Barcelona tourism acceptable change limit

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Introduction

How many tourists are many tourists? This is one of the universal questions of destination management: Can tourist spaces increase the number of visitors indefinitely or is there a threshold, a threshold above which each new tourist will be a new problem?
This question has traditionally been answered with the concept of carrying or hosting capacity, which has been widely studied by the scientific literature on tourism and incorporated into destination management manuals.

This is a study born from the transfer of this universal question to the geographical area of Barcelona: How many tourists are many tourists in Barcelona?. This is an idea that already appears in the World Charter of Sustainable Tourism of 1995, in which it is explicitly stated that it is necessary to *"consider the carrying capacity of destinations, not only in the case of natural sites, but also in urban areas , especially when the residents' quality of life can be compromised".* In Catalonia, some destinations such as Sitges, Siurana, the Alt Pirineu or Montsant have made proposals to limit the tourist load capacity.

The study is organized in two complementary parts. In the first part, a review of the literature on tourism carrying capacity is carried out, both in the main indexed journals and also those studies and reports that have had an impact on the scientific community and DMOs. The conclusion of this review is that the carrying capacity is not the best instrument to solve the initial question and, therefore, an alternative model is proposed, which is the LCA, the limit of acceptable change.

The second part of the study shows the estimates of the effects of tourism in a series of indicators related to the classic areas of tourism impact: the physical dimension, the environmental dimension, the economic dimension and the social dimension. The LCA method gives the decision on the level of tolerable change to the various agents involved in the life of the city. According to the estimates on the foreseeable impacts of tourism on the selected indicators, public and private agents and civil society must decide which are the tolerable changes and which are the red lines to be set in the future.

This is therefore a port of departure and not of arrival. It is a document that provides data to answer the question posed initially: How many tourists are many tourists?

1. Load capacity. State of the art

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The concept of load capacity is born in a very intuitive way. We are used to setting limits. We limit the capacity of a theater or a convention center, we set a maximum threshold of users of a parking lot, we define a maximum number of people who can follow a guided tour and wait patiently in the queue of the attraction of a theme park. On another scale, cities have the limits that set their planning and the homes on an island are conditioned by the capacity to supply basic resources.

The load capacity is based on the image of an inverted U. As is logical, the objective of a destination is to increase the number of visitors and in the initial phases we could think that the benefits inherent in tourism compensate for the impacts it generates. This concept imagines a theoretical point from which the balance between impacts and benefits is unbalanced in favor of the former, so the increase in tourists above this threshold will increase the distance between damages and gains. In this conceptual construction, there is a point from which each new tourist generates a marginal cost that exceeds the possible benefit, so the best option for the destination would be to stop growth.

In this heading, we present the results of the bibliometric study that has been carried out on load capacity. It is divided into two parts. In the first part, we present the quantitative results of the bibliometric research and in the second part, the evolution of the concept in the scientific literature and the current state of the term are detailed.

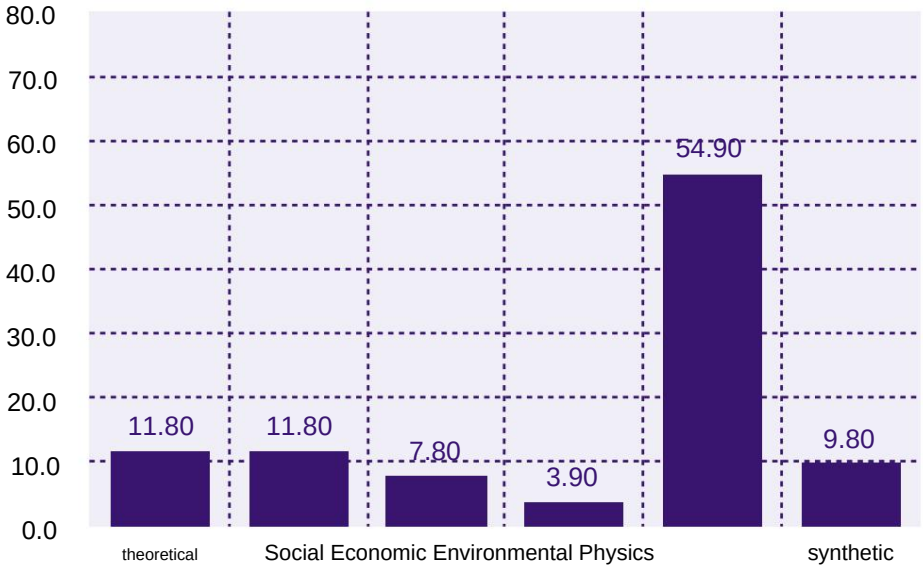
1.1. Bibliometric study of load capacity

The bibliometric study is based on the journals located in the first three quartiles of the *Journal Citation Report* for the *Tourism & Hospitality category.* Only those journals that were dedicated to the conceptualization, calculation or analysis of load capacity have been considered, so that those articles that mentioned the term, but were not part of the central body of the research, were not considered. All journals from initial issues to April 2022 have been analyzed.

The results identify only 51 articles that are dedicated to load capacity. There is a much higher number of articles that are partially linked to this concept, because they study the life cycle of a destination, the congestion of destinations, the impacts of tourism on environmental, economic and social systems or the models destination management and forms of governance. We have only considered, however, those articles that are linked to the concept of the destination growth threshold.

If we take into account the temporal evolution, we see that 45% of the articles were published before 2010. The explosion of scientific publications in the last decade (both in number of titles and in articles per year of each title) explains that in most bibliometric studies recent articles clearly predominate. That half of the articles identified are more than a decade old is a symptom of the loss of interest in this field of study.

Figure 1. Scope of study of load capacity articles



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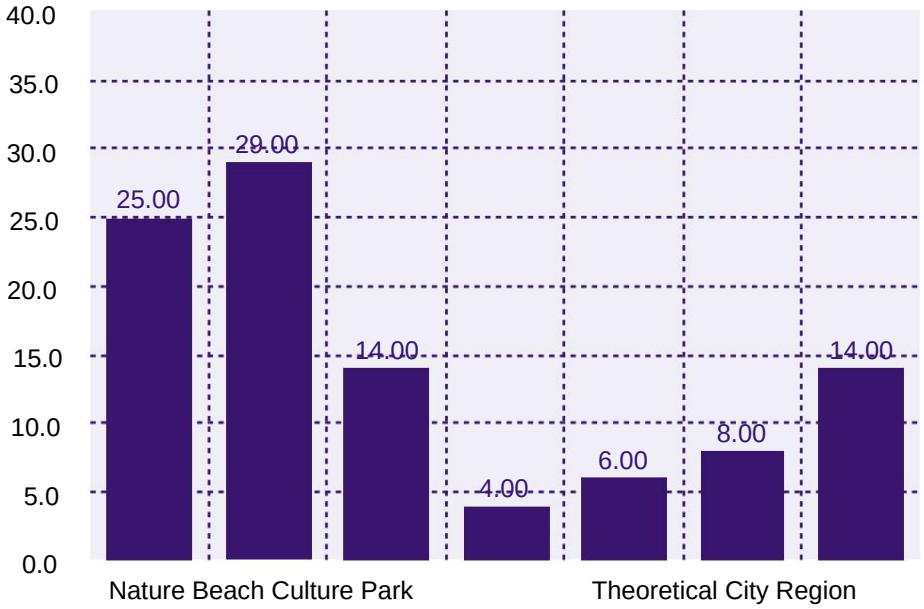
Regarding the object of study, most of the proposals are dedicated to the social load capacity, either from the perception of tourists or the perception of residents; this line of work represents more than half of the works studied. The rest have very similar values, with the exception of the load capacity based on economic criteria, which only represents 3.9% of the articles studied. The weight of the articles that propose a synthetic solution among the various indicators is also very low.

As for the geographical areas of study, the main destination is natural spaces (25%) and beaches (29%), which are actually natural spaces. It is very significant that more than half of the studied spaces are linked to natural environments. Cultural spaces (14%) or theoretical works without a geographical link also have significant relative importance. On the contrary, urban spaces only represent 8% of the total number of articles.

Figure 2. Geographic scope of load capacity items



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In short:

- Carrying capacity is not a relevant topic in the scientific literature on tourism. In fact, 27% of the articles criticize the concept or the method of obtaining the threshold.
- The focus of the research has been particularly on the analysis of the social load capacity, according to which a destination has reached its maximum threshold when this is how the local population or tourists perceive it.
- Research is more common in spaces that can be limited and controlled, such as a national park, a beach, an island, a historic center or a theme park. The larger and more complex the space (and cities are particularly large and complex spaces), the more difficult it is to set a threshold.
- Geographically, the articles have mainly focused on countries with a high tourist density, such as China, the United States, Spain, Italy or the United Kingdom; the growth of articles in China in recent years is particularly significant. However, there are also significant numbers in regions with weaker densities such as New Zealand, Australia, South Africa, Iceland or India.

1.2. The concept of load capacity

There is a consensus that the concept of carrying capacity was born in the 1960s in the United States in the framework of the management of natural spaces. The growth of the flows of the new middle classes towards the natural parks gave rise to a demand for the management of the most fragile spaces, in an attempt to reconcile the two functions of these parks: preservation and frequentation. In this context, an academic reflection and an empirical attempt was initiated to set a visitor threshold in the most vulnerable spaces. Already from the first reflections of the 60s it was suggested that there were two types of load capacities: One based on the biophysical characteristics of the space and another in accordance with the perception of saturation (McCool and Lime, 2001) .

In the 1970s, the initial theoretical reflections made it possible to draw the first applied results. For example, the National Park of the Grand Canyon of the Colorado established in 1973 a capacity of 96,500 users a day for people who carry out sports activities on the Colorado River. Years later this threshold was increased to 169,500, but the controversy still remains over the calculation model and over the possible variations of this figure. As the first examples of limit values appear, so do the first criticisms of the concept's weaknesses.

The most consistent criticism pointed to the determinism of a threshold based on the conditions of space. First, because the systems are dynamic, so the concept of carrying capacity

it can only be applied with the impossible hypothesis of invariance. Let's look at an example: The social load capacity takes into account the opinion of residents to evaluate the degree of congestion of a destination. But as the number of tourists grows, so does the number of people who derive a benefit from tourism and who are therefore more inclined to assume a higher density. So even tourism alters the initial conditions. Can a fixed threshold be set in a flexible and dynamic environment? The second criticism was associated with the idea of the criteria that determine the threshold. Different criteria give rise to different thresholds, so there is no fixed and universal value, but as many possible values as there are objectives.

That is why the concept of the limit of acceptable change appears in the 70s, which is adapted to the evidence that the load capacity threshold depends on the goals of the destination. A space whose fundamental objective is the preservation of the environment may end up prohibiting the presence of visitors, while other spaces with high degrees of degradation may act as areas for the mass reception of visitors. Thus, apart from the biophysical and social criteria, the recreational capacity defined as the amount of recreational use allowed by the management objectives of an area is incorporated. This definition raises two key ideas: (a) There is no such thing as an innate or intrinsic carrying capacity; (b) an area can have diverse capacities, in accordance with the management objectives that are set for this space (McCool and Lime, 2001).

The consensus that the carrying capacity and amount of acceptable change depends on the objectives was a key advance in the field of recreation and tourism management. Most protected areas have criteria so broad and vague ("preserve the environment", "environmental education", "promote social use"...) that it forced administrators and scientists to be more explicit and specific about which objectives were in effect in an area. It also led to the understanding that the development and choice of objectives is a social process, not physical or biological, so that the importance of governance was already intuited: The problem had shifted and now it was necessary to define some objectives on which the load capacity of the space would be fixed. This argument means that determining how much change is acceptable is a social judgment, political and ethical in nature, not a scientific assumption (Krumpe & McC

At this point, it is noted that the notion of tourist or recreational carrying capacity often confuses prescription with description. Wagar (1974: 274) states: "the term [carrying capacity] also tends to obscure an essential distinction between technical questions (involving what may be) and value choices (involving which of several possibilities it should be) ." The descriptive components involved in establishing a carrying capacity are mixed with the prescriptive component of the assignment.

In the 80s, studies on carrying capacity were characterized by two great conceptual leaps: The use of the criterion outside natural spaces and the finding of the non-linear relationship between impact and visitors. The 80s are the years of the tourist explosion as a result of the consolidation of recreational activities in the middle classes of Western societies; this Fordist expansion generated very high pressures in the receiving spaces, both due to the intensity of activity and the speed of change. For this reason, some authors begin to

suggest that also coastal spaces or monumental cities need boundaries and the first articles appear outside the usual space of the carrying capacity, natural parks and open spaces.

The authors also note that the relationship between the number of visitors and impact is not linear. The emergence of the concept of the life cycle of destinations (Butler: 1980), according to which tourist spaces go through a series of phases from exploration to stagnation, probably influenced it. The authors document that in the initial stages, an increase in visitors hardly has any impact on the receiving space, but on the contrary, in the more mature phases, the same increase multiplies the effects. Therefore, the idea of the non-linear relationship (exponential, logarithmic) between visitors and impacts appears, and therefore the need to reformulate the carrying capacity criteria.

Despite everything, very generic definitions of load capacity are consolidated. Mathieson and Wall (1982) integrate both environmental criteria and perception into the definition of carrying capacity, in a proposal that made a fortune: “[Carrying capacity is] the maximum number of people who can use a recreational environment without an unacceptable decrease in the quality of the recreational experience”. Shelby's (1987) utilitarian definition, which defines carrying capacity, has also been widely disseminated, as "the level of use beyond which the impacts exceed the levels specified by the evaluation standards".

O'Reilly (1986) describes two schools of thought on carrying capacity in this period. The first school of thought conceives tourism capacity as the capacity of the destination to absorb tourism without the host community feeling the negative impacts of tourism. Following Shelby's definition, carrying capacity would be the number of tourists we are willing to take on given a number of prerequisites. The second stream is heavily influenced by the theories of the life cycle of destinations and considers that the saturation threshold is reached when the harms of tourism influence the negative evaluation of visitors, who opt for other options.

Many of the definitions tried to integrate the two schools, on the one hand the resilience of the destination and on the other the perception of the visitors. In 1981, the World Tourism Organization defined tourist carrying capacity (CCT) as "the maximum number of people who can visit a tourist destination at the same time, without causing the destruction of the physical, economic, socio-cultural environment and a unacceptable decrease in the quality of visitor satisfaction”. Getz (1983) proposed a widely accepted view, in which he suggested that CCT had many dimensions: physical, economic, perceptual, social, ecological and political.

In the decade of the 90s, some methodological proposals appeared that tried to recover the idea of the numerical threshold. For example, Canestrelli and Costa (1991) using fuzzy programming techniques came to the conclusion that Venice could support about 25,000 visitors per day, considering the various demand profiles. But they are an exception. During this period the criticisms of the concept multiplied and es

they propose alternative ways. In his assessment of the scientific contributions up to that point, Price (1999) concludes that the carrying capacity concept is seriously flawed and is nothing more than a self-validating belief. In the same line Dhondt (1988), Mcleod (1997) or Roe (1997) suggest very severe criticisms of the proposal. Papageorgiou and Brotherton (1999) summarize this assessment as follows: "The concept is theoretically deficient, unfeasible in its application and impossible to measure". Specifically, it reaffirms the idea that there is no such thing as a “magic number”, because different goals and indicators will lead to different results (Buckley, 1999; Lindberg et al., 1997; Watson and Kopachevsky, 1996).

During this century, there has been a slight recovery of interest in tourist carrying capacity as a result of two events. Firstly, the progressive incorporation of sustainability in the tourism debate, because there is no sustainability without limits (Saarinen: 2006). Since then, the OMT has incorporated the message of a necessary reconversion of the sector with sustainability criteria, which is increased with the approval of the Sustainable Development Goals (ODS) and the recognition of environmental problems in the context of the emergency climatic Tourism appears as a factor that increases GHG emissions and exacerbates the environmental pressure of destinations because the resource consumption of visitors is always higher than that of residents. The second factor is the emergence of a movement in urban spaces (more than in mature destinations) that denounces the effects of tourism on the economy, society and the environment of urban spaces. In the main European cities, citizen initiatives are emerging that denounce the effect of tourism on local life.

There is a recovery of interest in carrying capacity from the development of the idea of 'overtourism' . The boom in congestion and overtourism studies is somehow connected to the initial idea of carrying capacity: If there are too many tourists in a destination, it means that we have crossed a certain invisible threshold that has upset the balance of the destination. Wall (2020) expresses it in these terms: “The number of tourists and their behavior can overwhelm the places they visit, damaging both tourism resources and the lifestyles of those who live in the destination areas”.

Saarinen (2006) has identified the three approaches that have guided studies on carrying capacity according to different ontological ideas and different epistemological perspectives. First, the tradition based on a positivist ecological perspective aims to protect the resource by introducing measurable limits and targets. Second, the tradition based on destination dynamics (especially Butler's product life cycle) considers that carrying capacity can be increased (or decreased) through commercialization, infrastructure improvement or renovation of the products. This approach is based on the development perspective, and is the approach adopted by several international organizations such as the World Tourism Organization. Finally, the community tradition emphasizes governance and residents' perception of the effects of tourism, so that it is the locals themselves who set the boundaries according to their goals, in a process of social negotiation

As we have discussed, there have traditionally been two ways of measuring load capacity. The first has been the delimitation of some physical criteria, based on the conditions of the environment and the second has been a social conception, based on the perception either of the residents or of the tourists. In addition, with the progressive consolidation of the sustainability paradigm, the concept of ecological carrying capacity has been added, while contributions on economic carrying capacity are very infrequent. Some works try to arrive at a capacity model based on the combination of the various elements. Let's briefly review the methodological proposals for measuring each of these criteria.

physical ability

Physical capacity is very intuitive and is based on the Malthusian idea of ecological balance: Spaces have physical limits that when exceeded create a very severe negative impact. An example that illustrates this fact is the eutrophication of certain sheets of water. The excess of nutrients, usually due to anthropogenic action, creates an increase in biomass well above the carrying capacity of that space, which consumes oxygen and makes the presence of most previously existing species unviable.

Physical carrying capacity is related to the idea of density.
Surely, the work that has had the most influence has been that of Cifuentes (1992), widely replicated, especially in the management of natural spaces. Cifuentes made a proposal to delimit the load capacity based on the criterion of the physical load capacity (CCF), the maximum number of people in accordance with the maximum density, extension and opening hours. Secondly, Cifuentes proposes correction factors that alter this capacity and which he calls real load capacity (CCR); the criteria that reduce the CCF can be insolation, precipitation, cold, avalanche risk, slope... For example, on days of heavy precipitation, the number of visitors must be reduced because the conditions deteriorate of the trails Finally, and this is one of the main contributions of the Cifuentes model, it incorporates the social load capacity (CCS) based on anthropic factors, such as for example the maximum number of people who can integrate a group, the average speed of route or the minimum distance between groups. For its part, the Williams and Micallef (2009) model has also been widely accepted, but in this case it only incorporates criteria of a physical nature and ignores the social determinants.

The physical capacity has been applied in controlled spaces, well defined, and in which the behavior of the visitors is relatively constant. The two most common areas have been natural spaces and beaches. For example, Collins-Kreiner et al. (2013) use the physical capacity criterion to assess the impact of visitors on bird behavior in the Hulla Valley, Israel. In this study, the authors detect high correlations between the number of birds and the minimum distance of visitors and the number of visitors: Every 100 visitors creates a reduction of about 65 birds in the observatory area and the reduction of the distance between birds and observers only occurs when the number of visitors is below 20 people. Basterretxea-Iribar et al. (2019)

they use it to determine the load capacity of the beaches of Bizkaia, taking into account the morphological variations due to the tides.

Despite the relevance of the physical load capacity in the scientific literature, there are not too many examples that have put this model into practice and have delimited the visitor threshold based on physical criteria. We have identified a carrying capacity project at Costa Rica's Guayabo National Monument with a CCF of 7,834 visits per day, a CCR that is reduced to 537 visits per day, and a CCS that stands at 404 visits per day. In a similar study in Goa Kiskendo, a CCF of 3,930, a CCR of 276 visitors/day and a CCS of 184 are calculated, but the average number of visits to this natural space is only 37 visitors/day (Suwarno . and Widjaya, 2018).

The delimitation of a physical load capacity has three essential problems. The first problem is that the correction factors that determine social and real carrying capacity are variable factors.
According to the objectives of the destination, the criteria can vary significantly. How do we determine, for example, that the minimum distance between groups is five meters and not three? The second problem is that tourists are not distributed homogeneously in time and space. We know that at some times of the year, or on some days of the week, the presence of visitors is much higher than the rest; and the time distribution is also very irregular, with entry points and low-occupancy valley areas. In spatial terms, visitors are not distributed homogeneously in space either; for example, we know that on the beaches the areas closest to the water have a much higher occupation than the areas further away. way that average values and average capacities actually hide very obvious spatial and temporal imbalances.

The main problem, however, with the physical load capacity is its usefulness in high-density spaces in which, on the other hand, there is the presence of other users. Natural spaces are usually only occupied by visitors, but cities are systems of interrelationships between many different types of users. Even more: Cities have been designed to function with high levels of density; they need high concentrations of people to be effective. Although the term *"overtourism"* is quickly associated with the image of physical saturation, it is not too often that the presence of tourists alters urban density to intolerable levels. This does not mean that there are no physical limits in urban spaces, but cities are more plastic and have a greater capacity for assimilation than the references on which the model of physical load capacity has been built. There are examples, of course. Feliziani and Miarelli (2012) estimate that the city of Rome should not exceed the threshold of 300,000 visitors per day.

Environmental capacity

Recently, the environmental variable has been incorporated into the debate on the limit of tourism growth, especially with the generalization of the concept of 'ecological footprint'. In this case, the idea of load capacity could be assimilated to that of ecological footprint: There are more visitors to the account when the consumption they make of resources exceeds the capacity of this space to supply these resources.

Tourism has two essential problems: First, a tourist implicitly bears the environmental cost of travel, which is logically much higher than the environmental costs of resident mobility. Second, the average resource consumption of a tourist is almost always (with very few exceptions) higher than that of a resident. A tourist consumes more energy, generates more solid waste and more liquid waste, consumes more water and generally has a much higher environmental footprint than a resident. In urban spaces, it is common for resource needs (food, energy, water, waste management, etc.) to far exceed the capacity of the urban area. By definition, metropolitan cities are large concentrations of people, so consumption always exceeds the area of influence. This raises the difficulty of setting an environmental limit for tourism, since this limit has been violated without the action of tourism.

There are two methodological processes for estimating the environmental footprint of tourism: *Up-bottom* and *bottom-up.* In the first, the general data on the environmental footprint is available and the consumption in a destination and a sector is inferred. If we know the equivalent CO2 emissions of the tourism sector in Catalonia, we can infer the specific behavior of the Val d'Aran in accordance with the characteristics of its offer. In the *bottom-up method,* the emissions data of certain companies are available and the aggregate values are calculated taking into account the characteristics of the destination. In both cases, however, there is a notable information gap and the results are usually based on simulations or estimates. If studies on the environmental footprint have been common in recent years, those that relate this threshold to the carrying capacity are more infrequent. There are also two different concepts regarding the imputation of environmental expenditure: RBA *(residence-based accounting)* or DBA *(destination-based accounting).* While the first model imputes environmental costs to the tourists' country of origin, the second relates them to the destination. For example, in a tourist trip of a German to Sicily, the RBA would impute CO2 equivalent emissions to Germany and the DBA to Italy.

Many studies have focused attention on the carbon footprint. As we have mentioned, tourism significantly increases this footprint due to the effect of transport, which has been estimated to represent 75% of tourism emissions. The UNWTO's latest report (2019) on the carbon footprint of tourism estimates that by 2030 tourist trips will increase from 8.8 billion to 15.6 billion between 2016 and 2030 and that the airplane will increase its relative value to reach 29% of trips, that is to say, almost 4.6 billion air tourist trips. The carbon footprint of tourist transport will therefore grow by 26% in the mentioned period, according to this estimate.

In general, studies on the carbon footprint highlight the differences in emissions according to the type of transport and the distance traveled. According to the UNWTO, a tourist trip generates on average 0.25 tons of CO2 equivalent, but this average is the result of an extreme diversity of situations. Dwyer et al. (2010) have estimated that in Australia tourism represents between 3.9 and 5.3% of the country's total emissions. In the case of Barcelona, Rico et al. (2019) have estimated a carbon footprint of 111.6 Kg CO2 equivalent per day for tourists and 42 Kg for hiking tourists.

Proposals on the delimitation of the footprint of other resources such as energy, water or waste generation are more infrequent, and the link between these calculations and the delimitation of the carrying capacity of a destination. Regarding the water footprint, the first essays have begun to be published that exceed the usual studies of water consumption. While the majority of works are focused on the direct consumption of water by tourists (drinking, showering, swimming pool water...), the water footprint takes into account direct water consumption and also the water necessary for the provision of tourist goods and services. For example, the city of Valencia has made public the results on the water footprint of the city's tourists, which they have placed at 0.315 cubic meters per tourist per day, of which 84% are not consumed directly by the tourist but are used by tourist goods A good example of the use of the water footprint to calculate the carrying capacity is the study by Cazcarro, Hoekstra and Sánchez Chóliz (2014) for the case of tourism in Spain.

Economic capacity

There is practically no reference to economic carrying capacity, beyond its theoretical formulation. As we have discussed, the history of carrying capacity has focused on biophysical criteria and environmental criteria, and has not given importance to economic criteria. Conversely, the definition of sustainability is based on a triangle that relates environmental criteria, economic considerations and social and cultural attributes.

We consider that the definition of economic carrying capacity has at least three essential problems: false causalities, *ceteris paribus* criteria and the limits of cost-benefit analyses. By contrast, economic data are open, detailed, contrasted and easily comparable with each other.

Let's imagine that we establish a direct correlation between the increase in visitors and the increase in the price of housing. We could think that if there is a direct relationship, the presence of one directly affects the inflation of the second. It could also be that both the price of housing and the number of visitors were two consequences of the increase in the reputation of the city, so that one would not directly affect the other but that both would be explained by a third invisible factor Urban economies are complex cogs and tourism is just another factor in their logic, so tourism movements interrelate with the other elements in a cogwheel game that has nothing to do with the simplicity of a linear relationship.

As economic systems are very dynamic, load capacity projections are based on constantly evolving starting situations. Let's imagine for example that we can establish a direct relationship between tourism and price inflation. This would allow us to project future inflation for a given level of tourism growth. However, in the future scenario the conditions of the other sectors will have changed and it will not be possible to apply the starting point ratio. It may be that a high increase in tourists does not affect inflation because the rest of the economic factors in the area are tied towards a

deflationary situation. For this reason, these models are based on the *ceteris paribus concept,* which means "assuming that the other factors do not vary".

The third problem is that economic analysis has abused cost-benefit relationships, which translates any externality into a measurable economic cost. There would be a favorable situation if the benefits were greater than the costs. However, this analysis compares magnitudes that sometimes cannot be compared. Job insecurity is an economic attribute, but it is also a social condition with ethical implications. The growth of NOx and PM15 in the air has an economic impact, but it also affects human health and quality of life, at levels that cannot always be transferred to a cost-benefit calculation.

The economic indicators have been integrated in most of the holistic proposals, which we will talk about in the last point. The most frequent criteria of these analyzes are: Poverty and marginalization, level of education and school failure, degree of economic diversity, structure of the labor market, impact on inflation (especially commercial inflation) and access to housing.

Social capacity

It soon became clear that carrying capacity is closely related to destination goals. It could be formulated as follows: There are too many tourists when people perceive that there are too many tourists. More than an intrinsic value of the territory, the ability to load would be a flexible value that depends on the social assessment. There are two great traditions in the definition of social capacity: The perception of residents and the perception of tourists. In the first sense, the carrying capacity is exceeded when the residents believe that the tourist activity generates more harm than benefits; in the second, the threshold is exceeded when visitors perceive such a high number of tourists in the destination that they can consider an alternative and, therefore, that will end up generating the decline of the destination.

Naturally, there are also interpretations that combine the two paths. The tourism social load capacity has been defined by Saveriades (2000) as the maximum number of tourists that can be present in a destination without their activities being unacceptable to local residents and without preventing tourists from enjoying the destination. When the number of tourists in a destination exceeds this social load capacity, the phenomenon of overtourism is observed (UNWTO et al., 2018). The social welcoming capacity of a destination is considered the optimal level of net benefits that tourism brings to the destination (Canestrelli and Costa, 1991). The marginal benefits of tourism exceed the marginal costs when tourism presence is low. As tourism intensity grows, marginal benefits decrease while marginal costs increase. The resulting overall net benefit curve follows an inverted U-shaped pattern, the peak of which corresponds to social carrying capacity. The social load capacity corresponds to the abscissa of the vertex of this inverted parabola.

The most widely used methodology has been that suggested by Shelby and Heberlein (1987), because it only requires tourists or residents to answer a question about the saturation rating.
According to this proposal, the carrying capacity threshold has been exceeded when two-thirds of respondents perceive overcrowding, while if less than a third perceive congestion, the area is likely to be below carrying capacity. This approach has been applied in leisure settings such as protected areas (Klanjšÿek et al., 2018), coastal areas (Gonson et al., 2018; Navarro et al., 2012), theme parks (Zhang, Li, & Su, 2017), cruises (Jacobsen et al., 2019), or beach destinations (Gonson et al., 2018), among others. This proposal has also received criticism for its arbitrariness: Why do two thirds show a problem and half, not?.

Studies generally show a very high tolerance of tourists to congestion. That there are many visitors in a space is perceived as an indicator of the success of the destination and, therefore, of the success of having chosen that space and not another. In fact, studies show the opposite effect: Visitors are more critical of the absence of tourists. It is the emptiness rather than the fullness that generates mistrust. Logically, the analyzes have also shown that different groups of tourists react differently to the same level of congestion. Navarro et al. (2013) show for example that only 20% of Costa del Sol tourists perceived overtourism and were predisposed to leave the destination. Another study with the same methodology in 1999 on the Costa del Sol concluded that only 10% of tourists perceived a situation of massification In this study, there is a relationship between this perception and the level of education or tourist expenditure (Navarro, 2005).

In some cases, attempts have been made to replace the direct survey with other indicators, such as the index of emotions measured in social networks. In a study carried out in Berlin based on the semantic analysis of comments on tripadvisor, Tokarchuk, Barr and Cozzio (2021) show that visitors need high densities to make positive ratings, although in situations of extreme congestion the ratings are negative.

In recent years, the utilitarian view on social capacity has been complemented by an interpretation from the local perspective and the interests and needs of the receiving population. According to this interpretation, tourism is excessive when people perceive it to be excessive, i.e. when they make a negative assessment of it. Again, this opens up a debate about the number and profile of residents that must be reached in order to consider that there is a negative assessment, what is the threshold from which we can consider the local view to be critical. One of the problems with this line of research, which is currently the majority, is hysteresis. Hysteresis is a concept borrowed from engineering that describes the tendency of a material to retain one of its properties, despite the absence of the stimulus that generated it. By analogy, this term is used to describe the persistence of a negative assessment of tourism by residents despite a decrease in visitors or the factors that explain the negative assessment.

Synthetic models

In some cases, the load capacity is defined from the sum or combination of the various factors simultaneously. It is common for these proposals to include indicators that help identify the impact of tourism on the attributes studied: energy, consumption, quality of life, job market... It is in this context that economic indicators are most often used, which they are never used in isolation. This proposal of indicators is the one that has been proposed by international organizations.

For example, the World Tourism Organization (2014) proposes indicators to measure the carrying capacity of urban destinations with criteria such as density, emissions, waste generation, the relative weight of visitors with respect to the total , resident satisfaction, congestion or use of public services.

This proposal does not set a synthetic threshold based on the aggregation of the various indicators, but suggests a series of indicators that can help evaluate the degree of congestion of the destination. In the same way, the report on load capacity proposed by the ESPON (2020) project funded by the European Union is a set of indicators based on environmental, physical, economic and social criteria with the intention of creating standards that can be contrasted and that they can be compared. Again, it does not determine a minimum threshold or a system for integrating diverse information, but rather selects the critical indicators and the method of obtaining them.

The limit of acceptable change (LCA)

The long journey on the load capacity allows us to reach a series of conclusions:

- Carrying capacity means different things to different people. There is no universal definition, but an extreme diversity of conceptions (Cooper et al., 1998)
- It is not possible to set a threshold value below which the destination does not suffer the effects of tourism and above which the increase in visitors will generate a negative cost-benefit ratio (Abernethy, 2001). There are few examples of obtaining this 'magic number', which is actually the result of a series of prior decisions conditioned by the destination's objectives.

- The carrying capacity, therefore, varies according to the desirable destination model, the relationship between tourism and the rest of the destination's activities and the criteria we use in its evaluation.
  Different indicators will produce different results and the same indicator can be read in different ways according to the evaluation criteria we incorporate into it (Miller, 2001).
- The establishment of a load capacity creates the fiction of objectivity or scientific criteria for a decision that is essentially political. The carrying capacity is not an immanent property of the places, but a decision of the actors involved in the management of the destination.
- There are four ways to measure carrying capacity, which are the physical criterion, the environmental criterion, the economic criterion and the social criterion. The scientific literature has focused essentially on the latter: There is

overtourism when overtourism is perceived (whether residents or tourists).

The alternative proposal on which this study is based is the acceptable change system (LCA). The LCA was developed in 1985, with the purpose of dealing with recreational load capacity management (Stankey, Cole, Lucas, Petersen, & Frissell, 1985). But unlike the carrying capacity model, the focus is not on the maximum number of tourists but on the tolerable changes in the environment, whether ecological, physical or social. In a way, it moves the initial question “How many tourists are too many tourists” to a new question that could be formulated as follows “How far do we want to go”

The application of LCA is based on the following parameters:

- The center of interest shifts from the amount of tourists admitted to the tolerable changes. It is the definition of the changes that do not want to be assumed, the fixing of the red lines, which determines the maximum number of visitors to a territory.
- Methodologically, this involves two complementary processes. Firstly, to identify the impact of tourism on a series of reference indicators; and, secondly, to estimate the changes that may occur in these indicators as a result of possible growth or reduction.

- The carrying capacity calculation experience shows that the relationships between tourism and its impacts are complex and dynamic. For this reason, the system of indicators and the estimation of the expected changes must be permanently reviewed with the contribution of new data and with the empirical evidence of effective changes. The LAC is a *working progress,* a process that is permanently under review with the provision of new information.
- The decision on tolerance thresholds, the maximum changes that a destination can assume, is a political decision. It is the governance of the destination, the participation of the various agents, that must set those red lines and, consequently, the maximum values of visitors that the destination should receive.
- There is no single tourist profile, but a diversity of cases that affect the various indicators unequally. A MICE tourist, for example, will have less pressure on the density of the Old Town (because its presence is much lower than that of the leisure tourist) but since it comes from more distant destinations it has a much higher carbon footprint. In other words, each tourist profile (nationality, motivation, form of accommodation, etc.) has an impact in one way or another on the set of indicators. Therefore, destination management must not only take into account the maximum number of visitors that best satisfy the tolerable changes defined in a social process, but also the visitor profiles that best suit each objective.

2. The acceptable change limit. The method

This is a study on the Acceptable Change Limit for tourism in the municipality of Barcelona. It is, therefore, a reorientation of the initial proposal to define the carrying capacity of the municipality. It is based, however, on the same criterion and follows the same methodological procedure as other studies focused on load capacity.

The study is based on the selection of a series of indicators linked to the physical, environmental, economic and social characteristics of the city, following the methodology used in similar studies focused on carrying capacity. The selection of indicators is itself a decision process: Each selected indicator also implies an excluded indicator, and different indicators could lead to different interpretations. Therefore, the process of selecting the indicators must be dynamic and must be part of the collective decision-making about the LCA. It should be borne in mind, however, that the indicators are also related to the available information: There are criteria that should be studied, but for which the necessary information is not available.

The pandemic has been a factor in the distortion of mobility and especially tourist trips. For this reason, we have chosen to place the study in the pre-pandemic scenario and base ourselves essentially on the period 2018 - 2019. We still do not know how COVID-19 will affect tourism dynamics, whether it will be a mere parenthesis or a new scenario . It is, therefore, a study that, like starlight, describes a reality that no longer exists.

The indicators chosen for the analysis are organized in the four areas mentioned:

physical scope

1. Density (tourists or visitors per km2)
2. Relative weight (percentage of tourists or visitors with respect to the total)
3. Density by district
4. Relative weight by district

Environmental criteria

5. Effect of tourism on water consumption
6. Effect of tourism on energy consumption
7. Effect of tourism on the generation of waste
8. Effect of tourism on the EGH of Barcelona

Economic field

9. Impact of tourism expenditure on GDP

Social assessment

10. Impact of tourism on the perception of tourists
11. Impact of tourism on the perception of residents

3. Tourist density

3.1. The number of tourists

Cities are the meeting point of many people who coincide in time and space. Cities are exactly that: the fragile balance between those users of the space who remain on a regular basis and those who access it on an occasional basis. A city only for visitors would be a failed city, a simple decoration; but a city of only residents, a city that has no contact with the outside and no temporal flows, is a flooded city. Cities have always been places and ports, meeting points and starting points.

We tend to divide city users between tourists and residents. And we have projected the image of visitors who relate to the place in a very superficial, very banal way, as opposed to the residents, who make up the city's identity. Tourists would be the liquid relationships and residents would represent the solid relationships. Between these two categories, however, there is a much higher number of cases and circumstances; there is a *continuum* of systems of relations with the city ranging from the generational link to the quick visit of the tourist tour.

It should be noted, first of all, that a tourist is a person who visits the city (outside their usual environment) for an unpaid activity in the destination. So the people who come to the city for a seminar on oncology treatments, those who train the human resources managers of a multinational located in Diagonal, those who visit a relative settled in the Eixample or the student from a master's degree in landscape at a university in the city center. Tourists are all those people who settle temporarily in the city without the will to work there regularly, that is to say, all temporary users of the city who are not migrants.

It is also not easy to specify what a resident is and, especially, to demarcate precisely the border between a resident and a non-resident. The extreme mobility of the metropolitan population, which frequently changes municipality of residence, property or status, does not facilitate the task of specifying who is a resident and who is not. There are students who decide to stay in the city beyond their studies, tourists who are trapped by the seduction of the city, digital nomads who have decided to settle temporarily in Gràcia or Poblenou, or retired people who transit through the city between curiosity and everyday life. More than two basic stages, like two collectives that can be separated into different spaces, we have to imagine a *continuum,* a wide range of grays that include increasingly diverse and heterogeneous situations. Many of these realities escape the usual statistical records. There are long-term tourists who live in rented flats or residents who use tourist facilities.

How many tourists are there on any given day in the city of Barcelona? It is a capital question to determine the effect of tourism on the urban density of the city. In the 2017 study on mobility (Barcelona City Council, 2017) it is estimated that the number of tourists in the city is 17.36 million people, who spend 50.82 million nights. This means that 139,000 tourists arrive in the city on an average day. In addition, in the same study it is estimated that the volume of hikers is 5.6

million so that on an average day there are 154,641 visitors to the city (tourists plus hikers).

We want to update this data with the records of 2019, at the same time we want to propose some calculation variations that will significantly increase this value.

3.1.1. Tourists staying in hotels

Barcelona had a very limited hotel offer before the Olympic Games. The city did not reach 20,000 places and was far from the tourist image of the great European capitals. The evolution of the plant has had two great leaps: Firstly, the impetus of the period between 1990 and 2000 which allowed the number of places to practically double and exceed the 30,000 threshold at the turn of the century. The Games only partially explain this milestone: Many urban destinations experience stagnation or decline in the post-Olympic period, but the city used the event as a lever, not an engine. The universal consolidation of Gaudí and the success of the city's tourist plan explains the second leap in the first decade of this century, when the city doubled its hotel offer again and reached 60,000 hotel places. Growth has moderated over the last decade and has reached 73,000 places, although the emergence of housing for tourist use has generated a strong increase in the total supply.

This is a key element in understanding the impact of tourism on the city. The city's accommodation capacity has gone from just over 20,000 in 1990 to 150,000 in 2019. Unlike tourism in other large European cities, which have had a relatively slower growth rate, Barcelona has gone from anonymity to success, to be among the great destinations of mon, in a very short time: It has had very little ability to adapt to assimilate the changes generated by tourist activity. During this short period of time, not only has the offer of accommodation increased significantly, but it has also diversified. Hotels represented the vast majority of the city's tourist offer in the pre-Olympic period, while currently they represent less than half of the total offer.

In 2019, Barcelona welcomed 9.5 million visitors to hotels who spent 19.9 million nights in the city. This data is collected by the Tourism Observatory in Barcelona, which does not match the data provided by the INE. The hotel occupancy survey identifies a significantly lower number of tourists (8.5 million) and instead an increase in overnight stays (21.3 million). It also does not match the data used by the *Tourism Data System* of Catalonia, which estimates that in 2019 there were 9.25 million arrivals and 23.3 million overnight stays, with an average stay of 2.52. These variations significantly affect the results. For example, the difference between the Observatory and TDS data is 3.5 million nights, which is higher than the expected growth variations in some of the scenarios. In this study, we will work with the estimate made by the Observatory.

Table 1. Tourists in Barcelona hotels according to different sources

	observatory	INE	TDS
arrivals	9,472,562	8,520,416	9,251,515
nights	19,852,416	21,361,391	23,334,580
average stay	2.1	2.51	2.52

Not all people who stay in hotels are, in the strict sense, tourists, because they should meet at least two conditions: That the person who stays there has left his usual space and that he has not received remuneration in destiny However, in practice all people staying in hotels are considered tourists because it is estimated that the percentage of non-tourists is very insignificant.

The number of stays is not the same as the number of nights. A person who sleeps two nights in a hotel will spend three days in the city. Although the official tourism statistics always work with overnight stays, in this study we are interested in days, the number of days. It is true that in some cases, the additional day will be very short because the visitor will leave very quickly towards their origin; in other cases, tourists can use the remaining time to speed up their stay in the city. But this diversity is also present in the rest of the city's users (residents, hikers, commuters...), who can have a full or partial stay. This consideration will change the data proposed in the study on tourist mobility. In this case, the calculation of the stay is as follows.

$$Ji = Ti \times (E + 1)$$

Tourist days for a given period will be the number of tourists multiplied by the average stay (nights divided by tourists) plus 1.

Table 2. Tourists staying in hotels

tourists	9,472,562
nights	19,852,416
average stay	2.1
Occupancy rate (rooms)	82.8%
Occupancy percentage (places)	72.7%
days	29,364,942
day tourists	80,451

source Barcelona Tourism Observatory

According to this criterion, the number of days of tourists staying in Barcelona hotels approached 30 million. The number of tourists per day will be the days divided by the number of days in the year.

3.1.2. Tourists staying in pensions and hostels

Pensions and hostels respond to a very specific demand profile in large European cities. In Barcelona in 2019, 6,489 places were offered in 290 establishments, preferably located in Ciutat Vella and the Eixample. According to data from the Barcelona Tourism Observatory, 770,000 arrivals were registered in 2019 with a total of 1.74 million overnight stays. Therefore, the average stay is slightly higher than that of hotels.

The degree of occupancy of pensions and hostels is, as in the case of hotels, very high and exceeds 80% if we take into account the occupancy of rooms and 74.4% if we consider the places.

We follow the same criteria as in the previous case, it has been considered that a day is the number of nights plus 1. In accordance with this, in 2019 there were 2.5 million days spent in pensions and hostels, so that we can infer that on an average day in the city of Barcelona we will find nearly 7,000 people staying in this type of accommodation.

Table 3. Tourists staying in pensions and hostels

tourists	770.151
nights	1,740,962
average stay	2.26
Occupancy rate (rooms)	82%
Occupancy percentage (places)	74.4%
days	2,510,692
day tourists	6,878

source Barcelona Tourism Observatory

3.1.3. Tourists staying in apartments

Apartments have a residual value in the city's supply model. With the emergence of housing for tourist use (HUT), this typology has lost relative weight and has almost no impact on demand as a whole. In 2019, the 12 apartment companies represent 765 places.

According to the Barcelona Tourism Observatory, in 2019, 781,006 nights were registered in apartments, with occupancy in places similar to hotels and hostels. The total number of days exceeds one million, which is equivalent to 2,722 tourists per day.

Table 4. Tourists staying in tourist apartments

tourists	230,436
nights	781.006
average stay	3.39
Occupancy rate (rooms)	80.2%
Occupancy percentage (places)	59.2%
days	1,011,614
day tourists	2,772

source Barcelona Tourism Observatory

3.1.4. Tourists staying in HUTs

Housing for tourist use (HUT) is a relatively recent form of accommodation, which has altered the supply system of the city and has had an impact on housing supply. The main service operator is Airbnb, a company founded in 2007 that quickly entered the international private home market. The 2011 law allowed the regulation of this type and there was an explosion of supply, which has been limited with the approval of the PEUiAT.

Tourist accommodation is a very unique type of accommodation. If originally this form of accommodation was associated with the collaborative economy, it soon transformed into a lucrative economic activity. Part of the offer is operated by professional services that manage several apartments simultaneously, while another part is offered by individuals.
According to the InsideAirbnb website, in 2019 the Airbnb portal had 8,778 hosts registered, of which 6,304 (71.8%) only managed one ad. Individual managers, however, represent 27.6% of the places while 50.4% of the places belong to multi-managers who have five or more ads; in fact, 1.2% of hosts manage 31.7% of places.

Catalan regulations require that homes for tourist use be registered and have a licence. The CEAT, the Census of Tourist Accommodation Establishments, identifies 9,572 establishments in Barcelona with a global offer of 58,583 places. On the other hand, the exploitation of InsideAirbnb data made by Montera34 identifies that in 2019 there were 17,807 advertisements on the Airbnb portal, which had a total offer of places for 61,121 people (Montera34, 2019)

Considering that not all homes are marketed on airbnb, there is a very significant gap between the number of permitted establishments and effective establishments, which indicates a significant volume of illegal places. In InsideAirbnb's data, the number of establishments with a license in 2019 was 6,242, i.e. 35.1% of the total. There are more than 3,000 properties that are licensed but do not appear in InsideAirbnb's captures, and conversely, there are 11,000 properties that are not licensed. As a consequence of the inspection policy of Barcelona City Council, and also the result of

agreement with industry platforms, the number of illegal registrations has been significantly reduced. The study by Montera34 estimates, for example, that between May and September 2018, advertisements for complete flats in Barcelona were reduced by 29%, as a result of this agreement.

In 2022 this situation has changed significantly. According to InsideAirbnb data, 8,799 homes can be found on the Airbnb portal, of which 5,616 have a license, that is to say 63%.
There is still a significant volume of supply without the compulsory license, but its relative weight has been significantly reduced. Recently, the High Court has ruled in favor of the Airbnb portal and exempts it from removing advertisements for homes that do not have a license, following a similar ruling in the case of HomeAway.

The factor that has had a greater impact on the system is the recent approval of Decree 75/2020 which authorizes the rental of rooms (home *sharing),* for stays of less than 31 days and with a maximum of 4 people per home. It is estimated that in Catalonia this offer represents around 14,000 rooms, of which between 7,000 and 8,000 are located in Barcelona. At the moment, the situation is in a stand-by due to the moratorium proposed by the City Council for the application of the Decree. Logically, this can be a factor in the distortion of supply because it allows an uncontrolled increase in supply in a context in which the PEUAiT has made it possible to slow down the previous rate of growth.

In short, the situation of HUTs in Barcelona is as follows:

1. The legalized offer of housing for tourist use has stabilized below 10,000 establishments and 60,000 places.
2. Airbnb markets around 16,000 offers, of which 60% are entire homes and the rest are shared rooms.
3. Legalized tourist use homes represent 68.6% of the offer on Airbnb.
4. In addition, the portal offers around 7,000 rooms in shared flats, which represent approximately 40% of the total offer. This offer is at an impasse after the moratorium proposed by the City Council.
5. A part of this offer does not generate tourist activity or has a very low booking volume. Of the 16,000 establishments on offer in Barcelona, 3,471 (21.6%) were occupied for more than 90 nights in the last 12 months. If the average activity of the 16,000 records is 51 nights, in this 21.6% it is 179.

