia, tourism is defined as a strategic activity due to its economic, social, cultural and environmental implications, based particularly on their ability to generate sustainable economic outcomes, and also on benefits for local communities. Tourism in Bolivia generated 326,580 direct and indirect jobs during 2019, which makes it the fourth most important sector, after mining, soy and hydrocarbons in exports, and generating almost 4.6% of GDP (QUIMSA, 2020).

2. Theoretical and conceptual framework

Climate Change

The climate of Earth has changed many times throughout its history. This variation was due to natural changes that have produced the equilibrium between incoming solar energy and the energy reemitted by Earth into space. However, since the Industrial Revolution, anthropogenic activities have multiplied exponentially with the burning of fossil fuels, industrial processes, and the generation of urban waste. All of these activities have resulted in an increase in the concentrations of greenhouse gases in the atmosphere above natural levels, increasing global warming and causing climate change.

Global warming and greenhouse gases

Global warming is a natural process, in which the gases that are present in the atmosphere "trap" the radiation that Earth emits into space. This radiation is the result of the warming of Earth's surface.

At the same time, although the land, the oceans, and icecaps are warmed directly by the sun, they do not absorb all the energy. Part of this is returned to the atmosphere as a different type of energy which, is absorbed by water vapor, carbon dioxide, methane, and other gases, such as chlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, nitrous oxide, and sulfur hexafluoride. The gases that have this property are known as Greenhouse Gases. The water vapor found in the atmosphere also makes a significant contribution to global warming, but it is not considered because its concentration does not vary with anthropogenic activities.

Carbon footprint

The carbon footprint constitutes an indicator of environmental pressure, as a measure of the use of natural resources and the release of environmental compounds into the atmosphere from human activities (Ercin & Hoekstra, 2012).

Specifically, the Carbon Footprint measures the greenhouse gas emissions generated by an entity or activity at a determined time, most often expressed in tons of CO_2e per year [CO_2e ton/year] (Galli et al., 2011). These emissions are classified using categories which define the operational limits relative to direct or indirect emissions (WBCSD & WRI, 2005). Usually, the final goal of counting greenhouse gas emissions is to establish a baseline for minimizing emissions, to ultimately find actions that "offset" or compensate the effects of these emissions (Daviet, 2006).

Potential of Global Warming

To determine the importance of greenhouse gases, according to their contribution to global warming, one uses the concept of global warming potential (PCG). This factor is used to express emissions in relation to the global warming potential of CO_2. Each greenhouse gas emission has a PCG that indicates the potential of specific emissions to retain infrared radiation, in comparison to CO_2. For example, 1 kilogram of methane (CH_4) can retain 25 times the amount of radiation compared to 1 kilogram of CO_2. For this reason, the PCG of methane is 25 (EPA, 2013). The following table shows the global warming potential of the primary greenhouse gases:

Table 1. Potential of Global Warming

Common name of greenhouse gas	Chemical formula	Global warming potential
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous oxide	N_2O	298

Source: IPCC (2017)

The unit that expresses the amounts of greenhouse gas emissions in terms of their PCG is equivalent to CO_2 [CO_2e]. For example, 1 kg CH_4 is equivalent to 25 kg CO_2e (WBCSD & WRI, 2005).

3. Methodology used

This section describes the procedures and the methodology used to quantify the greenhouse gas emissions for the sources of emission from tourist activity in Bolivia.

3.1 Mechanism of quantification

This section describes the methodology used to calculate greenhouse gas emissions from tourism. Below are the steps used to calculate the greenhouse gas emissions:

- **Selection of the estimation method:** The mechanisms of quantification of the Carbon Footprint (CF) are based on the multiplication between the Emission Factors (EF) and the Activity Data (AD), corresponding to each source of emission:

CF = EF * AD

Where:
CF = Carbon Footprint (t/kg/gr of CO_2e)
EF = Emission Factor
AD = Activity Data (cubic meters, liters, kWh, etc.)

The EFs are expressed in weight of contaminated greenhouse gases divided by unit of weight, volume, distance, or duration by emission activity; and should meet the following requirements:

- Recognized on an international level (for example, IPCC, GHG Protocol, DEFRA)
- Match the emission sources to the greenhouse gas identified
- Based on the most recent data
- Be consistent with the use of emission inventories

- **Collection of data:** Identify the sources of reliable data. It is also possible to consider the information included in the investigations and studies by third parties, and the development of estimation procedures.
- Application of tools for the calculation: The application of the methodology mentioned above, with the corresponding emission factors and the collected data.

3.2 Scopes and Limitations

The organization of the study covers the activities generated by the tourism sector of Greenhouse Gases (GEI) in Bolivian territory, including the GEI emissions from air and land transport with a final destination in Bolivia. The data is from tourist activity during 2019.

The tourist activity is divided into international and internal as defined below:

- **International tourism.** Tourism activities carried out by tourists from other countries.
- **Internal tourism.** Tourism activities carried out within Bolivian territory by people who reside in the country.

3.2.1. Temporal scope

The inventory of emissions takes into account the GEI emissions from one year of reporting, and covers 12 continuous months of reporting. In the case of emissions for the final disposal of solid wastes due to tourism activity, the study estimates emissions in the future that result from activities that occur within the reported year.

3.2.2. Scope of Methodology

To quantify the Carbon Footprint of the tourism sector this study applies the Life Cycle Analysis (ACV) following the guidelines of the ISO 14040 rules, where only the indicator that impacts climate change (Carbon Footprint) is considered. On the other hand, the quantification of greenhouse gas emissions follows the guidelines and procedures of the ISO 14064-1 and ISO 14067 to evaluate the carbon footprint of organizations, products and services. Similarly, this study follows the methodologies and procedures to calculate the emissions proposed by the national guidelines of the Intergovernmental Panel of Climate Change (IPCC) to calculate the Greenhouse Gas Effect Inventories. The focus of the life cycle considers the tourist activity in its different periods, from transport to the destination, lodging, food, and transportation for the tourist destination, as well as the emissions generated by the wastes created during the tourist activity. In summary, this study uses the following methodology:

- ISO 14064-1:2006 Bolivian Rule: “Greenhouse gases. Specification with orientation, at the level of organizations, for the quantification and the report of the emissions and removals of greenhouse gases.”
- ISO 14040: 2006 Rule: “Environmental management. Analysis of life cycle. Principles and reference marks.”
- ISO 14067 Rule: “2018 Carbon footprint of products. Requirements and guidelines for the quantification.”
- Technical guidelines established for the IPCC in the National Guides For the Calculation of GEI Inventories carried out in 2019

3.2.3. Methodology limitations

Due to the limitations of the information available regarding tourist activity, and the resources available for the production of this study, this study of the Carbon Footprint of Bolivia’s tourism sector has the following limitations:

- For international flights, the study assumes that flights are direct, meaning that they did not consider transfers in the routes of the different flights to Bolivia, due to the difficulty of obtaining this information from a verifiable source.