If we look at the official data collected in table 5, tourists staying in HUTs in Barcelona are about 3.5 million in 2019, with an occupation of 11.4 million nights. The percentage of occupancy is based on the maximum places, and not on the occupancy ratio. These 11.4 million nights represent about 15 million days, that is to say about 41,000 visitors a day. But these data only refer to regularized stays, and do not include stays in illegal accommodation.

Table 5. Tourists staying in HUTs (official data)

tourists	3,480,060
nights	11,433,427
average stay	3.3
Occupancy percentage	55.6%
days	14,964,258
day tourists	40,998

source Barcelona Tourism Observatory

The 2017 mobility study identified a relatively similar number of HUT users (3.1 million and 10.5 million overnight stays), but supplemented it with an estimate of employment in non-legalized spaces at 1.88 additional million visitors and 6.4 million overnight stays. This is the result of considering that 37.8% of HUT reservations take place in non-legalized homes, with the same average stay (3.4) in both groups. Probably, the relative weight of stays in non-regulated establishments has decreased significantly.

First of all, because there has been a process of regularization especially in homes, and not in rooms that continue to be considered an unregulated offer. But especially because the average employment of the non-regularized offer is much lower.
For example, in 2022 the InsideAirbnb portal estimates around 6,800 private rooms offered, but only 960 of those 7,000 have made a minimum 90-day reservation in the past year.

There are four methods for estimating the volume of unregulated HUTs, which result in very different values from each other: (a) the activity estimation method based on values from the InsideAirbnb portal; (b) the estimate according to the survey of visitors in the various points of the city; (c) the estimate based on data from FRONTUR and (d) the estimate on employment in tourist accommodation based on data from digital platforms. With the exception of the first case, the results of the estimates are very close to the official data and, in some cases, are even lower.

a. Estimate based on InsideAirbnb values

If in 2018 this website had registered 19,200 advertisements in Barcelona, in 2019 it had dropped to 17,807 (and 16,042 in 2022). The average number of records for each advertisement was 51 nights, so in 2019 the system detected 816,000 occupations; with an average occupancy of 4 people per accommodation we would arrive approximately at the official figure. It should be borne in mind, however, that there is a percentage of activity that is not registered and that logically not all activity is concentrated on this portal, although it is the most relevant.

We could try to measure the volume of demand in unregulated establishments based on the estimates of the InsideAirbnb portal. In 2019, the website had detected that the number of unlicensed homes was 3,063 (2,276 listed as "unlicensed" and 787 "exempt").

This means that 68.6% of homes for tourist use are regulated and 31.4% are not; the average occupation of these establishments would be 29 nights, that is to say around 89,000 occupations. As for the rooms, there are 538 with a license (they are probably homes offered by rooms) and 8,502 without a license; the average occupation is 27 nights, so that would be 229,554 occupations, probably with an average number of people per occupation lower than housing. With this estimate, in Barcelona in 2019 there would have been between 800,000 and 1.2 million tourists staying in unregulated HUTs.

b. Estimate based on visitor survey

To make an estimate of the volume of people actually staying in tourist accommodation and in shared rooms (legal or not), we have calculated the relative weight of this typology in the survey on the profile of visitors taking accommodation into account declared by tourists who have spent the night in Barcelona at open interception points, that is to say, those that are not located in hotels. The range is very variable and is at the highest points in the interceptions at the Picasso Museum (28.5%), Montjuïc (27.4%) or Santa Maria del Mar (27.1%); on the contrary, the lowest values are recorded in Fira Gran Via (14.4%), Sants (15.5%), Rambla del Raval (15.7%) and Portal de l'Àngel (17.2 %).

The weighted average of the relative weight of HUTs on the total number of people intercepted is 20.6%. According to this weight, the total number of days would be very similar to the 14.96 million that are collected in the official statistics (and also relatively similar to the total nights registered on InsideAirbnb). It is very likely that a part of the respondents will answer that they are housed in other categories. While the category 'hotel' is universal and is clearly limited and accepted, housing for tourist use can also be interpreted as other forms of accommodation, especially the stay in private homes and, to a lesser extent, the concept of hostel especially for the rooms.

c. Estimate based on FRONTUR data

The data collected by FRONTUR identify 19.3 million foreign tourists in Catalonia in 2019. The survey is carried out at the main points of entry (road, airport, port, stations...) and represents a total of 450,000 interviews in state scale. As can be seen in Table 6, 68.4% of tourists stay in hotels and similar with a total of 13.3 million. The total number of international tourists in rental housing in Catalonia would be 1.871 million (plus 285,242 from other forms of accommodation on the market). This would represent about 2 million international tourists. It should be borne in mind that in Barcelona 91.6% of tourists staying in HUTs are international. With this projection, we would be very far even from the official data of visitors in HUTs.

Table 6. International tourists in Catalonia by type
(Number of tourists)

Hotels and the like	13,297,031
Housing family or friends	1,913,463
Housing for rent	1,871,842
Camping	795,296
Own housing	614,373
Cruise ship	400,173
Other accommodation market	285,242
Other non-market accommodation	136,288
Country house	61,445

source FRONTIER

d. Estimate based on INE data

The INE is experimentally exploiting the data it has obtained from EUROSTAT based on information from the main platforms (Airbnb, Booking, Expedia, Tripadvisor...) for all those establishments that are part of CNAE category 55.2, made up essentially for homes for tourist use. The system offers data for the main destinations, including Barcelona.

Table 7. Tourists in accommodation CNAE 55.2

	total	state	international
occupations	907,000	83,000	823,000
Nights room	3,763,000	285,000	3,482,000
average stay	4.1	3.4	4.2
Tourist estimate	3,628,000	332,000	3,292,000
Nice estimate	15,052,000	1,140,000	13,928,000
Daily estimate	18,502,800	1,460,800	17,118,400

a. Estimated 4 people per accommodation
source INE

The data provided by this source (still in an experimental phase) makes it possible to estimate a number of tourists very similar to the information in the official data, but on the other hand a greater intensity in the nights and days, since a higher average stay is estimated . This source has the advantage of incorporating results from all platforms and not just Airbnb.

3.1.6. Tourists in hostels

Hostels are a very unique typology, with a strong presence in Barcelona. Half of the country's hostels are located in the capital: Barcelona's 128 establishments offer 10,457 places. There is no record of hostel users in the official statistics, so we have estimated the volume by applying to this offer the criteria of pensions and hostels (73% occupancy of the total places and 2.2 nights of average stay). The INE provides for Catalonia as a whole a significantly lower employment, but according to the results of the tourist profile survey, we have maintained this figure.

Table 8. Tourists staying in hostels

tourists	1,266,485
nights	2,786,267
average stay	2.26
Occupancy percentage	73%
days	4,052,752
day tourists	11.103

source Barcelona Tourism Observatory

3.1.7. Tourists in private houses

We know that some tourists choose to stay in private homes without any financial remuneration. These are stays in the homes of relatives and friends, which are not part of the city's tourist offer and which, therefore, are very difficult to identify. Traditionally, the method of estimating this typology has been the visitor profile survey. If we know the relative weight of this typology on the total number of visitors and we have the absolute values of other typologies (such as those staying in hotels), we can make an estimate of this volume.

Table 9.1. Accommodation declared by tourists intercepted in MICE spaces

	Hotel	Pension	HUT	Hostel	House	Other
Barcelona Fair (L'H)	72.8	0.4	14.4	3.6	8.3	0.5
Barcelona Fair (Montjuïc)	43.5	1.6	26.2	9.5	18.3	0.9
CCIB	73.5	1.6	17.8	2.4	4.5	0.2
Palau de Congressos de Catalunya	91.7	0.0	0.0	4.2	4.2	0.0
Congress Palace of Barcelona	73.3	0.0	13.0	5.3	6.9	1.5

source Profile and habits of tourists in the city of Barcelona 2018-2019

Table 9.1 shows the distribution of accommodation declared by tourists in MICE spaces. There is a clear preponderance of the hotel in all spaces with the exception of the Montjuïc Fair, where conversely the hotel is very secondary.

Table 9.2. Accommodation declared by tourists intercepted in transport spaces

	Hotel	Pension	HUT	Hostel	House	Other
Sants station	43.8	1.6	14.1	12.6	25.8	2.2
North station	26.4	3.2	16.2	20.1	32.0	2.1
Cruise Terminal	78.7	1.1	9.3	3.0	7.8	0.0

source Profile and habits of tourists in the city of Barcelona 2018-2019

In the surveys carried out in entry spaces, the differentiation of profiles is seen according to the means of transport. Cruises are related to hotel accommodation, while on the train other forms gain weight such as private houses or housing for tourist use, which are clearly the majority among those tourists who have been intercepted at the bus station.

Table 9.3. Accommodation declared by tourists intercepted in open spaces

	Hotel	Pension	HUT	Hostel	House	Other
Portal of the Angel	52.7	3.1	16.8	13.3	13.3	0.9
Cathedral	45.4	3.8	22.7	13.5	13.1	1.5
Catalonia Square	51.9	0.4	14.8	20.3	11.0	1.7
Royal Square	42.2	3.6	23.3	14.3	15.7	0.9
Rambla del Raval	41.4	4.3	14.3	11.9	26.7	1.4
Rambles	50.0	2.0	21.1	13.0	12.6	1.2
Arc de Triomphe	40.2	2.2	22.8	17.4	15.2	2.2
Citadel	42.1	0.0	19.0	19.3	16.9	2.7
Beaches	41.0	2.4	23.4	12.3	19.4	1.6
Old Port	45.6	1.2	19.1	15.8	17.4	0.8
Olympic Port	43.3	0.9	23.7	14.3	17.4	0.4
Seafront	45.7	2.4	17.1	18.1	15.7	1.0
Montjuïc	39.6	1.4	25.9	16.5	14.6	1.9
Glòries Square	42.9	1.6	17.3	14.7	22.5	1.0

source Profile and habits of tourists in the city of Barcelona 2018-2019

between 40% and 50% state that they are staying in a hotel, while the rest are divided between HUTs, hostels and private houses. The highest range occurs among those who declare to be staying in private houses, since it ranges between 11% in Plaça Catalunya and 26.7% in Rambla del Raval. It stands out, as in the other cases, the high value of the hostels, far above the relative weight that could be estimated according to their capacity.

The same behavior is evident among tourists who have been intercepted in closed spaces, in the main museums and monuments of the city. Again, tourists in hotels are in the range between 40 and 50 (although only 32.2% of MACBA visitors). In this case, however, the relative weight of visitors who declare to be staying in private houses is significantly reduced and in several cases it is below 10%. On the contrary, the values of visitors who declare to be staying in a house for tourist use are particularly high. As in the other cases studied, the high average value of the hostels stands out.

Table 9.4. Accommodations of tourists intercepted in spaces closed

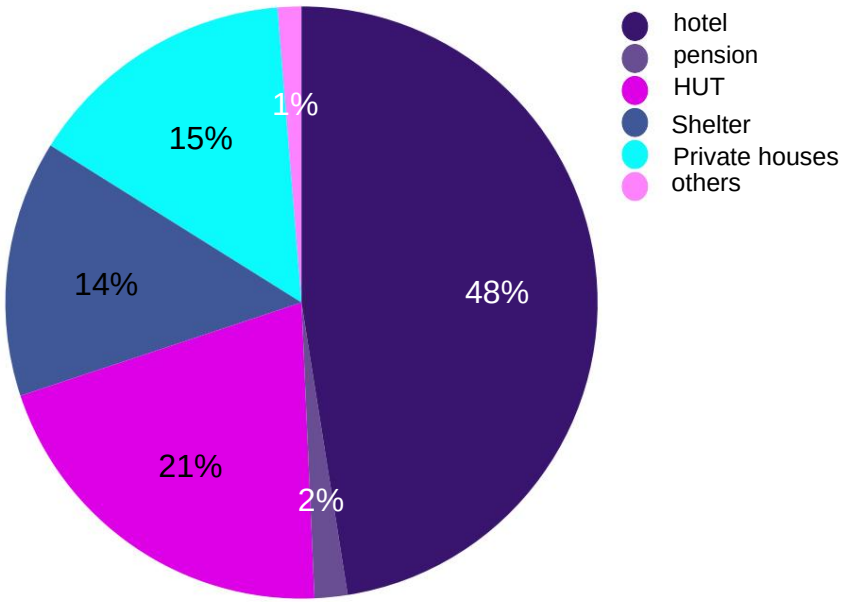
	Hotel	Pension	HUT	Alberg	House	Other
MACBA	32.2	3.4	19.2	14.9	27.4	2.9
Columbus	49.5	0.4	15.5	15.9	15.5	3.2
Picasso	42.2	0.8	26.9	15.7	12.4	2.0
Santa Maria del Mar	37.6	0.4	27.1	15.3	17.5	2.2
MNAC	46.1	0.4	22.0	17.0	11.6	2.9
Park Güell	45.2	2.2	22.2	18.9	8.9	2.6
Stone mine	42.7	3.6	26.3	19.7	6.9	0.9
Casa Batlló	48.1	1.3	23.1	13.0	12.5	1.9
Sagrada Familia	47.4	2.7	20.8	19.1	7.9	2.1
FCB Museum	50.6	2.5	26.2	11.7	8.6	0.3

source Profile and habits of tourists in the city of Barcelona 2018-2019

The first conclusion we must draw from these results is that the survey is very sensitive to the intercept. The design of the survey makes it possible to integrate very diverse visitors because a large number of points of tourist interest, open spaces in the city, as well as spaces related to transport or

MICE. But a variation in the weights of one space or another can change all the results about the visitors' profile. The survey is highly conditioned by the sampling points.

Figure 3. Accommodation declared by tourists intercepted in Barcelona* (%)



source Profile and habits of tourists in the city of Barcelona 2018-2019
**Tourists intercepted in hotels are not considered*

Based on these results, we could conclude:

- The declared average of hotel accommodation is very close to 50%, which is the main working hypothesis with which the survey design works. It should be borne in mind that this does not mean that 50% of tourists use this form of accommodation, but rather that it would correspond to 50% of the tourists' stays, since we are working with intercepted data.

- Pensions represent approximately 12 times the hotel stays; on the contrary, the ratio in this case is 24 times less. In other words, the relative weight of pensions is clearly undersized. It is very likely that a part of the users of these establishments declare at the time of the survey that they are staying in other forms, such as a hotel or hostel.

- According to this calculation, homes for tourist use represent 21% of the total number of declared accommodations. If the tourist days in official HUTs represent approximately half of the days in hotels, in this case the proportion is lower. This can be explained by the fact that some of the people who declare that they are staying in hotels actually use other forms such as apartments or pensions, but above all because some of the users of the housing for tourist use show other forms of accommodation (private houses or perhaps hostels). In any case, this value seems to indicate that there is not too much distance between the official nights and the effective nights in HUTs, as Frontur and INE data suggested.

- The main element of distortion of the results is the value of the hostels, which is clearly disproportionate. If we relate this value to the volume of hotels, 8.5 million tourist days should be registered, which is double what we estimated with an occupancy of 73%; in fact, even with 100% occupancy in the hostels we would be very far from this value. This difference could be due to a bias in the intercept (interviews are conducted in spaces where this profile is more likely to exist), but the results are very regular at all points with few exceptions. Therefore, it is likely that a portion of visitors who answer that they are staying in this form of accommodation have actually opted for another, especially a HUT (and very clearly in the form of a room).

- Finally, visitors who declare that they are staying in a private house represent 15% of the total, which is relatively constant in the majority of interception points except for closed spaces and MICE. If we project the days according to the value of the hotels, approximately 9.2 million tourist days have been recorded by visitors staying in private houses, that is, about 25,000 visitors per day.

If we use the value of 4 days on average in private homes, the 9.2 million stays would correspond to 1.8 million tourists (following the initial formula Ji = Ti x (E + 1)). In the FRONTUR surveys, around 2 million tourists have been identified staying in private homes, but it should be borne in mind that in Barcelona this type of accommodation is the one with a percentage of the non-international population higher (35.9%), so that people staying in Barcelona would represent 58.8% of the total of this type in Catalonia.

3.1.8. Estimation of the volume of tourists

Table 10 summarizes all the results of the previous sections. It is an estimate of the number of tourists and the intensity of their stay in the city during 2019.

This estimate uses official data from the Barcelona Tourism Observatory for hotels, apartments, pensions and HUTS. In addition, consider the hypothesis of 300,000 tourists in non-regulated HUTs, which is a synthesis of the various estimation models; it must be insisted that the estimates based on the INE and FRONTUR seem to suggest that the official data could be very similar to the real data. Hostels have been loved projecting the behavior of pensions and hostels. Finally, the estimate of tourists in private houses is based on the survey on the profile of visitors, but it represents 60% of the total of the typology for the whole of Catalonia in 2019.

Regarding the presence of tourists in the urban space, we have considered the criterion of days (or stays) and not of nights. This option significantly increases the number of tourists per day. For example, it should be borne in mind that the volume of tourists staying in hotels is much higher than the maximum capacity of the hotels: In the city there are many more tourists in hotels than tourists with a full annual occupancy of all hotel establishments. To understand this

paradoxa imagine a hotel with 200 places that opens on a weekend; 100% occupancy of the hotel will generate 200 overnight stays but 300 days because tourists will be in the city on Friday, Saturday and Sunday. So the number of days is much higher than the maximum capacity of the hotel. The more the average stay is reduced, the more this effect increases: In an average stay of 30 days, the number of days and nights would be very close, and on the other hand, in an average stay of one day, the number of days would double the number of nights This also helps to understand the concept of days: It takes into account the number of days a tourist is in the city, but does not necessarily count whole days.

According to these estimates, in 2019 (a record year) the city of Barcelona welcomed **17.355 million tourists** who generated **62.37 million days** in the city. Expressed in daily data, on an average day in Barcelona there are **170,877 tourists.** In this case, we have only considered tourists who spend the night in the city. We know, however, that some of the tourists who visit the city are staying in other municipalities in Catalonia. At this point we will distinguish metropolitan tourists (who are tourists staying near Barcelona and who carry out most of their activity in the city of Barcelona), excursion tourists (who are tourists who are staying far from Barcelona and who carry out a visit to the city of Barcelona without staying overnight) and cruise ships.

Table 10. Total tourists 2019 (estimate)

	tourists	days	day tourists
Hotels	9,472,562	29,364,942	80,451
pensions	770.151	2,510,692	6,878
Apartments	230,436	1,011,614	2,772
Regulated HUTs	3,480,060	14,964,258	40,998
HUTs not regulated	300,000	1,290,000	3,534
Hostelsb	1,266,485	4,052,752	11.103
Private houses	1,835,309	9,176,545	25,141
TOTAL	17,355,003	62,370,803	170,877

a. Estimation based on the various indicators
b. Estimate based on offer data
c. Estimate based on visitor profile survey

source Barcelona Observatory, INE and own estimate

3.2. Excursion tourists

Destinations are dynamic systems that have inputs and outputs.
Some of the tourists who are staying in Barcelona decide to go beyond the municipal limits and visit other localities and, in fact, this is one of the city's strategic bets, the stimulus of the centrifugal force.
That is why, in the promotion of Barcelona, mentions of the vineyard landscapes, the cistercian route or the industrial heritage of the river courses appear. Much more important, however, is the effect of centripetal force.
Barcelona also attracts some of the tourists who are staying in other locations. Strictly speaking they are tourists, but they are not part of the set of tourists who spend the night in the city (and which we have quantified in the previous point). We can identify three different groups:

- First of all, metropolitan tourists are those who are staying in municipalities very close to Barcelona, in the first ring. Most of these tourists consider that their destination is Barcelona and therefore change the limits of the municipality to a metropolitan dimension.

- We can call excursion tourists those tourists who have stayed somewhere in the Catalan geography (the Pyrenees, the Costa Daurada, the Costa Brava...) and who occasionally visit the Catalan capital during their stay in Catalonia, without an overnight stay in the city.

- Finally, there is a very relevant group which is that of excursion cruise passengers, who are again tourists because they are staying outside their usual space for a leisure activity, but who have a relationship with the city that does not generate an overnight stay.

3.2.1. Metropolitan tourists

We consider 'metropolitan tourists' those who are staying in the first urban crown. Most of these visitors have chosen Barcelona as their destination, even if the municipal term of their accommodation is different: The selection process, their behavior, their activity is essentially linked to the city of Barcelona. We must consider, however, that some of these visitors opt for a destination that is not strictly Barcelona. The Sant Boi de Llobregat Artichoke Fair, a commercial activity in Badalona or a stay at the Hospitality Fair in Llobregat can generate metropolitan overnight stays without any contact with the capital.

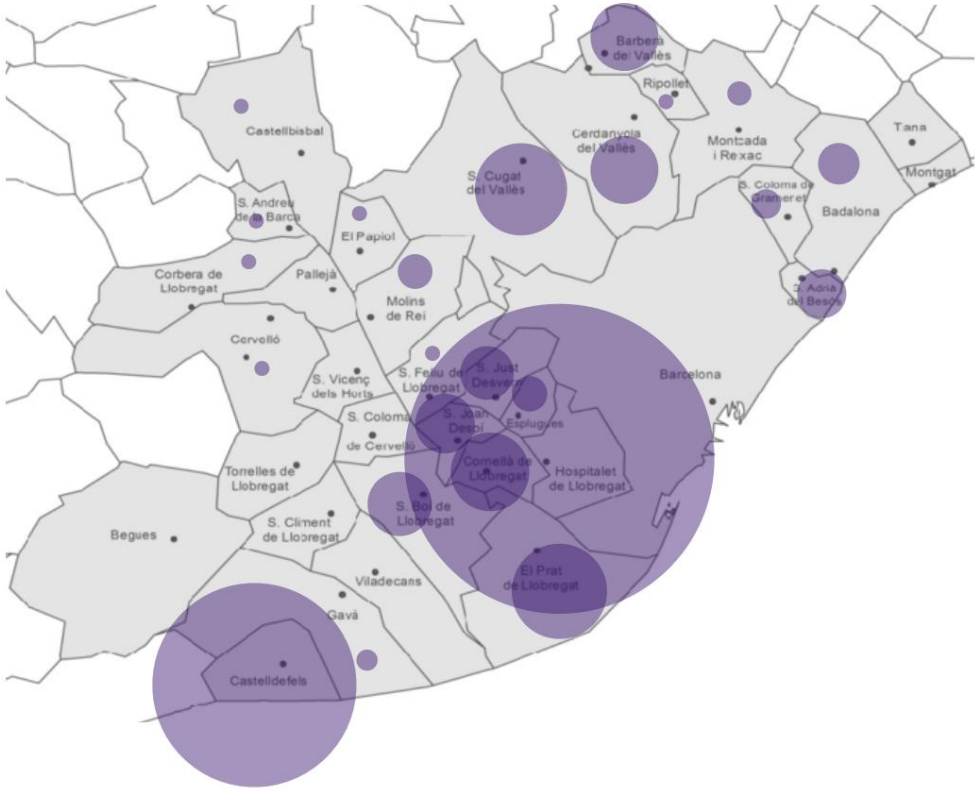
The metropolitan scale is the tourism scale of the coming decades. Historically, all the economic activities that have exceeded the capacity of the city have taken on a metropolitan dimension: Agriculture, industry, logistics, the knowledge economy... In addition, it is possible that one of the effects of the restriction of the 'accommodation offer provided by the PEUAT is the change of scale. This process of metropolization can have two derivatives: An offer of accommodation can be created near the direct connections with the city center, which will give rise to bedroom tourist cities, like the Lido effect of Venice; or, metropolitan attraction poles can be created which

allow generating new flows and a network structure, following the logic of the impact of the L'Hospitalet de Llobregat Fair.

In other studies, Barcelonès has been considered as an area of metropolitan tourism reference. The 2017 mobility study includes tourist stays in the municipalities of Barcelonès in the accounting of Barcelona tourists, as they are part of the actual city. The metropolitan dimension has, however, gone beyond the county limits and has spread over a wider area. In this report, we propose to integrate the municipalities of the Barcelona Metropolitan Area into the metropolitan dimension. It is true that this area is made up of municipalities that have their own tourist logic, that is to say, that are capable of attracting *ad hoc visitors,* apart from the Barcelona effect, such as Castelldefels.

The Metropolitan Area, however, is a space of very strong relationships, which takes advantage of a dense communications system and is made up of territorial and functional continuity. The accommodation offer of many of these municipalities presents the proximity to Barcelona (or the airport or the Fair) as the main tourist argument. The municipalities closest to the capital are perceived as part of the city, and as we move away from it, the image of the destination municipality takes on more weight. This is a scenario often ignored in the city's tourism debate, despite the fact that a metropolitan tourism plan was presented in 2017 and that the leap of scale is one of the fundamental axes of Barcelona's strategic tourism plan.

Figure 4. Hotel places in the AMB except Barcelona

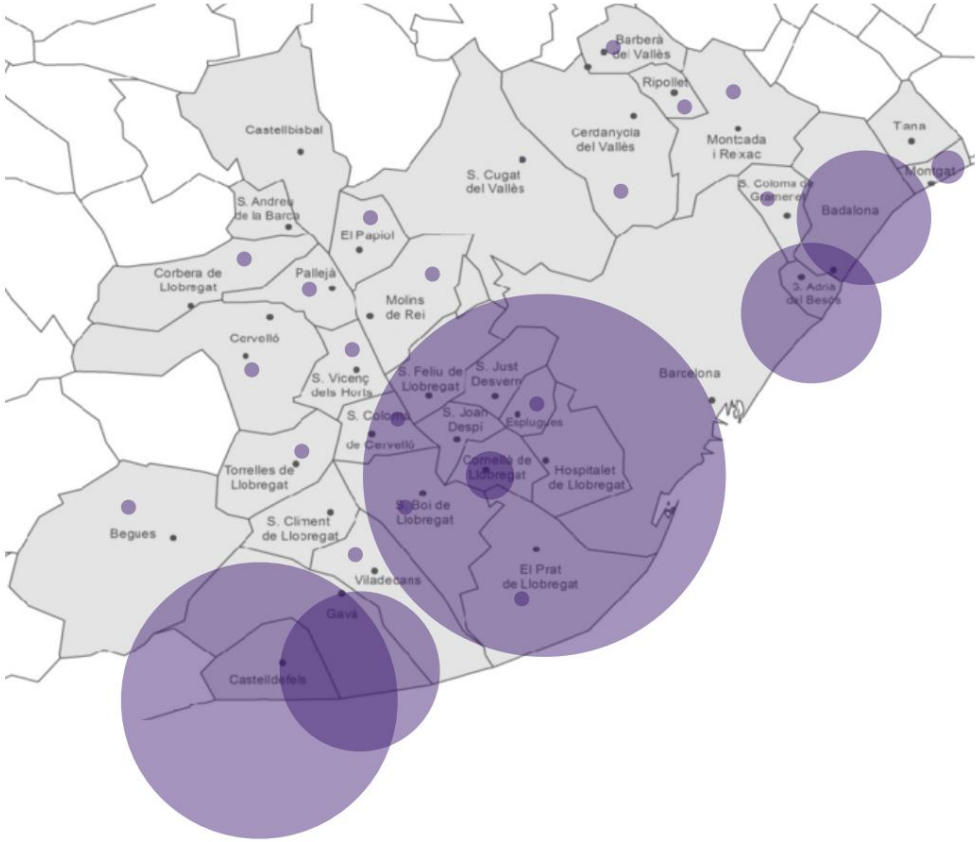


source IDESCAT

Figure 4 shows the distribution of hotel places in the Metropolitan Area of Barcelona. The Area offers 18,692 places in hotel establishments, which is a very significant number because the city of Barcelona has 73,173 places in hotels and 6,489 in hostels and pensions. The hotel plant in the Metropolitan Area of Barcelona without the capital therefore offers 19% of the Area's hotel capacity. Half of the offer of the 35 municipalities is located in three localities: L'Hospitalet de Llobregat (4,149), Castelldefels (2,702) and El Prat del Llobregat (1,262). Fifteen of the municipalities have no hotel offer or have a capacity of less than 100 places.

The relative weight of housing for tourist use is lower than that of hotels. There are 1,728 offers in the Registry of the Generalitat de Catalunya. Figure 5 shows the distribution of these establishments among the municipalities that make up the Metropolitan Area. In general, and as is logical, the HUTs are more present in the municipalities with a greater hotel offer. L'Hospitalet de Llobregat is once again the main municipality in the Area and has established itself as one of the main tourist municipalities in the country. In 2019, L'Hospitalet de Llobregat was the eighth municipality in Catalonia in collecting the tax on tourist stays, above centers with a tourist reputation such as Sitges, Calella or Tossa de Mar. In the case of HUTs, Gavà and the municipalities of Sant Adrià del Besòs and Badalona stand out again, which stretch the occupation of the coastal front to the north.

Figure 5. HUTs in the AMB except Barcelona



source Register of establishments of the Generalitat de Catalunya

The two maps show the two geographical dimensions of the Metropolitan Area. On the one hand, some municipalities have achieved a remarkable tourist dimension due to their proximity to the city, since visitors perceive the metropolitan reality without a solution of continuity. On the other hand, the coastal axis strengthens the touristic capacity of the municipalities located both to the north and especially to the south of the capital. Outside of these two geographic criteria (contiguity or coastline), the intensity of tourism clearly declines.

The data on the collection of the stay tax in tourist establishments (IEET) provide initial information on the territorial distribution of tourist activity. In 2019, this tax had a rate of 0.9 euros for four-star hotels and HUTS and 0.45 for the rest of the establishments, although Barcelona had a special regime. It should be noted that people aged 16 and under are exempt.

This means that the collection sets a demand that is between 1.11 times and 2.22 times the collection of the tax without considering children under 16 years of age. Apart from the main tourist center of the crown, the municipality of Castelldefels stands out (located in position 19 in Catalonia as a whole) and with a little less than half the revenue of L'Hospitalet. Perhaps the most relevant data is that there are nine municipalities in the Metropolitan Area located among the 50 with the highest revenue in Catalonia. We are probably not aware of the importance of the metropolitan crown in the Catalan tourist system: El Prat de Llobregat collects more than Palamós or L'Ametlla de Mar; Sant Boi de Llobregat more than Sant Carles de la Ràpita or Llançà.

Table 11. Collection of the tax on tourist stays in the municipalities of the AMB
(Euros)

	Position in Catalonia	collection
Hospitalet de Llobregat	8	760,751.05
Castelldefels	19	327,643.69
El Prat de Llobregat	27	255,823.13
Sant Cugat del Vallès	41	132,407.65
Sant Boi de Llobregat	42	130,339.35
Sant Joan Despí	45	107,509.95
Gave	46	105,608.86
Badalona	47	99,086.14
Villadecans	50	85,261.50
Cornellà de Llobregat	52	85,261.50
Montcada and Reixach	53	79,870.63
Sant Just Desvern	54	77,582.25
Splugues de Llobregat	67	55,983.60

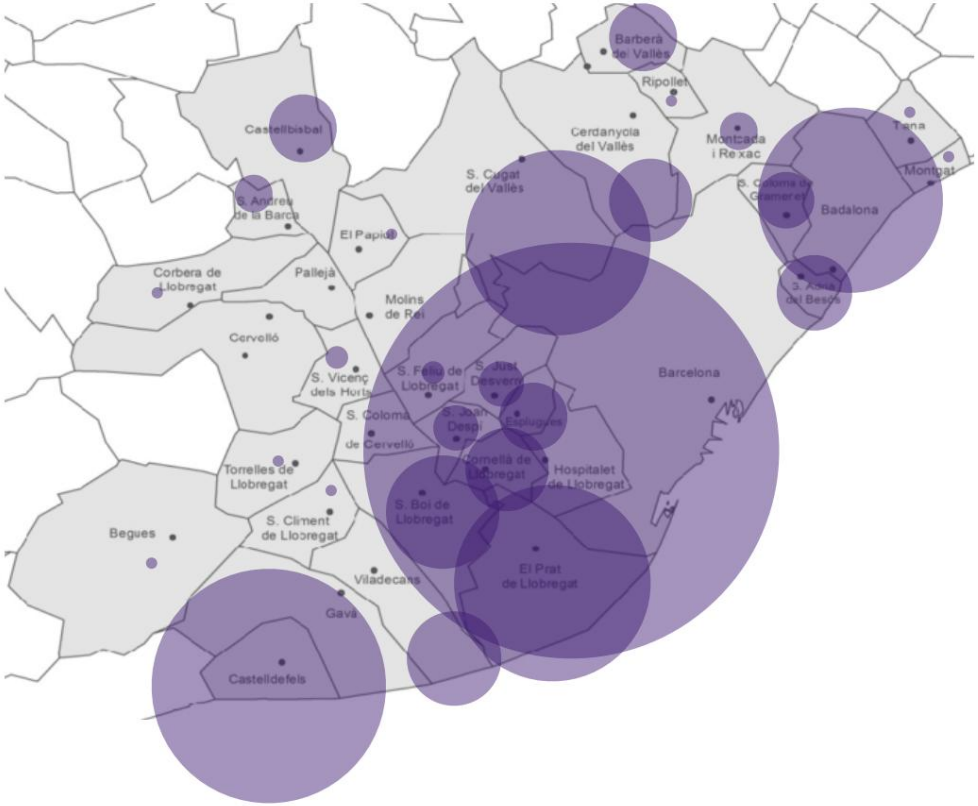
source Department of Business and Work. Government of Catalonia

One method to measure the intensity of tourism in the municipalities of the Metropolitan Area is the system for measuring international visitors that the INE has started experimentally since the summer of 2019. This system collects the data captured by mobile phone signals and identifies those linked to foreign operators. The mobile phone signal makes it possible to analyze the origin of the visitor, the destination (the municipality in which he spends the night), the number of nights and excursions outside the municipality of accommodation. The degree of coverage allows the data to be provided on a municipal scale.

Figure 6 represents the data for the period July - December 2019 for all municipalities in the Barcelona Metropolitan Area. The data for the municipality of El Prat have been rejected because the count gives it a very high value as a result of the effect of the airport. As the model imputes to the municipality that stay that occurs during a certain time interval, night flights create false overnight stays in this municipality. In the rest of the cases, the data coincides with the distribution of the offer and with the data on the collection of the stay tax. L'Hospitalet de Llobregat stands out, but also the string of municipalities on the coast and a closer first crown is clearly drawn, with greater tourist intensity.

According to these data, the municipalities that make up the AMB except Barcelona attract 15% of international visitors who stay overnight in this space; out of every 10 tourists who arrive in the Area, 8.5 stay in the municipality of Barcelona and 1.5 stay in the other municipalities.

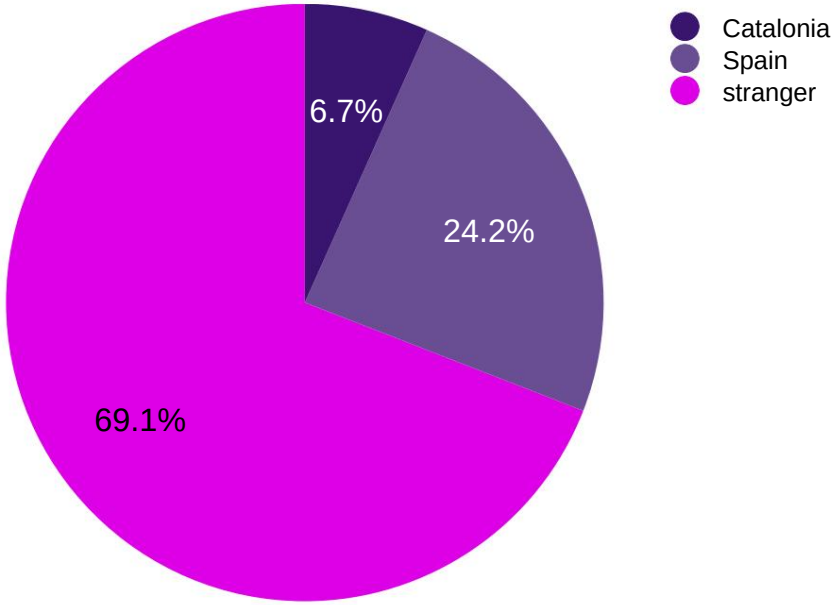
Figure 6. Nights of foreign tourists in the AMB except Barcelona *(July - December 2019)*



source INE (Measurement of tourists from mobile phones)

In addition, we have analyzed the 2019 Visitor Profile surveys carried out in the various municipalities of the Barcelona Metropolitan Area, which exceed the 2,000 threshold and which, therefore, can be considered representative of all tourists in the metropolitan area . Figure 19 shows the distribution of tourists in this space; the proportion of international tourists is much lower than that detected in the case of Barcelona.

Figure 7. Origin of tourists from the AMB without Barcelona (%)



source Profile and habits of tourists in the city of Barcelona 2018-2019

With this data, we can now estimate the volume of tourists in the municipalities of the 35 municipalities of the AMB (the metropolitan crown). If we have estimated the volume of tourists in Barcelona at 17.356 million and we know that 86% are international, the volume of international tourists in Barcelona is around 14.752 million. In the study on the mobile phones of international tourists, it was found that 85% of nights in the Metropolitan Area of Barcelona are spent in the capital. Therefore, the number of international tourists in the study municipalities is about 2.603 million. And given that in the survey on the profile of visitors in the municipalities of the AMB except Barcelona we calculated that 69.1% of arrivals are international, we can therefore determine that in the Metropolitan Area of Barcelona they stayed in the municipalities of the AMB 3.767 million tourists. This figure is similar to the one that would be obtained if we apply a weighting of 1.6 in the tax on tourist stays (see Table 11) or estimate an occupancy of 60% of the hotel floor, so it is a very consistent result.

Logically, not all of these people actually visit the city of Barcelona; as we have said, part of the demand is explained by the *ad hoc* offer of the municipality or the region: professional activities, recreational activities outside Barcelona... In fact, an indicator of metropolitanization of the tourist model is the weight of visitors staying in this crown that do not visit the city. In the visitor profile survey, the willingness to visit the city of Barcelona on the part of the tourists surveyed in these municipalities was 67.7%, that is to say 2.658 million tourists.

It is likely that a part of metropolitan tourists visit the city of Barcelona several times. Some hotels in this area have a clear overnight function and are located close to a means of transport that connects to the city centre. However, other tourists have only occasional contact.

In order to estimate the volume of stays of metropolitan tourists, we used the 2018-2019 Tourist Profile survey. We have excluded the surveys carried out in hotels and have considered those carried out in the various sample points. The percentage of respondents who are staying in Barcelona is very variable: at the Columbus Monument it is only 88.8%, at Port Vell 93.8% and at the Arc del Triomf at 93.8%; on the contrary, it reaches 100% at the Palau de Congressos de Catalunya or at the beaches of Mar Bella and the Banys Fòrum. The average number of tourists staying in Barcelona in the intercepts of the various sample points is 93.07% (excluding hotels). It should be borne in mind that the surveys do not include people staying outside the province of Barcelona. The set of municipalities that make up the Metropolitan Area of Barcelona represent 54.6% of those who do not spend the night in Barcelona (3.77% of the total); tourists staying in the rest of the province represent 45.4% (3.14% of the total).

We estimated 62,370,802 days of tourists staying in Barcelona, that is to say 62.37 million opportunities to be surveyed in some of the sample points. We must bear in mind, however, that tourists who are staying in Barcelona also move outside the municipality and become excursion tourists for nearby destinations. According to the 2018-2019 tourist profile survey, 89.35% of people staying in the city have not left the limits of the municipality, so that 10.65% of tourists in Barcelona are excursion tourists from other nearby tourist areas. Some of these tourists make more than one excursion, but the data on the number of days used for these multiple excursions is not available. Given that the average stay in Barcelona is very short, it is most likely that the different stages will take place on the same day, so we take the reference value of 10.65%. This means that tourists staying in Barcelona spend 1.848 million days outside the city, meaning that the total volume of days spent by tourists staying in Barcelona in the city itself is 60,522,494.

According to these data, the volume of tourist days that can be intercepted in the city of Barcelona and are staying in a municipality in the province of Barcelona is 64,522,915 days.
Of these days, 93.07% correspond to tourists staying in Barcelona.
3.77% are days of tourists staying in a municipality in the Barcelona Metropolitan Area, that is to say, 2,432,514.
We estimated that the willingness of tourists staying in a municipality in the Metropolitan Area of Barcelona to visit the city was around 2,658,000. Actual visits are slightly lower and most tourists are likely to stay in the city for a day.
Therefore, with an estimate based on supply, the number of metropolitan tourists in Barcelona would be 2.66 million and with an estimate of demand, 2.43 million. They are two similar values, which gives more consistency to the estimates.

Table 12. Metropolitan tourists in Barcelona

Estimate from the offer	2,658,000
Estimate from demand	2,432,514

source Estimate based on the INE and the tourist profile survey

3.2.2. Excursion tourists

Excursion tourists are people who are staying in some of the country's destinations and who make a trip to the capital for an unpaid activity. From the perspective of the city, they are hikers, because they do not spend the night in Barcelona, but in reality they are tourists since they are staying outside their usual environment.

We think it is important to make a conceptual distinction between metropolitan tourists and excursion tourists, even though they belong to the same category (they are tourists who visit the city of Barcelona, but who are not staying in the capital).

- Metropolitan tourists are tourists attracted by the city of Barcelona, but who have opted for the metropolitan crown to locate the accommodation space. As the metropolitan logic dilutes the municipal borders, these tourists consider that they are staying in Barcelona.

- Excursion tourists are tourists attracted by another destination in the country. They are tourists attracted by other attributes of the country and for this reason they identify their stay with a brand that is not Barcelona. During their stay in this destination, these tourists take an excursion to Barcelona, which is perceived as a complementary space to the main destination.

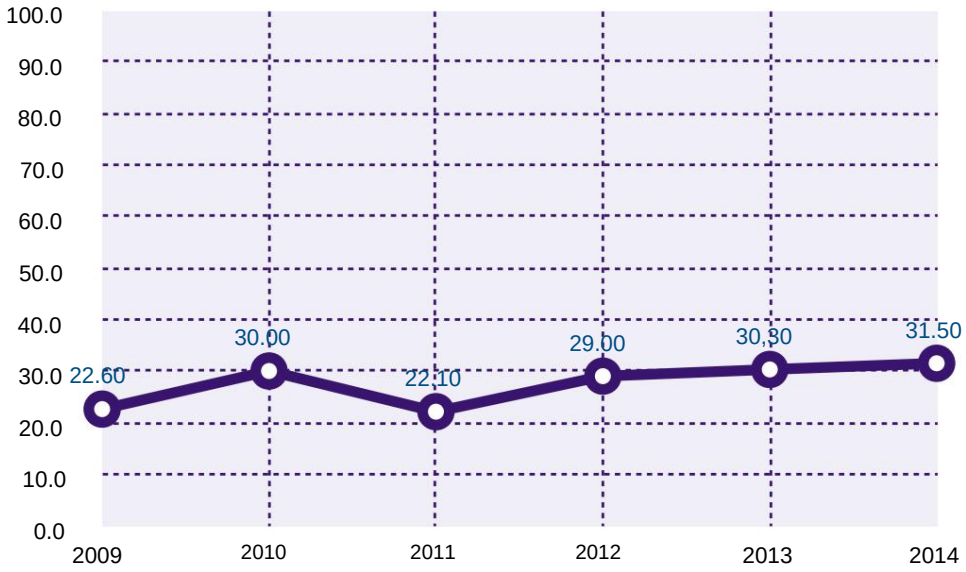
There is no statistical information on tourist mobility in the country. We do not know the intensity or the flows of agitation mobility, which takes place internally in a host destination. In other spaces, this mobility of agitation is fundamental in the tourist organization.
The coastal area of Tunisia is connected with the excursions of the south or the route through the cities of the north; in Andalusia, the network of cities is a structural component of its tourist offer. In Catalonia, the mobility of agitation is more reduced. However, a scenario of reducing the distance and increasing the average stay will probably result in greater interaction between tourism brands.

According to the calculations in the previous heading, we can estimate that the excursion tourists from Barcelona who are staying in a municipality in the province of Barcelona that is not located in the Metropolitan Area is 3.14% of the total number of days. The total volume of visits would be slightly higher than two million, specifically, 2,026,019. Most of the tourists come from the two coastal areas, the Maresme in the north and the Garraf in the south.

The data available in Tourism Open Knowledge prepared by the Observatory of the Scientific and Technological Park of Tourism and Leisure show the results of the survey carried out on visitors staying on the Costa Dorada. Until 2014, this source offers the results of the

tourist mobility of visitors staying in a municipality on the Costa Daurada. Figure 8 shows the percentage of tourists who express the intention to visit the city of Barcelona during the summers between 2009 and 2014. As can be seen, the percentage is in a range between 22 and 30%, although from 2012 seems to have consolidated at 30%.

Figure 8. Percentage of visitors staying on the Costa Daurada who visit Barcelona. summer (%)



source Observatory of the Science and Technology Park of Tourism and Leisure

The series is interrupted in 2014, so we do not have the data for 2019. If we project the average behavior of the last three years, we could estimate a predisposition to visit Barcelona of 30.2% of tourists staying on the Costa Daurada . It should be borne in mind, however, that these are summer data and that in the previous non-summer records, mobility is significantly reduced, so the data may be oversized. If this behavior had remained stable, in 2019 of the 5,091,652 tourist arrivals. on the Costa Daurada would have generated 1,541,073 visits to the city of Barcelona.

The Costa Brava brand does not carry out any survey on the behavior of visitors, so it is not possible to estimate the volume of hikers in Barcelona. A simulation could be made projecting the percentage observed on the Costa Daurada for tourism on the Costa Brava. Naturally, this is an approximate exercise because although the two Catalan coastal brands share common characteristics, they also have notable singularities. The projection of 30.2% on the 7.9 million arrivals on the Costa Brava in 2019 would represent 2,391,066 visits to the city of Barcelona.

Therefore, an initial approximation to the volume of excursion tourists would suggest around two million tourists from Destination Barcelona (outside the Metropolitan Area), one and a half million from the Costa Daurada and more than two million from the Costa Brava . We insist that this data is only a projection and that it should be contrasted in the future with empirical evidence, especially from the exploitation of the stages of mobile records.

Table 13. Excursion tourists in Barcelona, 2019 *(approximation)*

origin	total
Destination Barcelona (excluding the AMB)	2,432,514
Golden Coast	1,541,073
Costa Brava	2,391,066
total	6,364,653

source Own elaboration based on the Destination Tourism Observatory Barcelona, the Tourism and Leisure Science and Technology Park Observatory and the TDS

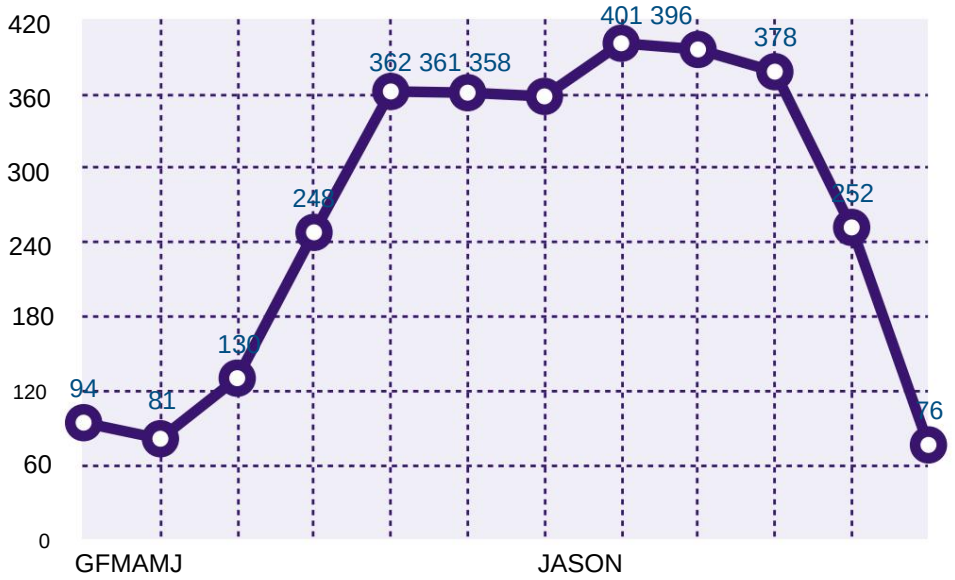
3.2.3. Excursion cruises

In 1995, Barcelona received around 225,000 cruise passengers. The cruise activity focused essentially on the American market had started a growth strategy in the Mediterranean and Barcelona will become the main node of this process. As can be seen in Figure 10, demand growth has been sustained throughout this period.

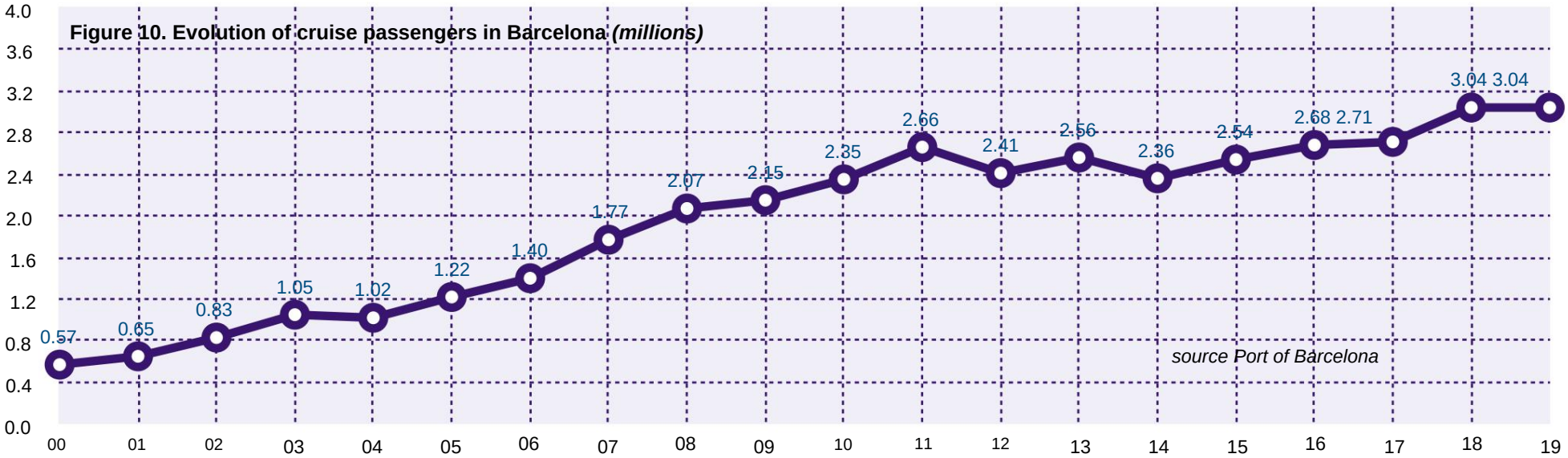
In 20 years, the number of cruise passengers has multiplied by almost 5. In 2003, the million threshold was exceeded; in 2008, the two million; and in 2018 it reached three million.

One of the singularities of the cruise activity is its extreme seasonality. The activity starts mainly in the month of May, reaches its peak in the summer months and declines sharply after October.
The most active month has five times more passengers than the least active month, a ratio that is far from the seasonal behavior of the other tourism sectors.

Figure 9. Arrivals of cruise passengers per month
(thousands)



source Port of Barcelona



In 2014, the Port of Barcelona and Turisme de Barcelona presented a study on the behavior of cruise passengers in the city. The study differentiate between transit cruisers and *turnaround cruisers.* The first ones have as point of departure and point of arrival a port that is not that of Barcelona, so that the city is another stopover on their route. Conversely, in the second, the city is the point of departure and arrival of the journey.

In 2019, 800 cruise ships arrived at the port, used by more than three million passengers. Of these, 1,384,696 are transit cruises and the rest (1,753,222) are *turnaround cruises.* The first are excursion tourists, because they do not spend the night in the city but stay there for less than 24 hours. Among the latter, the 2014 study shows that 18% are excursionists (they make a short visit to the city and embark), 46% are tourists (they spend the night in the city before or after the trip, with an average stay of 2.6 nights) and 36% do not have no link with the city (they access the ship directly).

Table 14. Excursionist cruises in Barcelona, 2019

	total
Cruisers in transit	1,384,696
Cruisers *turnaround* hikers	315,580
total	1,700,276

source Port of Barcelona and Study on cruise activity in BCN

Therefore, we can consider that the number of excursion cruise passengers in Barcelona, i.e. cruise users who visit the city but do not stay overnight, is 1.7 million. In the same study, it is estimated that the average time spent in the city by this profile is 4.2 hours.

2.3.4. Excursion tourists

We have seen, therefore, that in the city of Barcelona there are three forms of excursion tourists: metropolitan tourists (explained by a metropolitan scale expansion of tourist activity), excursion tourists (attracted by another destination , who make a one-off visit to the city); and excursion cruisers (those cruise users who make a short visit to the city without staying overnight).

Table 15. Number of hiking tourists in Barcelona

	total
Metropolitan tourists	2,432,514
Tourists hikers	6,364,653
Excursion cruises	1,700,276
total	10,497,443

a. approach

source Port of Barcelona and Study on cruise activity in BCN

The total number of excursion tourists in the city of Barcelona in 2019 can be estimated at more than 10 million people who are equivalent to 10 million days or stays, excluding overnight stays. Some are very short and involve a specific and concentrated use of the city, as we have seen in the case of cruises; in others the activity of hikers is very similar to that of tourists staying in the city and they differ only in the place of overnight stay.

In the 2015 mobility study, the number of hikers was estimated at around 5 million. This study included, on the one hand, excursion tourists from Barcelonès in the calculation of tourists from the city. On the other hand, it contemplated only excursionist tourists from the province of Barcelona.

3.3. The hikers

What is a hiker? According to the UNWTO and the concept widely accepted by official bodies and academia, a hiker is a visitor who spends the night at his place of residence. The only difference between a tourist and a hiker is that the former spends the night in accommodation other than their residence, while the latter returns home after the day at the destination.

This shifts the problem: What is a visitor and what differentiates a visitor from other mobilities? A visitor brings together two characteristics, one related to space and the other to motivation.
Visitors are those who move outside their usual environment.
This is an appreciation that has generated a lot of controversy, because it is not easy to determine where the usual space begins and ends; the OMT proposes that the delimitation be done with distance criteria and with frequency criteria. In other words, the journey takes place outside the usual environment because either a sufficient distance has been traveled to break with the everyday space or we have accessed an environment that is not familiar to us, that is not usual. The official bodies have had great difficulty in delimiting this usual space and have opted for administrative divisions, which facilitate statistical accounting.
For example, the INE considers the boundaries of the province to be common space.
But this is nothing more than a statistical choice.

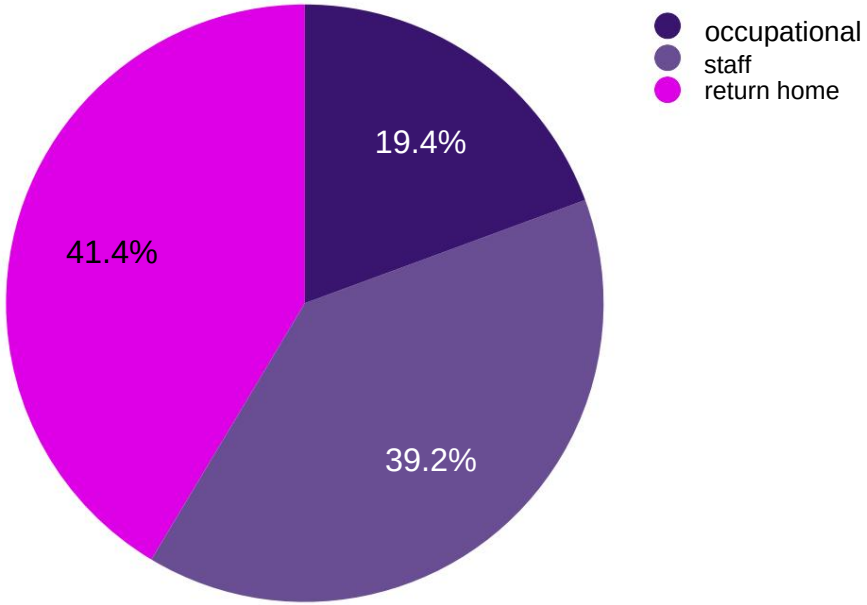
The second controversial element is motivation. In this case, the recommendations of the UNWTO have proposed that a person who travels "with any main purpose (leisure, business or other personal reason) other than being occupied by an entity resident in the place is considered a visitor visited" (UNWTO:2008, paragraph 2.9). We could, therefore, consider that hikers are visitors who do non-work mobility in the city and who do not spend the night there.

In order to estimate the volume of hikers in the city of Barcelona, we have worked on the mobility surveys managed by the Metropolitan Transport Authority. On the one hand, the ATM carries out an annual survey to measure the mobility of the population over the age of 16 in the area of the Integrated Fare System of Barcelona, during weekdays. In addition, in 2006 a large-scale survey was carried out (almost 107,000 interviewees) for the whole of Catalonia and combining working days with weekends and holidays.
The survey organizes the motivations for displacement in three main areas: occupational, personal and return. As can be seen in figure 23, personal journeys double those of occupational nature.

Occupational mobility is considered to be that which is related to work or studies. It coincides with the concept of forced mobility. On the contrary, personal motivations affect a much higher number of factors, as can be seen in table 22. Some of the motivations are easily associated with the idea of visitors, such as leisure or walking; on the other hand, others seem far removed, such as medical reasons or management. But as we mentioned, that person who moves outside of his usual environment is considered a visitor

for a non-remunerated purpose. Therefore, we will consider hikers all people who make a trip with personal motivation.

Figure 11. Motivation for travel on working days in the SIMMB area, 2019



source EMEF 2019 (ATM)

Table 16. Personal motivations for mobility in the SIMMB area *2019*

	Displacements	%
Everyday shopping	1,757,013	23.3
Non-daily purchases	248,182	3.3
Medical reasons	364,958	4.82
Visiting family or friends	554,244	7.3
accompaniment	1,937,266	25.64
Personal management	511,018	6.8
leisure	1,418,466	18.8
walk	754,783	10.0
others	12,068	0.2
TOTAL	7,557,998	100

source EMEF 2019 (ATM)

We have considered that the geographical area "usual space" is the Metropolitan Area of Barcelona. First of all, because the provincial level is too broad an environment; the flows from the Berguedà or the north of the Anoia can hardly be considered close. Second, because

The Metropolitan Area of Barcelona is an existing geographical space, with defined administrative boundaries, and with an extreme degree of internal mobility. Finally, the geographical criterion of the AMB is the same that we have used for the differentiation of hiking tourists and in this way we use a single administrative criterion. We therefore consider hikers to be people who travel from a municipality outside the Barcelona Metropolitan Area to the capital, for any of the personal motivations provided for in the EMEF survey.

3.3.1. Mobility on working days

In 2019, 19,259,466 trips were made in the study area as a whole, which affects about 4.7 million residents, which represents an average of 4.05 trips per person. If we exclude trips back home, the resulting flow matrix is the one shown in table 17. From Barcelona there are 420,000 trips for work or personal reasons towards the rest of the Barcelona Metropolitan Area (300,000 trips) or outside the AMB (120,000 trips). There is practically the same volume of work and personal movements. On the other hand, there are many more entries, as there are 750,000 trips to Barcelona for mandatory or personal reasons, of which 500,000 come from the Barcelona Metropolitan Area and 250,000 from the rest. That is to say, every weekday, 330,000 more people enter the city than leave, considering that in these flows each trip corresponds to one traveler.

Table 17. Matrix of journeys origin - destination on working days by mandatory and personal mobility, 2019
(millions of trips)

Obliged		destiny		
		BCN	WITH	remainder
origin	BCN	0.87	0.15	0.06
	WITH	0.30	0.53	0.09
	remainder	0.17	0.15	1.11
staff		destiny		
		BCN	WITH	remainder
origin	BCN	2.23	0.15	0.06
	WITH	0.20	1.80	0.10
	remainder	0.08	0.09	3.15

source EMEF 2019 (ATM)

According to the data from the Mobility Survey, on a working day **77,478 people** arrive in Barcelona from outside the Barcelona Metropolitan Area for personal reasons. More than 200,000 people from the Metropolitan Area also come there for personal reasons, but we do not consider them hikers because they are in their usual space.

Table 18 shows the hikers' personal motivations. Leisure travel is only 13%, i.e. about 10,000 people.
All other trips are personal, but we do not link them with the idea of a visitor: Shopping, visiting a relative, carrying out a medical consultation, carrying out personal management or accompanying an acquaintance or a relative on their way to the city .

Table 18. Personal motivations of hikers

	%
Everyday shopping	4.1
Non-daily purchases	3.6
Medical reasons	9.67
Visiting family or friends	12.6
accompaniment	30.03
Personal management	22.4
leisure	12.9
walk	2.5
others	2.3
TOTAL	0

source EMEF 2019 (ATM)

3.3.2. Mobility on holidays

The mobility survey carried out annually by the Metropolitan Transport Authority, the EMEF, is based only on the municipalities within the Comprehensive Transport System. Weekend mobility is much more dynamic and for this reason, we have to use the Daily Mobility Survey that was carried out in 2006, for the entire Catalan territory. When reading the results, we must bear in mind that we are working with a database that is more than ten years old and that, therefore, does not capture the most recent changes in cultural, recreational or personal habits.

Weekend mobility has two unique characteristics compared to regular mobility. First, the intensity of mobility is reduced. If 154 million journeys took place in Catalonia during the weekdays in 2006, at the weekend it was reduced to 16.2 million. This is the result in the first place of a strong increase in the non-mobile population. On a weekday in Catalonia, only 7% of the population does not travel at all; on the contrary, at the weekend, this percentage increases to 21%. The average number of trips is also reduced; if on a working day, each person makes an average of 3.57 journeys, at the weekend the average is 2.37 (2006 data).

The second characteristic of weekend mobility is the change in motivation. While during the week, the occupational mobility (studies and work) is practically the same as the staff, the bosses

per week, occupational mobility is only 4.1%. 48.7% of trips are for personal reasons and 47.3% correspond to trips back home.

Table 19. Matrix of journeys from origin to destination on public holidays by mandatory and personal mobility, 2019
(millions of trips)

Obliged		destiny		
		BCN	WITH	remainder
origin	BCN	0.11	0.01	0.006
	WITH	0.04	0.07	0.01
	remainder	0.02	0.02	0.38
staff		destiny		
		BCN	WITH	remainder
origin	BCN	1.48	0.13	0.16
	WITH	0.21	1.16	0.17
	remainder	0.17	0.11	4.30

source EMQ 2006 (ATM)

As we have mentioned, mobility is significantly reduced at the weekend. Not only is there a reduction in the number of people who move and also in the number of journeys, but external mobility, outside the municipality, is also reduced. On the study weekend (remember, with data from 2006) around 300,000 people leave the city and around 430,000 enter; the balance is again positive but this time there is a greater balance between inputs and outputs. Most of these entries are related to personal mobility, which is characteristic of weekends, with very little influence from compulsory mobility (work and study).

Of the 375,000 weekend tickets in Barcelona for personal reasons, nearly 209,000 come from other municipalities in the Barcelona Metropolitan Area. Therefore, we consider weekend hikers people who travel to the city from any municipality located outside the AMB that has a personal motivation.

This is **166,854** people according to the projection of the 2006 Survey; it is very likely that this mobility has increased in recent years, as we have seen in the 2019 data for working days.

3.3.3. Excursionists in Barcelona

The city of Barcelona has a strong centripetal force that affects the country as a whole. Beyond the limits of the Metropolitan Area, beyond the "real city", the city attracts people from the country who access it to shop in the commercial establishments, to cheer on their football team, to stroll through the Parc de la Ciutadella , to certify a sale at a notary, to visit the son who studies at the University of Barcelona or for a visit to the ophthalmologist. All these activities have in common that the visitor does not obtain remuneration, he has no professional motivation. For this reason, we consider them visitors and given that they do not spend the night there and have exceeded the usual space (the limits of the Metropolitan Area) we consider them hikers. According to the previous calculations, there are about 77,000 on weekdays and about 166,000 on weekends, that is to say, about 80,000 on average daily.

Table 20. Excursionists in Barcelona

	Excursionists
working day	77,478
Weekend	166,854
Day hikers (average)	79,178
Hikers (total)	28,899,970

source EMEF 2019 (ATM) and EMQ 2006 (ATM)

3.4. Visitors to Barcelona

How many people visit the city of Barcelona? There are many different ways to answer this question. In this estimate, we identify "visitor" with the same criteria as the Organization
Mundial del Turisme: All those people who have exceeded their usual space and who arrive in the city for an unpaid activity.
This includes three very different profiles: On the one hand, the tourists staying in the city, on the other hand the tourists staying in another space who make a visit to the capital and finally the hikers, who return to their residential space after the visit

The city is visited by around 17 million tourists, while around 10 million tourists staying in another destination (or on a cruise) visited the city during 2019. It should be borne in mind that this last figure is based on in an approximation, which should be empirically tested. The impact of each city is very different. While excursion tourists make a one-time stay in the city, tourists spend several days there, and therefore the total number of days is significantly higher. Although there are only 1.7 tourists for every hiker, tourists are in the city six times as many days. Or expressed in other terms, it is six times more likely to cross paths with a tourist in Barcelona than with an excursionist tourist.

We know very little about the behavior of hikers. They are visitors who don't stay overnight and who, therefore, leave much more of a trail

inaccurate than tourists. The opening of the data on the mobile phone signal opens up a very relevant field of research in the coming years.
All the mobility surveys highlight the growing importance of personal mobility in flows in Catalonia. These micromobilities must be progressively incorporated into studies on the behavior of visitors in all spaces.

If we project the EMEF data (which takes place in October and November) and the EMQ results over the year as a whole, we can estimate around 29 million arrivals. As in the case of hiking tourists, each arrival is equivalent to one day. Unlike tourists, hikers can make recurring mobilities; in fact, the only way to achieve 29 million arrivals is with a recurring visit to the city. On average, each person in Catalonia (excluding the AMB) would have to make 7 personal visits a year to Barcelona to reach this figure. Naturally, the result is given by very occasional visits from one part of the population and recurring visits from another part, some of them so frequent that they should lose the status of hikers, because the usual space is explained by distance or by frequency.

According to these data, the city receives an average of 279,000 visitors every day, of which more than 60% are tourists. Excursion tourists, on the other hand, represent only 10% of day visitors, while hikers equal 28% of total visitors.

Table 21. Visitors to Barcelona

	arrivals	days	day visitors
Touristsb	17,355,003	62,370,802	170,877
Tourists hikers	10,497,443	10,497,443	28,760
Hikersb	28,899,970	28,899,970	79,178
TOTAL	56,752,416	101,768,215	278,815

a. approach
b. Estimation

source Own elaboration from secondary data

3.5. The users of the city

The registration of the mobile signal provides us with information that has a very precise value. It helps us to identify effective uses of the city, regardless of the accommodation equipment they use or their specific activity. Since April 2019, thanks to a collaboration agreement between Barcelona City Council and the company Vodafone, it is possible to access the database on the behavior of the various users in the city, based on the trace that they leave their cell phones. An algorithm estimates the effective population taking into account the degree of penetration of the company among the various profiles of the population.

The pandemic has completely altered the mobility dynamics of the population and although it is true that the usual flows of the pre-pandemic period have recently been recovered, the impact of COVID-19 on the population's mobility patterns has reached 2022. For this reason, we have worked with the data between April 2019 (when the public information of the results starts) and February 2020, just before the impact of the pandemic, so we use the data for a year of eleven months, without data for the month of March.

The model identifies four types of users:

1. *Commuters,* who are people who regularly travel to the city of Barcelona from neighboring municipalities, and who therefore have an easily identifiable periodic relationship.

2. The residents, who are the people who reside in form common in the municipality.

3. Internationals, those who have a telephone operator registered in another country.

4. The nationals, who are the people of the Spanish State who are in the city but who do not normally reside there or make periodic trips.

The sum of the four collectives make up the set of users in the city. According to this source, on an average day the number of people in the city is 2.66 million people. It is a high figure because the municipality has 1.6 million inhabitants, so on an average day there are 1 million more people in the city of Barcelona than make up its population. This does not mean that there are 2.66 million people at the same time. The mobile registration takes into account all arrivals in the city at some point of the day; taking into account entries and exits, only a part of these 2.66 million coincide at the moment in the city.

The median, the value located in the central position, is very similar to the average and is located at 2.67 million people. Importantly, the deviation is relatively low, so the dispersion coefficient is only 10%. This means that there are no large fluctuations throughout the year in the total volume of people in the city. On the day with the fewest 'users' the city drops to 2 million people, while on the day with the highest volume it climbs to 3.2

millions In this study, we consider the 8th decile (or the 80th percentile if desired) as a marker of a high value, which removes 20% of the highest values and thus avoids the case distortion effect extremes The estimate of users of the city during decile 8 is almost 3 million people.

Table 22. Estimation of the "users" of the city

average	2,660,118
Median	2,673,432
deviation	272,327
Coefficient of deviation	10%
Minimum	2,011,886
maximum	3,289,183
Decile 8	2,933,183

source Barcelona City Council with data from Vodafone

There is a reduction in density during the weekend. This is due, as we shall see, to the fall in the number of commuters arriving in the city, but also to a lower incidence of national mobility.
In a typical week, the average number of users in the city is around 2.7 million people, slightly above the average value, while at the weekend the city loses around 300,000 users.

The system is particularly accurate in identifying commuters, that is to say people who have a regular link with the city, usually of a work nature. Commuters result in a very predictable flow of mobility that is easily identifiable by the city's mobile registration systems. Commuters are regular users of the city, with a reduction during the weekend and a lower intensity during the summer period, especially in August.

Table 23. Estimate of commuters in Barcelona

average	322,414
Median	356,534
deviation	97,290
Coefficient of deviation	30%
maximum	462,650
Minimum	145,049
Decile 8	411,630

source Barcelona City Council with data from Vodafone

On an average day in Barcelona there are 322,414 commuters. The median, that is to say the value in the 50% position, is very similar, with 356,534 individuals. The deviation is moderately high, with nearly 100,000 cases, so the coefficient of deviation is 30%. the value

minimum is very low: The day with the fewest commuters in the city was 145,049 individuals, while the day with the most commuters reached close to half a million people, 462,649 commuters. The 8th decile of commuters in Barcelona, according to the algorithm data based on the mobile phone signal, is 411,630.

The third group is the travelers resident in the State who are in the city of Barcelona and who are not commuters, that is to say they do not have a periodic mobility that is registered in the previous group, but instead access punctually It is made up of three collectives:

- First of all, it includes those people who live in the Metropolitan Area of Barcelona and travel for personal reasons in the city and who cannot be considered hikers because they do not exceed the usual space. These are metropolitan personal mobility and, as we have seen, represent a very important volume. Some also travel for professional reasons but do not do so regularly, so they are not counted as commuters.

- Secondly, it also includes personal mobility outside the Metropolitan Area of Barcelona, which we have considered hikers.

- Finally, there is a third group which are the people of the State who spend the night in the city and who for the most part (but not in their entirety) are tourists.

As you can see in the summary of statistics, this is a very significant volume of users in the city and has a very high impact on the occupation of the space. On an average day there are nearly 800,000 people in Barcelona who come from anywhere in Spain, but logically most of them come from the area of most immediate influence. This volume remains with a very low variation (only 12%), although the range is very high because the lowest value is below half a million people and the highest value is over a million. The median is very close to the eighth decile, which means that there are high numbers of cases between 700,000 and 800,000.

Table 24. Estimate of domestic travelers in Barcelona

average	784,116
Median	791,523
deviation	100,979
Coefficient of deviation	12.8%
Minimum	486,169
maximum	1,024,561
Decile 8	854,154

source Barcelona City Council with data from Vodafone

These are very significant data: They represent twice as many "users" as commuters and half of the city's census population. As we mentioned, this is a very heterogeneous group that

it is made up of non-recurring professional mobilities, metropolitan personal mobilities, hikers and non-international tourists.

The mobile *tracking* system also identifies the group of international users. Again, in this case we can meet two different groups: Either those people who reside in the city and maintain their connection with the telephone company in origin or the tourists. It is, therefore, neither a register of tourists (because some of the people are residents), nor is it a register of people of an international nature linked to the city (because some of them opt for a contract with a national telephone operator).

Table 25. Estimation of international users*

average	212,224
Median	209,762
deviation	62,518
Coefficient of deviation	29.5%
Minimum	84,224
maximum	354,163
Decile 8	272,451

**Users who maintain a link with an international operator*

source Barcelona City Council with data from Vodafone

The average of registered international people is 212,000, with a median (the value located in the central position) very similar. In this case, the deviation is very high, which means a significant fluctuation throughout the year. Thus, the lower value is below 100,000 people while the upper value exceeds 350,000. The eighth decile, which does not take into account the 20% of extreme cases, stands at 272,000.

Table 26. Estimation of the resident population

average	1,341,363
Median	1,360,131
deviation	123,723
Coefficient of deviation	9.2%
Minimum	962,223
maximum	1,572,699
Decile 8	1,442,956

source Barcelona City Council with data from Vodafone

Finally, the system counts all the people who have a permanent link with the city, the residents. This record is more reliable than official statistics because it is based on effective behavior and not on administrative affiliation: A resident is a person who is usually found in the city, even if this

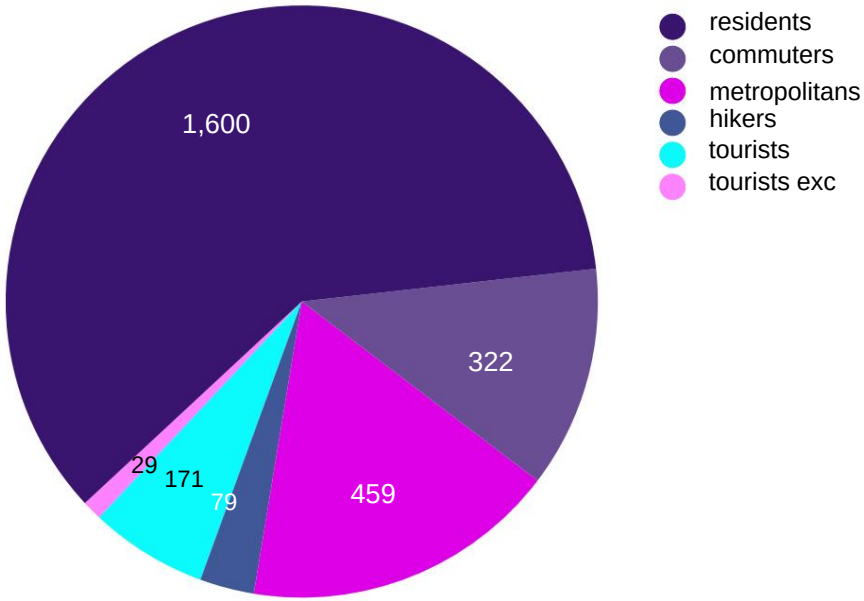
linkage is not visible in official records. As can be seen in the table, the average number of residents in the city is 1.3 million people, practically the same as the median. The deviation is very small, with a coefficient of deviation of 9%; this means that there are no great differences throughout the year in the number of people residing in the city. It is a figure much lower than the total number of people registered in Barcelona, which stands at 1.6 million. The lower limit is particularly low, below one million people while the upper limit is close to the total volume of residents. Since the system registers at any time during the day, this difference cannot be explained by external commuters (people who live in Barcelona and work outside), since they return to the city during the night and their activity is collected in the tracking process

As the deviation is not very high, decile 8 is relatively close to the average. Barcelona reaches the peak of 1.4 million residents if we do not consider the extreme cases. It is very likely that some of the residents are registered in the previous category (international users). But another part is explained by the discontinuous occupation of the house (tourist mobility, weekend mobility, work mobility...).

It is important to note that the number of people who are in the city on a given day is not the same as the number of people who are in the city simultaneously. For example, inflows and outflows of commuters create mismatched uses of the city; while some people leave Barcelona to work in neighboring towns, other people from the Barcelona Metropolitan Area enter the city

to work on it; for statistical purposes, both groups have 'used' the city, but it is likely that they do not coincide or that they do so for a short period of time. Therefore, when we say that there are 2.6 million users in Barcelona during an average day, we do not mean that 2.6 million people occupy the city simultaneously.

Figure 12. Users of the city on an average day
(thousands of people)



source Own development and Barcelona City Council with data from Vodafone

Figure 12 approximates the distribution of the various users in the city during an average day. The tourists roughly correspond to the international population register and the commuters coincide with the mandatory mobility from the Metropolitan Area of Barcelona.

The values are more confusing in the other two registers: We have seen in the mobility data that in 2019 around 750,000 people entered Barcelona, half of which are explained by labor mobility (many of them commuters). This means that there is a difference between the 350,000 people of personal and work mobility outside the AMB and the 784,000 records of non-international mobility captured with mobile phones. On the other hand, there is also a difference between the census population (1.6 million) and the resident register (which is 1.3 million). Given that the value is practically the same, we can deduce that the system is not considering some 300,000 people as residents, who are registered as non-international mobility. Let's also remember that every day 420,000 residents in Barcelona travel outside the city and that in this context of extreme interaction, it is easy for the records between residents and national mobility to get confused. So we will consider that the local population is 1.6 million (the census population) and that there is a contribution of one million people, of which a third are commuters and the rest are either visitors (tourists or hikers) or they are national mobilities (given the importance of the origin of the AMB we will call them metropolitan mobilities).

The set of visitors represents 10.49% of the city's users on an average day. Of these, 79,000 (3% of the total) are hikers, people who live in Catalonia and who travel to Barcelona for personal reasons. The number of tourists in Barcelona on an average day is 7.52% of the total users of the city. The majority are tourists staying in the city of Barcelona (6.43% of the total), while the impact of excursion tourists is only 1.1% of the total number of users in the city.

This average behavior has many spatial and temporal variations. The users of the city use it in very different ways, with very different degrees of intensity and for sometimes non-coincident periods. This gives rise to spatial and temporal concentrations of the various collectives in certain parts of the city or at times of the year. For this reason, in the next sections we will study the spatial and temporal behavior of city users and, specifically, of tourists.

3.6. The rhythms of the city

If we could map the movement of users in the city of Barcelona, we would immediately notice the cycles, the marked periods that draw concentrations and voids. We would see the disembarking of the cruise-goers who climb up the Rambla, the tourists who start to line up at the door of the Picasso, the schoolchildren who start their day at the door of the centers, the first congressmen who approach the facilities from Montjuic and the entrances and exits from Sants station.

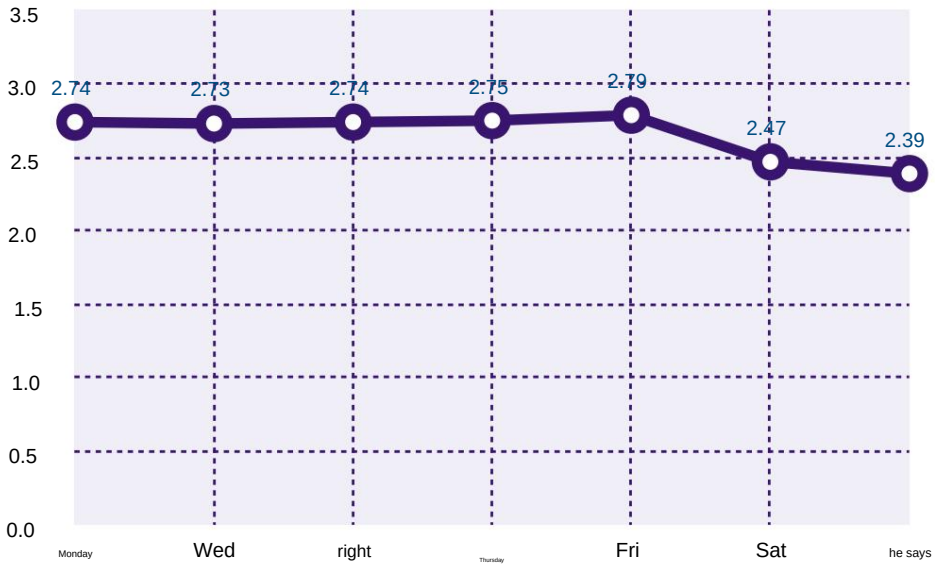
These rhythms have three different cadences, which overlap each other. First of all, there is an annual cycle, which makes it possible to identify the effect of summer or winter, the effect of the seasons on the mobility of the city. Secondly, there is a weekly cadence, with a very marked border between working days and weekends. And finally, the city moves with its own time rhythms, from the calm of the night to the excitement of the morning or the second wave of the afternoon. Not all users react equally to these stimuli. The city is the game of flows that users make, sometimes with similar rhythms and at other times, completely opposite, as if they were the two sides of a mirror. Cell phone records allow us to collect information on the monthly, weekly or daily behavior of the various groups.

If we study the behavior of the city's users as a whole, we will detect a reduction in density during the weekend. This is due, as we shall see, to the fall in the number of commuters arriving in the city, but also to a lower incidence of national mobility. On a typical working day, the average number of users in the city is around 2.7 million people, slightly above the average value, while at the weekend the city loses around 300,000 users (Figure 13).

As for movements throughout the year (figure 14), the distribution is relatively stable. There are logical monthly fluctuations, especially motivated by the incidence of holidays. The rank is high because the difference between the month with the highest number of users (2.99 million in July) and the month with the lowest incidence (2.42 million in August)

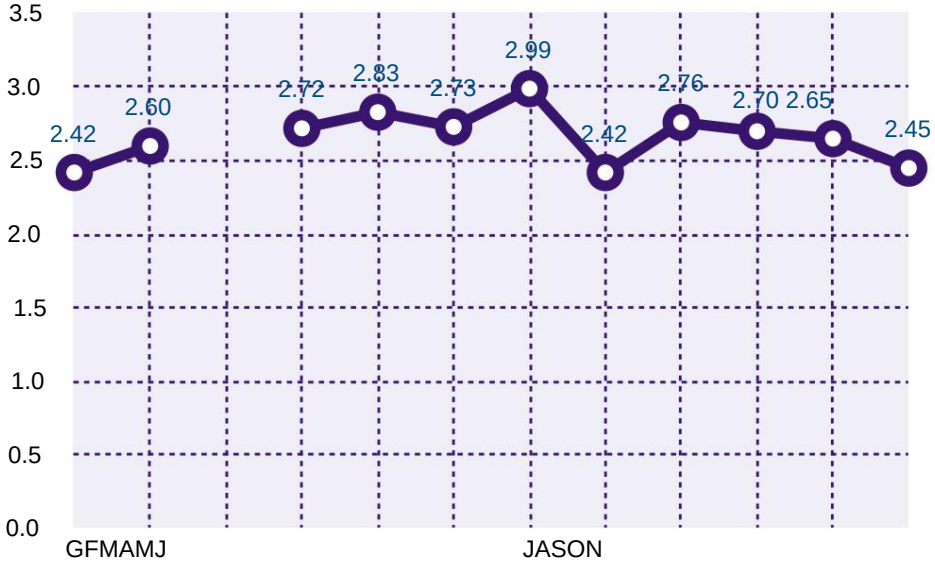
is very high During most of the year the number of users remains between 2.6 and 2.7 million people.

Figure 13. Weekly evolution of the city's "users" *(millions of people per average day)*



source Barcelona City Council with data from Vodafone

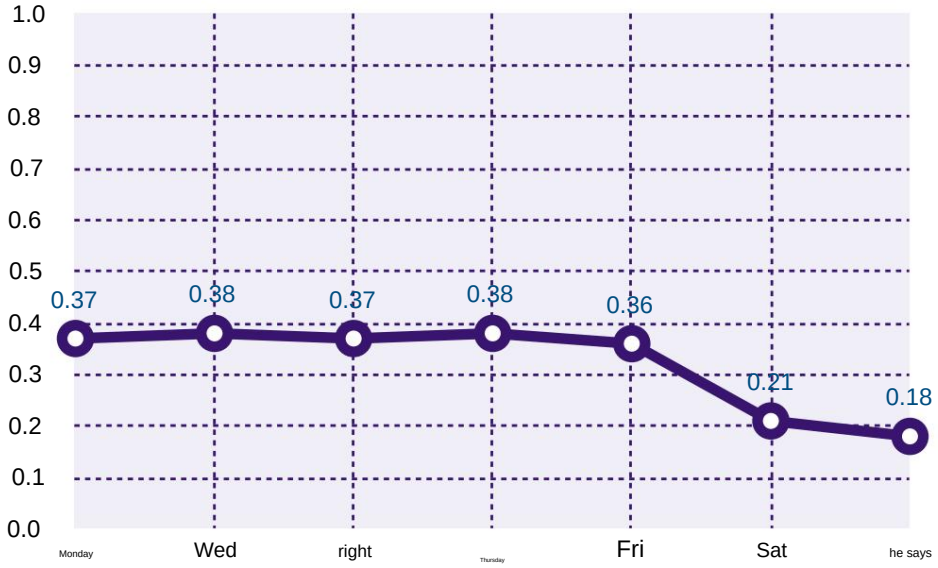
Figure 14. Monthly evolution of the city's "users" *(millions of people per average day)*



source Barcelona City Council with data from Vodafone

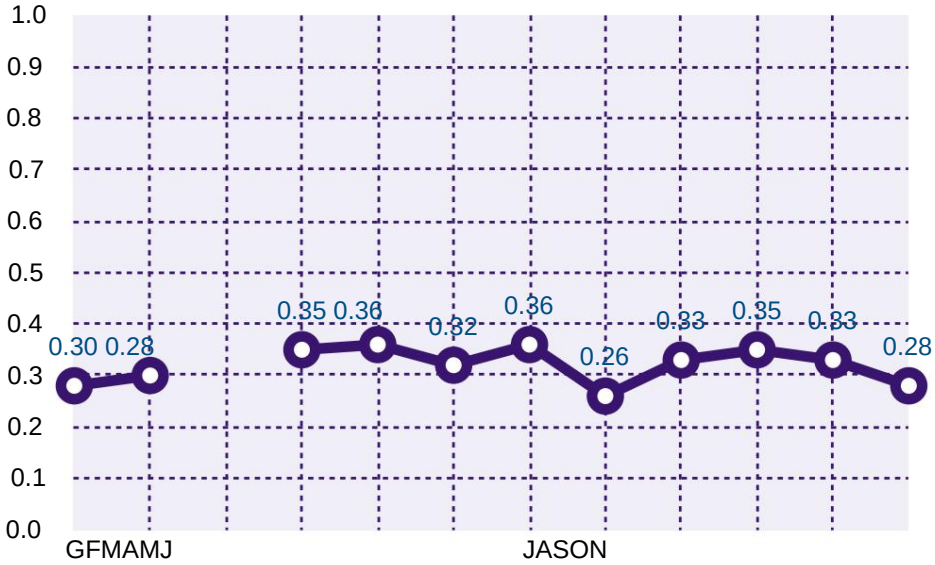
As is logical, the behavior of commuters varies greatly throughout the week. The peak of activity is the central days of the week (Tuesday to Friday), with few differences between the days of the week. At the weekend, this flow drops sharply, so that on a Sunday, half the commuting population moves than on a Friday, although it remains an important contingent that affects the rhythms of the city. The variation is not so high in the monthly differences. The month of August is the month with the lowest incidence, but even so the 260,000 daily tickets are maintained on average, rising to 280,000 in December. The distance between the month with the highest number and the month with the lowest incidence is 100,000 individuals.

Figure 15. Weekly evolution of commuters *(millions of people per day on average)*



source Barcelona City Council with data from Vodafone

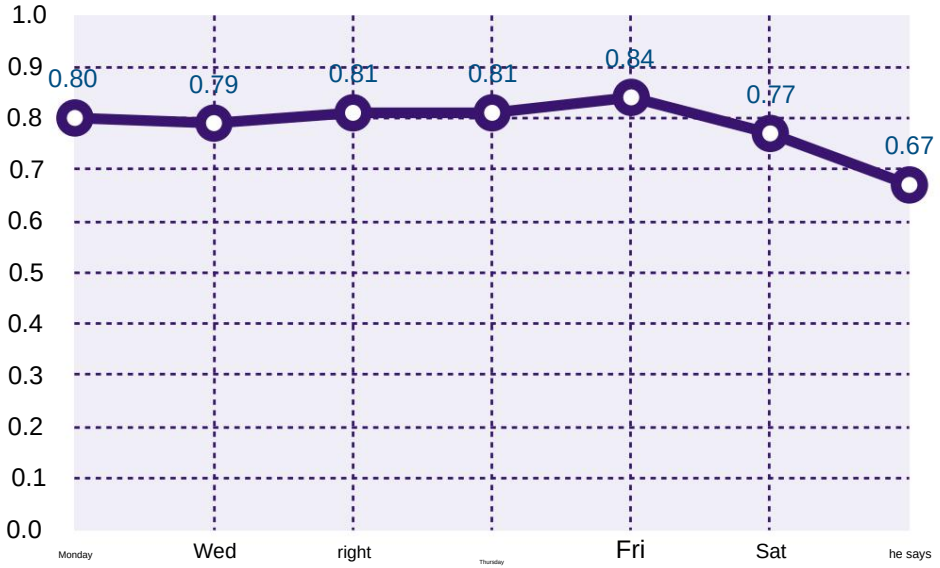
Figure 16. Monthly evolution of commuters *(millions of people per average day)*



source Barcelona City Council with data from Vodafone

The weekly distribution of the flows of domestic travelers shows a behavior closer to that of commuters, with a decrease in the number of people on Saturday and especially on Sunday, although the differences between working days and holidays are in this case much less relevant. Most of the movements of metropolitans displaced for personal reasons and hikers are collected here.

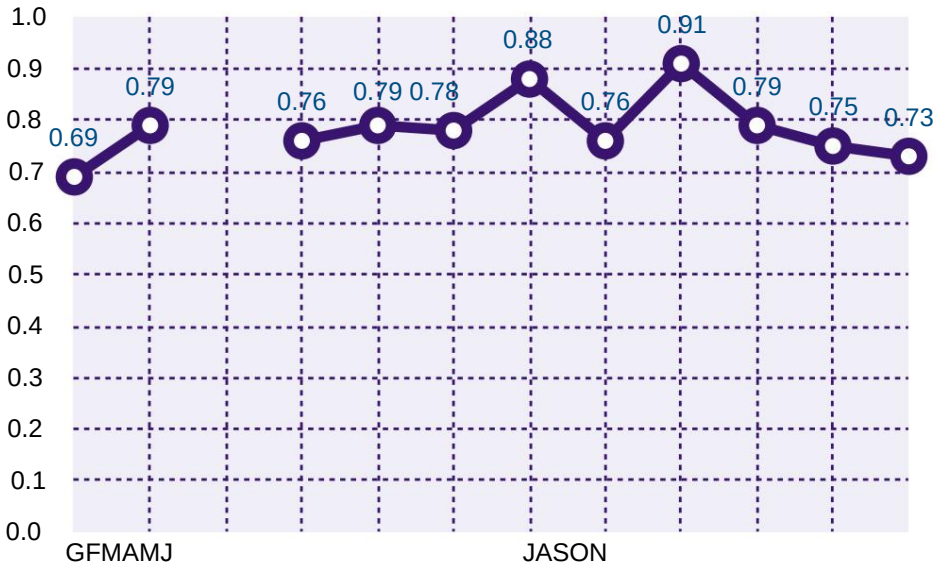
Figure 17. Weekly evolution of national travelers *(millions of people per day on average)*



source Barcelona City Council with data from Vodafone

The monthly differences are even smaller, since the behavior in the month of August is very similar to the rest of the year. The month with the lowest incidence for this group is January and the months with the highest volume are the summer months (except August), in which registrations approach one million people.

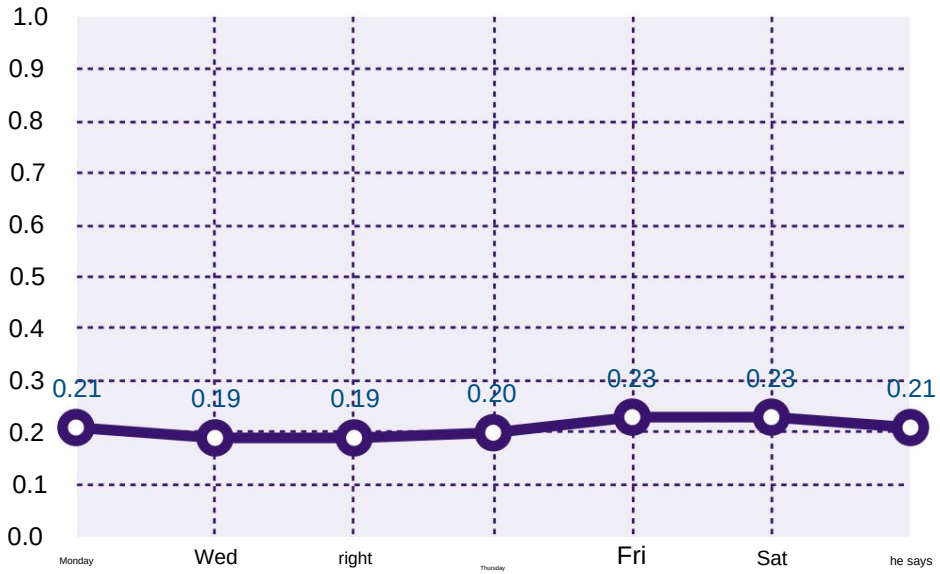
Figure 18. Monthly evolution of national travelers
(millions of people per day on average)



source Barcelona City Council with data from Vodafone

As could be expected, there is no incidence of the day of the week among the international group, because it has very low mandatory mobility.
In fact, the day with the highest value is Saturday.

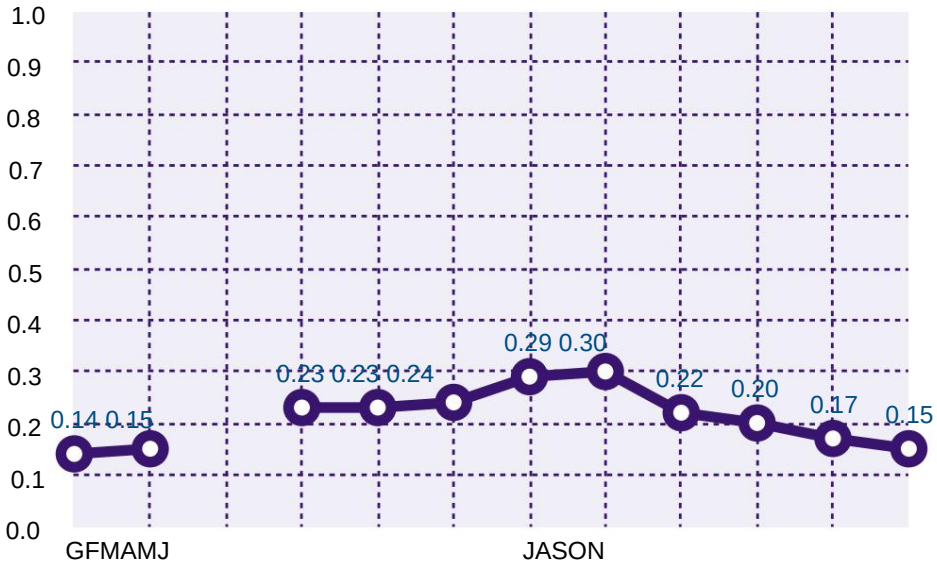
Figure 19. Weekly evolution of international users*
(millions of people per day on average)



**Users who maintain a link with an international operator*
source Barcelona City Council with data from Vodafone

The effect of tourism is reflected in the seasonal variation, which is very pronounced. The peak of people takes place in the months of August and July, which are the two months with greater tourist frequency; on the contrary, in winter the fall is very sensitive.