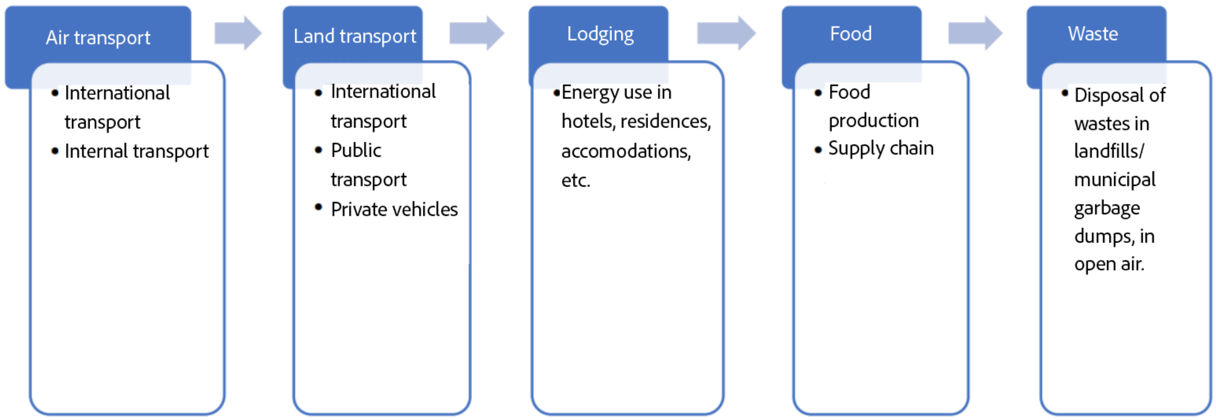
- The study assumes that international tourists return to their country of origin via the same route and method of transportation they used to arrive in Bolivia. A tourist who stays for a time in Bolivia as part of a trip to neighboring countries, for example, is not considered.
- The study uses default international indicators for energy use in accommodations, consumption of food and generation of waste from tourist activities, due to the lack of research and local studies.
- Emissions from the production of souvenirs and other products bought by tourists are not considered.
- Emissions from other services and tourist activities are not included as part of the emission factor for studies. For example, emissions from events such as parades, festivals, and concerts are not considered.

3.3. Identification of emission sources

This study considers the following sources of greenhouse gas emissions:

- **Air transport:** This refers to flights for international tourism and tourism within Bolivia. The emissions are produced from the burning of fossil fuels; in this case jet fuel for commercial flights.
- **Land transport:** This refers to trips made using self-owned vehicles, public transport, or hired vehicles for tourist activities. The emissions are generated from the burning of fuel in vehicles, such as gasoline, diesel, and natural gas.
- **Lodging:** This refers to the accommodations of national and international tourists in hotels, residencies and accommodations. It includes the energy use for lighting, electronics, and air conditioning.
- **Food:** This refers to the consumption of food by national and international tourists. This includes emissions generated by the production of food and those generated by the supply chain.
- **Wastes:** This is understood as the generation of wastes by national and international tourists. Greenhouse gas emissions are produced for the final disposal of wastes.

Figure 2. Emission sources considered in tourist activity



Source: Authors' calculation based on GHG Protocol

The sources of emission identified for the evaluation of the Carbon Footprint of the Tourism Sector of Bolivia in 2019 are shown in the following table:

Table 2. Sources of emission considered

Emission source	**Detail**
Air transport	International
	Internal (national)
Land transport	International
	Internal (national)
Lodging	Foreign tourists
	National tourists
Food	Foreign tourists
Waste	Foreign tourists

The factors of emission employed, as well as the sources consulted, are described in the following table:

Emission source	
Air transport	Based on the model developed by UNWTO (OMT, 2020). The value of the factor is 0.1042 kg of CO_2e per passenger per kilometer.

Land transport	Based on the model developed by UNWTO. The value of the factor is 0.03 kg of CO_2e per passenger per kilometer per kilometer in a bus, and 0.11 kg of CO_2e per passenger per kilometer in an automobile.
Lodging	Emission factor for stays in hotels and accommodations comes from "The Cornell Hotel Sustainability Benchmarking Index," which is based on data about the energy use of 20,000 hotels around the world (Ricaurte & Jagarajan, 2021).
Food	Based on the emission factor of the carbon footprint of an average diet of 2.5 tons of CO_2e per person per year (Wilson, 2022) and 8.9 tCO_2e per consumption of meat per year per person in Bolivia.
Waste	The emission factor from the generation of wastes is estimated based on a rate of waste generation of 1.1 kg per day (Obersteiner et al., 2017). The composition of wastes from non-residential activities is from the Information Update about Waste Management in Bolivia.

Source: Authors' calculation

3.4. Activity data for the identified emission sources

The primary sources of information on tourism and tourist activities in 2019 are shown below. The primary source of information comes from Bolivia's National Statistics Institute (INE). Tables 4 and 5 show the number of national and international tourists in Bolivia in 2019.

Table 4. Number of international tourists that visited Bolivia, by type of route, 2019

Number of tourists that entered the country		
Total	Via road	Via plane
1,239,281	856,310	382,971

Source: INE (2019)

Table 5. Number of national tourists, by type of route, 2019

Number of internal tourists

Total	Via road	Via plane
1,171,340	1,127,107	44,233

Source: INE (2019)

The tables show that the foreign tourists that visit Bolivia primarily come by car, roughly equal to internal tourists. Due to the available data, they also identified Copacabana and the Uyuni Salt Flats as the most visited tourist destinations in 2019 by land.

Table 8. Percentage and number of tourists that visited tourist destinations via land

Destination	Percentage	Number of tourists
Copacabana	8.8%	204,111
Uyuni Salt Flats	6.3%	146,118
Sun Island	3.3%	76,538
Tiwanaku	2.6%	60,303
Samaipata	2.6%	60,303
Coroico	2.5%	57,983
Tupiza	2.4%	55,664
Villazon	2.3%	53,345
Yacuiba	2.2%	51,025
Jesuit Missions	1.1%	25,513
Villamontes	0.8%	18,555
Sorata	0.7%	16,235
Titicaca Lake	0.6%	13,916
Camiri	0.6%	13,916
Villa Tunari	0.5%	11,597
Cotoca	0.5%	11,597
Montero	0.5%	11,597
Yungas	0.4%	9,277

Great Valley	0.4%	9,277
Guembe Biocenter	0.4%	9,277
Moon Island	0.4%	9,277
Rurrenabaque-Madidi	0.3%	6,958

Source: Data based on the "Survey of Spending from Received and Emitted Tourism 2010" calculated by the System of Statistical Tourism Information (SIET).

With regards the number of internal tourists that made interdepartmental trips, Table 7 shows that the highest percentage of these tourists came from Santa Cruz, La Paz and Cochabamba.

Table 7. Number of internal tourists who made interdepartmental trips

Department of origin	**Tourists (in thousands)**	**Percentage**
La Paz	314.87	26.89%
Cochabamba	180.68	15.43%
Santa Cruz	372.91	31.84%
Other departments	302.70	25.85%

Source: INE (2019)

On the other hand, with respect to the country of origin of the international tourists, the most common countries are as follows: Brazil, United States, Argentina and Spain. Table 6 shows more data about the country of origin and the number of people who come from different continents and therefore countries.

Table 6. Number of international tourists, by country of origin, 2019

South America	Country of origin	Number of people, 2019
	Argentina	35,735
	Brazil	46,102
	Colombia	19,016
	Chile	21,631
	Ecuador	11,598

	Paraguay	4,926
	Peru	26,691
	Venezuela	5,744
	Cuba	3,893
Central America	Mexico	9,282
North America	Country of origin	Number of people, 2019
	United States of America	47,592
	Canada	7,190
Europe	Germany	12,440
	Spain	33,765
	France	11,248
	United Kingdom	6,147
	Italy	7,347
Asia	Japan	9,128
	China	12,386
	South Korea	8,425
Other countries		42,685

Source: INE (2019)

Table 9. Number of tourists that entered Bolivia via land and border crossing

Entry location	**Number of tourists per year**
Desaguadero	243,001
Villazón	205,490
Kasani/Copacabana	91,312
Bermejo	89,032

Yacuiba	42,221
Hito Cajones	41,233
Pisiga	29,914
Suarez Port	25,399
Tambo Quemado	22,772
Chalanes	19,398
Avaroa	16,434
Ibibobo	11,992
Guayaramerin	5,838
Cobija	4,987
San Matias	4,832
Port Acosta	1,097
Port Carangas	881
Charaña	300
Uyuni	117

Source: INE (2019)

Based on the information about the number of tourists by country of origin, the foreseeable destinations and internal tourism routes, the study estimates the distances of the trips. Table 10 shows the information used to estimate the proportions of aerial and land transport, public and private transport of internal tourism.

Table 10. Method of transport used by national tourists, 2019 (%)

Transport method	**Percentage**
TOTAL	100%
Air	3.78%
Land (public service)	79.44%
Land (private vehicle)	16.62%

Other*	0.16%

Source: INE, 2019 Household Survey, Module of Internal Tourism and Excursions

Lodging

Table 11. Number of overnight stays of foreign tourists according to capital city in hotel establishments

Number of overnight stays

La Paz	Santa Cruz	Cochabamba	Sucre	Tarija	Potosí	Oruro	Cobija	Trinidad
326,524	302,534	69,821	57,505	55,976	20,915	15,949	5,578	5,133

Source: INE (2019)

Table 12. Number of overnight stays of Bolivian tourists

Location of stay	Type of accommodation	Number of overnight stays
La Paz	Accommodation	148,306
	Residence	37,513
	Hotel	45,086
	Average	27,261
Cochabamba	Accommodation	103,607
	Residence	26,207
	Hotel	31,497
	Average	19,045
Santa Cruz	Accommodation	289,573
	Residence	73,246
	Hotel	88,032
	Average	53,229
Other departments	Accommodation	215,789
	Residence	54,583

	Hotel	65,601
	Average	39,666

Source: INE (2019)

- **Food**

Since there is no available information on the consumption of food in Bolivia's tourism sector, the study assumes average emissions of 2.5 tons of CO_2e per person from food consumption each year. For the consumption of meat, this study uses the information from the "Emissions of greenhouse gases from the consumption of beef in Bolivia" study, which indicates that the consumption of beef in Bolivia emits 8.9 tCO_2e per year (Andersen et al., 2022). Based on these studies, this study assumes an emission factor of 28.9 kg CO_2e per day from the consumption of food.

- **Waste**

For the calculation of emissions generated by wastes, this study used the median amount of waste generated per tourist; 1.1 kg per day (Obersteiner et al., 2017). This study assumes that the amount of waste generated is similar to the average amount of commercial waste. Similarly to food emissions, this study only considers emissions generated by the production and disposal of wastes by foreign tourists.

4. Results

4.1. Carbon Footprint Estimation

The Carbon Footprint of tourism in 2019, following the limits and scopes detailed in this document, is 338,008 tons of CO_2eq. These emissions are equivalent to the emissions generated by the deforestation of 749 hectares of forests in Bolivia.

Table 13. Carbon emissions by source

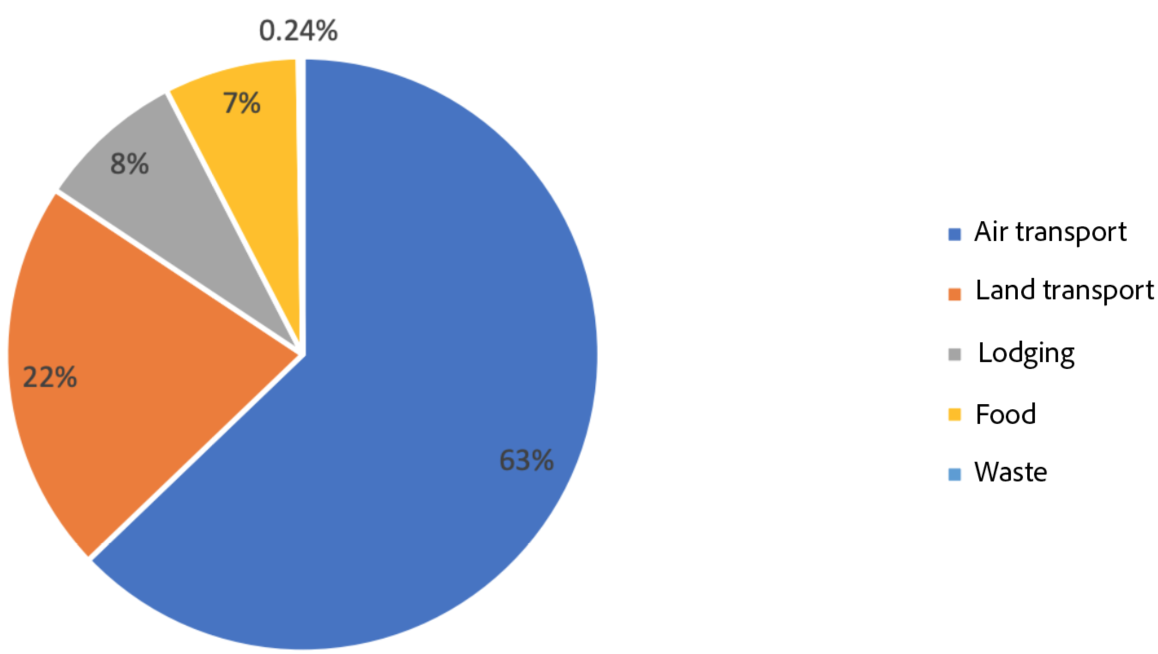
Activity	**Emissions in tCO_2e**
Flights	212,424
International flights	210,334
Domestic flights	2,091
Land travel	72,592
Domestic land travel	63,946

International land travel	8,646
Lodging	27,313
Foreign tourist lodging	6,580
Internal tourism lodging	20,733
Food	24,852
Foreign tourists	24,852
Waste	826
Foreign tourists	826
Total	338,008

Source: Authors' calculations based on information from each sector

Figure 4 shows the primary source of emissions is air travel, at 63% of emissions. The smallest source of emissions is waste generation, at 0.24%. Similarly, there are other emission activities such as the use of land transport (22%), stays in hotels, residences and accommodations (8%), and food (7%).