Figure 20. Monthly evolution of international users*
(millions of people per day on average)

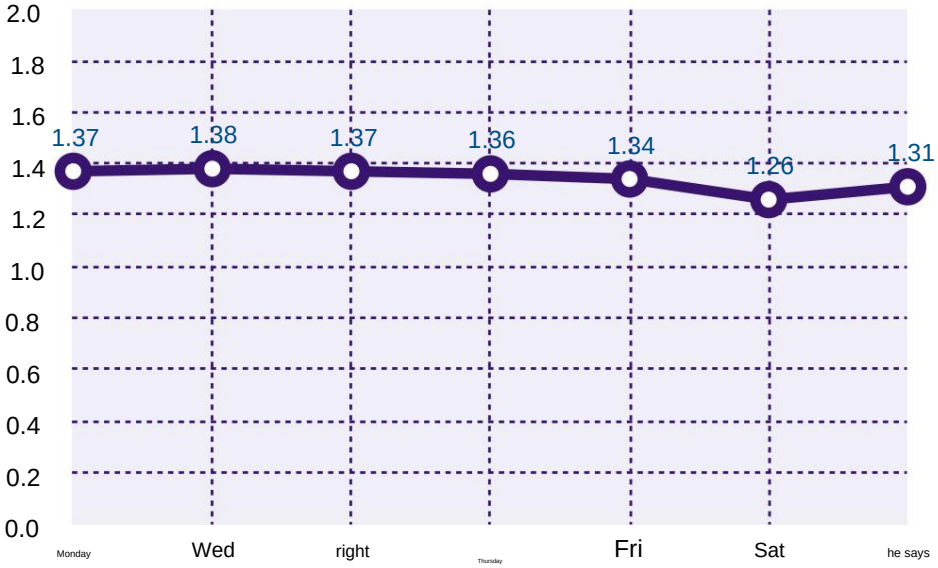


**Users who maintain a link with an international operator*

source Barcelona City Council with data from Vodafone

As is logical, there are few variations in the number of residents during the days of the week. The slight reduction on Saturday is essentially explained by leisure mobility which would affect an average of 6% of the population according to this data.

Figure 21. Weekly evolution of residents
(millions of people per day on average)

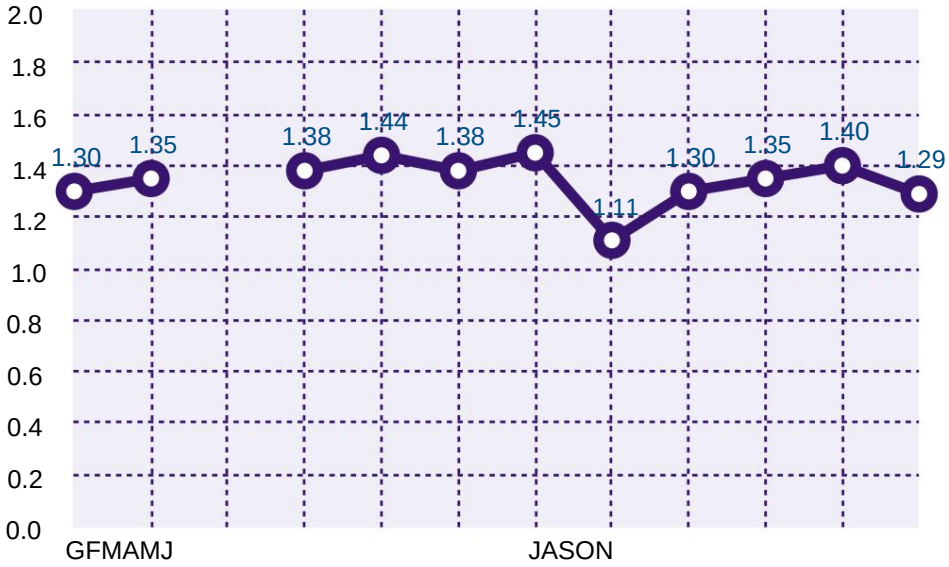


source Barcelona City Council with data from Vodafone

The effect of leisure mobility is much more evident during August, when the daily average of residents falls by 20%. There is also a significant reduction in the months of December and January due to the effect of Christmas. The resident population (and commuters) shrinks when the number of tourists, especially international ones, grows more clearly. There is a compensation system between groups that prevents peaking

summer of users. In fact, the more tourists there are in the city, the fewer users of the city there are, because the rest of the groups are reduced.

Figure 22. Monthly evolution of residents
(millions of people per day on average)



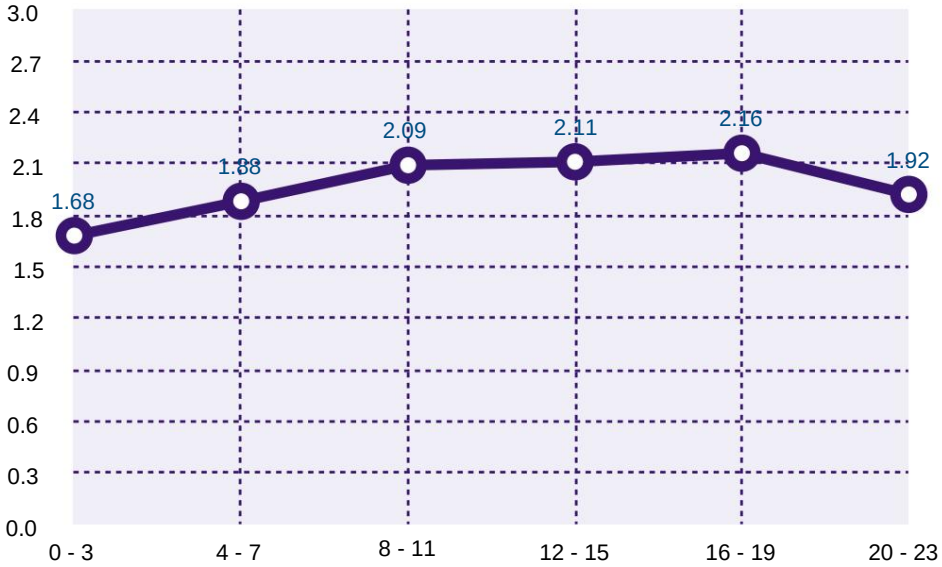
source Barcelona City Council with data from Vodafone

As we discussed earlier, the number of people who are in the city on a given day is not the same as the number of people who are in the city simultaneously. The time flows of users are very diverse and, in some cases, there are situations of a certain complementarity, so that when one group leaves the city, another enters it. If we study the volume of total visitors by time slots, we will see that the time when there are more people in the city is during the slot 16 - 19, which is half a million people below the total volume of users in the city on an average day.

The maximum intensity takes place between 12pm and 7pm, when Barcelona's industrial, economic, commercial and tourist life is concentrated. On the contrary, at night it reaches its lowest level with 1.68 million people, which is a figure very similar to the number of residents of the city.

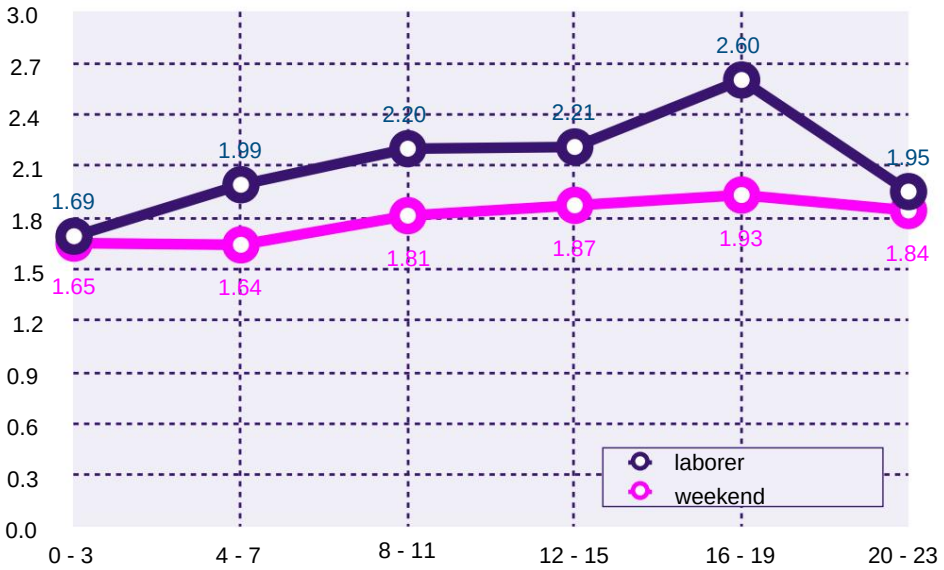
There is also a notable difference between weekday and weekend timetables. While during the night hours, there are practically the same number of people in the city on any day of the week, very close to the official permanent figure, the differences are much clearer during the day with differences of around 400,000 users between weekday and weekend values. This difference is clearly shot in the range between 4 and 7 p.m., when there is a difference of nearly 700,000 people between a working day (with 2.6 million users, the average value) and the weekend (with less than 2 million people in the city).

Figure 23. City users by time slots
(millions of people per day on average)



Therefore, there is a time of the day, which is the period between 4 and 7 pm on working days, in which a significant part of the people who occupy the city converge. During this temporary period, the city reaches its maximum occupancy ceiling, which is reduced in the night slots and during the weekend. There are also significant differences between behavior during the seasons. The greatest activity in the city takes place during the spring months and the lowest volume is reached during the winter months.

Figure 24. Users of the city by time slots and days
(millions of people per day on average)



source Barcelona City Council with data from Vodafone

Table 27. City users by time slots and seasons
(millions of people per day on average)

	winter	spring	summer	autumn
0 - 3	1.51	1.84	1.68	1.75
4 - 7	1.65	2.07	1.92	1.96
8 - 11	1.88	2.26	2.12	2.16
12 - 15	1.93	2.26	2.12	2.19
16 - 19	1.99	2.33	2.16	2.23
20 - 23	1.75	2.07	1.93	1.97

source Barcelona City Council with data from Vodafone

3.6.1. The rhythms of tourism

Barcelona tourism has annual rhythms that are marked by many factors that operate simultaneously. There are sectors, such as cruises, that have a strong seasonality and that concentrate their activity in certain months. The MICE sector is also very sensitive to event scheduling. Fira de Barcelona scheduled activities in 2019 that attracted 1.8 million visitors: Table 28 shows the fairs with more than 30,000 attendees in 2019. Two peaks can be identified in spring and autumn and the impact of the large fairs international events such as the Mobile World Congress.

Table 28. Visitors to the halls of the FIra de Barcelona

	month	days	visitors
MWC	February	3	109,000
Expo Sports	March	1	45,000
Education Fair	March	4	79,445
B-Travel	March	2	38,955
Long live the Moto	April	3	34,974
Salon del Cómic	April	2	118,000
Cosmobeauty	April	2	45,000
Car	may	10	138,554
ITMA	june	6	127,000
ACE	September	2	30,000
Nautical Hall	October	4	44,414
Caravanning	October	8	44,912
Manga Salon	november	3	150,000
Nice One	december	3	36,863

source Barcelona Fair
Only the salons with more than 30,000 visitors

The Fair has maximum activity during the autumn, while the number of attendees falls very noticeably during the summer. The month with a greater presence of visitors, however, is February, due to the impact of the Mobile World Congress.

Figure 25. Attendees at the Fira de Barcelona by month
(thousands of visitors)

source Barcelona Fair

Large events also generate concentrations of people in very specific periods of time. The 121 cultural festivals held in Barcelona in 2019 welcomed 2,436,507 attendees, 7% more than in 2018. This statistic only takes into account festivals with chronological continuity. One of the most relevant characteristics of these festivals is their spatial concentration: 34% were held in Ciutat Vella, 16% in Eixample and 13% in Sant Martí. Table 29 shows the music festivals with the largest number of attendees.

The distribution of attendees varies greatly between festivals: While 48% of attendees at Sònar or 60% at Primavera Sound are attendees from outside Catalonia, Cruïlla is aimed at 94% of Catalan attendees.

Table 29. Attendees at the main music festivals. 2019

Primavera Sound	220,000
International Jazz Festival	144,000
sonar	105,000
crossroads	62,387
Pedralbes Gardens Festival	57,411
Guitar Festival	54,815

source Cultural Observatory. ICEC

Tourism in Barcelona has a very different seasonal behavior to that of many other European cities. Urban tourism is characterized by a sharp drop in arrivals during the summer due to the weight of professional tourism and the increase in alternatives in domestic and international tourism. On the other hand, in Barcelona the months with the most tourist activity are July and August, while activity declines sharply during the winter.

This seasonal behavior is also observed in the movement of international passengers at the airport. It is present in travelers who come from the European Union, but it is even more marked in the rest of international passengers, since summer travelers double those in winter. This behavior is consistent with the dynamics of international users registered by the trace of their mobiles.

Figure 26. Monthly overnight stays in hotels. 2019
(million overnight stays)

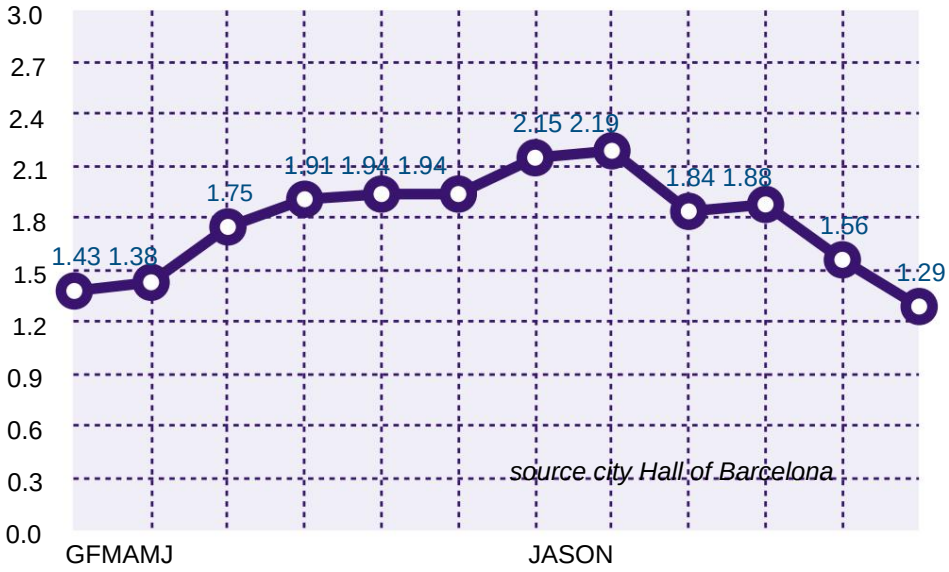
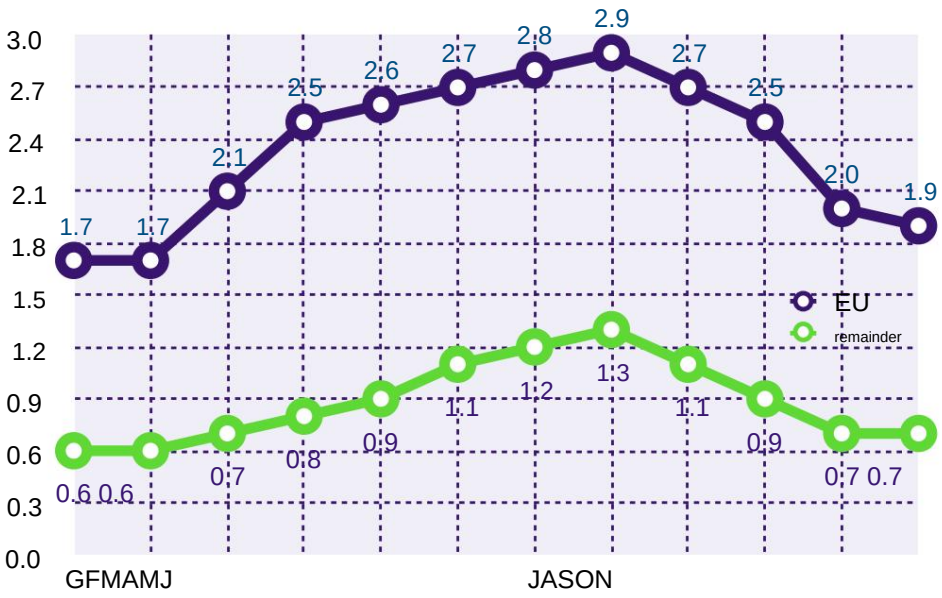


Figure 27. International passengers at the airport. 2019
(millions of people)



source Barcelona airport

In order to estimate the monthly behavior of the various users in the city, the following estimates have been taken into account.

- It has been considered that the monthly behavior of tourists follows roughly the same pattern as hotel accommodation in the city of Barcelona.

- It has been estimated that metropolitan tourists follow the same behavior as tourists from the city of Barcelona.
- The data on the monthly behavior of international tourism in Catalonia have been projected on excursion tourists who come from outside the Barcelona Metropolitan Area. • Data on monthly cruise arrivals have been

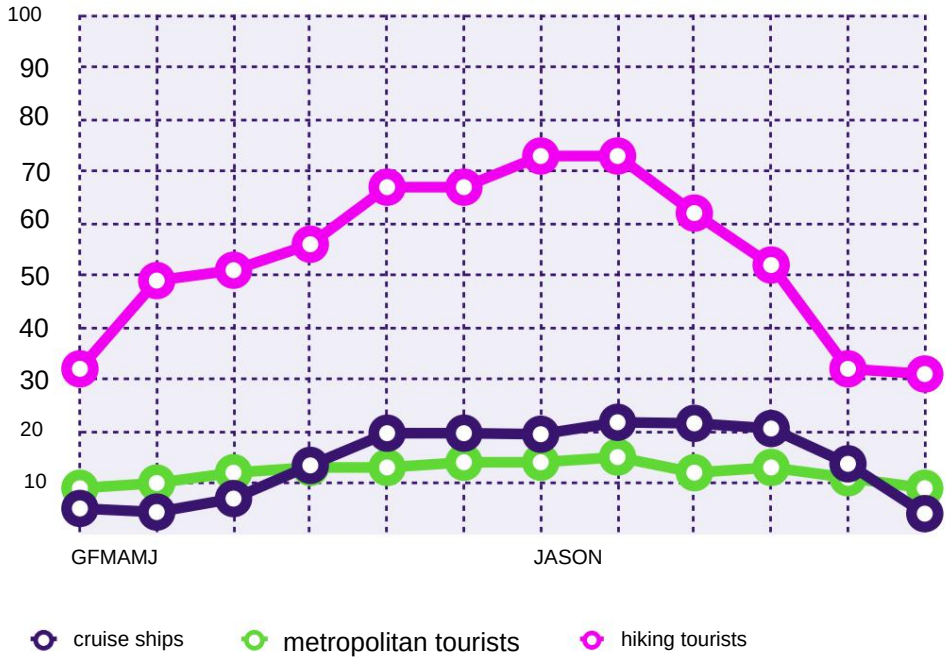
used for
determine the volume of cruise passengers.

- It has been considered that both hikers and metropolitan mobility follow the behavior recorded on mobile phones related to occasional mobility (those who are neither residents nor commuters nor international).

- Data from mobile phone records have been used to represent the behavior of residents and commuters.

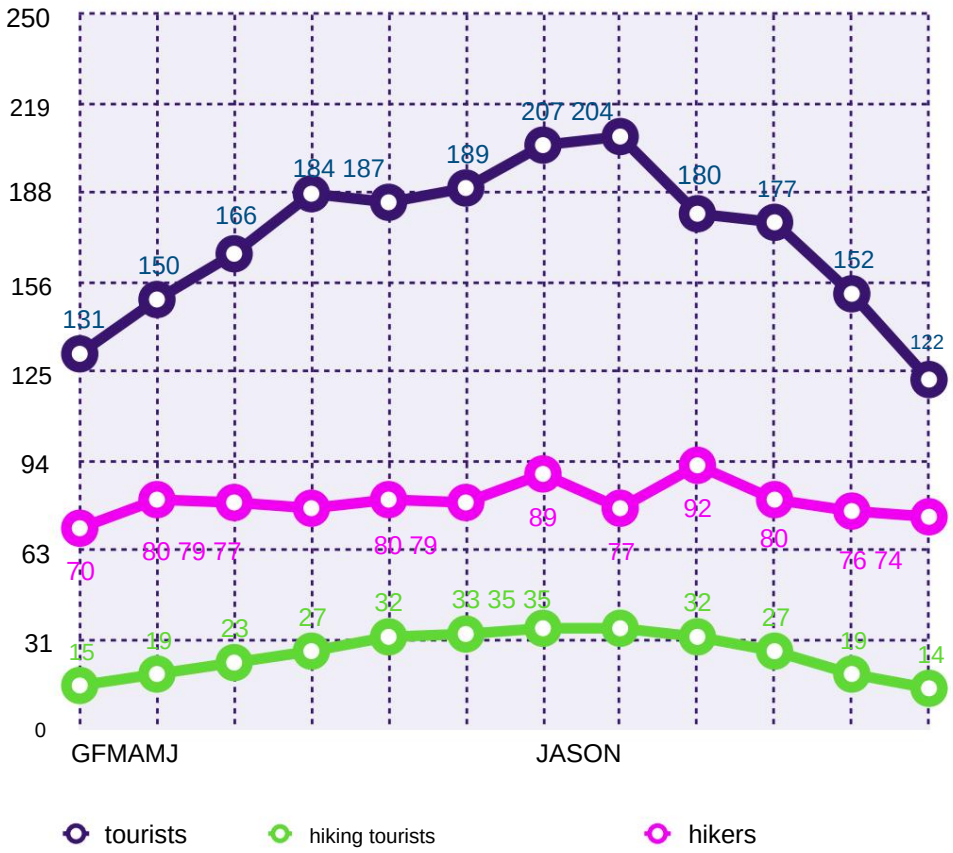
In accordance with these considerations, figure 28 shows the monthly behavior of excursion tourists in the city of Barcelona. You can clearly see the incidence of hikers during the summer period and the sharp decline during the winter.

Figure 28. Excursion tourists by month. 2019
(thousands of people per day)



source Own elaboration from various sources

Figure 29. Visitors by month. 2019
(thousands of people per day)



source Own elaboration from various sources

Figure 29 shows the behavior of the three types of visitors and their impact on the city during the year. As can be seen, tourists and hikers have a very marked seasonal component, while hikers are more evenly distributed throughout the year and are particularly reduced during winter and August. The sum of tourists and hiking tourists approximates the international mobility data recorded with mobile phones, with the exception of the summer months. In the summer, the records show a greater activity of the international population than shown in figure 29 (ignoring hikers, who are not international). This means that the monthly distribution of hotels may not capture the effective seasonality well, because other forms of accommodation (hostels, HUTs and especially private residences) may have a stronger seasonal component than hotels, which is the data we used as a reference.

Figure 30 makes an estimate of the behavior throughout the year of the various groups taking into account the following criteria:

- The daily behavior of tourists is based on the monthly distribution of visitors according to hotel occupancy records and disaggregated on a daily basis according to international mobile phone records.

- The daily behavior of commuters and residents follows the behavior recorded on the mobile phones of the two groups.

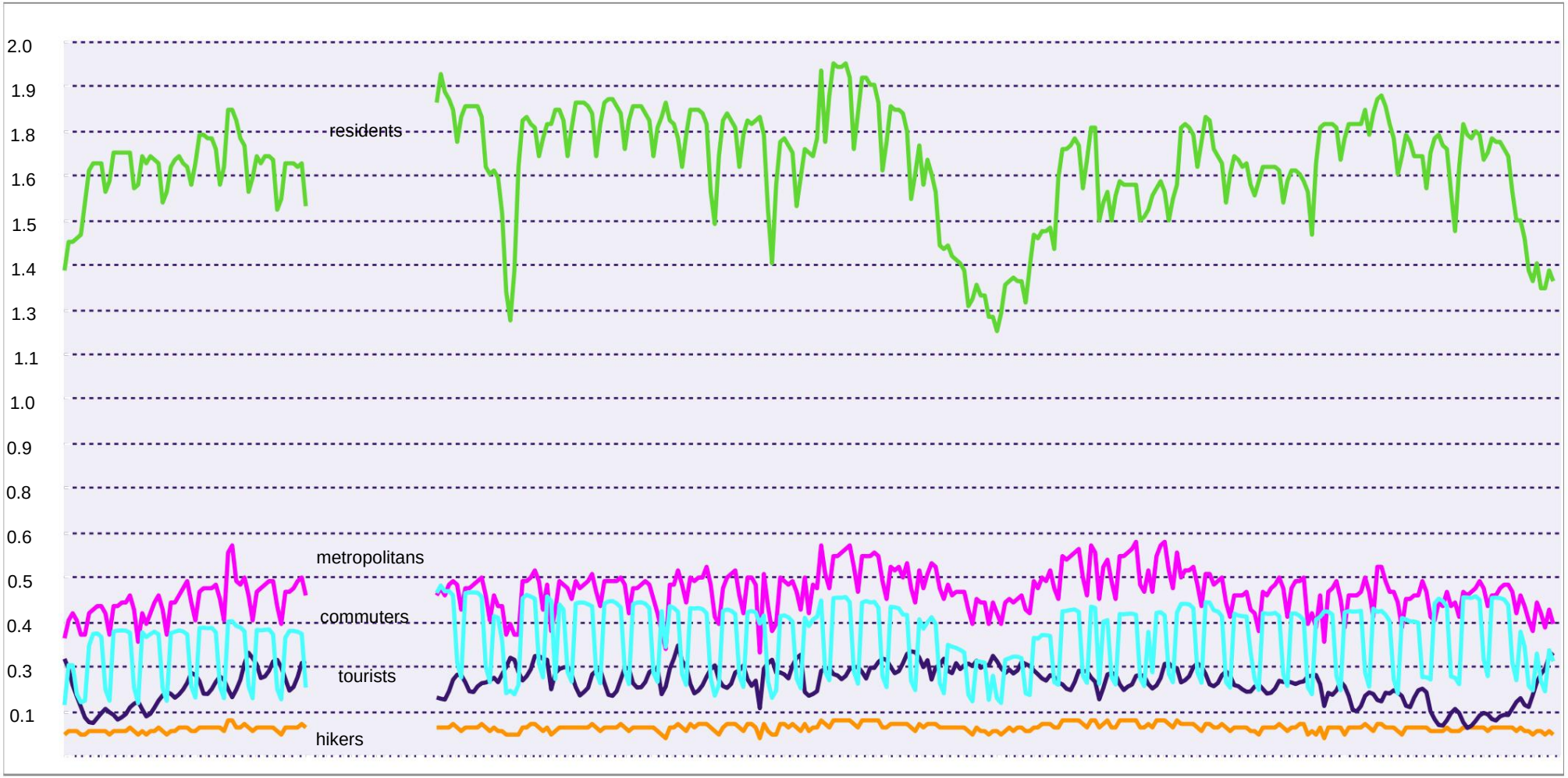
- The daily behavior of hikers and metropolitans follows the previously calculated monthly pattern and the daily distribution recorded in mobile phones that is not commuters or local population. •

Metropolitan tourists follow the same distribution pattern daily than the tourists of Barcelona.

- Excursion tourists and cruise passengers follow the monthly pattern of tourism in Catalonia and the movement of cruises. For daily data the behavior of international records has been identified.

As you can see, winter is the period with a lower intensity of use of the city, because it is the time when there are the lowest records of all groups. Another time of low intensity is August because, despite the fact that visitors reach their highest point, the rest of the users (and especially the residents) use it significantly less. Conversely, the periods of greatest intensity are spring and autumn. The month of July is the month with the greatest concentration of the various groups.

Figure 30. Daily evolution of city users *(millions of people)*



The indicators on the density of occupation of the space in Barcelona according to the previous estimates are as follows.

INDICATOR 1. GLOBAL DENSITY

TOURISTS	
Average density (tourists/km2)	1,687
Maximum density (tourists/km2)	2,586
Density P80 (tourists/km2)	2,027
TOURISTS AND EXCURSIONIST TOURISTS	
Average density (tourists/km2)	1,944
Maximum density (tourists/km2)	2,976
Density P80 (tourists/km2)	2,364
VISITORS	
Average density (viewers/km2)	2,724
Maximum density (viewers/km2)	3,845
P80 density (viewers/km2)	3.162

The density is an indicator of the degree of occupation of the space and relates the number of people and the surface area. It is an average distribution value that shows the number of people that would be in each surface unit if they were distributed homogeneously in space.
If we only took into account the number of inhabitants of Barcelona, the density of the city would be 16,149 inhabitants per km2. If we take into account the number of users, the density would be 25,881 people for each km2.

The average density indicator does not take monthly and daily variations into account. Given the seasonal behavior of tourism in the city, during certain periods of the year the presence of tourists is noticeably higher than average. The maximum value sets the upper end, but it is not usually used as a reference value because in all spaces there can be specific situations of overdemand. The 80th percentile (or decile 8) helps to identify the pressure on a space without taking into account the extreme cases: It identifies the value located in the 80% position, that is to say the maximum data if we ignore the 20% of extreme cases.

The density of tourists in Barcelona according to the 80th percentile is 2,364 tourists per km2. This value includes both tourists staying in the city and excursion tourists (metropolitan tourists, excursion tourists and cruise tourists). The 80th percentile of visitors (that is, tourists and excursionists) exceeds 3,000 Km2. The main problem of global density is that it assumes the hypothesis that tourists or visitors are distributed homogeneously in the territory and, as we will see in the next point, one of the characteristics of the geography of urban tourism is the concentrated distribution of tourists in certain spaces.

INDICATOR 2. RELATIVE WEIGHT

TOURISTS (%)	
average	6.4%
maximum	11.5%
P80	7.8%
TOURISTS AND TOURISTS (%)	
average	7.4%
maximum	13.1%
P80	8.9%
VISITORS (%)	
average	10.3%
maximum	16.13%
P80	11.97%

A second way to measure the weight of tourism in urban dynamics is to establish a relationship between the total number of tourists and the number of users of the city. We know that on an average day tourists (tourists staying overnight in Barcelona and excursion tourists) represent approximately 7.4% of the total number of people who are in the city in a certain moment The maximum value climbs to 13% and the 80th percentile is close to 9%. We must know how to read this result: The relative weight of tourists on the total number of users is the ratio between the influx of tourists and the number of people occupying the city that day. A high proportion can be the result of an increase in tourists or a sharp decrease in users. In fact, there is the paradox that the maximum value of tourists in the city over the total number of users coincides with the minimum value of residents and commuters, because part of these users are making a tourist stay outside of Barcelona. In other words, the greatest tourist pressure in Barcelona takes place due to the greatest tourist activity of Barcelona residents and commuters outside of Barcelona. It is the tourism of locals that increases the relative pressure of tourism in the city. For this reason, as we have mentioned, there is a certain compensation in the rhythms of the city that limit the saturation of public space.

If we consider visitors (tourists and hikers), their average relative weight is 10.3%. The maximum value exceeds 16% and is explained, as mentioned, by the increase in the number of visitors at the same time that the number of users in the city is reduced. If we do not take into account the extreme values, the 80th percentile of the relative weight of visitors is 12%. It is worth remembering that we are considering the number of people who are in the city at some point of the day, which is not the same as the number of people who are there simultaneously: Many of the users are in the city during a certain time interval and the intensities of use of each other are not always comparable. The temporal dimension must be the time, which we can access when the

data from mobile phone journeys provide the information in this dimension.

Both indicators take into account the temporal variable, but not the spatial one. For this reason, in the next section we will consider the spatial distribution of tourists and also of the rest of the city's users, with the aim of identifying the areas of greatest concentration.

3.7. Spatial logic

Cities are places of concentration. Economic activities, income levels, house prices or road congestion are not distributed homogeneously but follow very precise spatial patterns. Tourism is one of the activities with a greater tendency towards spatial concentration. Tourist itineraries, hotel locations, the most visited monuments, souvenir shops, tourist bus stops, restaurants where most of the customers are international, are located in narrow corridors where tourist life becomes . There is a game of empty and full, of shadows and lights, which stresses the system because it creates spaces of excessive concentration.

Spatial distribution is very relevant in studies on load capacity or acceptable change limit. For example, in the definition of the load capacity of the Alhambra in Granada, the capacity of the Nasrid Palaces was taken into account; the maximum number of visitors to this space has been the marker to define what the maximum volume is of simultaneous visitors that the entire space can tolerate (García, 2001). In the same way, a load capacity limit could be set in the city of Barcelona, taking into account not the average degree of saturation of the city as a whole, but the saturation of the areas with the greatest concentration. While other cities have a polycentric structure that allows tourist flows to be distributed over a wider area, Barcelona is characterized by extreme spatial concentration in a very small area.

Table 30 shows the distribution of tourist places in the districts of Barcelona in 2019, which is the reference year in this study because it is not affected by the impact of the pandemic. We can project the estimated number of tourists for each accommodation in order to know the approximate distribution of overnight stays in the districts of the city. We know, however, that the percentage of employment is not homogeneous and that some areas have higher employment rates than others, so that the degree of concentration is slightly underrepresented. The main methodological problem is the location of private houses. Private houses could be considered to be located similarly to the distribution of the city's residential population, but we have corrected this projection with the data on the immigrant population because we know that two-thirds of the people who stay in private houses are international in nature (and therefore possibly also their hosts).

Table 30. Tourist places by district (2019)

	Hotels	Pensions	Apart. HUT	Hostels	
Old City	19,339	2,778	239	3,216	1,347
extension	21,505	2,186	298	29,754	3,170
Sants - Montjuic	6,318	864	36	5,992	914
The Courts	6.121	48	0	1,595	583
Sarrià Sant Gervasi	3,355	277	66	3,248	580
grace	1,213	242	98	5,927	2,019
Horta Guinardó	913	28	10	1,449	147
New Neighborhoods	282	45	0	127	0
Saint Andrew	222	0	0	512	12
Saint Martin	13,905	21	18	6,763	1,685

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source Barcelona Tourism Observatory

Table 31 shows an estimate of the spatial distribution of day tourists if the tourists spend their entire stay in the district in which they spend the night. The table shows the weight of the Eixample, where a third of the overnight stays are located, and the Ciutat Vella - Eixample - Sant Martí triangle, which concentrates two thirds of the total overnight stays. in three of the city's districts (Horta Guinardó, Nou Barris and Sant Andreu) only 5% of the total nights take place.

Table 31. Estimate of stays by district according to the overnight stay criterion (2019)
(day tourists)

	day tourists	percentage
Old City	32,362	18.9
extension	57,873	33.9
Sants - Montjuic	16,752	9.8
The Courts	9,685	5.7
Sarrià Sant Gervasi	8,985	5.3
grace	10,362	6.1
Horta Guinardó	4,426	2.6
New Neighborhoods	2,695	1.6
Saint Andrew	2,283	1.3
Saint Martin	25,455	14.9

source Barcelona Tourism Observatory

Although accommodation gives us a first insight into the location of visitors in the city, visitors have a tendency to be mobile in order to visit the attractions that make up their selection. Table 32 shows, for example, the most visited spaces in the city that have a record of visits. Many of these cultural or recreational facilities have a high percentage of visitors who are tourists, but others are an offer that is essentially explained by metropolitan demand and that has a low tourist incidence. The main points of tourist interest are located in the large corridors of the Eixample and Ciutat Vella, so that the itineraries for visitors are located in a very small area.

Table 33 shows the percentage of visitors who declare to have visited a series of spaces that coincide with the concentration spaces detected in table 32. La Rambla, the Gothic Quarter and Plaça Catalunya is the basic triangle in which places the main activity of the visitors. There is a main corridor that connects with Barceloneta, the coastal front and that declines as it moves away from the center (Rambla del Poblenou, Parc del Fòrum) and there is a second corridor that connects with the main icon of the city, which is the Sagrada Família. Some relatively peripheral nodes partially help to decentralize tourist activity, such as visits to the Museu del Futbol Club Barcelona, the Glòries complex or Park Güell. Other spaces, such as Turó de la Rovira, have a marginal weight and show the difficulty of tourist itineraries to leave the main corridors.

Table 32. Cultural facilities with large crowds. 2019

	district	visitors
Sagrada Familia	extension	4,717,796
Park Güell	grace	3,154,349
Barcelona Football Club Museum	The Courts	1,661,156
The Aquarium	Old City	1,609,373
Born Cultural Center	Old City	1,161,755
Stone mine	extension	1,080,519
Picasso Museum	Old City	1,072,887
Casa Batlló	extension	1,065,222
Caixaforum Barcelona	Sants Montjuïc	1,050,068
cosmocaixa	Sarrià Sant Gervasi	1,002,965
Museum of History	Old City	926,235
Palau Robert	extension	909,898
Montjuïc Castle	Sants Montjuïc	881,215
MNAC	Sants Montjuïc	837,694

source city Hall of Barcelona

Table 33. Visits to Barcelona's High Traffic Areas (%)

	district	visitors
La Rambla	Old City	75.4
Plaça Catalunya and Passeig de Gràcia Eixample		67.0
Gothic Quarter	Old City	63.6
Sagrada Familia	extension	62.0
Barceloneta	Old City	51.1
Coastal Front	Old City	44.4
Park Güell	grace	38.6
Montjuïc	Sants Montjuïc	38.2
Rambla del Poblenou	Saint Martin	38.0
glories	Saint Martin	26.2
Camp Nou	The Courts	20.6
Sant Antoni market	extension	16.7
Forum Park	Saint Martin	12.4
Rovira Hill	Sants Montjuïc	8.1

source Profile and habits of tourists in the city of Barcelona 2018-2019

According to the results of the survey, a tourist visits 5.6 High Afflux Areas (EGA) on average. This is only part of its journey, for two reasons. First of all, because tourists experience the city in many different ways and visiting the main nodes or sights of the city is just one of them. Tourists get lost in the less traveled streets, enjoy the shows of the city, shop in the commercial establishments or simply visit a friend who lives in the upper part of the city. It is true that *sightseeing* is the main activity of tourists, but logically it is not the only one. Second, tourists also visit low-traffic spaces as a result of the long queue effect. Galí and Donaire (2015) already showed that tourists, once freed from their "obligation" to visit the big tourist sites, have a scattered look that is interested in very diverse elements.

EGAs are therefore only a fragment of the visitor experience.
The use of data on the behavior of tourists based on the mobile signal will soon allow us to work on the micro-scale and specify in more detail the effective behavior of visitors, but for this study we will work with the EGAs. According to the tourist profile data, the average number of places they visited was 5.6 out of the 12 options presented. If we take into account the geographical distribution of the EGAs and if we hypothesize a homogeneous temporal distribution between the spaces, an average tourist will spend 42% of his time visiting nodes in Ciutat Vella, 26% in the Eixample and a 14% in Sant Martí, as Table 34 shows.

Table 34. Geographical distribution of tourists in the EGAs with the hypothesis of a homogeneous temporal distribution

district	EGAs	%
Old City	La Rambla, Gothic Quarter, Barceloneta, Coastal Front	41.7
extension	Passeig Gràcia and Plaça Catalunya, Sagrada Família, Sant Antoni market	25.9
grace	Park Güell	6.9
Sants Montjuïc	Montjuïc, Turó de la Rovira	8.2
Saint Martin	Rambla del Poblenou, Glòries, Parc del Forum	13.6
The Courts	Camp Nou	3.7

source Profile and habits of tourists in the city of Barcelona 2018-2019

From a geographical point of view, one of the main problems of the tourist city of Barcelona is the extreme concentration of activity in the Ciutat Vella district. With the hypothesis of a homogeneous temporal distribution, an average tourist would spend 42% of *sightseeing* time visiting the elements of Ciutat Vella.

In 2016, Barcelona City Council carried out a survey on the mobility of tourists in order to prepare a study on mobility, as proposed in the Strategic Plan. Travel to accommodation represents 21.5% of total urban flows, while the majority of flows are explained by visits to the various spaces of interest to the city, the EGAs (High Afflux Areas). It must be borne in mind, however, that the time spent in the elements is much lower than the time spent in the accommodation spaces and for this reason we propose a ratio of 1/3 - 2/3. From the survey it is also very significant that 21.1% of the flows are explained by trips that are outside the catalog of main sights of interest; this is the relative weight of the long tail identified by Galí and Donaire (2015) in the study on tourist images.

Table 34 shows the destination of tourist flows that visit some of the city's sights and clearly draws a hierarchy that can be seen in similar studies on the image of the city and on the behavior of visitors. Tourist mobility is mainly explained by the extreme concentration of the visiting elements in a space of very small dimensions, which generates a very high pressure in the main corridor. The distribution of EGAs shown by the mobility survey is very similar to that of the tourist profile survey, as shown in table 35. The two most significant differences are a reduction in the weight of the Sant Martí district and an increase in the relative weight of the Eixample. In any case, the spatial behavior is very consistent: Ciutat Vella - the Passeig de Gràcia corridor - the main nodes of Sagrada Família and Park Güell - the coastal corridor.

Table 35. Destination of visitor flows (EGA) (%)

	district	visitors
La Rambla	Old City	5.4
Catalonia Square	extension	4.0
Stone mine	extension	2.8
Casa Batlló	extension	2.9
Gothic Quarter	Old City	4.4
born	Old City	2.4
Cathedral	Old City	2.0
Sagrada Familia	extension	7.7
Barceloneta	Old City	4.2
Old Port	Old City	1.2
Park Güell	grace	4.9
Montjuïc Castle	Sants Montjuïc	1.5
Picasso Museum	Old City	1.1
Saint Pau Hospital	extension	1.5
Camp Nou	The Courts	1.5
Olympic Port	Saint Martin	2.3
Spain Square	Sants Montjuïc	2.3

source Tourist mobility survey. 2016

Table 36. Geographical distribution of tourists in the EGAs with the hypothesis of a homogeneous temporal distribution

district	EGAs	%
Old City	La Rambla, Gothic Quarter, Born, Cathedral, Barceloneta, Picasso Museum	39.7
extension	Plaça Catalunya, La Pedrera, Casa Batlló, Sagrada Family, Sant Pau Hospital	36.3
grace	Park Güell	9.4
Sants Montjuïc	Montjuïc Castle, Plaza España	7.3
Saint Martin	Olympic Port	4.4
The Courts	Camp Nou	2.9

source Tourist mobility survey. 2016

In a simplification of the tourist's activity in the city, we can consider the itineraries created from the accommodation space and the visiting spaces. Again, we insist on the fact that this simplification does not take into account either the diversity of tourists visiting the city or the complexity of the routes, which can be analyzed with studies on mobile phone registration, applications, photographic captures or the location of the 'card activity. In these simplified routes accommodation space - visit space, we can estimate that one third of the stay time is dedicated to the accommodation and that two thirds corresponds to the visit. This is explained both by the rest time and

for the use of services close to the accommodation space. In a city where walking routes predominate, the accommodation area predisposes to a greater use of catering (breakfast, dinner), commercial or leisure services and is also the necessary space for outbound and comeback

Table 37 proposes an estimate of the spatial distribution of tourists in the city of Barcelona. If we compare the data of the two indicators, we will see that they are very similar, with the exception of Ciutat Vella which has a limited number of establishments but which welcomes a significant flow from the other districts. We know from other studies that the concentration is very pronounced at the scale of neighborhoods and that a few neighborhoods concentrate most of the city's tourist activity.
In accordance with this spatial distribution and taking into account the surface area of each district, the table also proposes the estimated tourist densities for each space. It is true that some spaces have low densities because the space occupied by the district as a whole is very large because it includes an area of parks, so the overall result hides possible concentrations in the neighborhoods with higher density. However, the result is quite eloquent: A few districts concentrate tourist activity and, therefore, have a much higher than average tourist employment density.

Table 37. Estimated daily tourist density by district
(tourists per Km2)

	% estimated Tourists		Surface Density	
Old City	34.1	58,269	4.11	14,177
extension	28.6	48,871	7.46	6,551
Sants - Montjuic	8.7	14,866	22.68	655
The Courts	4.4	7,519	6.02	1,249
Sarrià Sant Gervasi	1.8	3,076	19.91	154
grace	6.6	11,278	4.19	2,692
Horta Guinardó	0.9	1,538	11.96	129
New Neighborhoods	0.5	854	8.05	106
Saint Andrew	0.4	684	6.59	104
Saint Martin	14	23,923	10.39	2,302

source Own elaboration from various sources

Four of the ten districts have a higher than average density.
Sant Martí is one of the axes of growth of tourism in the last two decades from the Olympic axis and the forum and favored by its coastal condition. Even so, the density in the district does not deviate too far from the average density. The district of Gràcia is the second axis of

development of tourist activity; although the tourist volume is much lower than that of Sant Martí, the small dimensions of the space give rise to a significant density. The Eixample district has an average surface area and a very significant volume of activity, which results in a density four times higher than the average density.

Table 38. Average daily tourist density, maximum and p80 per districts

	average	maximum	p80
Old City	14,177	21,861	17,139
extension	6,551	10.102	7,920
Sants - Montjuic	655	1.011	792
The Courts	1,249	1,926	1,510
Sarrià Sant Gervasi	154	238	187
grace	2,692	4,150	3,254
Horta Guinardó	129	198	155
New Neighborhoods	106	164	128
Saint Andrew	104	160	125
Saint Martin	2,302	3,550	2,783

source Own elaboration from various sources

However, the main indicator of territorial imbalance is the extreme concentration of activity in a district that grew up enclosed between medieval walls and narrow streets, Ciutat Vella. The average tourist density in the district is 14,000 tourists per square kilometer. This value climbs to 22,000 tourists per km2 at its maximum value, and 17,000 tourists per km2 if we consider the 80th percentile, which is the control value we suggest (table 38). In these data, only tourists who spend the night in the city have been considered.

To estimate the spatial behavior of hiking tourists, we took into account the following considerations:

- The visitor profile survey only collects visits to high-traffic areas (EGA) by people who are staying in Barcelona. Nor does the survey on mobility present data on visitors who do not spend the night in Barcelona. Therefore, it has been considered that metropolitan tourists and excursion tourists have a mobility explained by the distribution of EGAs of tourists staying in the city. • With regard to cruise passengers, the results of the survey on the profile of the cruise passengers,

which is also included in the report on visitor mobility and which is shown in table 36, have been projected. Ciutat Vella and the Eixample concentrate almost all the activity of tourists in the city, since the time of stay is very short and the nodes closest to the port are privileged.

Table 39. Places most visited by cruise passengers

	average
Rambles	69%
Gothic	49%
Sagrada Familia	35%
Passeig de Gràcia	29%
Old Port	23%
Columbus Walk	22%
extension	19%
Boqueria market	12%

source Vayà, E.; Romaní, J.; Suriñach, J. (2016)

With this projection, the results on the density of excursion tourists in the city of Barcelona are shown in the attached table. Due to the effect of cruise passengers, the concentration of this group in the two districts with the greatest pressure is slightly higher than the behavior of tourists. In any case, as the average stay of excursion tourists is very low (equivalent to one day), their relative impact on density is much lower than that of tourists.