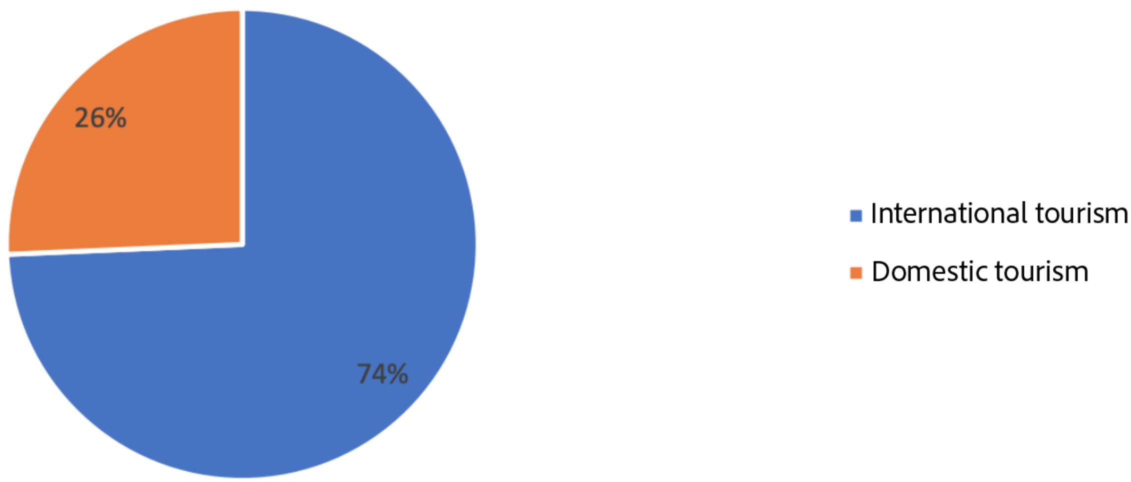
Figure 4. Carbon Footprint of Bolivia's tourism sector by emission source in 2019 (%)



Source: Authors' calculations based on the results of the Carbon Footprint of Tourism in Bolivia

Table 5 shows the results separately for international and domestic tourists. International tourism is responsible for 74% of emissions, primarily by activities related to international flights, while the majority of emissions from domestic tourists comes from land transport.

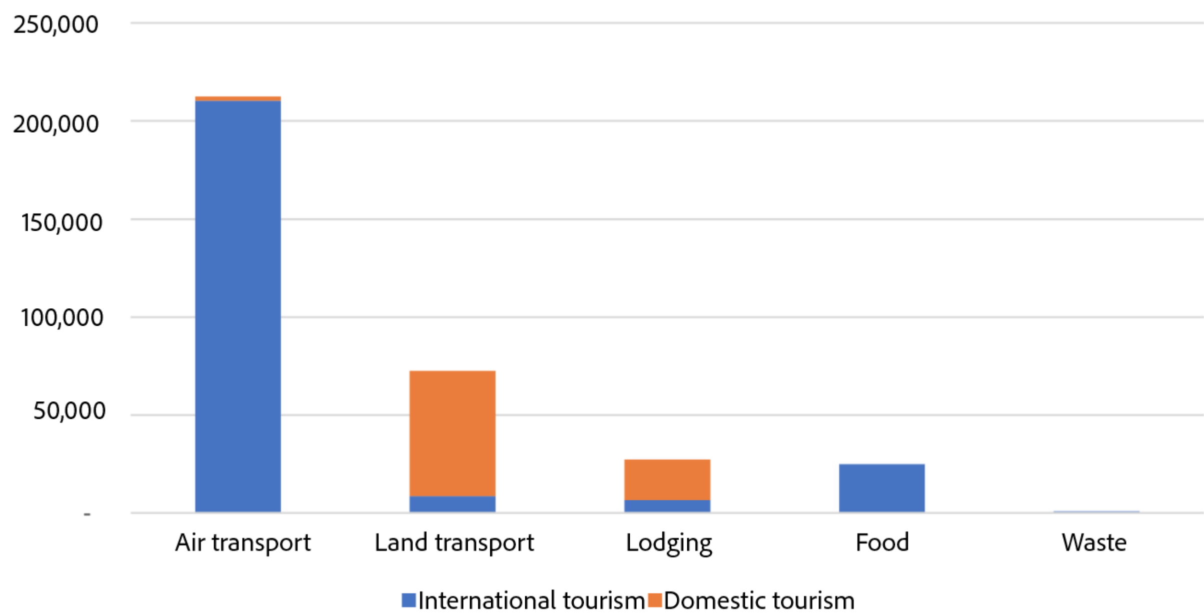
Figure 5. Emissions from international and domestic tourism (%)



Source: Authors' calculations based on the results of the Carbon Footprint of Tourism in Bolivia

Figure 6 shows the emissions by source of emission and origin (international and domestic tourism). With respect to the emissions from air transport, the greater impact is from the international flights of foreign tourists. Similarly, most of the emissions from food consumption are due to foreign tourists. The primary cause of emissions from land transport and stays is domestic tourism at 79%, and the remaining 21% of emissions are from foreign tourists that arrive to Bolivia through land border crossings. 76% of emissions from lodging are from foreign tourists.

Figure 6. CO_2e emissions generated by domestic and international tourists (in tons of CO_2e)



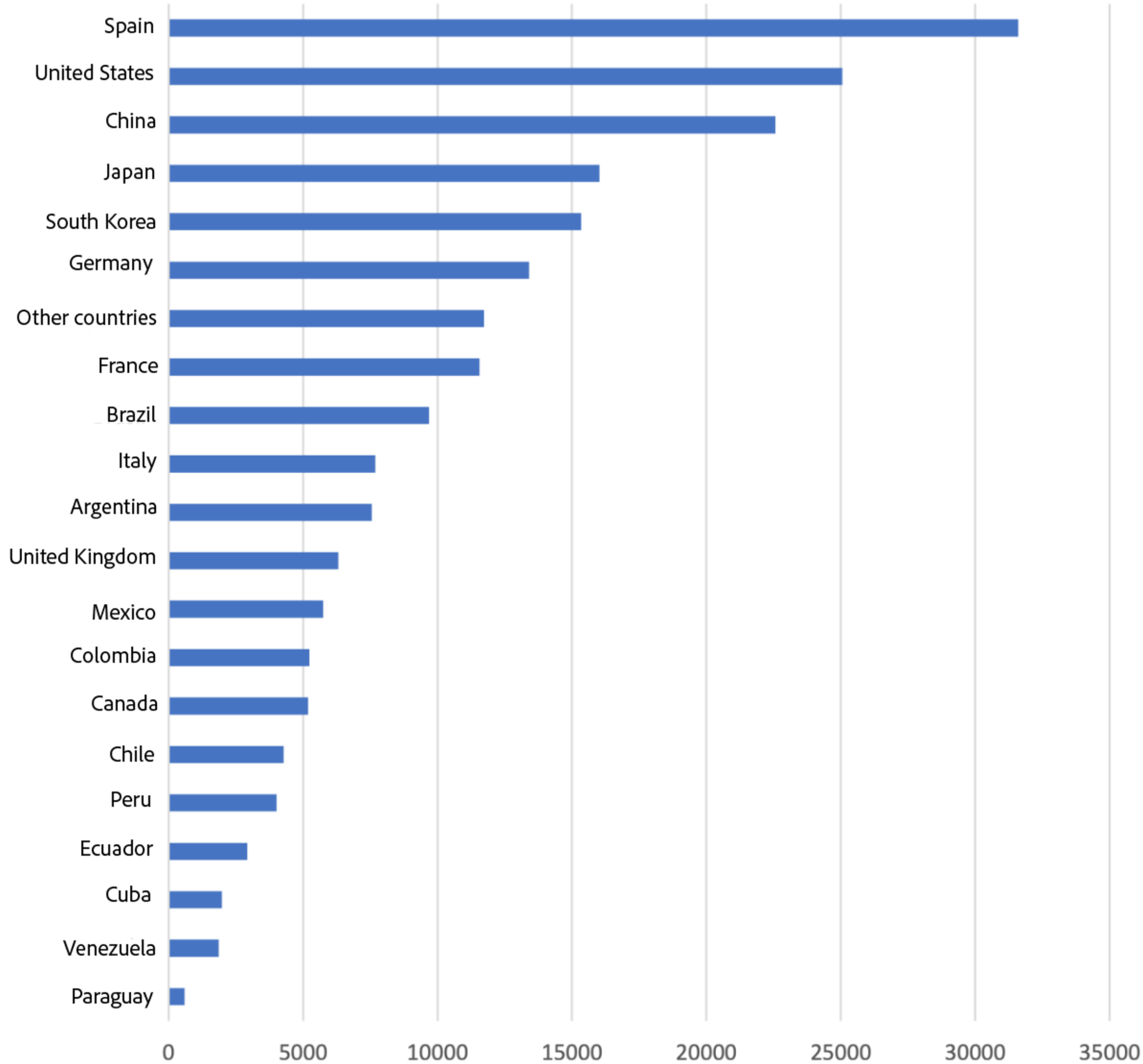
Source: Authors' calculations based on the results of the Carbon Footprint of the Tourism sector in 2019

4.2. Carbon Footprint by source of emission

4.2.1. Carbon Footprint of air transport

Air transport is the largest source of emissions, and 99% of air transport emissions come from international flights or foreign tourists. Figure 7 shows the emissions from international flights by country of origin.

Figure 7. Emissions from international flights by country of origin in tCO_2e

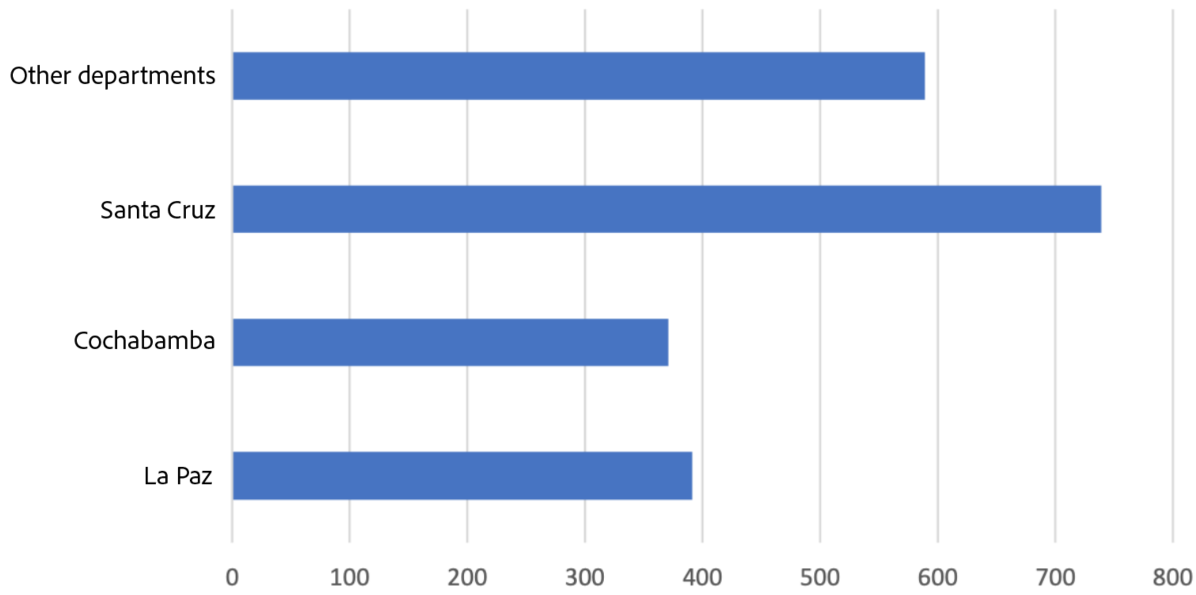


Source: Authors' calculations based on the results of the Carbon Footprint of Tourism in Bolivia

Figure 7 shows that the largest emissions come from the transport of tourists from Spain, the United States, China. The smallest percentage of emissions comes from tourists from Paraguay, Venezuela and Cuba. For this estimation of emissions, the study has not considered the stops incurred in traveling to Bolivia. In addition, the study assumes that a tourist will return to their country of origin the same way they came to Bolivia.

Figure 8 shows the emissions from the internal use of air transport, in other words, from air travel between airports within Bolivia. There are high greenhouse gas emissions from flights in Santa Cruz, with 35% of emissions from flights within Bolivia, 19% from flights in La Paz, 18% from flights from Cochabamba, and the remaining 28% is distributed amongst the remaining six departments. Similarly to international tourists, this study assumes that tourists return to their city of origin using the same method of transport.

Figure 8. CO2e emissions from air transport within Bolivia (in tons of CO_2e)



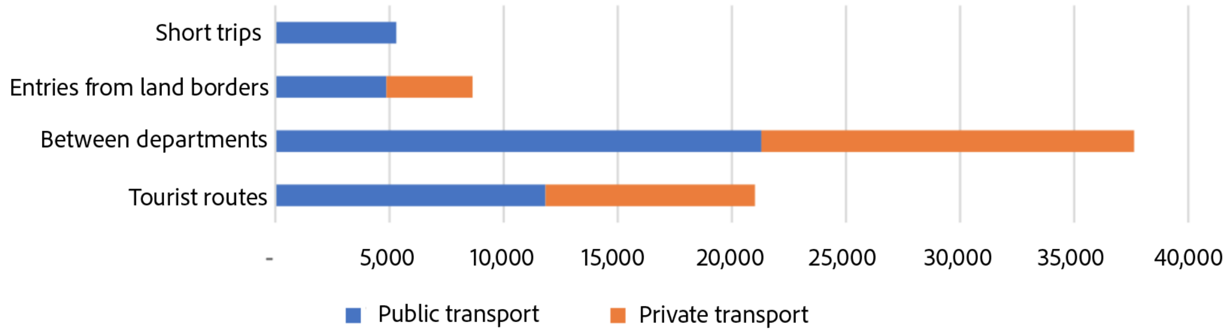
Source: Authors' calculations based on the results of the Carbon Footprint of Tourism in Bolivia

4.2.2. Carbon Footprint by land transport

The land transport sector is the second largest source of emissions, accounting for 23% of all emissions. This study further disaggregates emissions from land transport into emissions from public transport (type of bus) and private transport (common vehicles for 4 people). The following table shows the emissions by type of land transport:

Table 5. Emissions by land transport in tCO_2e

	Tourist destinations	Between departments	Entries through land border crossings	Short trips	Total	(%)
Public transport	11,843	21,293	4,873	5,303	43,312	60%
Private transport	9,172	16,334	3,774		29,281	40%
Total	21,015	37,628	8,646	5,303	72,593	
(%)	29%	52%	12%	7%		100%



Source: Authors' calculation based on data from the results of the Carbon Footprint of Tourism in Bolivia

The land transport between departments generates the most emissions (52% of the emissions of the land transport sector). The second largest source of emissions is land transport in tourist routes such as Copacabana, Uyuni Salt Flats, Samaipata, among others (29% of land transport). The third largest source is international land transport that enters from borders, accounting for 12% of emissions, and finally transport to the final destination such as a taxi, or other methods of public transport with 7%. Table 5 shows emissions from land transport divided by public (60%) and private (40%) transport.