Table 40. Average, maximum and p80 daily density of tourists hikers by district

	average	maximum	p80
Old City	2,768	4,532	3,715
extension	1,125	1,862	1,497
Sants - Montjuic	92	156	121
The Courts	176	297	231
Sarrià Sant Gervasi	22	37	29
grace	380	641	498
Horta Guinardó	18	31	24
New Neighborhoods	15	25	20
Saint Andrew	15	25	19
Saint Martin	325	548	426

source Own elaboration from various sources

To calculate the frequency of hikers, we have considered the destination district of the flows generated outside the Metropolitan Area of Barcelona for non-work reasons. For working days we worked with the 2019 mobility survey, but for weekends we took into account the 2006 survey, so the results do not capture changes in mobility habits over the last decade. The results show that during working days the spatial distribution of hikers is relatively dispersed, although the Eixample is clearly the main attraction district; these days, Ciutat Vella has a lower than average attendance. On the contrary, at the weekend the pressure on Ciutat Vella increases and the two central districts approach 45% of all flows. The result is that although there is a certain concentration at the weekend in the two central districts and that the Eixample has a pressure well above the average, as a whole the hikers have a much more dispersed spatial distribution. Their effect on the density of the city is much more diluted than tourists, who are located in a very limited space of the urban area.

This greater dispersion is explained in the first place by the diversity of motivations that explain the motivations, where leisure is another factor in a very wide catalog of factors. And, secondly, for hikers, tourist attraction criteria (such as sights) have no influence, so their spatial behavior is closer to what we observed for the , population as a whole.

Table 41. Distribution of the flows of arriving hikers in Barcelona, resulting volume and average value and p80 of the density

	% labor	% head of week	average density	density p80
Old City	6.4	13.3	1,614	1,762
extension	28.3	28.4	3.005	3,282
Sants - Montjuic	13.3	6.3	394	431
The Courts	5.9	7.2	826	902
Sarrià Sant Gervasi	12.3	14.9	518	566
grace	4.1	4.8	811	886
Horta Guinardó	6.9	6.2	443	484
New Neighborhoods	5.6	4.6	523	571
Saint Andrew	6.9	6.3	808	883
Saint Martin	10.4	8.1	742	810

source Own elaboration from various sources

INDICATOR 3. p80 OF DAILY TOURIST DENSITY

	tourists	tourists and hiking tourists	visitors
Old City	17,139	20,854	22,616
extension	7,920	9,417	12,699
Sants - Montjuic	792	914	1,345
The Courts	1,510	1,741	2,643
Sarrià Sant Gervasi	187	215	781
grace	3,254	3,752	4,638
Horta Guinardó	155	179	663
New Neighborhoods	128	148	719
Saint Andrew	125	145	1,027
Saint Martin	2,783	3,210	4,019

This allows us to obtain indicator 3, which is the behavior of the 80th percentile of tourist density, taking into account the three groups we have identified: tourists, "extended" tourists (tourists staying or not in Barcelona) and the visitors. Tourism generates a strong pressure on Ciutat Vella, which reaches a very high density, and also on the Eixample, which is the area of the city that concentrates the three types of flows. Gràcia and Sant Martí are the two spaces with the greatest secondary pressure.

In order to determine the relative weight of tourism in the density of the city, we must take into account the mobility of the rest of the users and their unequal use of urban spaces. Urban spaces are anthills that create complex itineraries of comings and goings, so that the population present at a given time in a given district does not correspond to its census population. We know that some parts of cities have essentially a residential function and that urban life tends to be concentrated in central areas where services, cultural and leisure facilities, commercial establishments or relationship spaces are located. With more detailed information on the urban routes captured by the mobile we will be able to access this system of relationships, but the current data only provide information at a municipal level. For this reason, we have worked with the data from the weekday mobility survey. The method was as follows:

- We considered all the flows that had as origin and destination the city of Barcelona, that is to say the internal flows of residents.

- We have eliminated all return journeys to the home, because if we consider them the matrix would be practically a zero sum. We only considered travel for work or personal reasons.

- For each district, we have calculated the balance of entries and exits, that is, the result between all people in the city who have arrived in the reference district minus the residents of the district who have gone to other spaces.

- Finally, we have identified the number of people equivalent to each journey, taking into account that the average number of journeys is 4.05 and that 41.8% of the journeys are to return home.

The attraction capacity of the Eixample is evident, which is the main area for capturing the internal flows of the city of Barcelona. In the opposite sense, a number of districts have essentially a residential function and their balance is clearly negative. In any case, with the exception of the Eixample, the variations between the census population and the population estimated based on the space have a range of -/+10%. We will take these values into account to determine the effect of tourism on the overall density of city districts and their contribution to congestion.

Table 42. Estimated population by district according to population census and the city's internal mobility. 2019

	Population	balance	Effective population
Old City	105,820	12,157	117,977
extension	269,095	52,014	321.109
Sants - Montjuic	185,450	-13,943	171,507
The Courts	82,591	13,312	95,903
Sarrià Sant Gervasi	150,446	9,154	159,600
grace	122,853	-12,087	110,766
Horta Guinardó	172,473	-18,187	154,286
New Neighborhoods	171,290	-18,123	153,167
Saint Andrew	150,264	-16,822	133,442
Saint Martin	240,076	-7,474	232,602

source Own elaboration from EMEF 2019

Using the same source, we have taken into account the distribution by district of commuters' entries and metropolitan journeys (personal motivations of residents in the ÀMB). Table 37 shows the results and reveals the strong attraction capacity of the Eixample, but also

the activity of urban spaces such as Sants and Les Corts. On the contrary, Ciutat Vella is not a space with high frequency of these entrances.

Table 43. Destination district of commuters and journeys metropolitan personals. 2019

	commuters		metropolitans	
	%	users	%	users
Old City	8.3	26,760	6.1	31,293
extension	21.9	70,609	27.4	140,562
Sants - Montjuic	14.7	47,395	10.9	55,917
The Courts	14.4	46,428	11.3	57,969
Sarrià Sant Gervasi	11.8	38,045	10.8	55,404
grace	3.9	12,574	1.8	9,234
Horta Guinardó	6.7	21,602	4.9	25,137
New Neighborhoods	2.2	7,093	5.3	27,189
Saint Andrew	4.7	15,153	7.6	38,988
Saint Martin	11.4	36,755	13.9	71,307

source Own elaboration from EMEF 2019

With the projection of the preceding data, we can estimate the number of users in each area and for each district. We could say that the distribution of the various users in the city is relatively balanced. Most districts move in a dimension close to 200,000 people in average values. The district with the least intensity of use is Gràcia with around 150,000 people. There are, however, two districts that stand out clearly: Sant Martí and Eixample.

Sant Martí is close to 370,000 people, because it is a center that attracts all forms of mobility (metropolitans, commuters, hikers or tourists), despite the fact that its population balance is negative. And the main area of attraction in the city is the Eixample, which is the center of gravity for all forms of mobility: It has a high residential balance (it attracts many more residents than it loses), it is the main center of attraction of labor mobility and flows from the Metropolitan Area and is one of the main tourist areas of the city.

If the Eixample has a census of around 270,000 people, on an average day there are almost 600,000 people in this space, much more than double.

If we analyze the maximum values, we see that all the districts have pressure peaks much higher than the average values. The most obvious case is that of the Eixample, which has a peak of use that exceeds 700,000 people, that is to say, three times the population of the district. We have already commented that the extreme values may not be significant, as they show a one-time situation, so the 80th percentile allows us to identify the high values if we do not consider the extremes. This value climbs in the districts of Sants - Montjuïc (328,000), Sant Martí (405,000) and especially in the Eixample (658,000).

Table 44. Users by district

	middle	maximum	p80
Old City	255,760	312,421	276,578
extension	598,643	728,683	657,926
Sants - Montjuic	295,714	361,849	328,258
The Courts	208,258	259,402	234,356
Sarrià Sant Gervasi	261,485	320,466	289,953
grace	148,462	177,197	161,841
Horta Guinardó	205,916	248,687	225,584
New Neighborhoods	190,322	227,301	205,676
Saint Andrew	190,144	230,029	207,519
Saint Martin	369,351	446,415	404,680

source Own elaboration from various sources

Districts have very variable dimensions that logically affect the results, so it is much more useful to take into account density, i.e. the ratio of population to area. In reality, the density is very much conditioned by the morphology of the urban space, since the extent of the green spaces, the structure of the streets and especially the size of the buildings explains the differences between the cities. Figure 31 shows the densities of the main European cities, which are mainly explained by the extension of the municipality's perimeter, the incorporation of open spaces and also the morphology of the buildings. Barcelona is one of the cities in Europe with the highest density, with over 16,000 people per km2. On top of this initial pressure, the presence of the various users increases the density because large cities attract students, workers, metropolitan visitors, hikers or tourists. All large cities have a density higher than that fixed by the ratio between area and population because the "real population" is much higher than the census.

The density is between 15,000 and 30,000 people in most districts, which are very high values. The districts of Les Corts and Sant Martí stand out, with around 35,000 people per km2. And, above all, the Eixample and Ciutat Vella districts, between 80,000 and 60,000 people per Km2, extreme values that put a lot of stress on these two spaces. Beyond the effect of tourism on these two environments, a first diagnosis is that the city's activity gravitates too much on two points of attraction. The dispersion strategy must not only take into account tourism and, in fact, a tourist dispersion will not be possible if the whole of the city's activity fails to generate a more polycentric model. If we take into account the extreme values, the 80th percentile of density reaches 90,000 people in the case of Eixample and 70,000 people in Ciutat Vella.

Figure 31. Population density in the main European cities

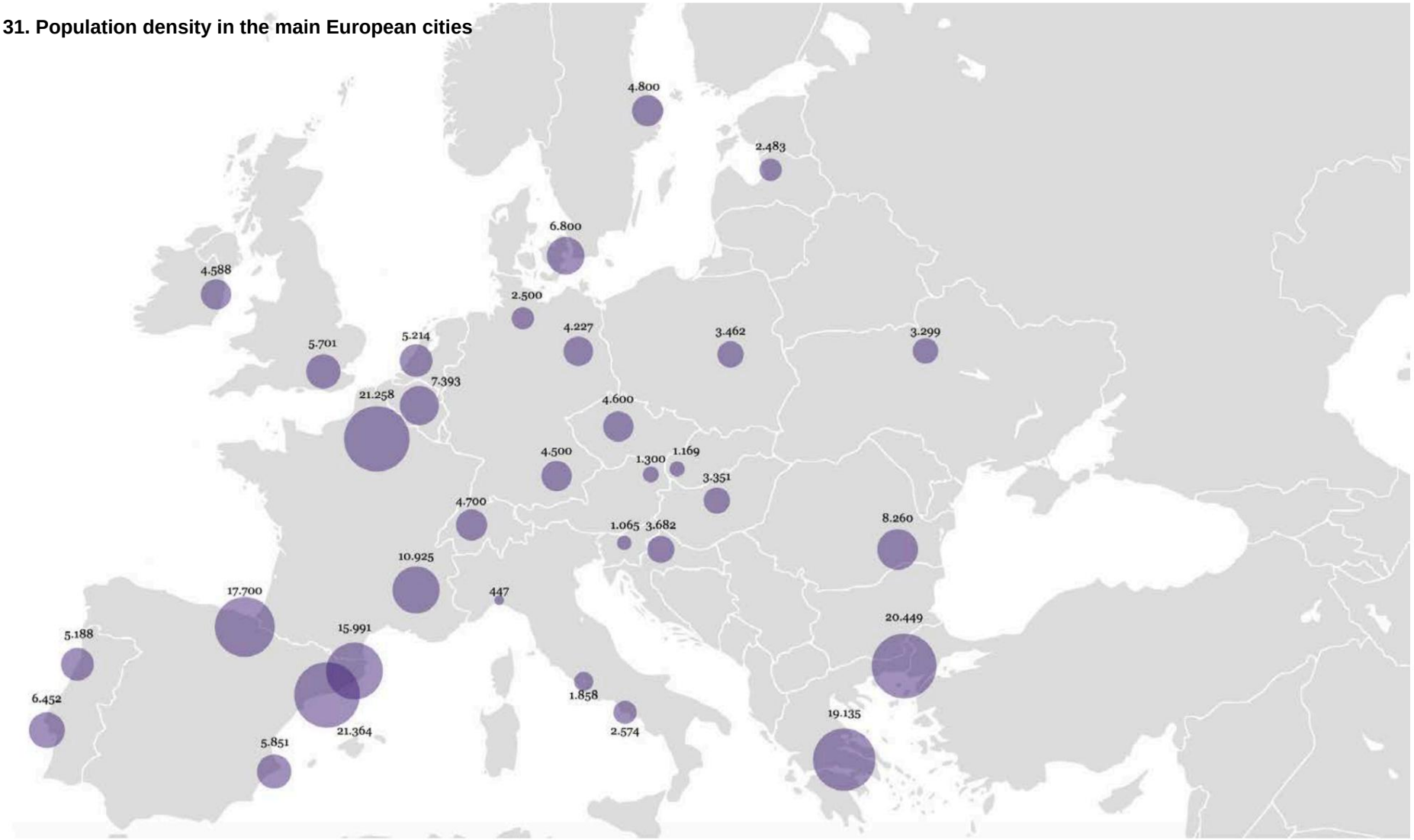


Table 45. Density of people by district

	middle	maximum	p80
Old City	62,229	76,015	67,294
extension	80,247	97,679	88,194
Sants - Montjuic	13,039	15,955	14,473
The Courts	34,594	43,090	38,930
Sarrià Sant Gervasi	13,133	16,096	14,563
grace	35,432	42,290	38,625
Horta Guinardó	17,217	20,793	18,862
New Neighborhoods	23,642	28,236	25,550
Saint Andrew	28,853	34,906	31,490
Saint Martin	35,549	42,966	38,949

source Own elaboration from various sources

There is a fundamental difference between Ciutat Vella and Eixample. In the first case, tourist activity has a decisive influence on the congestion of the district; on the contrary, the Eixample is the result of an attraction of all forms of activity. Table 46 shows this essential difference: 30% of Ciutat Vella's users are tourists and almost a third are visitors. In the Eixample, tourism is another factor in the criteria of attraction and the average values are not far from the value of the city as a whole. The relative weight of tourism in the urban density is significant in the districts of Sants - Montjuïc, Gràcia and Sant Martí, with values that range between 5 and 7% in the average records of tourists and exceed 10% if we take the visitors' p80. The rest of the districts barely have a tourist impact.

Table 46. Relative weight of tourists in the density of the districts

	tourists			tourists and hiking tourists			visitors		
	middle	maximum	p80	half max p80			half max p80		
Old City	22.8	35.2	26.6	29.5	44.7	34.7	32.1	47.0	37.2
extension	8.3	14.6	10.0	9.6	16.7	11.7	13.3	20.5	15.5
Sants - Montjuic	5.1	9.4	6.2	5.8	10.6	7.1	8.8	13.8	10.3
The Courts	3.7	6.9	4.6	4.1	7.7	5.1	6.5	10.3	7.7
Sarrià Sant Gervasi	1.2	2.3	1.5	1.2	2.3	1.5	5.2	6.9	5.7
grace	7.7	13.7	9.3	8.8	15.7	10.7	11.1	18.0	13.1
Horta Guinardó	0.8	1.4	0.9	0.8	1.4	0.9	3.4	4.5	3.7
New Neighborhoods	0.5	0.9	0.6	0.5	0.9	0.6	2.7	3.5	2.9
Saint Andrew	0.4	0.7	0.4	0.4	0.7	0.4	3.2	4.0	3.4
Saint Martin	6.6	11.8	8.0	7.5	13.3	8.0	9.6	15.5	11.2

We identify indicator 4 with the 80th percentile of the relative weight of tourism on the set of users in the city. Visitors make up a third of Ciutat Vella's users in the highest values if we remove the extremes, and exceed 10% in Eixample, Gràcia, Sants Montjuïc and Sant Martí.

INDICATOR 4. p80 OF THE RELATIVE WEIGHT OF TOURISM

	tourists	tourists and hiking tourists	visitors
Old City	26.6	34.7	37.2
extension	10.0	11.7	15.5
Sants - Montjuic	6.2	7.1	10.3
The Courts	4.6	5.1	7.7
Sarrià Sant Gervasi	1.5	1.5	5.7
grace	9.3	10.7	13.1
Horta Guinardó	0.9	0.9	3.7
New Neighborhoods	0.6	0.6	2.9
Saint Andrew	0.4	0.4	3.4
Saint Martin	8.0	8.0	11.2

The following figures show the distribution of the various users (residents, commuters, metropolitans, tourists and hikers) in the various districts of the city. The graphics make it possible to visualize very well the difference between the situation of the Eixample, with a saturation due to the accumulation of the various collectives in the district, and Ciutat Vella, which is a space with a very significant presence of tourists in the composition of the users of the space. Likewise, we identify three spaces in which tourism is beginning to have a significant relative importance, which may increase in the coming years: They are the districts of decongestion of tourist activity, which act as distributors of new flows, but which can also alter the structure of these districts if growth is increased. The most obvious case is Gràcia, which suffers from a strong concentration in a space of reduced dimensions, and also the districts of Sants - Montjuïc (which has a very important weight of hikers) and Sant Martí (with a more diverse typology). Conversely, there are five districts with a very low relative weight of tourism in its composition: Les Corts and Sarrià - Sant Gervasi are below average and the districts of Horta Guinardó, Sant Andreu and Nou Barris have a very high presence discreet

Figure 32. Daily evolution of Ciutat Vella users

Figure 33. Daily evolution of L'Eixample users

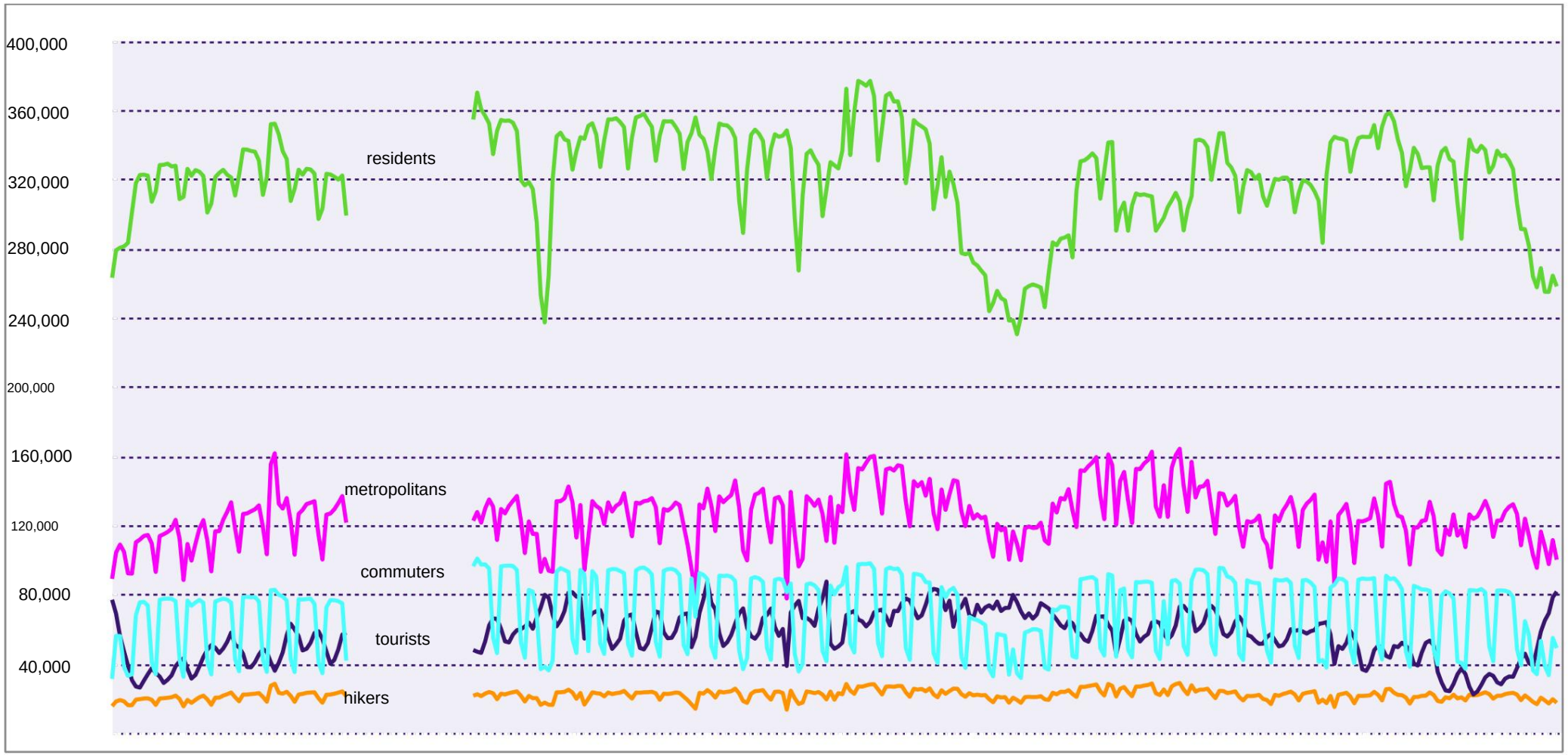


Figure 34. Daily evolution of Sants - Montjuïc users

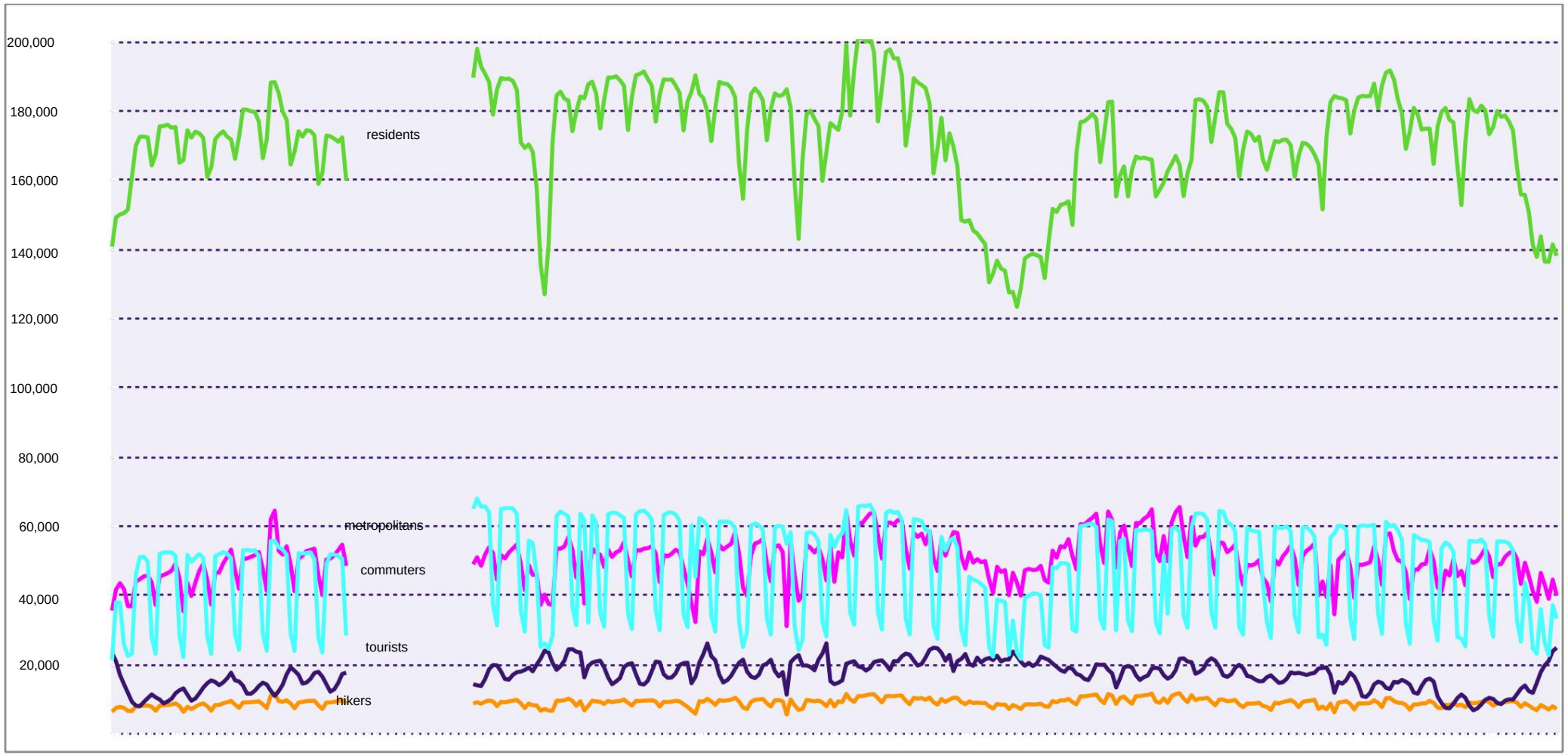


Figure 35. Daily evolution of Court users

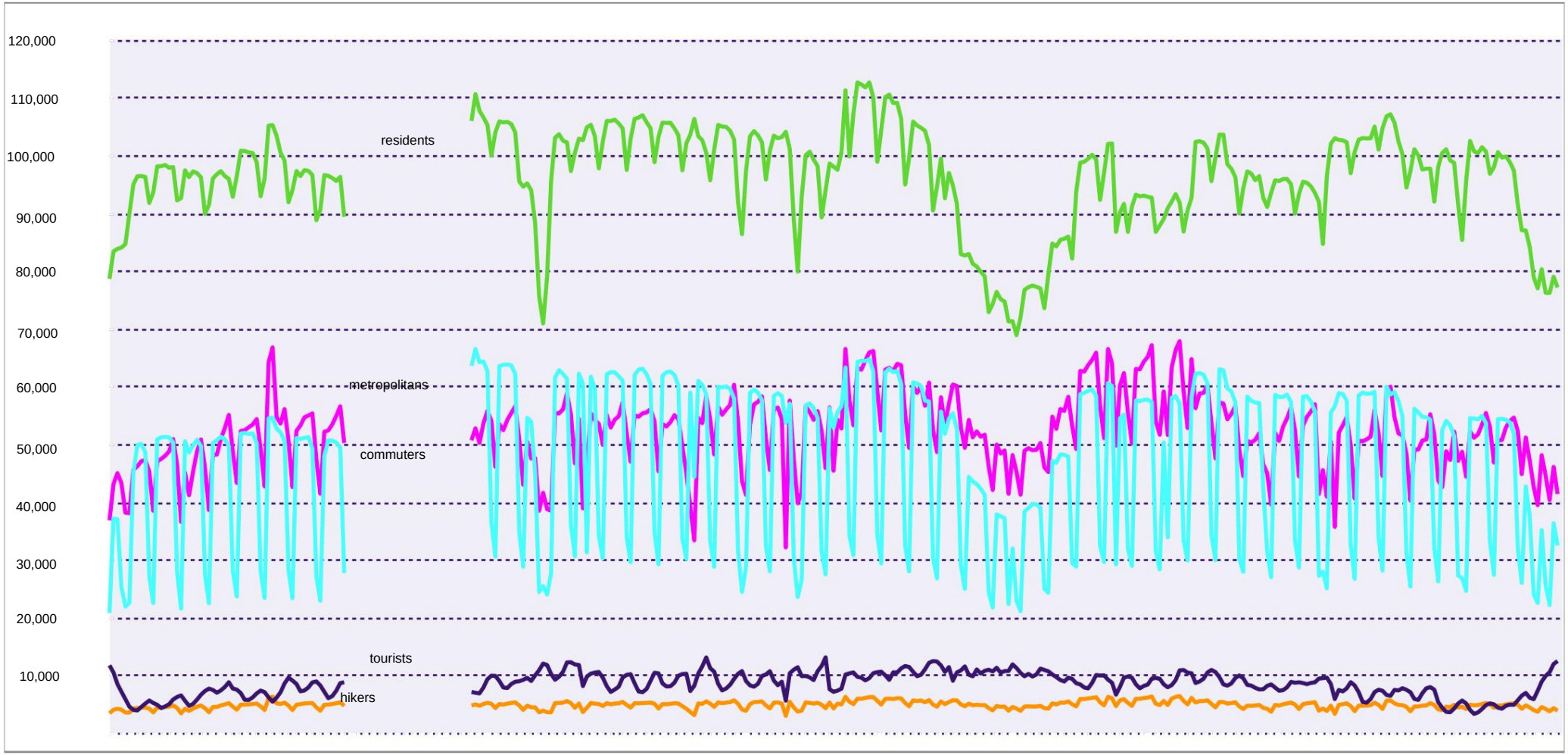


Figure 36. Daily evolution of Sarrià - Sant Gervasi users

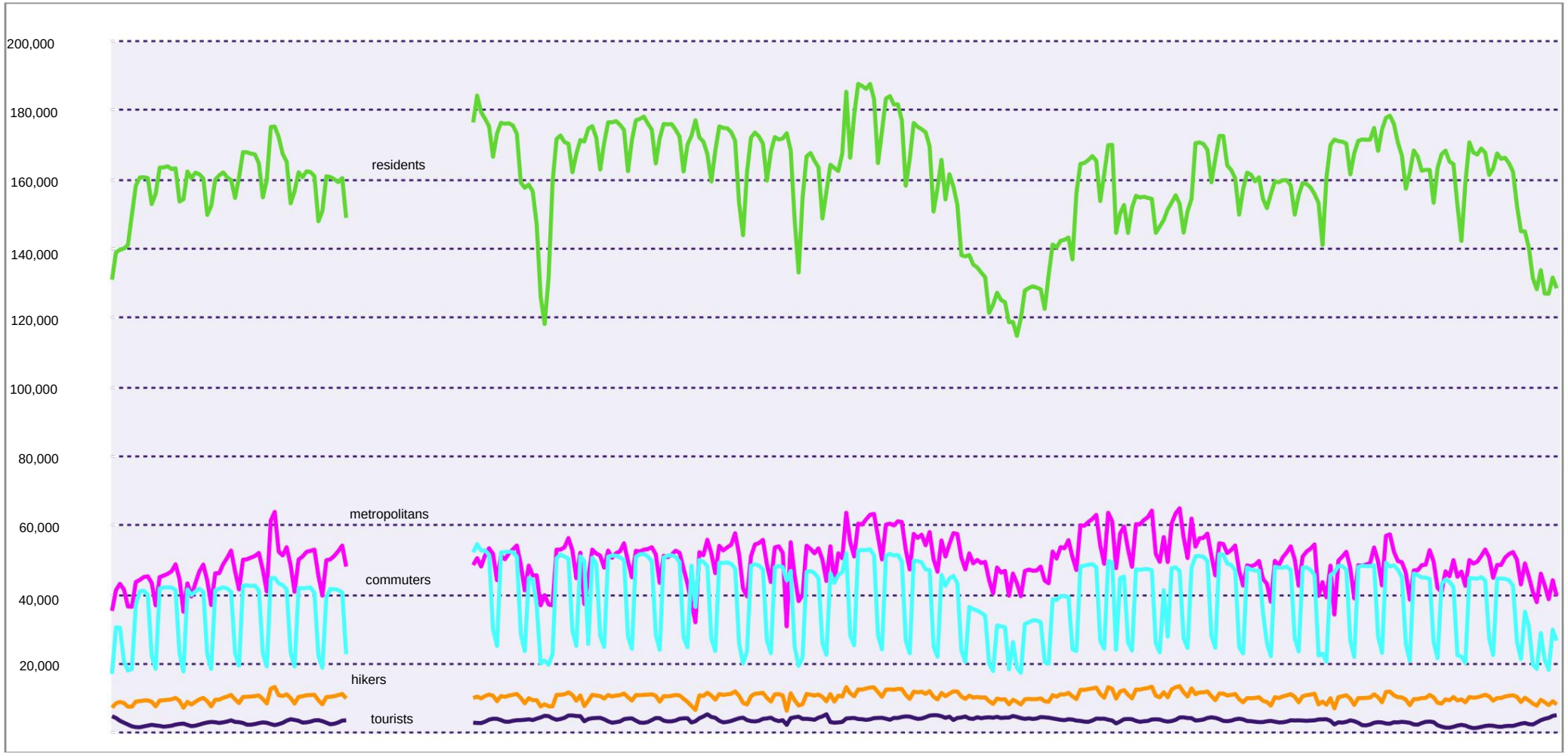


Figure 37. Daily evolution of Gràcia users

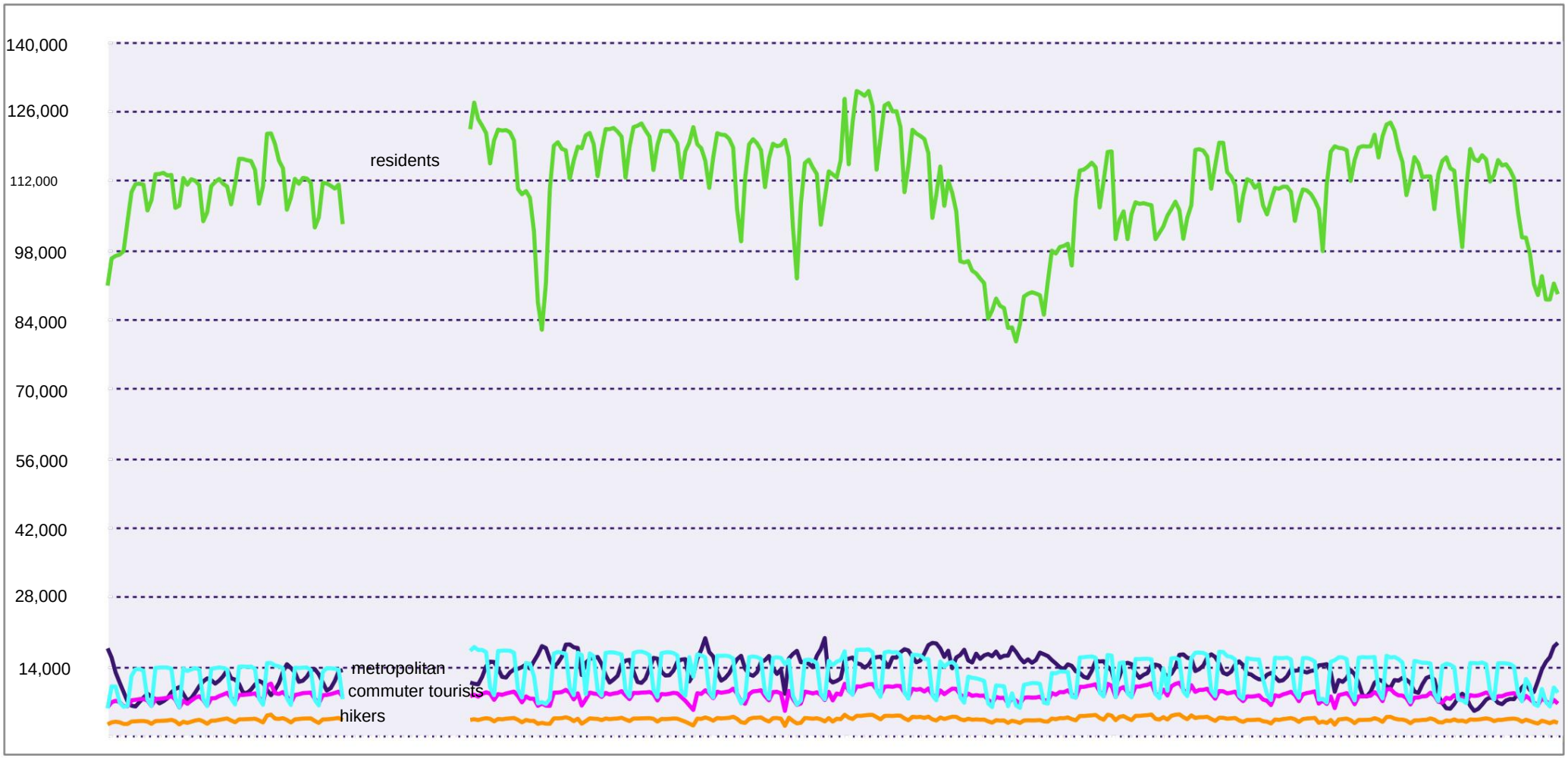


Figure 38. Daily evolution of Horta - Guinardó users

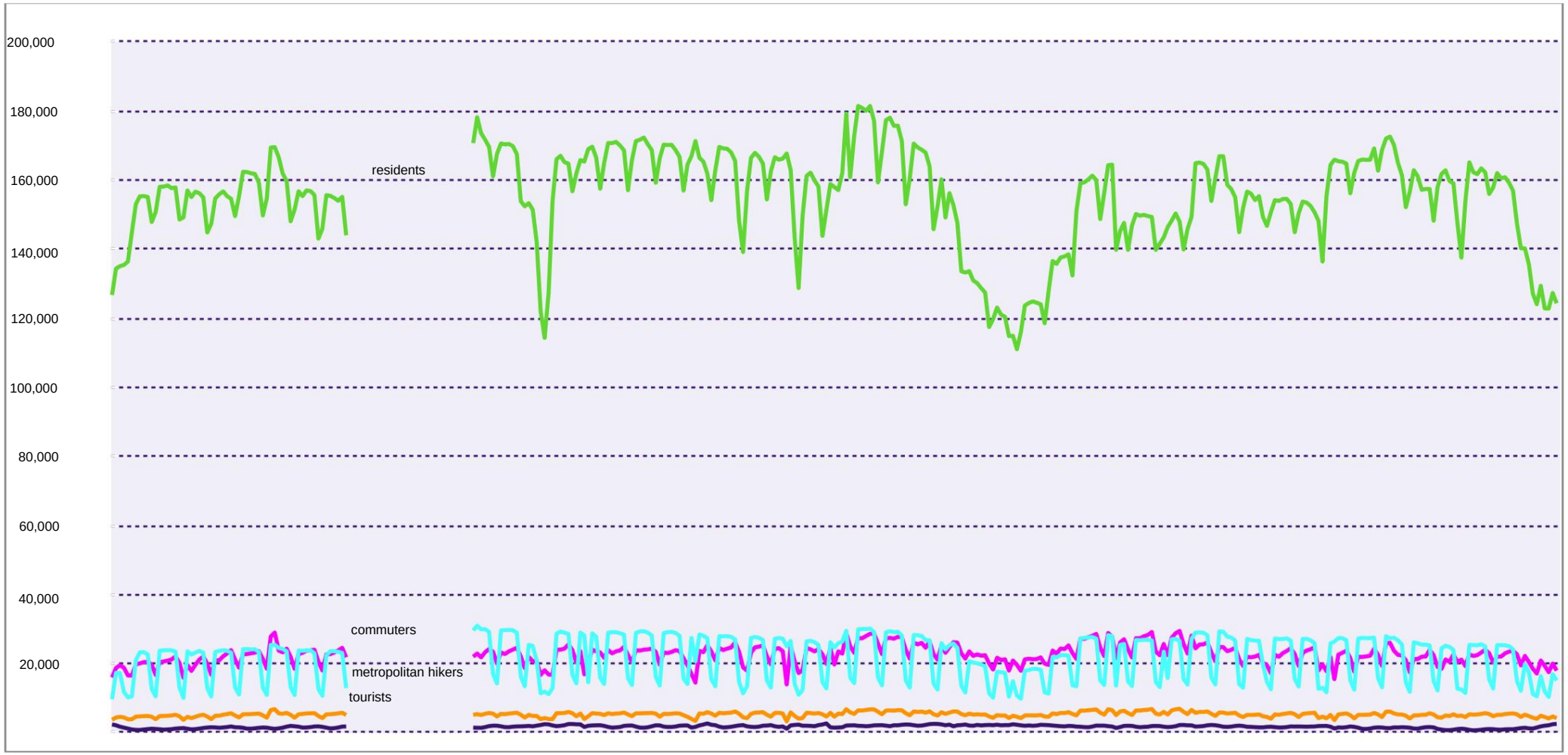


Figure 39. Daily evolution of Nou Barris users

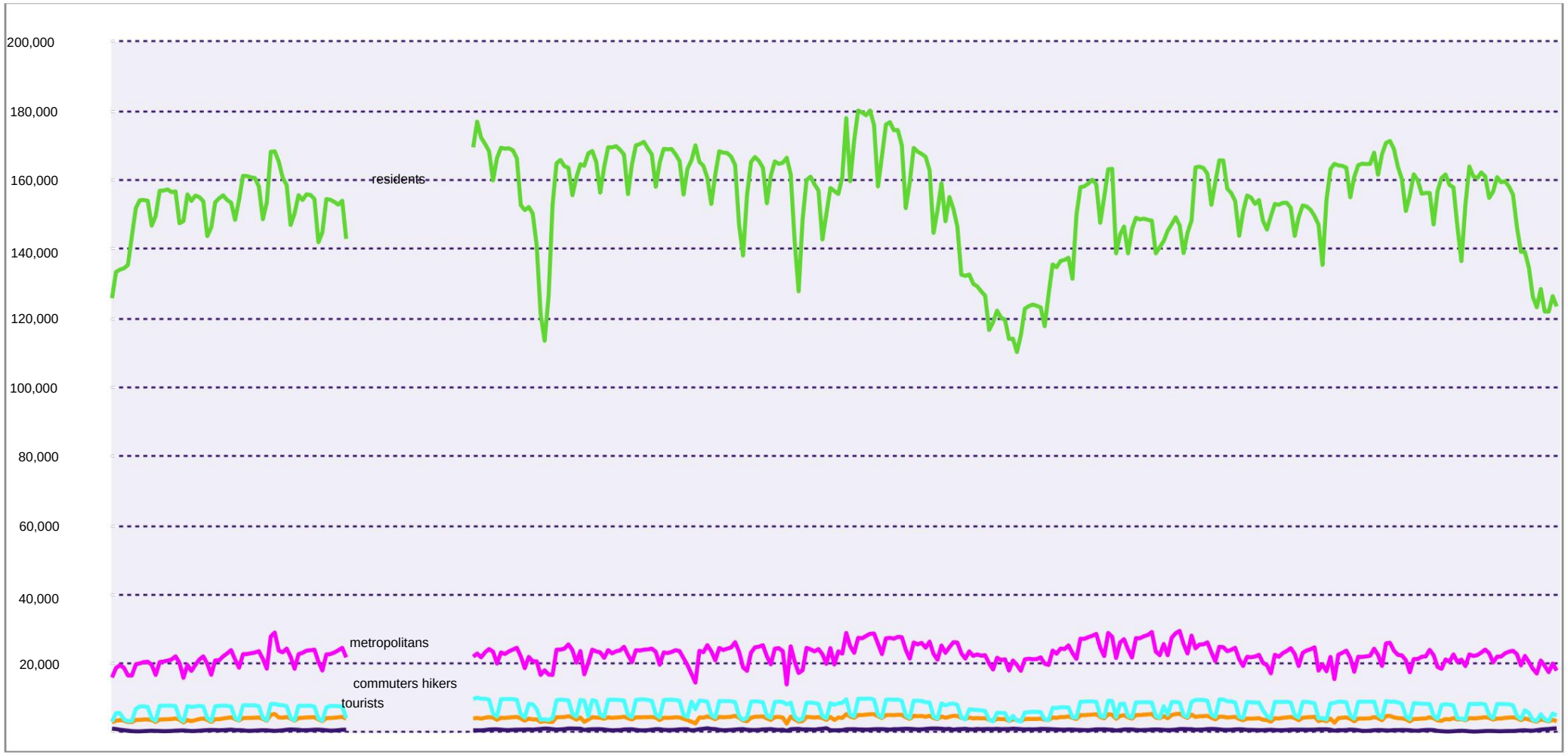
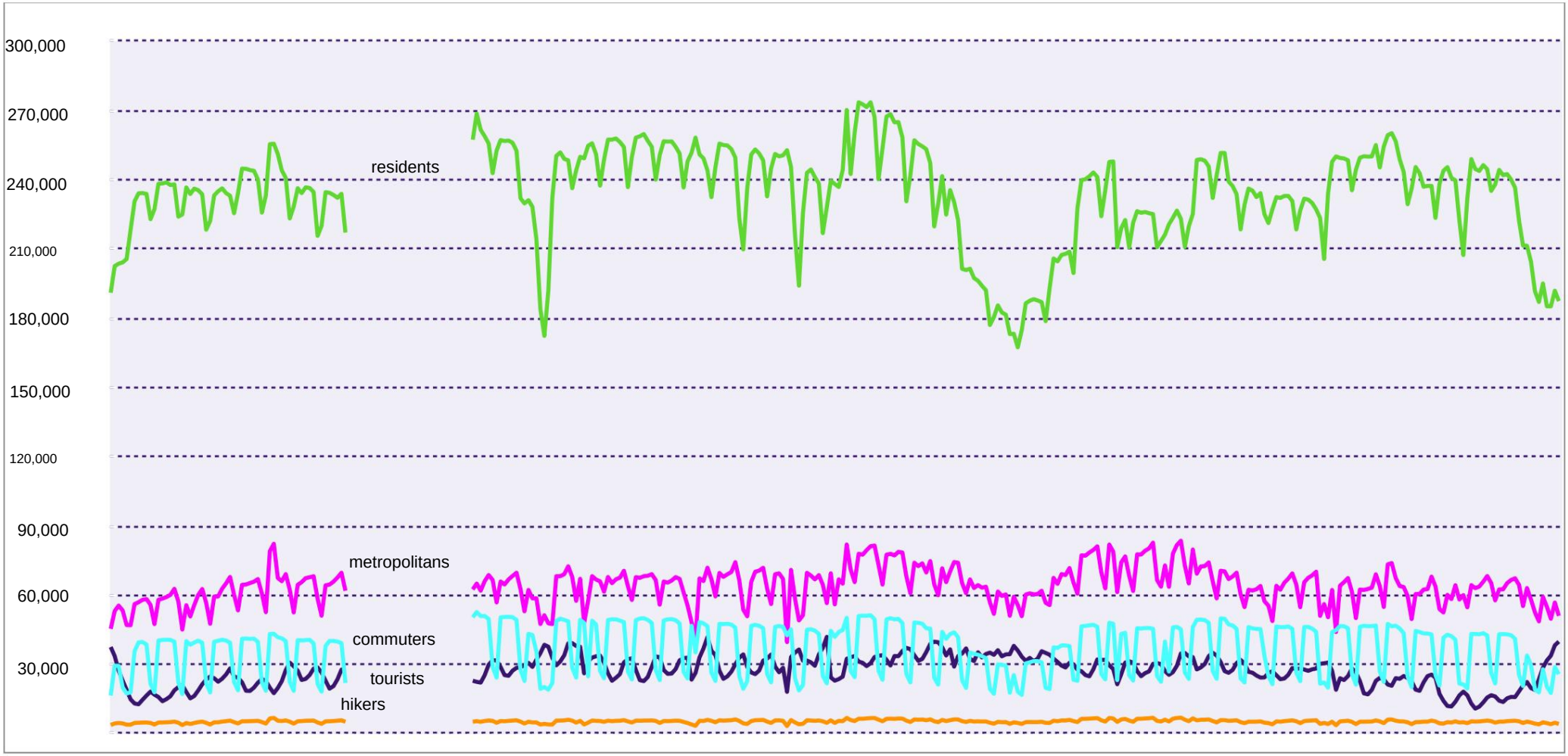


Figure 40. Daily evolution of Sant Martí users



LCA

The environmental footprint

4. The environmental footprint

Tourism generates two environmental effects that compromise its sustainability: On the one hand, each visitor generates the environmental impact equivalent to the journey from origin to destination. This footprint is very variable according to the means of transport or the distance from the origin; the shorter the visitor's stay, the greater the impact of this travel on tourist days. Secondly, tourists have an average consumption of resources that is higher than that of locals. Around the world and in all forms of tourism, visitors consume more water, generate a higher water footprint, produce more solid and liquid waste, demand more energy per capita and emit more carbon dioxide than locals. A visitor has a much higher consumption behavior than the locals, has greater mobility, uses the receiving space more intensively and has imported consumption guidelines, which do not always match the local parameters.