4.2.3. Carbon Footprint by lodging

Below are the results of the Carbon Footprint associated with the consumption of energy from the lodging of foreign and domestic tourists. These results have been calculated from the number of overnight stays that are registered by department in the INE registries for 2019.

Table 6. Number of overnight stays by department and by type of tourist

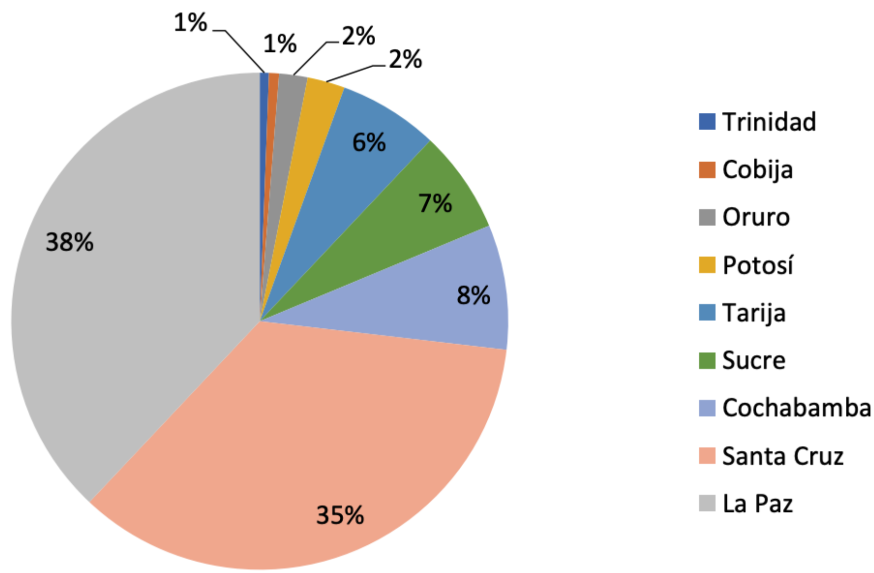
	Number of overnight stays	
	Foreign tourists	Domestic tourists
La Paz	326,524	314,869
Cochabamba	69,821	180,863
Santa Cruz	302,534	372,907
Sucre	57,505	
Tarija	55,976	
Potosi	20,915	

Oruro	15,949	
Trinidad	5,133	
Cobija	5,578	
Other departments		302,701
Total	**859,935**	**1,171,340**

Source: INE, 2019

Figure 9 shows that the cities of La Paz and Santa Cruz generate the majority of emissions from stays of foreign tourists, with 38% and 35% respectively.

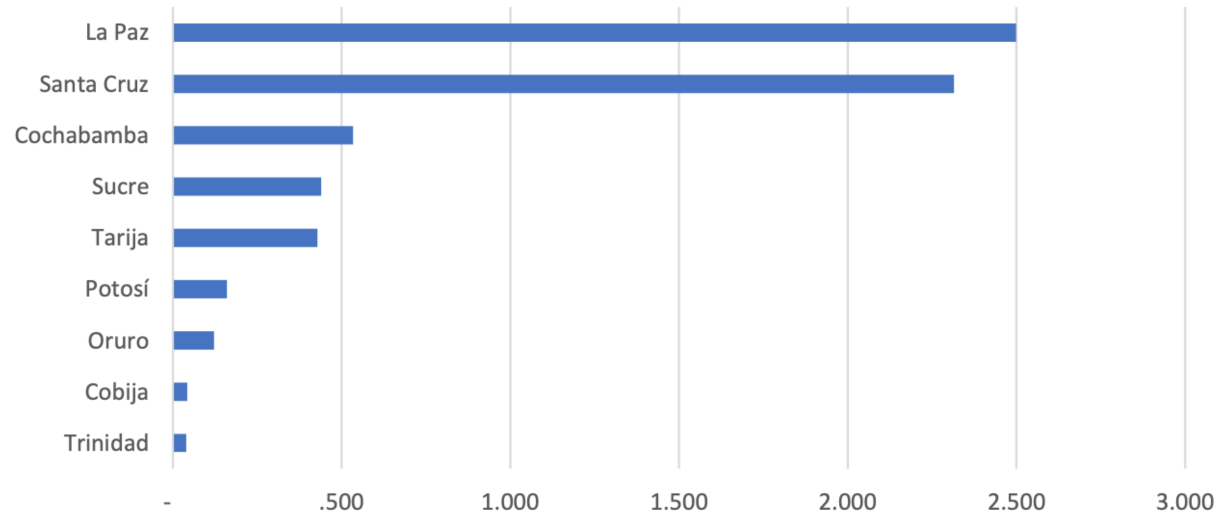
Figure 9. CO2e emissions from stays of foreign tourists by city (%)



Source: Authors' calculations based on the results of the Carbon Footprint of Tourism in Bolivia

Figure 10 shows the emissions in tCO_2e by number of overnight stays of foreign tourists, by city.

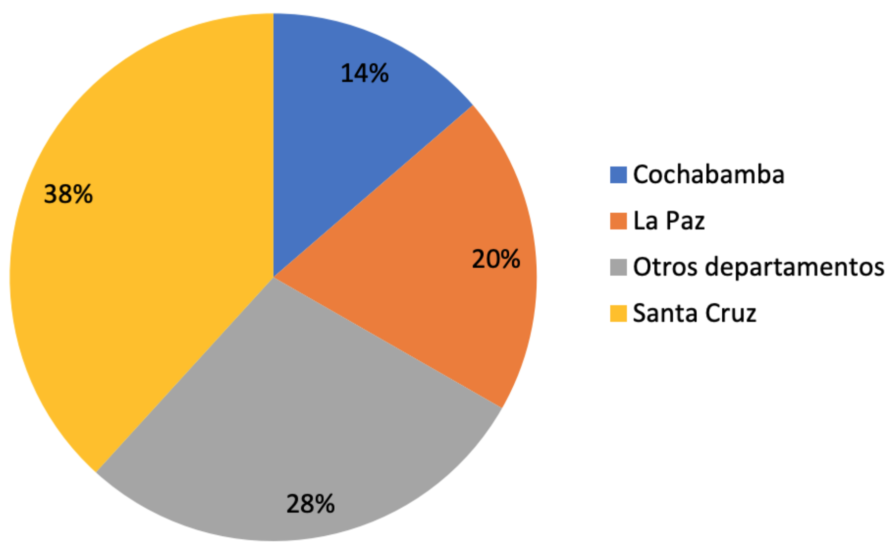
Figure 10. CO_2e emissions from foreign tourist stays in tCO_2e



Source: Authors' calculations based on the results of the Carbon Footprint of Tourism in Bolivia

For Bolivian tourists, the emissions generated by hotels are primarily from hotels in Santa Cruz, as seen in the figure below:

Figure 11. CO_2e emissions from domestic tourist stays by city (%)



Source: Authors' calculations based on the results of the Carbon Footprint of Tourism in Bolivia

4.2.4. Carbon Footprint of food

The emissions from food represent 7% of total emissions with 24,852 tCO_2e. It is important to mention that the emissions from food have only been estimated for the food of foreign tourists, given that the emissions from the food consumption of domestic tourists are not considered additional to the emissions that would be generated without tourist activity on the Carbon Footprint level of Bolivia. The emissions from food have been estimated from the number of stays reported by INE in 2019 by department. The results are shown below:

Table 7. Emissions from food in tCO_2e by department

Location of stay/lodging	Emissions from food in tCO_2e
La Paz	9,437
Cochabamba	2,018
Santa Cruz	8,743
Sucre	1,662
Tarija	1,618
Potosí	604
Oruro	461
Trinidad	148
Cobija	161
Total	24,852

Source: Authors' calculations based on INE, 2019

4.2.5. Carbon Footprint from the generation of waste

With respect to the generation of waste, the study estimates that around 946 tons of waste per year comes from the tourism activity of foreign tourists. To quantify the emissions from the degradation of organic waste in final disposal sites, such as landfills and municipal garbage dumps. Although the plastic waste is significant in tourism activities, it does not generate greenhouse gases during its disposal.

Table 8. CO_2e emissions from the disposal of solid waste (in tCO_2e)

Generation of waste	Emissions in tCO_2e
Foreign visitors	826

Source: Authors' calculation based on the results of the Carbon Footprint of Tourism in Bolivia.

4.3. Comparison with other studies

To compare the results with other studies, this study uses the indicator of emissions per tourist (per capita) per year.

Table 9. Indicator per capita for emissions per tourist (in kg CO_2e per tourist)

Country	PPC in kg CO_2e/tourist
Bolivia	140
Baltic Sea	188
Mallorca	1163
Riviera Maya	7053

Source: Based on authors' data and WWF: Initiative for a Low Carbon Tourism in Quintana Roo

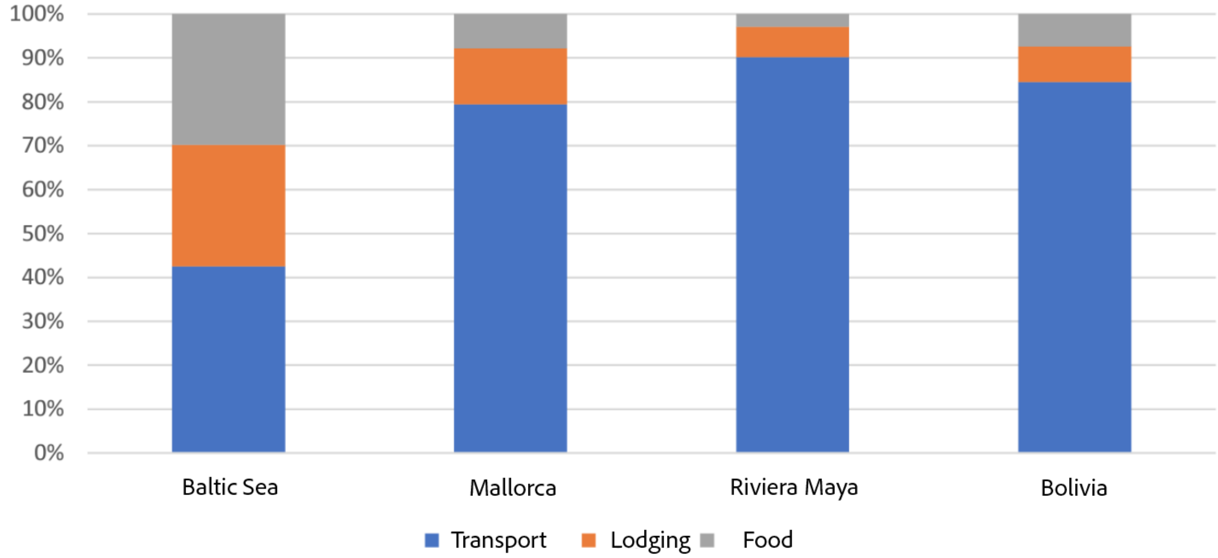
When divided by emissions source the following data are obtained:

Source of emission	Baltic Sea	Mallorca	Riviera Maya	Bolivia
Transport	80	925	6361	118
Lodging	52	148	487	11
Food	56	91	205	10

Source: Based on authors' data and WWF: Initiative for a Low Carbon Tourism in Quintana Roo

For the studies of emissions in these 3 tourist destinations, the study measures the emissions from transportation to the destination (air, land, and other), lodging and food. These estimates can therefore be compared to the emissions thus study calculates for tourism in Bolivia.

Figure 12. Comparison with other studies by source of emission (%)



Source: Based on authors' data and WWF: Initiative for Low Carbon Tourism in Quintana Roo

4.4. Guidelines for minimization and compensation

As indicated by the most recent IPCC report from 2021, the urgent need to combat climate change is more evident than ever before. The activities associated with the tourism sector release greenhouse gases into the atmosphere, supporting climate change. At the same time, similarly to other sectors, tourism is affected by climate change. The demand for tourism is sensitive to economic, environmental, and negative social impacts. It is therefore of great importance to decarbonize economic growth and development of the tourism sector on the international level and in Bolivia.

Climate change is one of the greatest challenges that humanity has faced. The tourism sector, as well as contributing to greenhouse gas emissions through associated activities (trips, electric consumption, food, etc.), is highly vulnerable to the effects of climate change, which is why it is fundamental that the sector puts in the effort to combat climate change. Below, we discuss some guidelines and actions for the reduction of the Carbon Footprint of the tourism sector in Bolivia:

The role of the private sector

The private sector, particularly the large and medium-sized companies such as hotels and tourism agencies, has an important role to play in efforts to reduce carbon emissions in the tourism sector.

The adoption of sustainable practices can help improve a company's performance. Specifically, a company can become more competitive by reducing the use of energy and water, reducing emissions from waste, and by encouraging employees to care for the environment. For example, in Bolivia there are hotels and tourism companies that have calculated the Carbon Footprint of the services they offer and are implementing plans to reduce the use of water and energy. A business in the tourism sector in Bolivia, in addition to quantifying and reducing their emissions, has also installed solar kitchens in the rural area where they operate. In both cases, the goal is to obtain an ISO certification that backs up their efforts to quantify, reduce, and compensate for their emissions.

The actions that the private sector can implement are as follows:

- Develop and implement a climate change strategy at the company level.
- Measure the baseline carbon emissions (carbon footprint).
- Identify opportunities to reduce carbon emissions.
- Inform key actors relevant to the business (employees, clients, investors, etc.)
- Implement plans to reduce greenhouse gas emissions.
- Explore opportunities of environmental certification (for example, ISO) and other quality regulations.
- Develop systems to measure the consumption of water, gas, energy, etc. to evaluate measures undertaken to reduce emissions.