Sustainable tourism would be that which makes it possible to reduce the distance between the environmental effects of visitors and tourists and at the same time that which reduces the environmental impact of travel. Barcelona's strategic tourism plan already establishes the need to reorient the city's tourism model towards more sustainable criteria. In fact, the plan explicitly calls for a reorientation of the production system: "Sustainability is a central and unavoidable objective if we want to ensure the success of the destination, maintain its uniqueness, guarantee and promote new experiences, provide added value to all the chain, (...) and turn tourism into one innovative and enriching activity for the city" (Strategic Plan for Tourism of Barcelona 2020, p. 4).

As part of the Strategic Plan, Barcelona City Council promoted the drafting of a study on the *environmental externalities of tourism in the city of Barcelona,* which is an excellent x-ray of the environmental effects of tourism in the city. The environmental indicators of the Acceptable Change Limit proposal are based on this document prepared in 2019. The main results of the study based on data from 2018 or previous years are the following:

- Water consumption by tourists in accommodation establishments is between 8% and 12% of the city's total water consumption, depending on the calculation criteria used. Water consumption in the areas of interest is globally around 372,000 m2.

- Tourist activities in Barcelona are responsible for the annual consumption of 952 Gwh of final energy. 74% of this consumption is related to the accommodation sector and 26% to internal mobility and points of tourist interest. The study does not consider energy consumption associated with the restaurant sector.

- The tourism sector has very little impact on the low quality of the city's air because the majority of journeys are made with active mobility or collective transport. The study estimates that tourism causes 1.63% of nitrogen dioxide (NO) pollution and 0.66% of particulate matter pollution of less than 10 microns (PM10).

- The tourism sector is responsible for 9.2% of waste generation urban solids in the city.

- CO_2 emissions linked to tourism can be estimated at 9.6 million tons of CO_2 equivalent per year, of which 0.9% are direct emissions, 3% are related to electricity consumption and 96% are linked to transport. This means that at the time of the study, the total emissions per visitor per day can be estimated at 96.93 Kg CO_2 equivalent. This is one of the first approaches to the carbon footprint of urban tourism at an international level (Rico et al., 2019)

The use of environmental indicators is based on the document prepared for the Barcelona City Council, with an update of the data on visitors to the city and with some specific modifications of the methodology to fine-tune the proposed models. Specifically, in this heading, the following indicators will be calculated:

- Indicator 5. Weight of tourist water consumption on the total
- Indicator 6. Weight of tourist energy consumption on the total • Indicator 7. Weight of tourist solid waste on the total
- Indicator 8. Weight of CO_2eq emissions on the total of the city

4.1. Water consumption

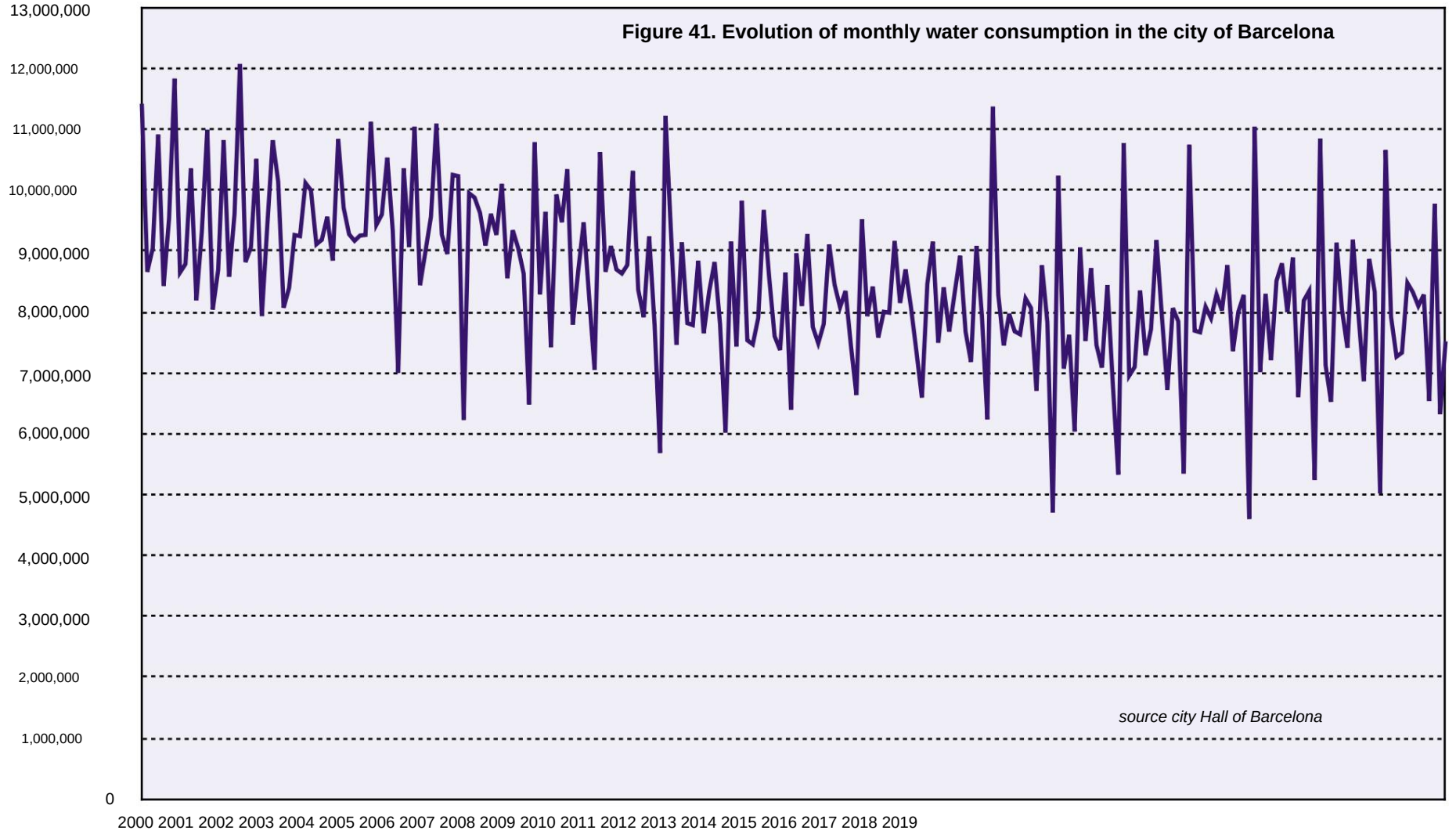
The spaces located in the area of influence of the Mediterranean climate have a very complex relationship with water. Climatic conditions result in recurrent episodes of low rainfall during summer and winter, and especially irregular rainfall with recurrent periods of water stress. Historically, the intelligent use of water has allowed the accumulation, diversion and optimization of the resource and its distribution among the various types of consumers: domestic consumption, agricultural uses, industrial uses and services.

The water supply in the city of Barcelona comes from the contributions of the Ter River and the Llobregat River, which represent nearly 85% of the total supply. 12% originates from groundwater, while 4% comes from the ITAM (seawater treatment facility). In 2019, 96.5 million cubic meters of water were consumed in the city of Barcelona, of which 64.1 million corresponds to domestic consumption. Seen in perspective, water consumption in the city has decreased significantly both in domestic consumption and in global consumption. In 1992, water consumption per inhabitant in Barcelona was 221.5 liters per person per day, while in 2017 it had dropped to 162.5 liters per person per day.

Per capita consumption in the city by 27% and domestic consumption has also dropped by 20%, following a trend that is evident in Catalan cities. Figure 41 shows the monthly evolution of water consumption in Barcelona since 2000 and we can see two periods: An a decline in consumption in the first decade and a stabilization in the second, as if a maximum savings had been reached.

Water consumption is only one component of the water footprint. In reality, the water necessary for the development of an activity must take into account not only the direct consumptions but also the indirect ones, that is to say, the water necessary for the provision of goods and services that make possible the activity For example, tourism is closely linked to catering, which needs a significant contribution of water for the production of the raw materials used in this offer. Valencia has recently published the results of the study of the water footprint in the city (Fundació Visit Valencia, 2019). The calculation estimates a footprint of 74.23 Hm3 of water, of which 75% comes from tourist activity, 21% from hikers and 4% from cruises.

Direct consumption accounts for only 16% of the water footprint, so estimates of direct water consumption only reflect a small part of actual water expenditure. Barcelona City Council should periodically calculate the water footprint of tourism, and this should be the reference indicator.



What percentage of the city's water consumption is explained by the presence of visitors? We cannot answer this question directly because we do not have information on the effective consumption of the various equipment related to tourist activity, so we have to estimate the volume of consumption. The main problem is that the data can vary greatly according to factors related to tourist practice and also to the characteristics of the various facilities. An establishment with swimming pools, large gardens, a spa and constant turnovers involving high cleaning activity will have a much higher water consumption than a modest establishment with few services and a lower turnover. Figure 42 reproduces the results of Becken's (2014) study on water consumption per tourist per day in several countries around the world. As you can see, the range is very high and vary from less than 200 liters per person per day to nearly 1,000. The map highlights the difficulty of assigning average consumption to tourist activity, because the deviations are very high.

Dinarès and Saurí (2015) published the results of a specific research in Barcelona on water consumption in a sample of 262 hotels in the city of Barcelona. Table 47 shows the first results of the research and we can see three pieces of evidence: Firstly, water consumption has generally decreased, with some specific exceptions, following the behavior detected in the city's domestic consumption. Second, there are very noticeable differences in all categories, so the deviations are very high. We cannot speak of an average consumption, but of a wide range of situations. And, finally, the third factor that affects water consumption is the category: The higher the category, the greater the water consumption.

Table 47. Water consumption in BCN hotel establishments

	1999	2004	2008
average			
1 star	2,601	2,478	2,386
2 stars	5,266	5,471	5,673
3 stars	6,963	7,716	6,732
4 stars	15,179	16,659	14,873
5 stars	55,419	56,172	46,324
deviation			
1 star	2,077	1,571	1,744
2 stars	3,644	3,265	3,263
3 stars	4,535	4,746	4.132
4 stars	12,413	16,981	17,555
5 stars	50,808	62,260	52,260

source Dinarès and Saurí (2015)

Water consumption appears to be driven by three main factors. First, the data is very sensitive to the outsourcing of the laundry service. The high turnover of tourists implies a very recurring activity of cleaning clothes, which increases water consumption; but if the service is outsourced, the hotel's consumption log does not detect this activity. The second factor involved in the disparity of values is the catering service; as Dinarès and Saurí (2015) point out, the three factors that explain the differences are the number of restaurants in the hotel, the number of kitchens and the number of services. Finally, the hotels differ in the importance of the facilities, especially the garden and the swimming pools. However, in *the Study on the environmental externalities of tourism* it is clarified that the volume of the swimming pools in the city of Barcelona is so small that its impact on total water consumption is not very relevant.

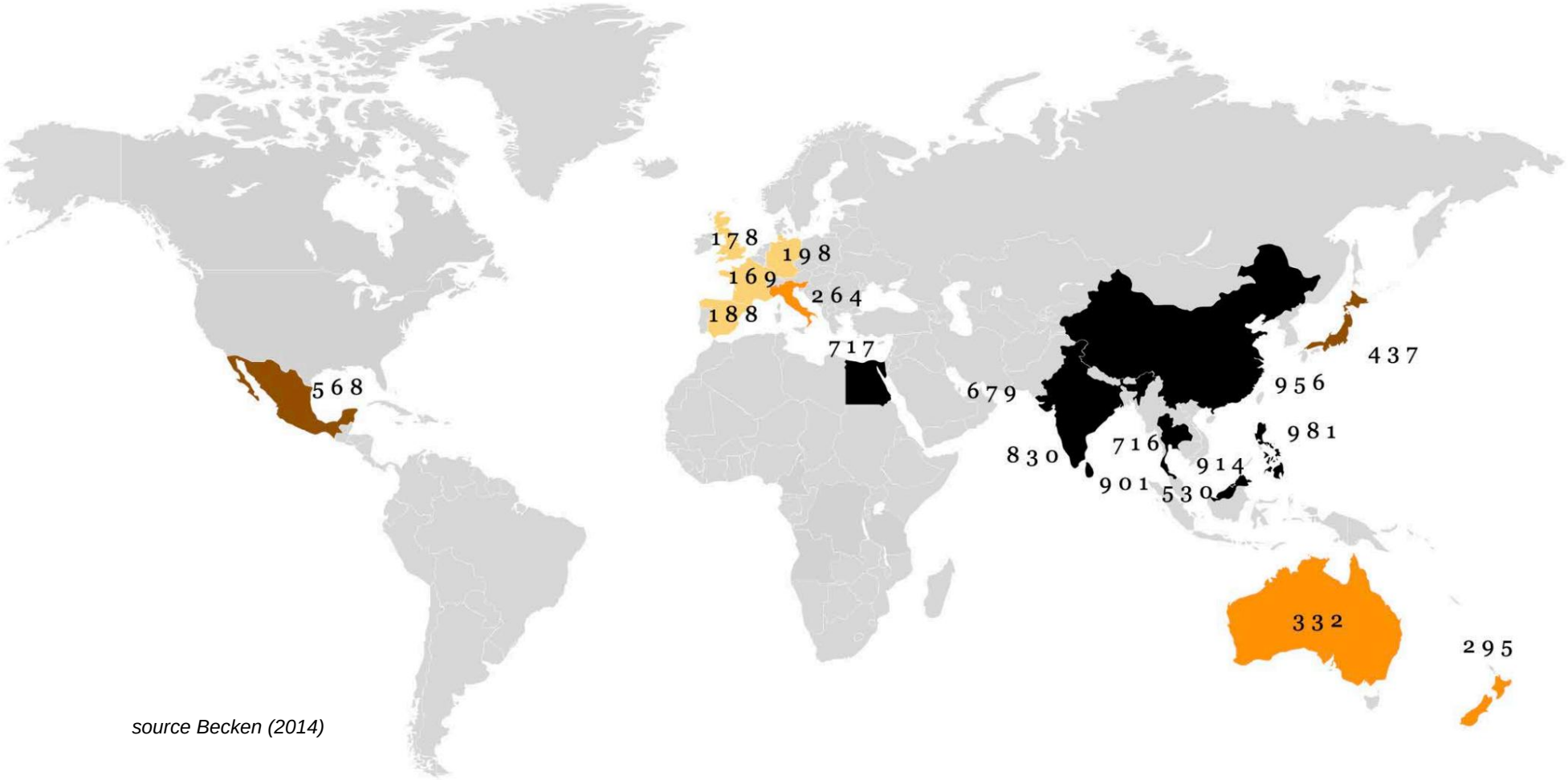
For the estimation of water consumption in tourist establishments, we followed the same criteria as *the Study on the environmental externalities of tourism.* We used the criteria of the survey carried out by the General Directorate of Tourism to a sample of accommodation establishments. The results of the estimation are shown in table 48 and are very close to the data obtained in the 2019 study. The global water consumption in the accommodation would be 10.7 million cubic meters of water, which represents 9% of the 96.5 million cubic meters consumed in Barcelona. According to this criterion, each tourist consumes 238 liters per night linked to accommodation, while local consumption is 107.3 litres.

Table 48. Estimation of water consumption per tourist and night in accommodation establishments. 2019

	nights	consumption (l/night)	Total (m3)
5 star hotels	2,108,592	545.5	1,150,237
4 star hotels	10,562,854	373.3	3,943,113
3 star hotels	5,012,880	232.0	1,162,988
2 star hotels	1,571,498	165.5	260,083
1 star hotels	616,664	130.1	80,228
pensions	1,740,541	146.0	254,119
Apartments	781,178	146.0	114,052
Official HUTs	11,484,198	207.2	2,379,526
Unregulated HUTs	990,000	207.2	205,128
hostels	2,786,267	130.1	362,493
Private houses	7,341,236	107.3	787,715
total	44,995,908	237.8	10,699,682

source Update of the Study on the environmental externalities of tourism in the city of Barcelona

Figure 42. Tourist consumption of water per capita and day



source Becken (2014)

There is very little information on the water consumption of the restaurant. In fact, there is no mention of it in the study on environmental externalities, precisely because of the difficulty of accessing the data. Deng and Burnett (2002) have estimated that kitchen service represents approximately 22% of water consumption in hotel restaurants; Bohdanowicz and Martinac (2007) estimate that the average consumption of water in hotel restaurants ranges between 35 and 45 liters per user. Styles, Schoenberger and Gálvez - Matos (2015) estimate a water consumption of 20 liters in the most modest hotels with breakfast service and with an additional service, approximately 15% of the total consumption. We could therefore estimate that the catering service has a water consumption per customer of around 30 litres, knowing that the range can oscillate between around 15 liters and around 40 or 50, according to the measures of 'efficiency that have been implemented and also in accordance with the characteristics of the establishments.

Table 49 shows an estimate of the estimated water expenditure in the catering sector, based on the assumption of 30 liters per person and one meal for tourists and hikers and two meals for tourists (taking into account overnight stays and not stays). Part of the tourists' meals are made in hotels, so that the values of the accommodation and the restaurant have a space of intersection, although I do not know their magnitude. According to this estimate, the restaurant sector would consume 3.88 million m3 due to the tourist impact, of which the most relevant bulk corresponds to tourists.

Table 49. Estimation of water consumption in catering establishments. 2019

(cubic meters of water)

Excursion tourists	314,923
Excursionists	866,999
tourists	2,700,948
total	3,882,870

source Update of the Study on the environmental externalities of tourism in the city of Barcelona

The study on the environmental externalities of tourism has also estimated the consumption of water in the areas with the greatest influx. This estimate is based on the combination of three data: (a) the number of visitors to the main facilities; (b) the proportion of tourists on the total equipment; and (c) the total water consumption for each element. This made it possible to estimate that in 2019 water consumption in these high-traffic spaces was 372,279 m3. In table 50 we have updated the data on the number of visitors to the EGAs identified for the year 2019 and we have considered that the other two factors (aic) remained at values similar to those of the study, which refers to 2015.

Table 50. Estimation of water consumption in high traffic areas. 2019

	2015			2019		
	visitors	tourists	m3 water	visitors	tourists	m3 water
Museums and collections	10,373,587	5,294,297	237,058	10,271,304	5,242,096	234,721
centers of exhibitions	2,362,691	628,955	3,233	2,351,860	626,072	3,218
monumental spaces	11,576,662	6,396,503	55,736	13,541,834	7,482,328	65,197
leisure spaces	1,019,002	405,700	76,252	1,076,619	428,639	80,563
TOTAL	25,331,942	12,725,455	372,279	27,241,617	13,779,135	383,700

source Update of the Study on the environmental externalities of tourism in the city of Barcelona

The influx to the city's main attractions has not changed significantly. Museums, exhibition centers and leisure spaces welcomed practically the same number of visitors in 2019 as in 2015. The main difference can be seen in the monumental spaces, which have increased the number of visitors by 1.5 million compared to 2015, which they explain the increase in admissions to the Sagrada Família (+1 million) and Park Güell (+0.5 million). The attraction model of the city is generating a constant growth of the main nodes and a stabilization of the rest of the nodes, despite the fact that the number of visitors has increased significantly. These slight differences explain why the water consumption derived from tourist visits to the city's EGAs is very similar to what the study of environmental externalities estimates.

According to the previous data, we can estimate that the water consumption derived from tourism is close to 15 million cubic meters (14,996 m3), of which the greater part is explained by the water expenditure of the accommodations. For this reason, the water consumption of hikers and hiking tourists is very little relevant. Considering that in 2019 the city of Barcelona consumed 96.5 million cubic meters, the relative weight of tourist water consumption can be estimated at 15.5% of the city's total. The difference with respect to the study of the environmental externalities of Barcelona is explained because in this case we made an estimate of the water consumption linked to the restaurant. If the behavior of tourists in Barcelona were similar to that of tourism in Valencia, direct consumption would represent 14% of the water footprint of tourism in the city, which would be 689 cubic hectometres.

INDICATOR 5. RELATIVE WEIGHT OF TOURIST WATER CONSUMPTION

	TOTAL	% on the total
tourist consumption of water	14,966,000	15.5%

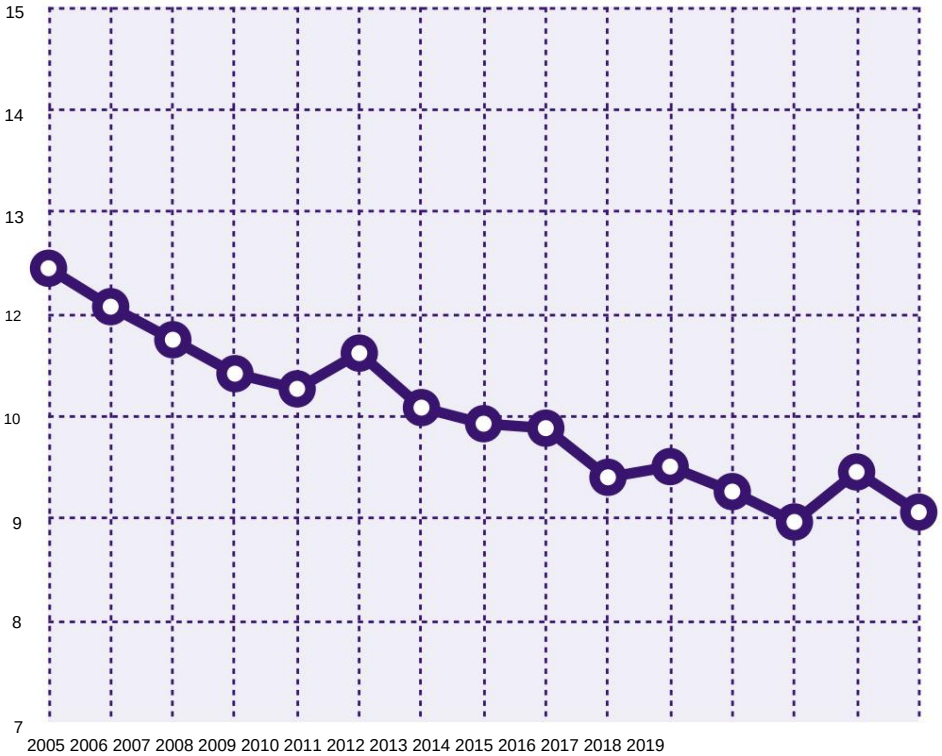
4.2. Energy consumption

Energy consumption is one of the main environmental challenges facing tourism and, by extension, all productive activities. The National Pact for the Energy Transition projects in Catalonia the objective of decarbonisation by 2050 and the application of the criteria of efficiency, savings and the use of renewable sources. All the empirical evidence highlights the direct relationship between the increase in tourism and that of energy consumption (Khanal, et al., 2021).

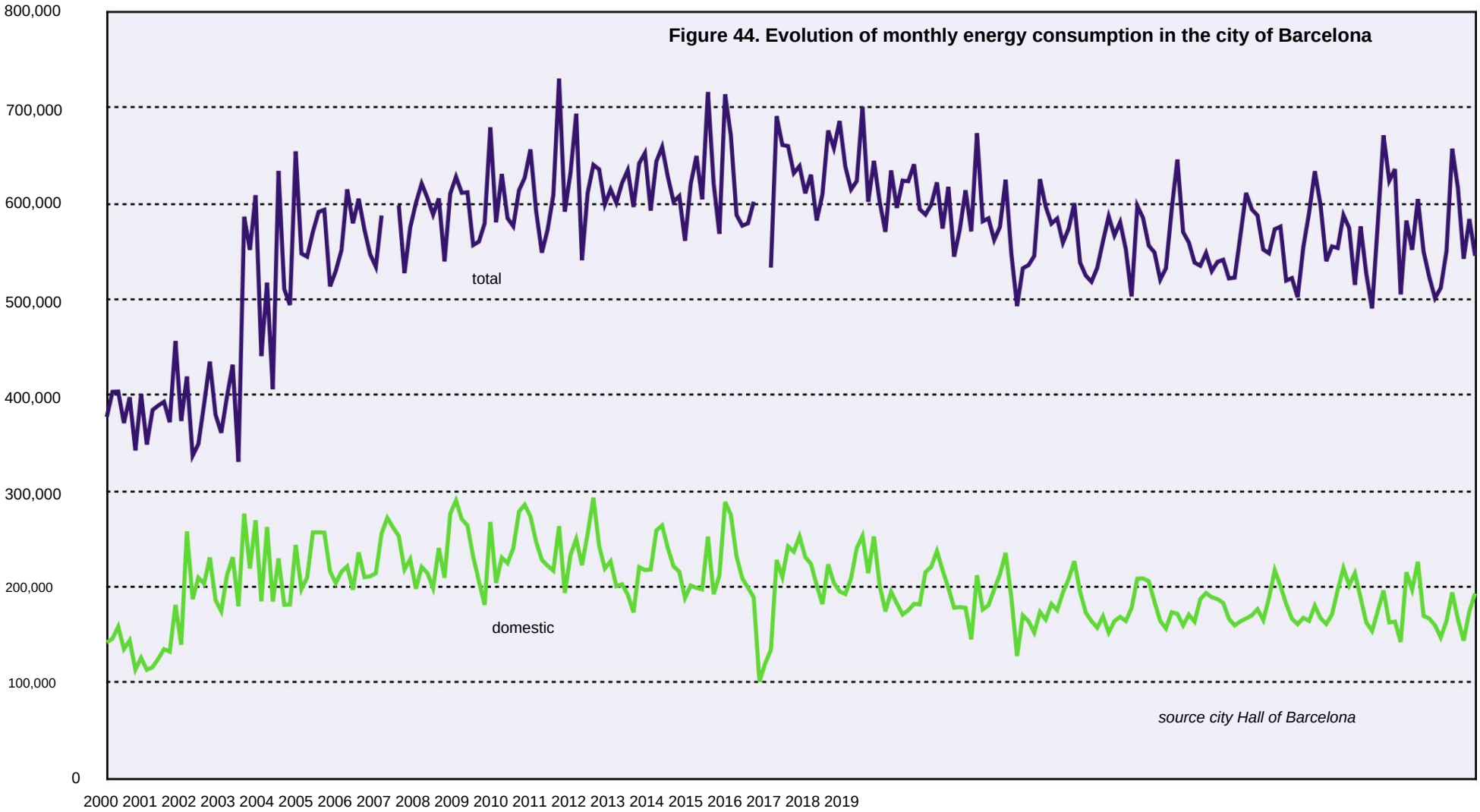
The same sources show that the average energy consumption of tourists is higher than the average consumption of residents.

Figure 44 shows the evolution of energy consumption in the city of Barcelona during this century. In addition, figure 43 shows the evolution of energy consumption per capita in recent years. If in 2005 the average consumption per inhabitant was 12.09 Mwh, in 2019 it had fallen to 9.36 Mwh, that is to say, there has been a reduction of nearly a quarter of consumption per capita in recent years . In the pandemic year, a record of 7.94 Mwh was reached, but that is the result of the exceptional conditions of the year 2020. Overall, the city of Barcelona consumed 15,320 Gwh in 2019, which contrasts with the 16,609 of the year 2013 on which *the Study on the negative externalities of tourism is based.*

Figure 43. Evolution of energy consumption per capita



source city Hall of Barcelona



Energy consumption in Barcelona shows the weight of the tertiaryization of the economy. In 2018, 34% of consumption is explained by the commercial and service sectors, 29% comes from domestic uses, 24.9% is the result of transport and only 10.5% responds to industrial uses. Seen in perspective, the weight of the service sector has not stopped growing during these last two decades. In 2000 the consumption of the service sector was 4,000 Gwh and in 2018 it has climbed above 5,500 Gwh; in the opposite direction, the 3,000 Gwh consumed by the city's industrial sector in 2000 has fallen below 2,000 in 2018. The domestic and transport areas remain with values similar to those of the year 2000. Therefore, the sector services is increasingly relevant in the city's energy strategy. It should be borne in mind that the energy model of the city of Barcelona, like that of the country as a whole, is very dependent on non-renewable sources. In 2018, the final energy consumption in the city was distributed with 6,400 Gwh of electrical energy, 5,000 Gwh of natural gas and 3,700 related to transport and a very residual value for liquefied petroleum gas.

We do not know what percentage of the Gwh of the commercial and services sector is explained by tourism activity. The General Directorate of Tourism carried out a survey on the consumption of accommodation establishments; if we unify the surfaces, we see that in the four and five star hotels there is a certain disparity of data while in the rest the values are more homogeneous. Globally, as in the rest of the tourist areas, the increase in the quality of the hotels implies an increase in average consumption. At the lowest levels there is also an increase in consumption probably due to the low energy efficiency of the buildings.

Based on the survey of the General Directorate of Tourism, the Study on the environmental externalities of tourism in the city of Barcelona has estimated an average consumption per category according to 2013 data. This allows us to establish an estimated consumption per overnight stay for the various forms of tourist accommodation. Table 44 shows the results of a consumption estimate for 2019, which is the result of the 2013 estimates with updated data for 2019. This estimate has two main problems:

- Firstly, electricity consumption behaves differently from water consumption or waste (shown in the next section). In general, water consumption is directly related to the number of visitors because the factors that explain this consumption (laundry, cleaning, hygiene...) are directly related to the number of visitors. Conversely, in electricity consumption, there is a basic expenditure and an expenditure that is explained by variations in employment. Hotels heat or light with low or very high occupancies. Therefore, variations in demand partially explain consumption but it is not a linear relationship as obvious as in the case of water consumption or waste. It is true that during this period the hotel park in the city has increased and, therefore, the basic consumption has also grown due to the expansion of the offer.

- Secondly, the energy saving measures are not reflected in this estimate because it projects data from 2013. During these years, the establishments have carried out improvements in the lighting or heating systems that are not collected in the projected consumptions. It would be interesting to update the survey to the

accommodation establishments in order to improve the quality of data on average consumption.

For this reason, the estimate of electricity consumption is approximate and the results must be read very carefully. The study on the 2013 data identified an energy consumed in tourist establishments of 702 Gwh, which represented 5.6% of the total energy consumption in Barcelona. and 37% of energy consumption in the tertiary sector. With the updated data (and with the two factors we specified) energy consumption would have risen to 851 Gwh, that is to say, it would have increased its consumption by 21% while the total volume of energy consumption in the city has been reduced For this reason, the relative weight of the energy consumption of tourist establishments has risen to 8.87% of the total energy consumption in the city.

The second factor that determines the energy consumption of tourism is the activities of visitors and their use of the city's equipment and facilities. There is a part of this consumption that is related to spaces with a lot of traffic, unique transport (especially the tourist bus) and professional activities. We estimated the energy consumption with the update of the 2015 data for 2019 and with the assumption that the energy consumption value that had been calculated in 2015 remains constant. According to this criterion, the total consumption of 'energy of the various elements of interest of the city is 85.12 in 2019, practically the same value as in 2015.

Table 51. Estimation of energy consumption according to the type of establishment. 2019

	electricity	Natural gas	Gwh
5 star hotels	78.63	53.37	132.00
4 star hotels	218.65	177.03	395.68
3 star hotels	65.37	42.21	107.58
2 star hotels	9.18	10.39	19.57
1 star hotels	2.92	3.69	6.61
pensions	8.77	5.52	14.29
Apartments	6.62	1.76	8.37
Official HUTs	97.27	36.40	133.68
Unregulated HUTs	8.39	3.14	11.52
hostels	14.04	6.27	20.31
Private houses	1.65		1.65
total	510	339.8	851

source Update of the Study on the environmental externalities of tourism in the city of Barcelona

Table 52. Estimation of energy consumption in large spaces influx 2019

	2015			2019		
	visitors	tourists	GWh	visitors	tourists	GWh
Museums and collections	10,373,587	5,294,297	31.83	10,271,304	5,242,096	31.52
centers of exhibitions	2,362,691	628,955	2.82	2,351,860	626,072	2.81
monumental spaces	11,576,662	6,396,503	15.49	13,541,834	7,482,328	18.12
leisure spaces	1,019,002	405,700	0.67	1,076,619	428,639	0.71
singular transports		2,971,044	20.92		2,710,698	19.09
professional activities			12.88			12.88
TOTAL	25,331,942	12,725,455	84.61	27,241,617	13,779,135	85.12

source Update of the Study on the environmental externalities of tourism in the city of Barcelona

The internal mobility of tourists also has an energy consumption that affects the overall balance of the city. We know the behavior of visitors well because in 2016 a survey on tourist mobility was carried out on a large sample of 3,207 visitors. We used the values of this survey to estimate the global mobility of tourists, based on the data obtained for 2019. Visitors declare a mobility of 3.90 trips per day, which is slightly higher among tourists for leisure reasons, those who come from the European Union and those who are staying in hostels. Table 53 projects the movements of tourists in the city according to the projection of the results of the 2016 survey and the specific behavior of each form of accommodation for 2019. We have taken into account day trips and not overnight stays, which is the general criterion of the study.

It should be borne in mind that the study on environmental externalities used the data for overnight stays from the visitor profile survey, which places the number of nights at 5. Instead, this projection works with the value proposed by the 'Tourism Observatory, which is located in approximately two nights per visitor; therefore, although the number of tourists has increased significantly since the 2013 estimate and despite the fact that we use the value of stays and not nights, the total value of trips we obtained is very similar.

Table 53. Estimate of tourist trips. 2019

	average	Displacements
Hotels	4.00	117,459,769
pensions	4.26	10,695,549
Apartments	3.93	3,975,643
Official HUTs	3.93	58,809,534
Unregulated HUTs	3.93	5,069,700
hostels	4.26	17,264,724
Private houses	3.48	31,934,377
Total tourists		245,209,295

source Own elaboration based on the Study on the environmental externalities of tourism in the city of Barcelona and the Mobility Survey

Table 54 updates the data on travel by means of transport from the study on environmental externalities with data from 2013. Tourists have an internal mobility pattern with low energy consumption because they preferentially use active mobility (45% on foot) and collective transport, such as the metro (33%), the bus (5%) or the train (1%). The consumption derived from the tourist bus is calculated in the previous chapter on singular transports.

Table 54. Trips by means of transport and average consumption loved by tourists staying in Barcelona. 2019

	total		tourists		
	trips	Gwh	trips	Gwh	type
Subway	411,950,000	252.1	77,731,347	47.57	electricity
	411,950,000	6.0	77,731,347	1.13	Natural gas
	411,950,000	27.1	77,731,347	5.11	Gas
bus	206,800,000	188.3	12,640,295	11.51	Gas
	206,800,000	8.5	12,640,295	0.52	electricity
	206,800,000	126.8	12,640,295	7.75	Natural gas
Train (Suburbs) first crown	30,900,000	98.4	2,007,873	6.39	electricity
Train (FGC)	25,693,566	20.0	865,127	0.67	electricity
tram	29,772,109	6.7	597,589	0.13	electricity
taxi	90,000,000		2,877,454	10.09	Gas
			2,120,229	5.58	Diesel (hybrid)
			708,762	1.77	LPG
			321,063	0.54	Natural gas
car			1,187,367	4.16	Gas
total				102.94	

a. 2.85 Occupancy, 4km Range and IMT Drive Ratio (2019)

source Study on the environmental externalities of tourism in the city of Barcelona, AMB, IMT and Barcelona City Council

In all forms of accommodation, the main means of transport is active mobility. In urban tourism, trips on foot usually predominate, although in Barcelona they are even more important due to the small dimensions of the compact urban plot and especially due to the extreme concentration of tourist attraction spaces. The main tourist corridors are the axis of Passeig de Gràcia, the monumental axis of Ciutat Vella and the coastal front; transport is used especially to connect with the nodes of Sagrada Família, Park Güell or Montjuïc. The metro is the main means of transport for tourists in the city of Barcelona if we do not consider active travel. It represents a third of the total, which is fairly evenly distributed among the various groups. Despite the fact that taxis have a small relative weight on the total number of trips, the energy consumption is high because it is the means with a greater need for energy and, in addition, with a greater volume of emissions. The AMT is promoting the decarbonisation of the fleet; in 2019, hybrids represented more than 25% of vehicles and electric vehicles 0.4%.

In addition, we have to consider the internal travel of hiking tourists and hikers. In this case, we applied the results of the 2016 mobility survey for the "non-accommodated" typology, which is characterized by greater use of private vehicles and the railway.

Table 55. Trips by means of transport and average consumption

beloved of backpackers and hikers. 2019

	Excursion tourists		Excursionists		
	trips	Gwh	trips	Gwh	type
Subway	10,439,707	6.4	28,741,020	17.59	electricity
	10,439,707	0.2	28,741,020	0.42	Natural gas
	10,439,707	0.7	28,741,020	1.89	Gas
bus	1,760,421	1.6	4,846,525	4.41	Gas
	1,760,421	0.1	4,846,525	0.20	electricity
	1,760,421	1.1	4,846,525	2.97	Natural gas
Train (Suburbs) first crown	2,415,462	7.7	6,649,883	21.18	electricity
Train (FGC)	1,187,261	0.9	3,268,587	2.55	electricity
tram	204,700	0.2	597,589	0.47	electricity
taxi	256,971	0.9	707,455	2.48	Gas
	189,348	0.5	521,283	1.37 Diesel (hybrid)	
	63,296	0.2	192,130	0.43	LPG
	28,672	0.1	78,937	0.14	Natural gas
car	1,315,929	4.6	3,622,818	12.07	Gas
total		25.0		68.16	

source Update of the Study on the environmental externalities of tourism in the city of Barcelona, AMB, IMT and Barcelona City Council

According to the previous results, the final energy consumption necessary for the development of the activities of tourists, excursion tourists and hikers in the city of Barcelona in 2019 exceeded 1,100 Gw, if we consider accommodation, equipment of leisure and culture and internal travel. Considering that in 2019 the city consumed a total of 15,320 Gwh, tourism represents 7.39% of the city's energy consumption, which is lower than the relative weight of the three groups in the city.

Table 56. Estimation of the energy consumption of tourists, the hiking tourists and hikers. 2019

	Gwh
Accommodations	851.26
Spaces and activities with high frequency	85.12
Internal travel of tourists	102.94
Internal travel for tourists and hikers	25.00
Internal trips for hikers	68.16
TOTAL	1,132.48

source Update of the Study on the environmental externalities of tourism in the city of Barcelona, AMB, IMT and Barcelona City Council

This makes it possible to identify indicator 6, which is the relative weight of energy consumption on the city's total. As a whole it represents 7.4%, which is essentially explained by tourist activity, since the largest share of consumption corresponds to accommodation. On a Catalan scale, however, we should consider the energy consumption of tourists staying in other municipalities in the country; it is not that they consume less, but that their activity counts in other spaces. To determine the consumption of each group in the highly frequented spaces, we considered their relative weight on the total number of visitors. The hikers' values are overrepresented because their use of these equipment is much lower.

INDICATOR 6. RELATIVE WEIGHT OF ENERGY CONSUMPTION

energy consumption	TOTAL	% on the total
tourists	1,006.37	6.57
hiking tourists	33.78	0.22
hikers	92.33	0.60
TOTAL	1,132.49	7.39

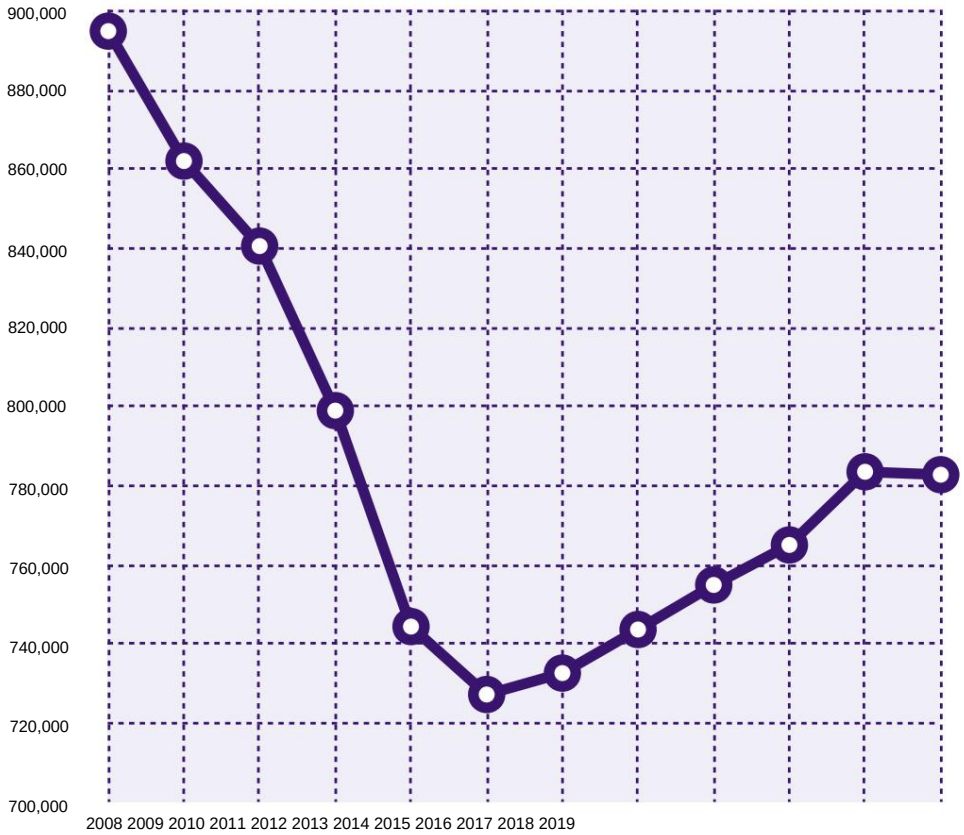
4.3. The generation of urban solid waste

Waste is one of the main problems of tourist activity because the consumption patterns of tourists tend to generate a very high volume of waste: food waste, excess packaging, the weight of single-use items, the low level of reuse and the relaxation of visitors' social habits create conditions that do not favor the reduction of urban solid waste (MSW). For example, Martius and Cró (2021) have estimated that tourism in Madeira is responsible for between 42 and 47% of the archipelago's total waste, which contrasts with 26% of the weight above GDP or 17% on the generation of jobs. However, other studies have highlighted an inverse situation: Sbert et al. (2013) show that on the island of Menorca a 1% increase in the number of tourists causes a 0.282% change in the volume of solid waste on the island, which represents approximately 1.31 kg per day and visitor, is say, a volume that is 13.2% lower than the effect of the increase in residents. The social habits of visitors could be the main cause of this reverse situation.

Of all the fractions, plastics is one of the wastes with the greatest impact on the environment. Certain tourist companies have a greater predisposition to the use of plastic, especially with single-use items. The UNWTO and UNEP have led the *Global Tourism Plastic Initiative program,* to which more than 100 international institutions have subscribed, and which aims to significantly reduce the volume of plastics generated by tourist activity.

Figure 45. Evolution of urban solid waste in Barcelona

(Tons)



source WITH

The economic crisis of 2007 partially explains the drop in waste generation, which is closely related to economic activity and also to the level of consumption. In addition, the municipal waste reduction strategies have allowed a very significant reduction in a very short period of time. From 2013, with the economic recovery, the volume of waste has increased constantly, although it has not reached the starting levels and the 800,000 tons seems to be an upper threshold. The pandemic has suddenly caused waste to fall to its historic minimum, but logically it is the result of an exceptional situation that does not allow projecting a trend.

Figure 46 shows the distribution of waste per capita in the Barcelona Metropolitan Area. In 2019, 1.31 kg of waste was generated per inhabitant per day in Barcelona, which is slightly above the average for the Metropolitan Area. There seems to be a relationship between the economic level of the municipality and the volume of waste; the type of municipality also influences it. The range is very wide and the internal differences are very important: A resident of Begues generates 1.86 kg of waste per day while in Torrelles de Llobregat they practically reach 1 kg per inhabitant per day.

Figure 46. Urban solid waste per capita in the AMB

(Kilograms per person per day)

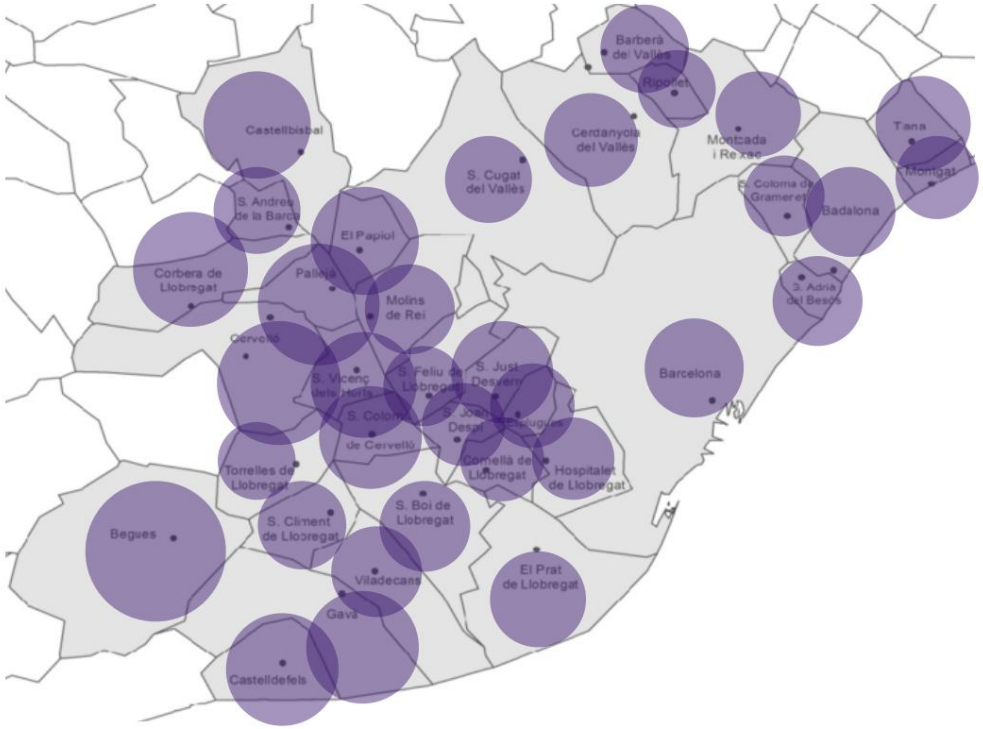


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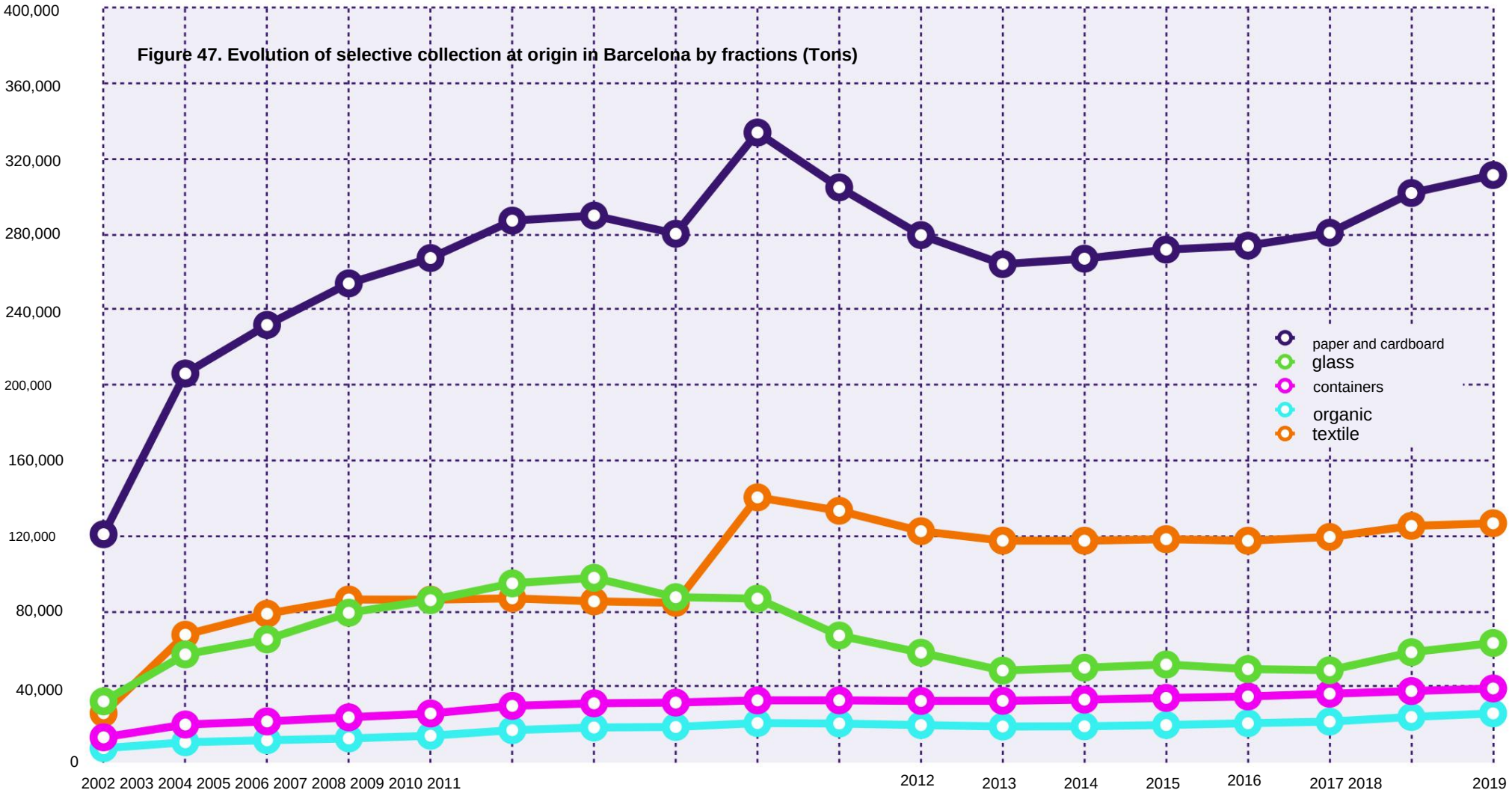
Figure 47. Evolution of selective collection at origin in Barcelona by fractions (Tons)



In the same way as in the rest of Catalonia, the value of the selective fraction has also changed significantly. In 2002, a resident of Barcelona generated an average of 1.35 kilograms per person, of which only 0.22 kg was the selective fraction and 1.13 kg the rest. In 2019, a similar value of 1.34 kilograms per person remains, but now the organic fraction represents 0.52 Kgs and the rest 0.82, still far from the standards proposed by the European authorities.