The role of the public sector

Coordinated governmental support, both at the local and national level, is necessary to decarbonize the tourism sector. The public sector plays an important role in promoting the participation of all the actors involved, actions such as the development of frameworks and regulations, the implementation of incentives, new technologies, and "green" policy infrastructure.

Below, are some of the actions that can be taken by the public sector:

- Identify, develop and present clear commitments and goals for climate action in the tourism sector, in line with the contribution of Bolivia laid out by the international Sustainable Development Goals.
- Incentivise the private sector to commit to reducing emissions from their businesses, and create incentives to use renewable and efficient energy.
- Establish clear policies for adapting and mitigating climate change. Implement Monitoring, Report and Verification Systems (MRV) in order to provide information regarding the risks and climate opportunities that contribute to the planning and decision-making of the sector.
- Promote "green" construction to create sustainable infrastructure, such as airports and energy network infrastructure. Some of the Carbon Footprint of tourism can be reduced by using construction materials with a low carbon footprint, local materials and labor, and efficient technologies, as well as by installing solar panels using energy efficient devices.
- Develop and promote associations of businesses to encourage collaboration along the entire value chain, and include small and medium-sized enterprises. Many climate challenges can be met through joint investigations, activities, products and services. In the security sector,

for example, large companies can provide local hydro meteorological information for the small and medium-sized firms that operate in a territory vulnerable to climate change.

- Facilitate the transition of the different actors of the sector into a low-carbon economy through training, including vulnerable groups such as women and children. Support digital tools that help prevent climate risks, measure and monitor emissions, and mitigate their impact.
- Support the monitoring of climate impacts in the tourism sector. Access to more quality information will allow better decision-making for investment, planning, and the development of policies.
- Develop fiscal policies and financial instruments of support to promote sustainable and innovative technological solutions that support climate action and the resilience of the sector. Ensure that the fiscal measures promote, incentivize and reward the practices that support green and inclusive development.
- Manage investments and finances for actions that strengthen and protect the natural resources that tourism depends on. The conservation of biodiversity and the natural ecosystems and landscapes are key for constructing a higher resilience to climate change. This can be supported through solutions based on nature, the conservation of vegetation cover, and reforestation.
- Create platforms and spaces that support the tourism sector in its management of climate change, by means of training, guides for the calculation and reduction of greenhouse gas emissions, and the establishment of standards and guidelines.

Reduction of emissions in lodgings

Emissions related to the accommodations of tourists can be reduced through the following actions:

- Improvement in efficient energy through the growth of thermal performance of the energy networks in the installations and implementation of automatic control panels, according to the environmental requirements. For newly-constructed hotels, it is important to consider sustainable construction criteria as part of the designs. This includes more efficient energy installations, which have the potential to avoid wasting energy in the medium and long term.
- Improvement in the operation of energy systems, such as the adjustments of the heating and cooling systems, hot water for laundry and guest use, and the installation of air conditioning, more efficient lighting, and curtains that allow use of sunlight, can significantly reduce energy consumption.
- Menus and diets low in carbon chosen by guests and employees can be promoted by hotels, reducing the consumption of food products, such as meat and dairy products, which emit large amounts of greenhouse gases. It is important to educate people on the benefits of

sustainable products, materials and services, particularly those that reduce water and energy use, and improve waste management.

- Sustainable hiring practices can help lower emissions from private transportation.
- Encourage use of renewable energy sources, including induction gas stoves and heat pumps.
- It is possible to reduce waste generation through programs to reduce food waste. It is important to reduce the use of plastic and one-use items, whenever possible.

Reduction of emissions through tourism operations

- Emissions from the transportation of tourists can be reduced by choosing more efficient vehicles, "massive" methods of transport such as buses or trains, or encouraging the consumers to choose more sustainable trips or routes.
- Emissions from worker transportation can be reduced by the use of hybrid work arrangements, along with the use of new communication technologies.

Reduction of emissions by the burning of jet fuel

- The use of new and more fuel-efficient planes can effectively reduce emissions from plane trips. The technical updates, such as better motors and improvements to the fuselage, reduce emissions by about 20% relative to older plane models.
- New airplane designs with alternative propulsion technology, such as electric airplanes or hydrogen engines, can potentially replace some traditional airplanes with conventional motors. The reduction of emissions through new technology will be feasible for short-distance flights.
- Improvements in operational efficiency, due to, for example, planning flights and routes to make more efficient use of fuel.
- Sustainable jet fuel (SAF) is a sustainable alternative to fossil fuel, and can make up to 50% of the final mix of fuel in the engines of current airplanes. SAF is currently the only option to reduce the emissions of medium and long-distance flights that can be used by airplanes currently in operation.
- Government support is especially important for the actions described above. For example, to increase the use of sustainable jet fuel, governments should support the development of the SAF industry, including providing subsidies and loan guarantees for the industry. They should also reduce the price gap of sustainable fuel relative to conventional fuel and support research and the development of the local industry of sustainable fuels.
- While more sustainable technologies and fuels are being developed, many airlines promote voluntary compensation programs for carbon to mitigate the impact of emissions from jet fuel. Additionally, the compensation system designed by the United Nations should be used

by the airlines of participating countries to purchase carbon credits to compensate for the emissions that exceeded the 2019 level in specific routes.

5. Conclusions

It is becoming more and more important to fight climate change, as has been shown in the most recent IPCC 2021 report. The activities associated with the tourism sector generate greenhouse gas emissions in the atmosphere, contributing to climate change, and at the same time, equally with other sectors, the tourism sector is affected by climate change. Tourism demand is sensitive to economic, environmental and negative social impacts, which results in companies, communities and ways of life that depend on tourism becoming more vulnerable each time to the effects of climate change. For this reason, it is of utmost importance to contribute to the decarbonization of economic growth and development in the tourism sector at the international level and in Bolivia.

Climate change represents one of the major threats that humanity has confronted. Although the global response has been slow, the pace of response has accelerated in recent years. Some examples of the global response are the historic adoption of the 2015 Paris Accords to limit global warming to 1.5ºC; the adoption of the 2030 Agenda for Sustainable Development with its 17 Sustainable Development Goals (ODS), and the United Nations Climate Action Summit in 2019.

In this context, it is fundamental that the tourism sector contributes to fighting climate change. According to the obtained results, the Carbon Footprint of the carbon sector for 2019 according to the limits and scopes detailed in this document, is 338,008 tons of CO_2eq. These emissions are equivalent to the emissions generated by the deforestation of 749 hectares of tropical forest in Bolivia.

According to the data generated, the sources of emissions are: first, air transport with 63%, next, land transport with 22%, lodging in hotels, residences and accommodations at 7%, and finally the generation of waste with 0.24%.

As a result of the identification of actions and strategic guidelines for reduction, it is necessary to promote the reduction of emissions from distinct levels and actors. There are many actions that can be taken by the public sector at the national, departmental and municipal level. On the other hand, there are concrete actions that can be carried forward by the private sector, and all of the actors of the value chain, hotels, airlines, tourism operators, tourists, and the public in general. The information generated can be considered as a starting point to develop a roadmap, with the identification of the key actors that allow the planning of a short, medium, and long-term intervention strategy, with the goal of reducing emissions, and continuing with the process of measuring, reporting, and evaluating the Carbon Footprint of the sector.

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