There is very little information on the impact of tourists on the overall volume of urban solid waste. The few references are focused on accommodation, which is probably the main factor of generation, but there are no data on the impact of tourist activity on waste linked to catering, to leisure and recreational activities or to leisure establishments. Attempts to quantify the volume of waste from hotels and accommodation establishments show extremely heterogeneous results. The classic study by Pirani and Arafat (2013) identifies an estimate of between 1.81 Kgs and 3.18 kgs per night in a study on Florida; another with a range between 0.23 and 12.93 also in Orlando; and a third report that places the average waste at 1 kg. per night The report of Styles, Schönberger and Gálvez (2013) by the European Commission includes an estimate of the urban solid waste generated monthly by 135 medium-quality chain establishments in the continent and reach a median of 1.05 Kgs. A study is needed on the impact of Barcelona's accommodation and tourism industry on waste, with a special focus on plastic waste and the need to reduce the organic fraction that is mainly caused by food waste.

In the study by Pirani and Arafat (2013) they review the results on the composition of the waste in studies of various geographical spaces, and in all of them organic matter is (by far) the main component of solid waste.

Table 57. Fractions of MSW in studies on hotel waste

	paper	organic	glass	plastic
Toronto	20.17	46.40	26.50	7.00
New York	39.90	27.80	7.60	7.00
Los Angeles	37.00	46.00	5.60	6.70
United Kingdom	21.00	41.00	14.00	10.00
United Kingdom	25.00	37.00	10.00	15.00
malaysia	5.77	71.73	2.68	5.07
chicago	19.60	60.30	6.20	6.70

Source: Pirani and Arafat (2013)

Table 58. Approximation to the MSW of the tourist accommodations of Barcelona

	nights	MSW (Kg/night)	Total (Tone)
5 star hotels	2,108,592	5.47	11,534
4 star hotels	10,562,854	1.98	20,914
3 star hotels	5,012,880	1.98	9,926
2 star hotels	1,571,498	1.98	3.112
1 star hotels	616,664	1.31	808
pensions	1,740,541	1.31	2,280
Apartments	781,178	1.31	1,023
Official HUTs	11,484,198	1.31	15,044
Unregulated HUTs	990,000	1.31	1,297
hostels	2,786,267	1.31	3,650
Private houses	7,341,236	1.31	9,617
total	44,995,908		79,205

Source: Updated data from the Study on the environmental externalities of the tourism in the city of Barcelona

As long as the precise information on the volume of waste related to Barcelona's tourist activity is not available, we will use an estimate that adapts the values of the Study on the environmental externalities of tourism to the context of 2019 and that is based on estimate made by PEUAT in 2016. The value of the five-star hotel is based on the environmental declaration of a hotel in the city in 2010; the value of four-, three- and two-star hotels is based on a study by Hamele and Sven (2006) with data from 2006; in the other forms of accommodation, the average values of the residents are projected. It should be borne in mind that this average includes all waste, not just household waste. Therefore, it is an approximation that has a high margin of error and that should be updated with a study on tourist waste in the city of Barcelona. With the approximation based on the aforementioned indicators, the accommodation sector would generate around 79,000 tonnes of solid urban waste, which represents 10.11% of the total waste in the city of Barcelona.

INDICATOR 7. RELATIVE WEIGHT OF TOURIST MSW

	TOTAL (Tone)	% on the total
Tourist MSW	79,205	10.11%

4.4. The carbon footprint

In 20o5 the UNWTO had estimated that CO2 emissions related to tourism transport totaled 982 million tons of CO2, including hikers. This accounted for around 18% of total transport emissions and 3.7% of all CO2 emissions
caused by humans (26.4 billion tons). Overnight stays accounted for 849 million tons and same-day visitors accounted for 133 million tons. These emissions were produced by a total of 9.7 billion tourist trips, of which 750 million arrivals correspond to international tourists, 4 billion arrivals are domestic tourists and an additional 5 billion domestic and international visitors on the same day. It should be noted that international tourism, despite the fact that it is clearly in the minority, is the one that has the greatest impact on CO2 emissions. (WTO, 2019).

In 2016, international tourist arrivals reached 1.2 billion, a 65% increase over 2005. Domestic tourist arrivals climbed to 8.8 billion (a 119% increase over 2005). In addition, the number of day-trippers (non-overnight visitors) doubled compared to 2005 and reached 10 billion. In total, in 2016 it is estimated that around 20 billion tourist trips were made internationally.

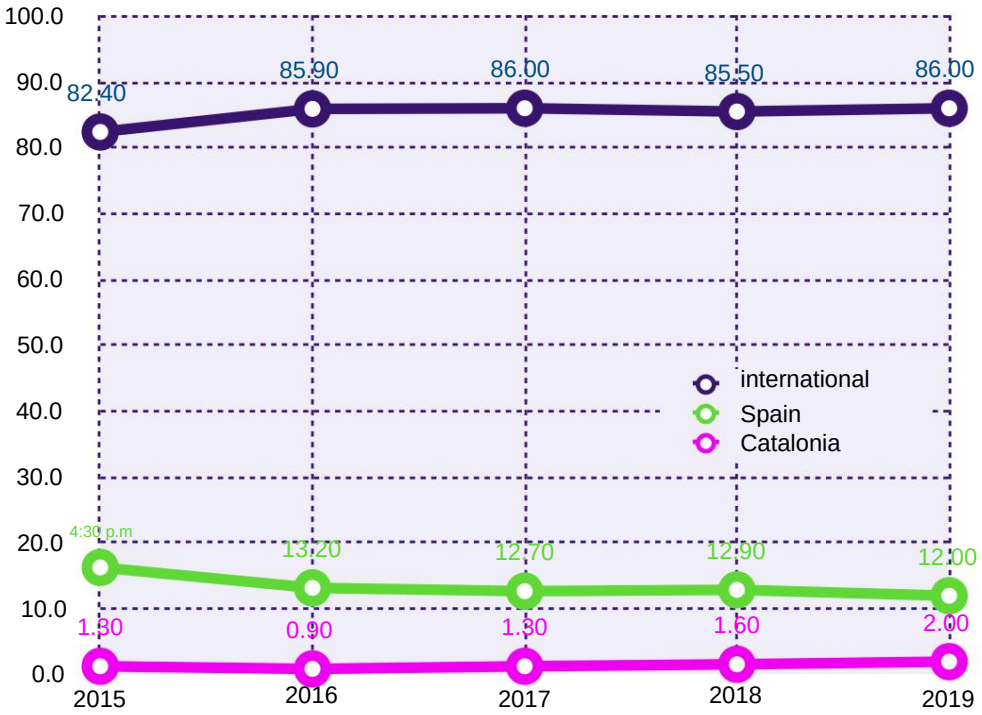
Emissions from these transport-related journeys reached 1,597 million tonnes of CO2, of which 1,371 million are produced by tourists and 200 million by hikers. The total emissions of tourism related to transport go
accounting for around 22% of total transport emissions and 5% of global human-caused emissions (32.1 billion tonnes) in 2016 (UMTO, 2022).

In the study presented by Barcelona City Council (2019) on the negative environmental externalities of tourism, an estimate was included on GHG emissions from tourism in the city. This estimate was published in Rico (2019) and is one of the first contributions on the impact of urban tourism on the carbon footprint.
The study referred to data from 2015, so we have updated the data following the same methodological process and incorporating the results of the demand analysis from the previous chapter.

The study by Rico (2019) uses the methodology of the analysis of the life cycle of products, processes and systems (LCA) and focuses on energy flows. There are two ways to impute the carbon footprint of tourist trips: at origin or at destination. In the first case, the emissions are related to the regions from which the tourists depart, in the same way that the emissions from the consumption of meat or the transport of goods are imputed. In the second place, the emissions affect the calculation of the destination. There is no one model that is better than the other, but each one measures the same reality from two perspectives. Following the methodology of Rico (2019), the updated data are based on the greenhouse gases generated at all stages of the life cycle of energy consumption. Specifically, the data collect emissions from means of transport (arrival and departure), accommodation, activities and internal transport of tourists.

In 2015, visitors to the city of Barcelona generated 9,578,359 tonnes of CO2 equivalent, of which 0.9% are direct emissions, 3% are related to energy consumption and 96% correspond to transport. A visitor emits 96.93 Kg of CO2 each day of stay.

Figure 48. International tourist arrivals (2019)



source Barcelona Tourism Observatory

Table 59. Origin of Barcelona's international tourists

	percentage
Rest of the European Union	50.5
Rest of Europe	6.5
North America	11.8
South America	19.6
Africa	2.4
asia	7.0
oceania	2.2

source Barcelona Tourism Observatory

In 2019, 86% of tourist arrivals in Barcelona were interational arrivals. In the last five years, the international component of Barcelona's tourism has been consolidated, which has grown by more than three relative points and which practically affects 9 out of every 10 tourists who visit the city. This is a very relevant feature of Barcelona's tourist model, since in other tourist cities in the world national tourism is a significant component. Figure 48 shows the evolution of the three components of the city's tourism and highlights the value of international arrivals.

In addition, long distances have a very significant weight. Only half of international arrivals come from EU countries
Europe, and 6.5% from other European countries, so that more than 40% of international arrivals in Barcelona are transcontinental.
This has a direct impact on GHG emissions because long distances logically generate a much higher volume of emissions.

In order to determine CO2 emissions, we have considered all arrivals from countries that represent at least 0.3% of the total.
We have grouped the rest into continental categories, because they have no statistical significance. The first step has been to calculate the GHG emissions of the flights from the countries of origin. We used the ICEC from the ICAO (International Civil Aviation Organization), a body attached to the United Nations, which uses a meter that takes into account not only the distance, but the aircraft model and technical considerations .
Calculations are based on round trips and economy class. We have also taken into account whether the flights are direct or whether you need to make a stopover to get to the city; we used the scale value that represents a lower time cost. Finally, we have estimated the environmental cost of access; to do this, we have calculated the emissions needed to access from the main cities of the countries to the connecting airports, weighted by the demographic value of the cities and their region.

Table 60. GHG emissions (direct and access) per passenger i nationality and relative weight of each nationality on the total *(kg of CO2 equivalent)*

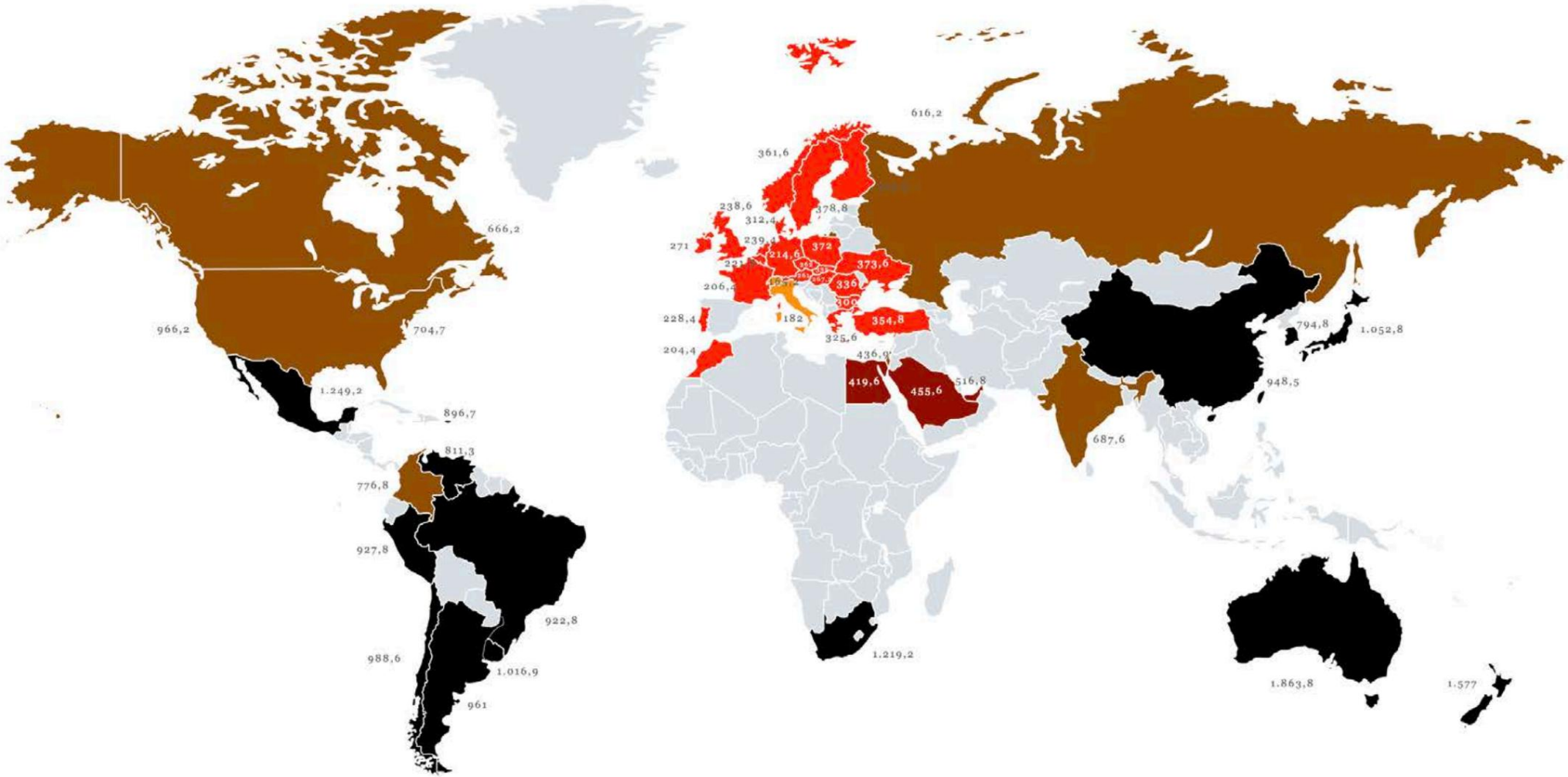
Broadcasts	direct	of access	relative weight
Germany	215	91.8	6.8
Saudi Arabia	456	21.9	0.4
Argentina	961	86.5	5.5
Australia*	1,864	131.2	1.6
Austria	262	22.2	1.0
Belgium	222	3.6	1.7
Brazil*	923	178.4	3.3
Bulgaria	301	64.3	0.4
canada	666	167.5	1.8
colombia	777	92.1	2.1
korea	795	68.0	0.3
Denmark	312	19.4	1.1
UAE	517		0.5
Egypt	420	74.8	0.3

Slovakia*	335	39.7	0.3
Finland	413	107.1	0.6
France	206	59.8	7.6
Greece	326	64.4	0.6
Hungary	267	37.1	0.5
India*	688	164.6	0.8
Ireland	271	46.0	0.8
Israel	437	18.5	0.9
Italy	182	49.3	7.3
Japan*	1,053	74.4	0.4
morocco	204	57.4	0.5
Mexico	1,249	202.4	2.0
Norway	362	106.4	0.7
New Zealand*	1,577	117.1	0.3
Netherlands	239	19.0	2.1
Peru*	928	68.8	0.6
poland	372	101.9	1.3
Portugal	228	57.7	1.6
Puerto Rico	896	44.0	0.3
A. Czech	262	46.9	0.6
United Kingdom	239	87.1	7.8
Romania	336	59.6	0.7
Russia	616	116.0	2.1
South Africa*	1,219	159.4	0.3
sweden	379	69.9	1.0
Swiss	165	21.1	1.3
Turkey	354.8	119.6	0.6
Ukraine	373.6	83.1	0.7
Uruguay*	1,016.9	40	0.3
USA east coast	704.7	218.8	8.2
US West Coast	966.2	179	
Venezuela*	811.3	118.2	0.3
Chile	988.6	156.9	1.2
China*	948.5	204.5	0.4

** Flight with stops*

source Own elaboration based on ICAO's ICEC

Figure 49. Direct GHG emissions per flight from countries of origin of international tourists *Source. Own elaboration based on ICAO's ICEC*



The cartographic representation (figure 49) makes it possible to identify very clearly the effect of distance on the increase in GHG emissions. Whereas continental trips emit a volume of less than 400 kgs. per trip per passenger (with the exception of Russia), flights originating in the southern hemisphere exceed a tonne of CO2 per passenger. In other words, a tourist traveling by plane from Mexico emits as many greenhouse gases as seven tourists who come from Italy also by plane. As the volume of intercontinental visitors is very significant in Barcelona, the incidence of transport emissions is higher than in other European tourist cities.

Not all entries are made by plane. Table 61 shows the entrances by means of transport of international tourists by country of origin. The plane is the main means of transport in all nationalities and only in two of them the relative weight of the plane is below 80%: France and New Zealand. The train has gained relative weight as a means of entry, thanks to the progressive extension of the high-speed network, which will be one of the axes of greatest growth in medium and short distances in the future. Boat tickets are related to the weight of cruise ships in the city's tourism model.

Finally, it is necessary to note the importance of the bus as a means of transport to enter the city, which suggests the growing relevance of European circuits and the integration of the city into the continent's urban tourism networks.

Table 61. Means of transport for international tourists (%)

	airplane	ship	train	bus	car
Germany	92.2	0.8	2.7	1.4	2.2
Saudi Arabia	93.5	2.2	2.2	0.0	2.2
Argentina	89.1	0.7	6.6	1.5	2.2
Australia	82.1	2.4	6.5	5.4	2.4
Austria	96.2	1.0	0.0	1.0	1.0
Belgium	88.8	0.0	2.2	2.2	6.7
brazil	90.6	1.3	5.2	1.9	0.6
Bulgaria	89.4	0.0	2.1	4.3	4.3
canada	87.9	4.5	5.1	1.5	1.0
colombia	91.3	0.5	3.1	4.1	0.5
korea	94.1	0.0	0.0	2.9	2.9
Denmark	97.5	0.8	0.0	1.7	0.0
UAE	92.3	0.0	3.8	0.0	3.8
Egypt	100.0	0.0	0.0	0.0	0.0
Slovakia	96.4	0.0	0.0	0.0	3.6

Finland	96.7	0.0	1.6	1.6	0.0
France	60.9	0.0	10.7	7.9	20.4
Greece	98.6	0.0	0.0	1.4	0.0
Hungary	93.0	0.0	0.0	1.8	5.3
India	90.9	1.1	3.4	1.1	3.4
Ireland	96.4	1.2	0.0	2.4	0.0
Israel	97.0	0.0	1.0	0.0	1.0
Italy	92.5	0.7	1.3	1.8	3.2
Japan	92.5	0.0	5.0	0.0	2.5
morocco	93.2	1.7	0.0	3.4	1.7
Mexico	92.5	1.9	2.8	2.3	0.5
Norway	97.2	1.4	0.0	1.4	0.0
New Zealand	64.3	7.1	14.3	10.7	0.0
Netherlands	92.1	0.4	3.9	0.9	2.2
Peru	89.9	0.0	2.9	7.2	0.0
poland	97.8	0.7	0.0	1.5	0.0
Portugal	94.9	0.6	1.7	1.1	1.1
Puerto Rico	93.3	3.3	0.0	0.0	3.3
A. Czech	94.2	0.0	0.0	4.3	1.4
United Kingdom	95.2	1.3	2.0	0.7	0.6
Romania	92.1	2.6	2.6	1.3	0.0
Russia	96.5	1.8	0.9	0.4	0.4
South Africa	92.9	7.1	0.0	0.0	0.0
sweden	92.3	1.0	4.8	1.0	1.0
Swiss	91.7	0.7	2.8	0.7	4.2
Turkey	98.4	0.0	1.6	0.0	0.0
Ukraine	90.4	4.1	1.4	0.0	2.7
Uruguay	84.4	0.0	9.4	3.1	3.1
USA	90.2	2.8	4.6	1.1	0.9
Venezuela	80.6	0.0	6.5	6.5	6.5
Chile	85.0	0.0	9.4	4.7	0.0
china	91.1	4.4	4.4	0.0	0.0

source Barcelona Tourism Observatory

According to these data, the direct emissions of flights between the airports of origin and the city of Barcelona represent a volume of greenhouse gases of 6.916 million tonnes of CO2 equivalent. This is the value of emissions that represent at least 0.3% of the total volume of visitors and that have statistical significance. In this calculation we have incorporated all entries from distant countries, despite the fact that the declared percentage of entries by plane is smaller. This means that these tourists who come from distant countries have entered Europe through another point and that from there they access Barcelona by land or sea. There is a relevant conceptual debate in determining how transcontinental emissions are imputed. Let's imagine a visitor who comes from the United States and who makes a route through several European cities, including Barcelona. In this exercise, we impute the emissions of the connecting flight to Barcelona even if it was not the point of entry, but there would be other options, such as affecting all the emissions in the city of the airport of entry or distributing the emissions between the cities of the routes. If we only imputed emissions by means of declared transport, the volume of emissions would be reduced to 6.359 million tonnes of CO2 equivalent.

There is a very high number of countries that are below the 0.3% threshold. Although they represent the majority of nationalities, they have a very small weight in the set of international tourists, only 4.5% of the total number of tourists. As a nationality cannot be assigned by its null statistical value, we have applied the average emissions of the countries of its continent. Among minority countries, 23.3% are American, 19.9% are Asian, 18.7% are European and 14.1% are African. The average emissions of the countries that come from Europe is 303 Kg of CO2 equivalent, 655 from Asia, 907 from America, 614 from Africa and 1,720.4 from Oceania. In total, we can estimate that international tourists who come from minority countries (below 0.3% of the global) together generate 0.38 tons of CO2. As a whole, international tourists therefore emit 7.296 million tonnes of CO2, which is explained by connecting flights between origin and destination.

We have made an estimate of the emissions generated by scale transport, i.e. from residential spaces to connecting airports. For example, a visitor who resides in Mendoza and travels to Barcelona will generate the emissions that correspond to the flight between Buenos Aires and Barcelona, but also the connecting flight between Mendoza and Buenos Aires. This information was very laborious because we had to take into account the distribution of the population in each country of origin, the connections with Barcelona and the access systems to the airport. The projections of the average access emissions can be seen in table 60. The emissions generated by the access of international tourists to connecting airports is 1.232 million tons of CO2 equivalent. We can estimate that the emissions to access the connecting airports between the minority countries is 0.0736 million tons, so that the total connections 1.318 million tons of CO2. Therefore, the total emissions generated by international tourists traveling by plane is 8.614 million Tonnes of CO2, if we consider both the direct emissions of the flight and the indirect emissions of access to the airport.

For the calculation of the car emissions of international tourists, we have considered that the point of origin is the most populated city in the country. The average emissions value of 113.5 g of CO2 per kilometer proposed by the UNWTO report and the International Transport Forum (2020) as well as the International Energy Agency (2018) have been used. It is worth saying, however, that in 2019 the average emissions of new vehicles in Europe was 123 grams per car.

We have taken into account the composition of the group among visitors from each country who travel by vehicle; for example, in a family unit of four members who travel in their own vehicle in Barcelona, the per capita emissions will be a quarter of the vehicle's emissions. Table 62 shows the distance, the average occupancy and the average emission per passenger. The estimated emissions generated by those arriving in Barcelona by vehicle (whether owned, rented or shared) are 38,098 tonnes of CO2 equivalent. Logically, this low value (especially in relation to air tickets) can be explained both by the lower emissions per passenger from vehicles and above all by the relatively small weight of car tickets. Tourism in Barcelona is heavily penalized by the high weight of plane tickets and the average distance travelled: The status of a global city implies a strong environmental impact.

Table 62. Emissions from cars of international origin and destination Barcelona (Tn CO2 equivalent). Round trip

	distance	Average occupation	Total emission
Germany	1,864	2.4	4,452
Austria	1,778	1.0	664
Belgium	1,396	2.8	2,270
Bulgaria	2,373	2.0	792
Slovakia	1,864	4.0	196
France	1,039	3.0	21,240
Hungary	1,926	2.5	794
Italy	1,358	3.2	3,950
Netherlands	1,560	3.3	842
Portugal	1,245	3.5	252
R Czech	1,712	2.0	292
United Kingdom	1,490	2.6	1,044
sweden	2,784	4.0	262
Swiss	835	3.2	554
Ukraine	3.108	4	584

source Own preparation based on the 2018-2019 Visitor Profile Survey

In the same way, we have estimated the emissions of bus and rail tickets. Again, there is a very high range of emissions from both modes of transport. Bus emissions depend essentially on the degree of occupancy, but other aspects such as model, speed, load or road condition are also involved.

The European Environment Agency suggests 68 grams of CO2 equivalent per kilometer, based on the TRAACS database and using the TERM 027 method. This calculation is based on an average of 12.7 passengers per journey, although the average is significantly higher for tourist journeys. We have chosen the source of the report of the UNWTO and the International Transport Forum (2020) and the International Energy Agency (2018), which estimate 30 grams of CO2 per kilometer and passenger on tourist routes. Table 63 shows the total emissions by country of origin. Globally, the emissions of bus tickets are 14,840 CO2 equivalent, considering the round trip.

Regarding train tickets, we have also followed the source of the UNWTO report and the International Transport Forum (2020), which estimates emissions of 20.5 grams per passenger and kilometer. Partial results by country are shown in table 63. Taken as a whole, train entries generated 14,356 tonnes of CO2 equivalent, roughly the same as the bus.

Table 63. Emissions from buses and trains of international origin and destination Barcelona (Tn CO2 equivalent). Round trip

	Bus broadcasts	Train emissions
Germany	1,798	2,454
Austria	176	0
Belgium	552	378
Bulgaria	420	144
Denmark	408	0
France	6,456	5,998
Finland	350	238
Hungary	178	0
Italy	1,818	932
Netherlands	842	916
poland	464	0
Portugal	234	240
R Czech	466	0
United Kingdom	866	1,676
sweden	278	952
Swiss	78	214
Ukraine	0	212
TOTAL	15,384	14,354

Tourists from the rest of the State represent 12% of the total number of entries. In order to determine transport emissions, we have followed the same criteria as for international entries:

- Aircraft emissions have been calculated based on ICAO's ICEC criterion because it takes into account the technical specificities of flights. Flights have not been counted if the two locations do not have any connection.

- Vehicle emissions take into account the same value we used for international arrivals (113.5). We calculated the average number of occupants from the Visitor Profile Survey and used the same record for all provinces, 2.27 occupants per vehicle. The distance has been calculated from the provincial capital and round-trip emissions have been considered.

- Bus and train emissions are based on the values proposed by the UNWTO report and the International Transport Forum (2020) and the International Energy Agency (2018), 30 grams for buses and 20, 5 grams by train.

Table 64 shows the provincial emissions by each means of arrival and the total provincial emissions. As a whole, emissions from state tourist arrival transport represent 171,720 tonnes of CO2 equivalent.

Table 64. Transport and total emissions from tourists in Spain by province (Tn CO2 equivalent)

	airplane	train	bus	car	total
Alaba		261	64	850	1,176
Albacete		441	108	629	1,179
Alicante	1,536	1.901	262	875	4,575
Almería	2,381			133	2,515
Avila		812	639	456	1,908
Badajoz	2,900	278	101	169	3,449
Balearic islands	6,091				6,091
Burgos		246	120	400	767
Caceres		93		228	321
Cádiz	4,615	225			4,841
Castellón		245		368	613
Ciudad Real		281	137	229	647
Córdoba		674		205	880
A Coruña, La	7,564			180	7,743
basin		73		267	341

Granada	4.304	347		847	5,497
Guadalajara		91		335	427
Gipuzkoa		270	197	329	796
Huelva		445			445
Notch			80	268	348
jaen		292	284		576
Lion	5,613	370		258	6,241
La Rioja		161	94	79	335
Lugo		101		247	348
Madrid	11,403	7,600	2,299	4,660	25,961
Málaga	8,337	926		161	9,424
Murcia		178	65	325	569
Navarre		757	264	351	1,372
Ourense				699	699
Asturias	5,650	60		147	5,858
Palencia		94			94
Palms, Las	19,826				19,826
Pontevedra		952		1,742	2,694
Salamanca		340			340
Tenerife	22,830				22,830
Cantabria	3.131		70	584	3,785
Seville	10,112	673		329	11,114
Soria		31		77	108
Teruel		29	42	70	142
Toledo		234		228	462
Valencia	1.108	1,912	829	1,209	5,058
Valladolid	1,924	395		362	2,680
Biscay	4,505	371	121	402	5,399
Zamora		112		273	385
Zaragoza		242	193	322	757
Melilla			108		108

Source: Own preparation

Finally, the emissions of tickets from the rest of Catalonia have been estimated, which only represent 2% of the total number of visitors. In addition, collective transport is of significant importance, the plane does not intervene and the distances are very short. For this reason, the set of visitors' entrances represents only 995 tonnes of CO2 equivalent.

Table 65 shows total emissions from tourists' trips by place of origin. As we have mentioned, international tourism has a very significant impact on the volume of emissions, which can be explained both by the high relative weight of international entries, and by the clear primacy of the use of airplanes and 'high average distance.

Table 65. Transport emissions according to type of tourists (Tn CO2 equivalent)

	Broadcasts
International tourists	8,681,294
Tourists from Spain	171,720
Catalan tourists	995

source Own production

Hiking tourists show the methodological problems of the allocation of emissions at a local scale. Let's imagine, for example, a tourist who has stayed in Sitges and who takes a tour of various points in Catalan geography, including the city of Barcelona.
Following the criterion of attribution of emissions to the destination, the municipality of Sitges would be assigned all the emissions from the journeys from the origin to the municipality of Garraf and, instead, the rest of the municipalities visited (among them, Barcelona) they would have none.
This shows the problems of reducing to a municipal scale a phenomenon that operates on several scales (international, national and regional). In order to maintain consistency with the approach of the previous point (and following the criterion of the study on the environmental externalities of tourism), we have not considered origin-destination trips in the calculation of the emissions generated by hiking tourists.

The 2018-2019 survey does not have data on the mobility of excursion tourists staying in a municipality in the province of Barcelona. We know how the tourists got to the various municipalities and we know what means of transport they used in the city, but we don't know what means they used to get there. For this, we will use the distribution of trips from the 2016 mobility study and project it onto the 2019 data. We have weighted the distances taking into account the supply capacity indicator of each metropolitan municipality and have taken into account both the outward and the return journey. The calculations are based on an average distance of 21.02 kilometers and an estimate of emissions according to the feeding systems of each transport system.

Table 64. Transport emissions of metropolitan tourists (Tn CO2 equivalent)

	percentage	Displacements	Tn CO2eq
train	31.50	1,532,484	660.36
FGC	4.50	218,926	94.34
Subway	16.40	797,865	343.81
tram	3.60	175,141	75.47
Bus and coach	8.60	418,392	263.84
taxi	8.90	154,638	368.93
car	26.30	448,948	1,071.09
total	100	4,855,298	2,877.83

a. Occupation 2.85

source Own preparation based on the 2016 tourist mobility survey

We do not have information on the means of travel of tourists staying in the other tourist brands in the country, with the exception of tourists from the province of Barcelona. We cannot project this data for the rest of the brands because the accessibility conditions of the Costa Brava and the Costa Daurada are very different from the situation in the Maresme or the Costa del Garraf, which have access systems by rail. To make an approximation, we have considering that one third of trips are made by train, one third opt for private transport and one third use the bus or coach, following the opinion of several tour operators consulted. Logically, this is an approximation with a high margin of error, precisely among the group that has a greater relative weight among hiking tourists. We have made an estimate of the travel distance that takes into account the weighting of tourist activity by municipality, in accordance with the collection of the tax on tourist stays in 2019, for all the municipalities that exceeded 10 that year million euros from the IEET. The weighted average distance is 98.81 kms., which is a value that does not take into account the distance friction (when the distance increases, the willingness to travel decreases).

Table 65. Approximation to the emissions by transport of hiking tourists (Tn CO2 equivalent)

	Broadcasts
Metropolitan tourists	2,878
Excursion tourists	27,779
Cruisers	2,929,633

a. Occupation 2.85

source Own production

A similar problem occurs with cruise ships. What are the emissions that we must consider related to the presence of cruise ships in the city of Barcelona?: The global emissions of the route, a distribution of the emissions between all the ports of call, consider only the emissions when the port is the start of the route or consider only the emissions derived from the ship's stay in port? All answers would be valid and each would result in a completely different value.

Despite the growing importance of cruises in the international tourism model, we have very little information on the environmental impacts of this type. Howitt et al. (2010) monitored 68 international cruise ships in New Zealand and estimated a weighted average emission level of 390 grams of CO2 equivalent per passenger per kilometer. Factors such as the size of the ship, its capacity or the degree of occupancy make this average value vary very sensitively. Taking into account that the typical route of cruises in the Western Mediterranean (about 7 - 8 days with a perimeter route in the Gulf of Leon and the Tyrrhenian Sea) is about 3,500 kilometers, it would involve about 1,365 Kilograms per route. The main international cruise company, Carnival, has published the results of its audit on emissions and it is in values similar to those of Howitt's forecast (between 342 and 358 grams per passenger and kilometer).

Simonsen, Walnum and Gössling, S. (2018) have published the results of a study based on the Ship Traffic Emissions Assessment Model (STEAM), which uses data from the Identification System
Automatic (AIS) to track the movements of ships at high tide spatial and temporal resolutions. AIS data provides accurate data on the location of ships at any given time, allowing speed or port dwell times to be calculated. Based on the STEAM data, the authors estimate average emissions of 1,671 kilograms per person and cruise. If we use the same criterion as with air entries and impute to the entry destination the emissions of international tourism, we will have to consider that the 1,753,222 cruise passengers who use the port of Barcelona as a port of entry and/or arrival generated a total of 2.93 million Tn of CO2 equivalent.

Table 65. Transport emissions according to type of hiking tourists (Tn CO2 equivalent)

	percentage	Displacements	Tn CO2eq
train	33.30	4,238,859	8,586.25
Bus and coach	33.30	4,238,859	2,513.05
car	33.30	1,487,319	16,680.18
total	100	4,860,163	27,779.49

source Own production

Finally, to estimate the volume of hikers' emissions, we have relied on the daily mobility survey of 2019. For each locality, we have estimated the distance from Barcelona and the proportion of means of transport. Contrary to what you might think

assume there are no significant differences in the average distances by means of transport. Most journeys are made by vehicle, which is why the volume of emissions is so high.

Table 65. Emissions from transport of hikers (Tn CO2 equivalent)

	Average distance	Percentage Displacements		Broadcasts
bus	35.14	13.53	3,910,166	4,122.10
train	35.97	18.47	5,337,824	3,936.03
car	38.78	68.00	6,895,431	30,350.45
total		100	16,143,422	38,409

Source: Own preparation

If we make a synthesis of the emissions derived from the transport of visitors, we would obtain results very similar to those of the study on the environmental externalities of tourism. The bulk of the emissions correspond to tourists (especially international tourists), because they are the bulk of the demand and because of the predominance of travel by plane.
In metropolitan tourism and excursion tourists, we do not impute access emissions from the origin to the destination, but only the emissions related to the journey from the destination to Barcelona. If we analyze these emissions on a Catalan scale, the values would soar. We have attributed to Barcelona the emissions from the cruise ships that enter and/or leave the city, and this has a very significant impact on the final value. Hikers have a relatively low level of emissions because, despite a very significant volume of flows and intensive car use, the average distance is very short. Globally, the emissions derived from tourist activity can be set at 8.9 million tons of CO2 equivalent if we do not consider cruises (9.2 million in the study on environmental externalities) or 11.85 million if we include the impact of

cruise ships

Table 66. Transport emissions of all types of visitors (Tn CO2 equivalent)

	Broadcasts
tourists	8,853,909
Metropolitan tourists	2,877
Excursion tourists	27,779
Cruisers	2,929,633
Excursionists	38,409
visitors	**11,852,607**
Visitors (no cruise passengers)	**8,922,974**

Source: Own preparation

Emissions from the accommodation sector are explained by three factors. On the one hand, consumption per night and by form of accommodation based on estimates of overnight stays and the consumption ratio by category; we insist again that these ratios are based on information that should be updated and refined periodically to improve the accuracy of the estimate; the second factor affecting emissions is the type of final energy used and especially the weight of the electrical energy. And, thirdly, we have estimated the volumes of emissions for each energy source in accordance with the criteria used by the Barcelona Energy Observatory. It should be borne in mind that in 2019 the electricity mix reached a very low value: in 2015, the reference year of the study on environmental externalities, emissions per Kwh were 398 grams of CO2eq. In 2019, emissions had dropped to 241 grams (Catalan Climate Change Office, 2019).

According to the criteria indicated, the emissions that are explained by accommodation companies are 184,074 Tn CO2eq, a moderate growth compared to the 2013 estimate of the study on the environmental externalities of tourism, which predicted emissions of 150,488 Tn. This means that the carbon footprint per visitor has been significantly reduced; this reduction is explained by two factors. Firstly, a methodological variation in the calculation of overnight stays, which particularly affects average stays. And, secondly, as we have mentioned, it is explained by the reduction in emissions derived from the electricity mix.

With the same criteria, we have calculated the emissions that derive from accommodation or frequenting the spaces with the highest tourist density, following the methodology of Rico (2019) and starting from the results we have presented in the chapter on energy consumption. The emissions are calculated based on the document of the Catalan Office of Climate Change (2019), which is the same criterion used by the Barcelona Energy Observatory.

We have included the emissions derived from waste in the calculation. If tourism represents 10.11% of urban solid waste in the city of Barcelona, and at the same time waste treatment accounts for 10% of the city's total emissions (2018 data), the treatment of tourist waste is responsible for 1.01% of the city's total emissions, which in 2019 were 3.6 million tons of CO2eq. This means that the emissions derived from the treatment of tourist waste can be estimated at around 36,000 tonnes for the year 2019.

In order to calculate CO2eq emissions that are explained by commercial activity, we calculated the relative weight of tourism commercial expenditure on the total and considered this to be an indicator of the weight of tourism commercial emissions on the total commercial emissions. In 2019, tourist expenditure represented 21.1% of expenditure at the destination excluding accommodation; this means around 17.4 euros per tourist per night. If we know that overnight stays by tourists were about 45 million in all forms of accommodation, the direct commercial expenditure can be estimated at about 781.7 million euros. If the spending behavior of excursion tourists is similar, the volume of commercial tourism spending can be estimated at 992 million euros. Given that the volume of commercial turnover in Barcelona in 2019 was 39,608.5 million euros *(Trade in Barcelona,* 2019), the

tourist expenditure represents approximately 2.5% of global commercial turnover.

In the annual monitoring and evaluation report of the Barcelona 2030 Agenda, it is estimated that CO2eq emissions from the commercial sector for the year 2018 was 729,700 Tn, so we can infer that the direct emissions derived from commercial consumption by tourists (without taking into account the expenditure of hikers) is about 18,000 Tn of CO2eq. This is a significantly lower value than that calculated in the study on the environmental externalities of Barcelona. In any case, a systematic study of the incidence of tourism in the city's commercial sector would be necessary, both from an economic and environmental point of view.

Restoration is also an activity that has a strong impact on greenhouse gas emissions. Inèdit's study on the carbon footprint of the food sector in Barcelona in 2019 calculates the emissions that can be attributed to the entire production and distribution chain of food in Barcelona, excluding distribution emissions urban and consumption; in the study, it is estimated that emissions from the food sector outside the city represent 2.5 million tons of CO2eq. Of these, 13.3% correspond to extra-domestic consumption by non-residents, that is to say, visitors (tourists and hikers), commuters, and metropolitan flows.

We know that visitors represent 26.3% of the total and tourists 18.9% of the total, so we could estimate about 87,700 tons of CO2eq for all visitors and about 62,900 tons for tourists.
These emissions are indirect: They take place outside the city, however they are explained by the activity of the city. As with the water footprint, we must determine not only the direct effects of tourist activity (transport, heating, electricity...), but we should also consider the emissions that have caused the necessary goods and services for tourist activity. In any case, we will follow the same criteria as the rest of the report and Rico (2019) and will only impute direct emissions, that is, those that are explained by the activity of the visitor and not by the provision of goods and services necessary for tourist activity.

We do not have data on the emissions that can be attributed to the restoration activity. Rico (2019) estimates that tourism-related catering is responsible for 5% of destination emissions (excluding travel).

Tables 67.1 and 67.2 show the synthesis of the calculations on the carbon footprint of the city's tourism sector; it is, in essence, an update of the study by Rico (2019) for the 2019 data, with the methodological modifications that we have discussed throughout the heading. Globally, the sector's carbon footprint is very high because we impute to the city the environmental costs of visitors' travel. If we use the same criterion with cruise ships, that is to say, we allocate to the city the emissions derived from tourist activity due to the arrivals and departures of cruise ships, the emissions reach 12 million tons of CO2.
In both cases, transport is the main responsible for emissions as a result of the international nature of tourist demand and the absolute predominance of travel by plane.

Table 67.1. Summary of emissions from tourist activity (not considering cruises)

	Broadcasts	%
Transportation	8,922,974	96.7
Accommodation	184,074	2.0
Leisure activities and equipment	19,585	0.2
Internal displacements	47,697	0.5
Treatment of tourist waste	36,360	0.4
Commercial sector	18,243	0.2
total	**9,228,933**	

Table 67.2. Summary of emissions from tourist activity (with the impact of cruises)

	Broadcasts	%
Transportation	11,852,607	97.5
Accommodation	184,074	1.5
Leisure activities and equipment	19,585	0.2
Internal displacements	47,697	0.4
Treatment of tourist waste	36,360	0.3
Commercial sector	18,243	0.2
total	**12,158,566**	

Indicator 6 shows the various interpretations of the carbon footprint of tourism in Barcelona. Globally, tourism emissions range between 9 and 12 million tonnes, if we include cruise ship emissions in the calculation.

The Barcelona Energy Observatory has been calculating GHG emissions in the city for some time, using the calculation standards for urban spaces. We have already commented on the methodological difficulties that arise from using a local scale for a phenomenon (emissions) that has local, regional and global dimensions. For example, the Observatory calculates in the emissions the activities of the port and the proportional part of the airport that affects the GDP of the city, but it is clear that there are many externalities (supply of goods and services, travel,...) that are explained by the city's activity and that should appear in the emissions balance. For this reason, we must bear in mind that we are comparing two different magnitudes, which are tourism with inflows and outflows versus urban life in the municipal limits. With these criteria, and taking into account that in 2019 global emissions were around 3.6 million tonnes of CO2eq, tourism represents 338% of the city's emissions, which is conceptually impossible. This data relates emissions from tourism and tourist transport (but not transport of tourist goods and services) to emissions in the city.

If we consider tourists and hikers, the emissions are 212 Kg of CO2 per person per day, but logically this is a very distorted figure due to the unequal contribution of each. Therefore, if we only consider tourists, the emission value per tourist is 434

kgs of CO2 that integrates the externality of the displacement. If we measure it in expenditure per day, the emissions are 166 kgs per day, so if it is possible to increase the average stay, the cost of transport will have an impact on the days of stay and the average effect will be reduced. Finally, if we don't take travel into account, a tourist in Barcelona generates around 10 kgs. of GHG emissions.

INDICATOR 6. TOURISM CARBON FOOTPRINT

Tn CO2eq of emissions	9,228,933
Tn CO2eq of emissions (with cruises)	12,158,566
Weight on global emissions (%)	338
Emissions per visitor (Kg CO2eq)	214.24
Emissions per visitor and day (Kg CO2eq)	119.47
Emissions per tourist (Kg CO2eq)	434.48
Emission per tourist per day (Kg CO2eq)	166.07
Emissions per visitor at destination (Kg CO2eq)	5.39
Emissions per tourist at destination (Kg CO2eq)	9.95

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The economic impact

5. The economic impact of tourism

The economic benefit of tourism has usually been raised as the counterpoint to the environmental, cultural or social costs. And it is true that tourism has a direct effect on the GDP of the city, on the job market or taxation. The direct benefits of tourism (more resources, more taxes, more jobs) are added to the indirect impacts.
On the one hand, the Tourism Satellite Account shows that tourism has an impact on other sectors of the economy such as transport, the agri-food sector or commerce. On the other hand, tourism activity can positively affect other intangible attributes of the city, such as its reputation, brand image, attracting investment or attracting talent. The study carried out by Barcelona City Council in countries of origin in Asia, Europe and America in 2018 shows the connecting vessels between the capacity to attract tourists and the attraction of residents, investments or talent *(Barcelona in the eye of the world,* 2018).

Tourism also has negative effects on the economy. The increase in tourist pressure affects prices in general and, specifically, the price of those scarce resources that compete with other uses in the city, such as housing. For example, the study on the impact of holiday rentals on the residential rental market in Barcelona from 2016 concludes that the income obtained by housing for tourist use has an average return estimated between 7.68% and 13.4 %, which is much higher than the profitability of traditional rent. This generates a displacement of the rental housing stock towards the tourist market, which the PEUAT has stopped.

Tourism also has a negative effect on the quality of the job offer. The study published by Barcelona City Council on the tourist job market shows that activities classified in the tourist categories have an average gross salary of 22,187 euros, which is 26% less than the average salary in the city. As a whole, these activities have a greater degree of temporality, a greater weight of wage earners and a greater wage difference between men and women. Therefore, the economic impact on the labor market has two sides. On the one hand, according to the Mostra Contínua de Vides Laborals of 2018, in the city of Barcelona, tourism-related activities represent 12% of the city's labor supply as a whole and is, therefore, a key piece in the structure of the municipality's labor market; the same sample, however, shows that the wages of these activities (especially in the area of food and drinks) is well below the average wages.

The impact of tourism on municipal revenue must also take into account the weight of municipal tourism expenditure on total expenditure. An estimate by the Barcelona Institute of Economics in 2020 considers that the impact of tourism on the expenditure of the Barcelona City Council is between 3.13% and 5.82% of non-financial expenditure, it is that is, between 81 and 150 million euros; this impact on spending would be less than the impact on income, which would be between 1.77% and 2.05% of non-financial income, therefore between 46 and 53 million euros, despite that the application of the tax on the

stays in tourist establishments would make it possible to recover a significant part of this differential.

Therefore, tourism generates positive effects on income, on the labor market and on municipal taxation, has a positive impact on the sectors that supply goods and services to tourism companies and also improves the brand image and positioning of the municipality. But at the same time, tourism affects the prices of the city and especially the prices of scarcer goods such as housing, creates a part of low-quality employment and involves public expenses that could exceed tax revenues.

The incorporation of the economic impact in the calculation of the load capacity has repeatedly encountered two problems. The first problem is that the economy is a multi-gear system in which it is very difficult to establish simple causal relationships. Does tourism impact the housing market? It is evidence. But we cannot establish a direct relationship between the growth of tourists and its impact on the decline of the housing stock, nor can we easily answer the question "How many tourists explain the conversion from residential housing to tourist housing?", because they operate many other factors, such as internal and external migration, the incomes of new residents, the weight of renting over buying, the financial market or speculation in the real estate market. Aside, logically, that the PEUAT has modified this relationship due to the limitation of the growth of the supply foreseen in the plan. We can say that an increase in the number of tourists directly affects the density of a district, the relative weight of tourists, emissions or water consumption; but we cannot claim that the increase in tourists will cause a proportional increase in prices, a decrease in rental housing or a drop in the average salary.

The second problem stems from this first. If the causalities are multiple, it is very difficult to project a future scenario based on current conditions *ceteris paribus,* that is, without the other variables changing. The relationships between the various factors are constantly being redefined and it is not possible to establish a projection that helps to delimit the carrying capacity. For example, we can establish a causal relationship between the price of certain commercial products, such as textiles, and tourist pressure: Tourists increase demand and this affects prices. But the increase in demand also affects the increase in supply (and its diversification and specialization) and other external factors (GDP, consumption, savings, the increase in the prices of raw materials, the incidence of electronic commerce or concentration in large areas) constantly alter this simple relationship. Will the increase in tourists increase commercial prices? It depends on many variables that are permanently redefined. For this reason, the studies on carrying capacity barely incorporate the economic dimension in their formulation.

In this proposal, tourism expenditure and its weight on the city's economy are identified. This is an indicator that is directly related to the increase in visitors (more tourists means more tourist spending), although its weight on the local economy is logically conditioned by the evolution of the municipality's GDP. There are two ways to read the relative weight of tourism spending on the economy

local: There is a positive reading, according to which tourism contributes to the economic development of the municipality and corrects the deficits of other sectors in crisis; and there is a negative reading, which considers that a system in which the relative weight of tourism is excessive alters the economic structure of the municipality and increases its dependence. From this perspective, the relative weight indicator would set the limit of acceptable change, from which tourism dependence alters the conditions for the rest of the sectors and for the economic system of the municipality as a whole.

5.1. The weight of tourism. View from the offer

Most economic sectors measure their impact based on the analysis of the activity of the companies that make up the sector. We can measure the activity of the publishing sector, the construction of buildings or the manufacture of pharmaceutical products by adding the activity of all the companies that make up this sector. Usually, we work with gross added value, which takes into account the value created by a sector, once intermediate consumption and indirect taxes have been deducted. These sectoral calculations are put in relation to the general GDP, in order to determine the relative weight of each sector on the economy of the area studied (a municipality, a region or a country).

The main problem that the tourism sector has is that it is not really an economic sector. The statistical classification of the CCAE 2009 covers five categories:

- Tourism transport
    - Interurban passenger transport by rail (491)
    - Other types of land passenger transport (493)
    - Sea transport of passengers (501)
    - Passenger air transport (511)
- Accommodation services
    - Hotels and similar accommodation (551)
    - Short-term tourist accommodation (552)
    - Campsites (553)
    - Other types of accommodation (559)
- Food and beverage services
    - Restaurants (561)
    - Provision of meals for celebrations (562)
    - Beverage establishments (563)
- Travel agencies and tourist operators
    - Travel agencies and tour operators (791)
    - Other related reservation services (799)
- Other tourism services
    - Organization of conventions and fairs (823)
    - Creative, artistic and show activities (900)
    - Cultural activities (910)
    - Activities related to gambling and betting (920)
    - Other recreational activities and entertainment (932)

As you can guess, the problem of tourism is twofold: On the one hand, part of the demand for these services is not touristic; and, on the other hand, part of the resources generated by tourist activity do not affect any of the aforementioned sectors.

A very obvious case for its importance in terms of income or the labor market (as we have seen) is the hospitality sector, represented by restaurants (561) and drinking establishments, such as bars or cafes (563). It is clear that a significant part of the customers of these two establishments are not tourists; the restaurants respond to the needs of tourists and hikers, but also to those of commuters, metropolitans and residents. When Barcelona City Council estimates, for example, the wages of the tourism sector, it is actually estimating the wages of the activities included in the heading of tourism, even though a very relevant part of the activity of these companies (and of its workers) has no link with tourism. On other occasions, the relationship of the companies is not with the receiving tourism (the tourists who arrive in the city), but with the sending tourism (the tourists who leave the city), such as the sending travel agencies.

Conversely, part of the activity of tourists is not reflected in this accounting because it affects other sectors of the economy that are not included in the tourist headings. The most obvious example is commercial activity, which is a central part of tourism spending and, on the other hand, its activity is not counted in the general accounting on the weight of tourism in the GDP or in the labor market. For this reason, the World Tourism Organization proposes the use of the Tourism Satellite Account, which relates the perspective of supply and the perspective of demand. Since 2014, Catalonia has had a tourism satellite account model, which we will comment on in the following section.

The Municipal Data Office publishes an annual report on the behavior of the GDP in the municipality. In 2019, the GDP of the city of Barcelona reached 87,404 million euros, which represents 34.9% of the GDP of Catalonia and 7% of the GDP of the State as a whole. The city's economy is characterized by its extreme tertiaryisation, as the service sector represents 89.3% of the municipality's GVA structure, while in Catalonia the contribution of the tertiary sector is 74.4%.

Figure 50 shows the weight of the sectors related to tourism activity in the structure of the municipality's GDP and compares it with the weight of the same activities in Catalonia's GDP, which allows us to assess the degree of specialization of 'these sectors. As can be seen, Barcelona's commercial activity and passenger transport have a weight on the Catalan GDP comparable to that of the economy as a whole, close to a third of the total. On the contrary, hospitality (accommodation and food and drink service) has a relative weight well above the average, which demonstrates the specialization of the city's economy in these two areas. Likewise, the artistic, cultural and recreational activities of the city approach 50% of the proportion with respect to the total of the country, which is an even higher level of specialization. These two activities even exceed the relative weight of the services sector in Barcelona compared to the services sector in Catalonia (38.8%).

We must emphasize that a significant part of the users of the hospitality sector are not tourists, because the restaurant sector and bars are aimed at all users of the city, but it is an indicator of the centrality of the city and of its capacity of attraction.

Figure 50. Relative weight of the various sectors of the municipality's economy in relation to Catalonia's GDP (%)
(average value = 34.9%)

Source: Municipal Data Office. city Hall of Barcelona

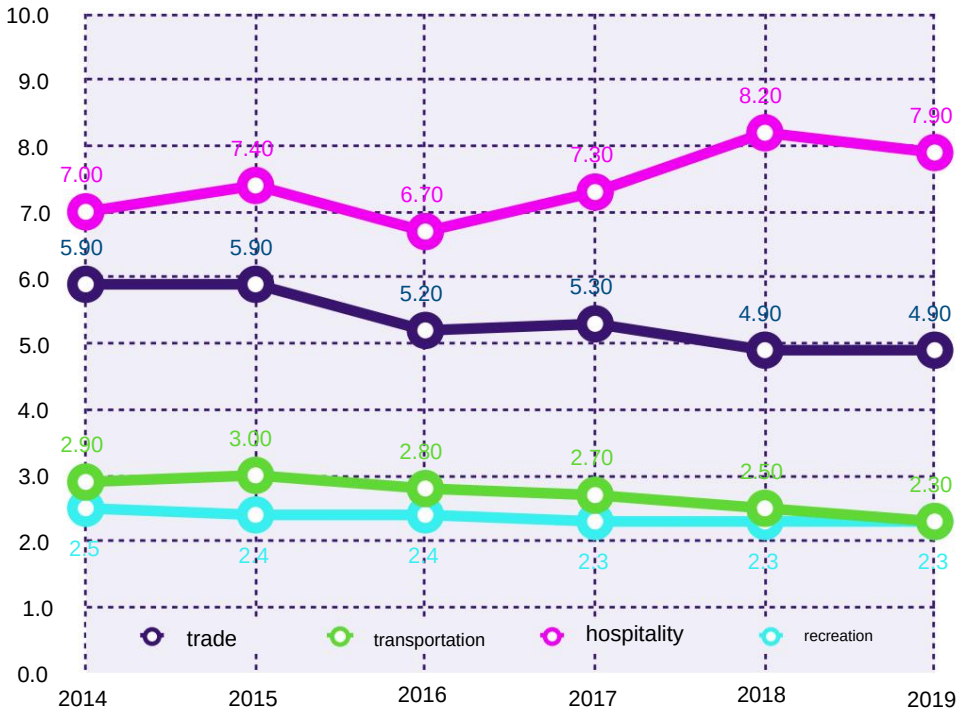
Figure 51 makes it possible to identify the volume of the gross added value of these four sectors. The transport sector represents 2.3% of the city's GDP and the hotel industry contributes 7.9%; on the other hand, artistic, recreational and entertainment activities contribute 2.3% to the GDP of municipality Retail trade (excluding the sale of vehicles) represents nearly 5% of the city's GDP.

Figure 51. Participation of the tourism sectors in the municipality's GDP

(millions of euros)

Source: Municipal Data Office. city Hall of Barcelona

Figure 52. Evolution of the weight of the tourism sectors in the GDP (%)



Source: Municipal Data Office. city Hall of Barcelona

Figure 52 shows the evolution of the weight of the various sectors related to tourist activity in the city's GDP. There is no relationship between the evolution of tourist activity and the behavior of these sectors in the city's GDP because logically many other factors are involved simultaneously (general economic situation, financial situation of companies, saving of households, competition behavior...), which do not allow for any linear relationship. For example, 2019 was a record year in tourist arrivals and spending and, on the other hand, the relative weight of the hospitality sector fell compared to 2018. Yes, we can see a series of medium-term trends, such as the reduction of the relative weight of trade and transport in the city's GDP, the stability of the entertainment sector and the increase in the weight of the hospitality industry, although with constant ups and downs. In the six years of the series, the relative weight of hospitality in the city as a whole has increased by almost one point.

5.1. The weight of tourism in the economy of Barcelona. Vision from the demand

Tourism is a sector that is essentially explained from the perspective of demand. It is the tourist's spending behavior that allows us to measure the economic activity generated by their stay. A tourist can influence transport (a taxi), professional services (a translator/interpreter), educational services (a university seminar), the craft sector (the purchase of a set of ceramics), the health field (an eye examination), in the real estate sector (a second home) or in finance.

In order to determine the behavior of tourist expenditure, two complementary sources are available. Traditionally, the indicator that has been used to determine the distribution of expenditure is the survey of visitors and this is the method proposed by the UNWTO for the calculation of the Satellite Account. The two surveys that provide information on spending are EGATUR at state level and the survey of the profile and habits of tourists in Barcelona. This survey incorporates a series of questions about the distribution of expenditure, which allows the economic variables to be related to the rest of the tourist variables in the survey.

The second indicator that has recently been added to the analysis of tourist expenditure is international credit card movements. The consolidation of this source will make it possible to know the effective behavior of the expenditure (which is more precise than the declared behavior), with a spatial and temporal precision that the survey cannot provide. For example, Figure 53 shows the proportion of retail spending by domestic and international customers collected from a sample of the city's point-of-sale (POS) terminals. The data show the cyclical rhythms of the municipality that we have identified in the analysis of users, with an increase in international activity at weekends and a very significant presence in the summer, as a result of the increase in the number of international tourists and also due to the reduction in the number of residents. In any case, the data still do not allow the tourist status to be clearly identified, it focuses on commercial activity and provides information on proportions and not on volumes For this reason, we have worked with data from the Barcelona tourist profile survey.

The survey of the tourism profile and habits carried out by the Barcelona Tourism Observatory includes questions about tourist expenditure, which allows us to see the series over time. We must keep in mind that these data are based on declared behavior, which can have two types of bias. The first is knowledge bias because visitors can unintentionally alter actual spending; the second bias is anticipation because it must project future spending at the time of the survey. There is, therefore, a margin of error that is reduced when we compare behavior over the years.

Tourist expenditure is organized into three main areas, the cost of transport, the cost of accommodation and expenditure during the stay (leisure activities, internal travel, restaurants...). Figure 52 shows the relative weight of the three areas declared in the surveys. In schematic form, the expenditure is organized into three parts, one third goes to transport, one third to accommodation and one third to expenditure during the stay. However, the cost of accommodation is the smallest item and in no case does it reach 30% of the total; on the contrary, the highest expenditure is that of transport from the origin, as a result of the strong international component of tourists and, especially, due to the relative weight of long-distance tourists.

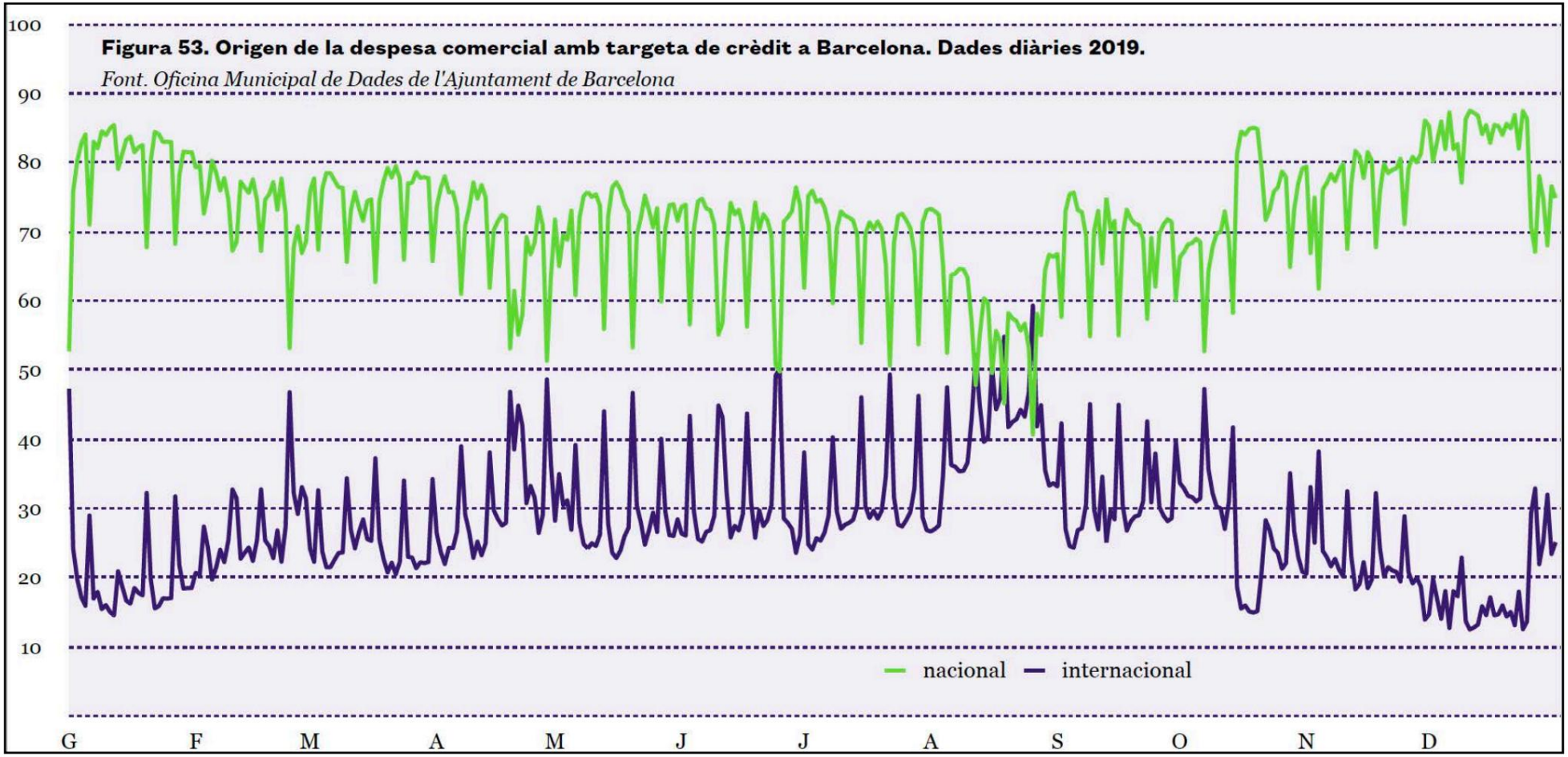
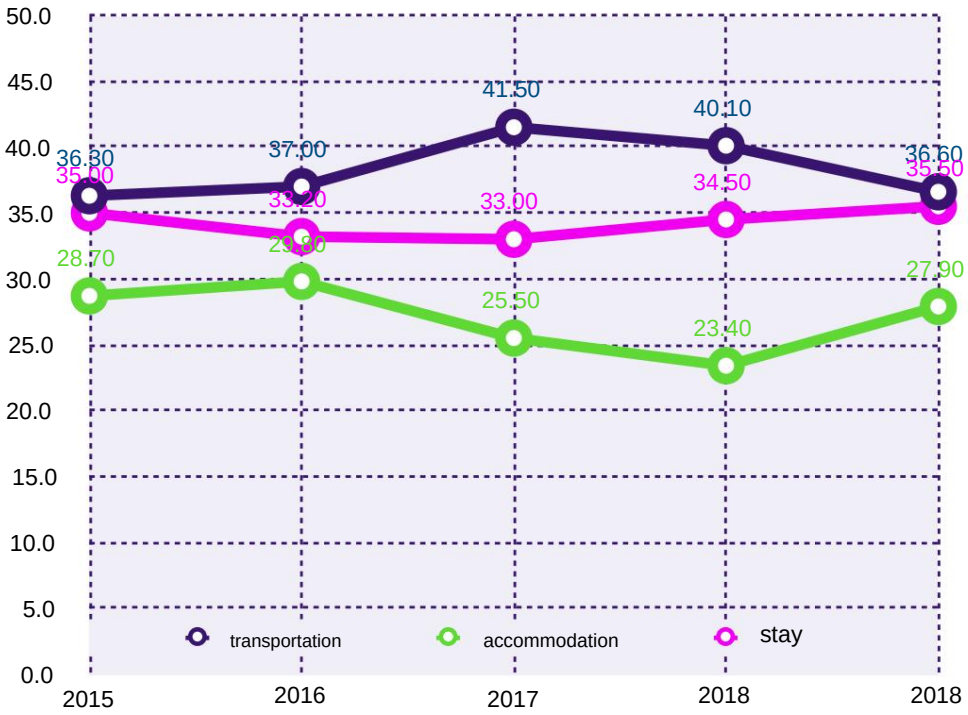


Figura 53. Origen de la despesa comercial amb targeta de crèdit a Barcelona. Dades diàries 2019.

Font. Oficina Municipal de Dades de l'Ajuntament de Barcelona

Figure 54. Evolution of the relative weight of the components of tourism expenditure (%)

Source: Barcelona Tourism Observatory



Transport is, logically, a game that is very conditioned by the origin. Table 69 shows the expenditure on transport by the various origins and shows the strong incidence of visitors from the rest of the world in the average expenditure on transport.

Table 69. Average expenditure per tourist on transport according to origin (round trip)

	expense
Rest of the province	13.9
Rest of Catalonia	57.0
Rest of Spain	105.9
Rest of Europe	183.5
rest of the world	703.6
average	**355.9**

Source: Barcelona tourist profile and habits survey. 2018-2019

The accommodation item is the one with the lowest average value. In this case, the most significant differences occur between the types of accommodation. The expenditure per visitor per day in the hotel doubles the expenditure of the other forms of accommodation. Hostels are the cheapest form of accommodation, with just over 34 euros per person per day, if we logically exclude stays in the homes of relatives and friends.

Table 70. Average expenditure per tourist per night on accommodation according to type (euros)

	expense
hotel	98.2
five stars	170.3
four stars	106.3
three stars	76.9
two stars	61.4
A star	58.3
pension	50.2
HUT	51.4
Shelter	34.5
Home of friends and relatives	
Other forms of accommodation	47.2
average	**59.5**

Source: Barcelona tourist profile and habits survey. 2018-2019

The third component is the expenditure at the destination and includes all items that do not correspond to accommodation or transport.
In this item it is possible that the bias is higher, especially when the expenditure is broken down in the various areas. While the travel and accommodation expenditure has already been incurred, destination expenditure is a projection based on previous experience, which may vary during the stay. Table 70 shows both general expenditure and the distribution in the areas of trade, catering, leisure and leisure, internal transport and other expenditure at the destination.

Table 71. Average expenditure per tourist per night in the destination according to type (euros)

	Food and drink	purchases	leisure	Internal transport	others
hotel	42.0	23.3	15.6	3.6	7.0
five stars	59.9	46.7	24.3	21.7	8.8
four stars	43.0	22.1	14.6	14.4	7.6
three stars	36.1	18.9	14.3	10.9	5.3
two stars	33.0	12.3	13.3	8.4	1.5
A star	31.5	12.8	13.4	8.8	1.8
pension	27.6	14.3	12.9	7.0	0.6
HUT	32.5	11.7	13.6	8.1	1.7
Shelter	28.8	11.8	15.9	8.1	1.1
private house	26.9	12.1	9.6	6.9	1.1

Source: Barcelona tourist profile and habits survey. 2018-2019

It should be noted that 9.21% of the people interviewed state that they have contracted a tourist package, with an average expenditure of 1,160 euros. The majority of packages (nearly 87%) are related to hotel accommodation and, to a lesser extent, to HUTs and hostels.

With this information, we can calculate the total expenditure of tourists in the city of Barcelona, based on the distribution of stays in the second chapter of this study. We have assigned to each type of accommodation the average cost of transport, accommodation and expenses at the destination. This makes it possible to establish a weighted average of expenditure based on the allocation to each type of accommodation of the average expenditure and the estimated number of nights. The survey of the profile and habits of the tourist estimates an average overnight stay of 5 nights, while the values we work with in this report are much lower; this means that the global average expenditure is reduced (fewer nights lead to less expenditure) and increases the relative weight of the cost of transport on the total expenditure of the tourist. According to the projection, the direct expenditure of tourists in the city of Barcelona of 14,617 million euros, including transport and taking into account the expenditure on tourist packages.

A significant part of this expenditure generates a spillover effect, that is to say it does not have a direct impact on the municipality but affects a wider geographical area. This is particularly evident in the case of transport. The airport is a fundamental asset of the city's economic model, but a significant part of the airport's economic activity has an impact on a very wide geographical area, on a global scale. For therefore, it is interesting to isolate the expenditure related to accommodation and staying in the municipality because they are the two areas that have a clearer direct impact on the local economy and the spillover effect is much less relevant. This forces the tourist package to be fragmented into its transport and accommodation components, based on a simulation based on existing data. If we remove the effect of transport, the direct economic expenditure of tourism in the city of Barcelona could be estimated at **6,803 million euros,** which represents **7.78% of GDP.** In this proportion, only the direct impact of the tourist activity (the actual expenditure of the visitors) is taken into account, but not the indirect impact (the provision of goods and services to tourism companies) or the induced impact (on the labor market).

To estimate the impact of excursion tourists, the average expenditure in the destination is usually calculated, that is to say the same expenditure of the tourist except for accommodation. This practice is likely to overestimate actual spending for two reasons, because the average length of stay of hikers is lower than that of tourists, and the reduction in available time affects final spending. If excursion tourists had a similar spending pattern to tourists (domestic transport, food and drink, shopping and leisure activities), excursion tourists would have a direct expenditure of **€841 million.**

In the case of hikers, we have taken into account the motivation for travel according to the mobility survey. While we have kept both domestic transport spend and food and drink spend in all cases, we have only imputed expenses

commercial expenses for those journeys motivated by commercial activity and leisure expenses for similar reasons.
This implies a direct expenditure of **1,408 million euros.**

This allows us to identify a new indicator, which is the weight of direct tourism expenditure on the city's GDP, without considering indirect and induced impacts. These impacts require the calculation of a specific multiplier effect for the city of Barcelona, since the unique behavior of metropolitan tourism does not allow using the input output tables of the higher levels. According to this estimate, the direct expenditure of tourists in the city represents approximately 9% of the municipality's GDP, and if we include visitors the relative weight would be 10%.

INDICATOR 7. ECONOMIC DIMENSION OF DIRECT TOURIST EXPENDITURE WITHOUT TRANSPORT

% of tourism expenditure on GDP	7.78
Expenditure by hikers and tourists as % of GDP	8.75
% of visitor spending on GDP	10.36

The social impact

6. The perceived load capacity

We can determine that a natural space has reached its carrying capacity threshold when the number of visitors severely alters the ecosystem, compromises the viability of the fauna, generates pressure on the geophysical attributes, or even creates a demand of resources that the environment has difficulties in supplying. In closed, controlled spaces, with specific management objectives and precise governance, entry limit criteria can be formulated with relative objectivity. There is always an imprecise border between the descriptive, technical, carrying capacity components and the prescriptive components of the allocation, allowing pressure groups to call for changes to the capacity limits in the Medes Islands, Cap de Creus or in the gorges of Sadernes. In natural spaces, monumental spaces or historic centers of small dimensions, technical criteria (imprecise, debatable) can be established to set a maximum capacity, a load capacity. But when the scale is changed, when the limitation of complex spaces with strong activity and high densities is considered, efforts to set a maximum threshold of visitors have not yielded results. This is particularly evident in urban and metropolitan spaces, as in the case of Barcelona, because they are spaces designed and developed to tolerate high densities and a high pressure of users. For this reason, in the last decade, studies on carrying capacity have been reoriented to perceived carrying capacity. According to this criterion, there are no objective conditions that limit the load capacity of the space, but rather it is a subjective assessment. Various groups can consider that the number of tourists is tolerable or excessive, so it is the users' perception that allows the identification of the carrying capacity threshold. There are two ways to consider the perceived load capacity. The most common questions the residents and evaluates the way the locals interpret the impact of tourism. The second strategy studies the perception of visitors and their reaction to the presence of other tourists.

6.1. Residents' perception

The perception of residents is related to the pressure exerted by tourism on a series of factors, such as prices, access to housing, urban density, the typology of services or the relative weight of tourism on the commercial offer or the economic activities of the city. Tourism is also positively related because it is perceived as a source of income and jobs, because it allows to increase the offer of certain services (from the cultural offer to air connections) or because it gives an opportunity to cultural exchange and interaction with other cultural codes. As pressure on the destination increases, negative perceptions increase and positive assessments of the effects of tourism decrease. The intuitive idea about carrying capacity sets a theoretical threshold above which the perception that residents will have about tourism will be more negative than positive: The balance of assessment will have tipped.

Sharpley (2014) carried out an extensive review of the scientific literature on the perception of residents and came to the conclusion that this relationship number of tourists - perception is conditioned by many variables, extrinsic and intrinsic, that modify the perception of residents . The variables are the following:

- Product life cycle. As the destination enters a maturity phase, following the life cycle model, residents' perception tends to become more negative.

- Type of tourists. There is a correlation between the perception of residents (positive or negative) and the basic characteristics of tourists, with factors such as nationality or motivation.

- Density. The increase in the density of tourists in areas of high concentration negatively affects the perception of residents both of the area of high density and of the town as a whole.

- Seasonality. In periods of greater temporal concentration, residents have the most negative perceptions.

- Link with tourism. The relationship of the residents with the tourist activity directly conditions the perception they have of the impacts of tourism and also their evaluation of the tourists.

- Distance from the tourist area. Residents who are located in areas far from the largest tourist concentrations are less sensitive to the negative effects of tourism.

Almost all studies on residents' perceptions of carrying capacity are based on surveys of the local population. There are three major indicators that are part of perception studies:

- Indicator of overtourism. The questions ask residents about the feeling that the number of visitors is higher than desired, without assessing the effects that this overtourism can have on the life of the city. It can refer to the perception of the immediate geographical area (the neighborhood) or of the whole (the city). It is the most intuitive concept of social load capacity: The threshold is exceeded when residents consider the number of visitors to be excessive.

- Cost - benefit indicator. The respondent must carry out a contrast exercise between the benefits brought by tourism and its harms in order to place themselves on one of the two points of the scale. In this scenario, there is too much tourism when the negative effects or impacts of tourism predominate over the positive ones.

- Indicator of the effects of tourism. The third group of indicators studies the negative impacts perceived by tourism in a series of spatial areas such as access to housing, prices, the quality of the labor market, the density of the space, the noise, loss of identity or conflicts of use.

The city of Barcelona regularly carries out opinion polls for residents and users of the city. The barometer of Barcelona offers a historical series on the evolution of the problems affecting the city. Since 2015, in addition, the city collects the specific opinion of residents in the survey on the assessment of tourism.

6.1.1. The barometer of Barcelona

The Municipal Barometer of Barcelona provides a very wide range of residents' perception of the city. With a quarterly frequency, the survey collects the opinion on the situation of the city, the assessment of the municipal management or the intention to vote. There are three questions that help us see the evolution of the general perception of the city: (a) the perception of the evolution of the city *("In general, do you think that in the last year Barcelona has improved or gotten worse?");* (b) expectations about the city *("And, looking to the future, do you think Barcelona will improve or get worse?")* and the main problem of the city *("What do you consider to be the most serious problem facing the city at the moment ?").*

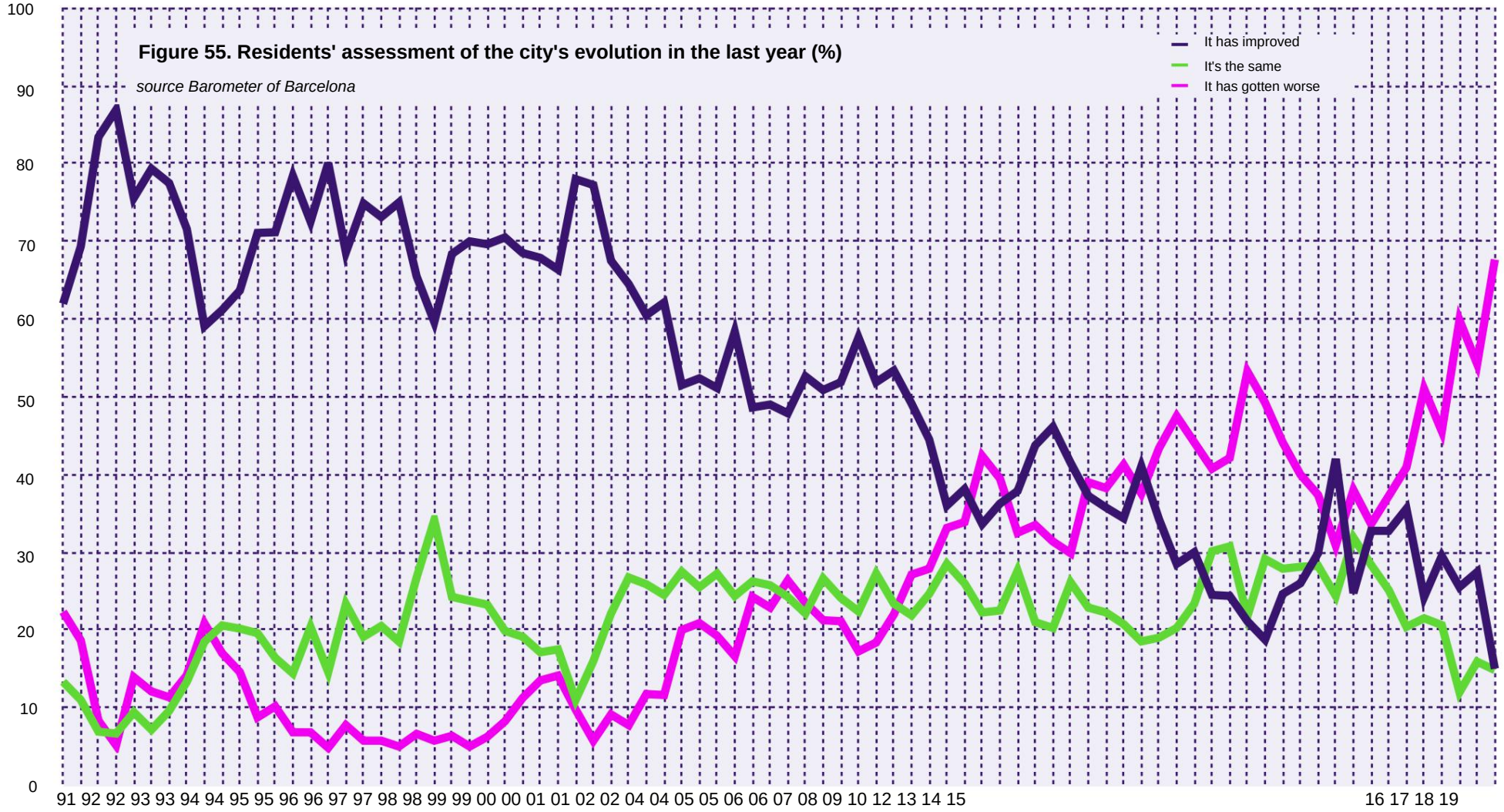
Figure 54 shows the temporal evolution of the perception of the question about the evolution of the city. Two periods are drawn very clearly with a turning point from 2004 and very clearly with the economic crisis of 2007. There there is, therefore, a post-Olympic city that maintains a positive view of the city's capacity and its evolution, which stops from 2004 (the year of the Forum), and from that moment the perception of the city enters into an assessment negative that remains until now with various variations. The evolution of the city's outlook is very similar and the graph shows a similar behavior.

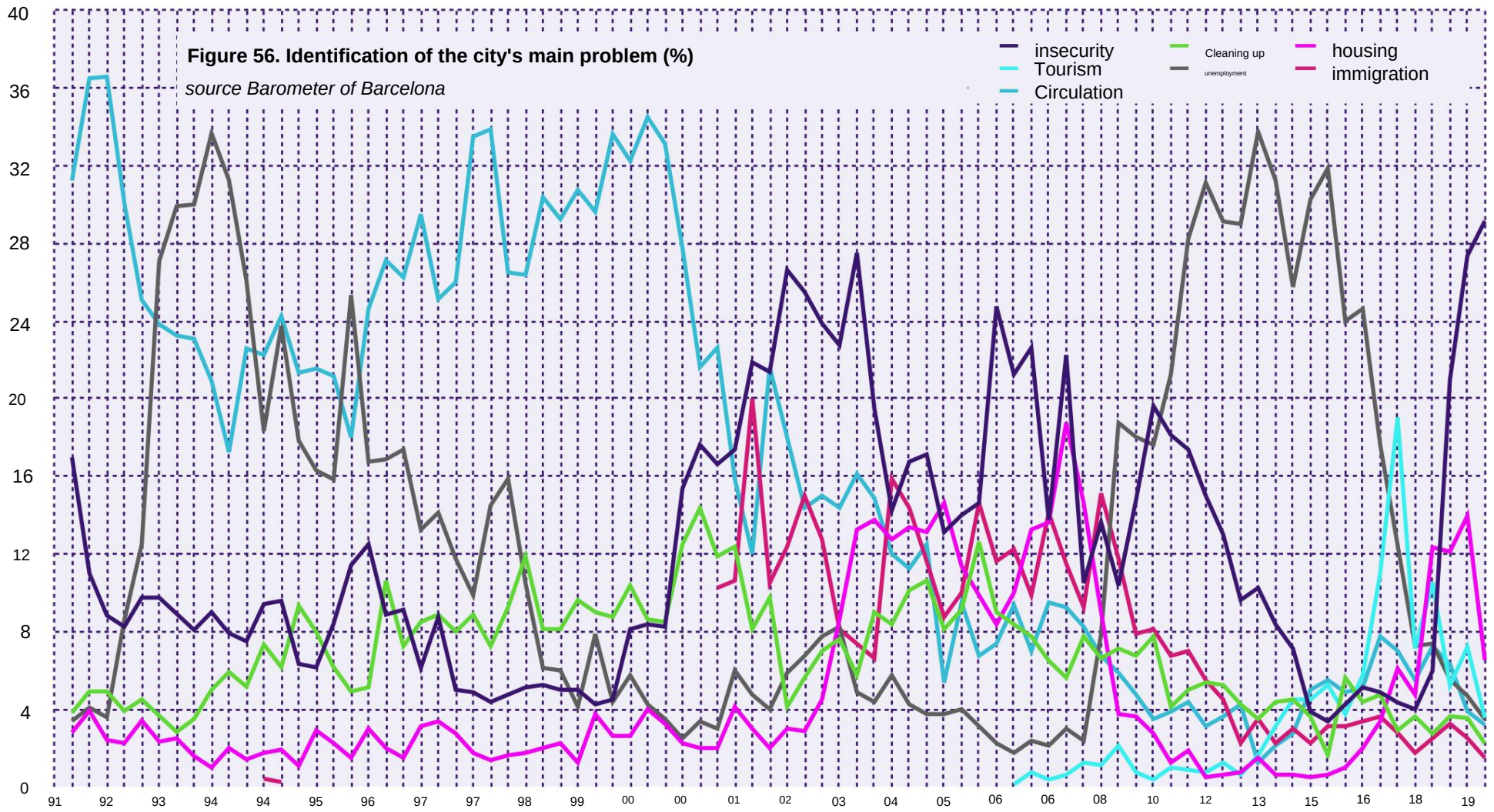
The third question of the barometer helps us to identify the main factors that explain disaffection with the city. It must be borne in mind that the question forces the interviewee to identify a problem; in moments of better perception of the city, this problem can be considered minor or secondary because the overall vision of the city is very positive, and, on the other hand, in the context of a negative perception, the main problem can be another factor of a set of dissatisfaction factors.
We have selected the most significant issues over the 20 years of the Barometer, which are represented in Figure 56.

The problems concerning the city have followed very different evolutions. In a first period, which coincides with the most positive vision of the city, the main problems are traffic and unemployment; little by little, the complaints about mobility subside and, instead, the labor issues will recover with the financial crisis. There are some problems that do not reach the rank of the big problems of the city, but which are mentioned repeatedly throughout the series, such as cleanliness or access to housing. And finally, there are problems that seem to have a conjunctural character because they appear suddenly, take on a very strong dimension and then diminish, and in some cases disappear.
For example, the problems arising from immigration had a very relevant appearance at the beginning of the century and a decade later their relative weight fell and has not again had a significant weight in the assessments.

Figure 55. Residents' assessment of the city's evolution in the last year (%)

source Barometer of Barcelona





Tourism seems to behave like these phenomena of strong occasional incidence. Table 72 shows the evolution of residents' perception by age group between 2005 and 2019; we have selected the data from the summer barometer (when the impact of tourism is most noticeable) except in those years when there is no June wave and we have opted for the nearest survey. In 2005, tourism is not on the agenda of the city's major problems: No age group mentions it. Its appearance is in 2006, when the debate on the effects of tourism begins to be presented, as it has been studied in Zerva et al. (2019). The onset of the tourism "problem" is initially very mild and has a residual value especially among the middle ages. Between 2006 and 2013, tourism was cited repeatedly among almost all age groups (with the notable exception of the oldest), but always with values between 1 and 3%.

It is from 2014 when the dimensions of the tourism problem reach a new level and it appears with remarkable records in all age groups, with the exception of the oldest. In 2016 the values double again among all age groups and reach a very high range especially among the youngest. This year it is already the second most important problem among people under the age of 25 and among those aged between 25 and 34. Values multiply again in 2017, when tourism becomes the city's main problem and exceeds the 25% threshold among the youngest. On the contrary, in 2018 the relative weight of tourism as a problem falls sharply and in 2019 (a record tourist year) tourism has reached a much lower value.

Table 72. Percentage of people who consider tourism to be the city's main problem by age group

	18 - 25	25 - 34	35 - 44	45 - 54	55 - 64	65 or +
2005						
2006		1.2	0.7	1.7	0.9	
2007		2.5	2.7	1.6		
2008	1.6	1.3	1.3	1.6	1.9	
2009	1.6	0.6	1.3		1.9	
2010	3.4	0.7	1.3	1.6		0.5
2011		2.1		0.8	1.9	
2012	1.7	1.4	1.3	2.3	0.9	
2013	1.8	1.5	1.9	1.5	3.7	0.5
2014	5.3	6.0	4.4	7.5	6.4	1.0
2015	5.6	5.1	4.3	10.2	3.2	4.0
2016	12.7	11.4	4.0	5.9	6.8	1.7
2017	26.4	31.9	17.0	20.2	15.5	12.8
2018	16.9	14.2	12.2	10.2	10.9	5.8
2019	11.3	6.6	8.0	7.6	8.1	5.2

The marked cells show those cases where tourism is the maximum value
Source: Department of Opinion Studies. city Hall of Barcelona

There are other factors that are related to the tourist impact and that are also collected in the barometer: overcrowding, access to housing and the city model. Figure 57 shows the evolution of these three factors together with tourism.

- Access to housing is a structural problem of the city and appears recurrently in all the barometers in the series, and in all major European cities throughout this century. The factors that explain housing problems are multiple and tourism is another factor that alters the housing access market. The most common is that the housing problem is in a range between 4% and 8%. There are two very significant exceptions: One is the period between 2003 and 2008, which is the period in which, for the first time, negative perceptions of the city exceeded positive ones. After a period of reduction of the problem, from 2015 this trend is recovered and the assessment soars, so that in 2019 it is perceived as the main problem of the city.

- There is a second problem, which is overcrowding and the perception that the city has an excess of activity. We have seen that this overcrowding is the result of the coexistence of many city users (commuters, metropolitans, tourists, hikers...), but we tend to associate this problem with overtourism. The perception of overcrowding has remained almost basal throughout the series, between 2% and 4%, and it would seem logical that it would have a greater incidence in those spaces most affected by high densities.

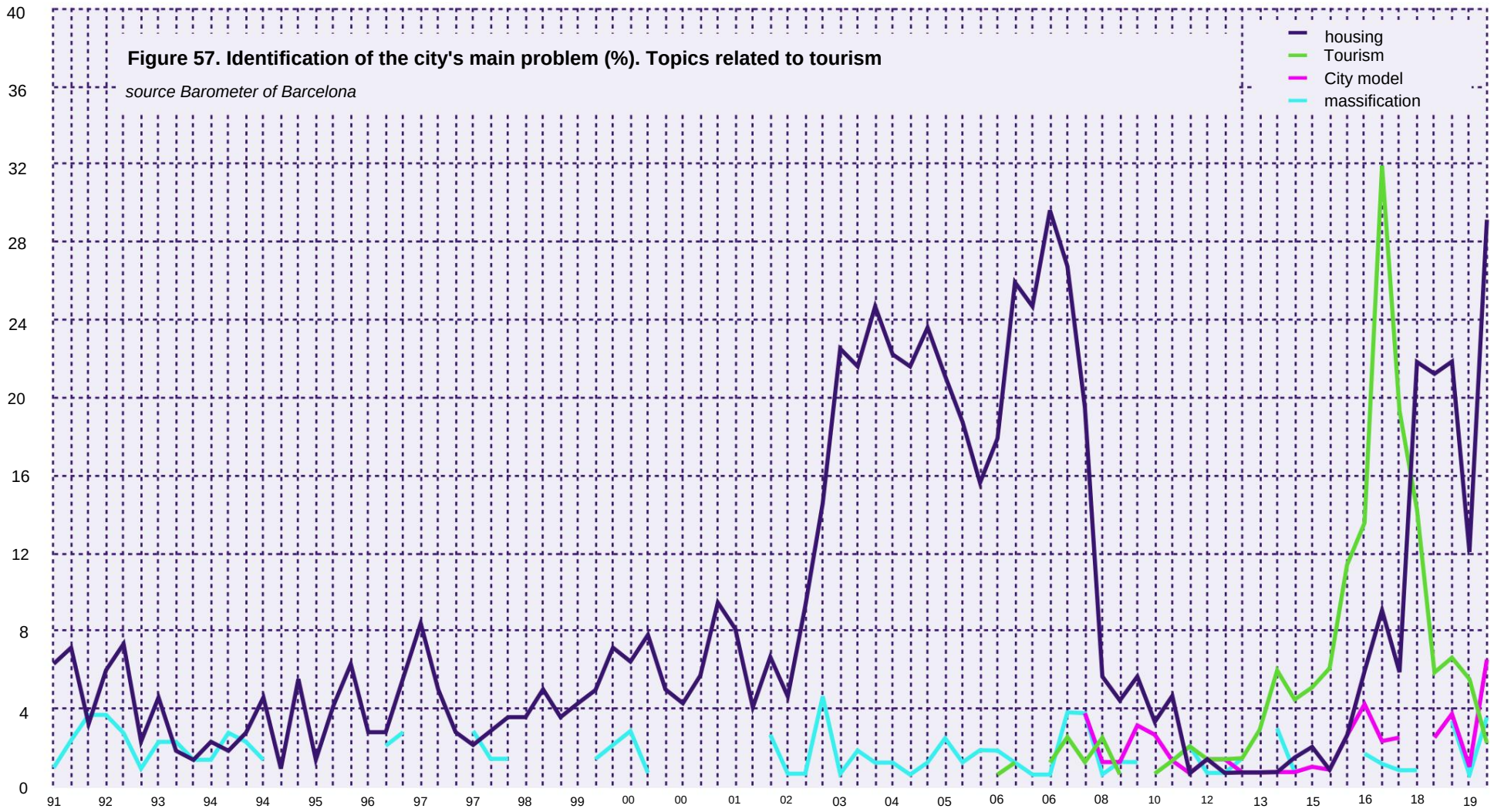
- The third problem that is related to the impact of tourism is the city model. Again, the factors that explain the perception of a problem with the city model are multiple and the weight of tourism is only a partial explanation of a complex perception.
  In any case, the relative weight of this perception appeared in 2008 and has remained stable with a significant increase in the last record.

The Barcelona Barometer highlights three very relevant ideas about the perception of tourism in the city:

1. Firstly, tourism has not been perceived as a problem until the last 15 years, first very discreetly and from 2015 with great intensity.

2. There is no causal relationship between the evolution of tourism and the behavior of the perception of tourism. There is no model that can relate the evolution of the number of tourists (and its effect) to public perception. In fact, 2019 was a record year and instead the negative perception of tourism declined significantly. Perceptions are complex systems that are logically connected to reality and social processes, but are also related to value systems, narratives, and power groups.

3. If we consider the various factors that are explained (partially or totally) by tourism, in recent years there has been an increase in the negative perception related to access to housing, the city model or overcrowding, which compensate the reduction of the negative perception about tourism.



6.1.2. Perception of tourism in Barcelona

Barcelona City Council has been carrying out a regular survey on the opinion of residents on tourism since 2007. This allows for a very long series on the evolution of citizens' perception of tourism and its relationship with tourism indicators. The first surveys were carried out with a discrete sample (400 telephone interviews), in three waves, which did not allow the results to be analyzed disaggregated by district or neighborhood. As of 2015, the sample is significantly expanded, so that the unique behaviors of the residents of each district of the city can be analyzed. On the other hand, the questionnaire has also been expanded, so in the last waves the diversity of the information is very wide. There are a number of questions that have remained from the initial surveys and this provides a record of the evolution of residents' perceptions.

a. Stock

A first way to approach the assessment made by residents on the tourist impact is the result of the balance between costs and benefits. Specifically, question 2 of the perception survey is:

"Is tourism rather beneficial for Barcelona or rather harmful?"

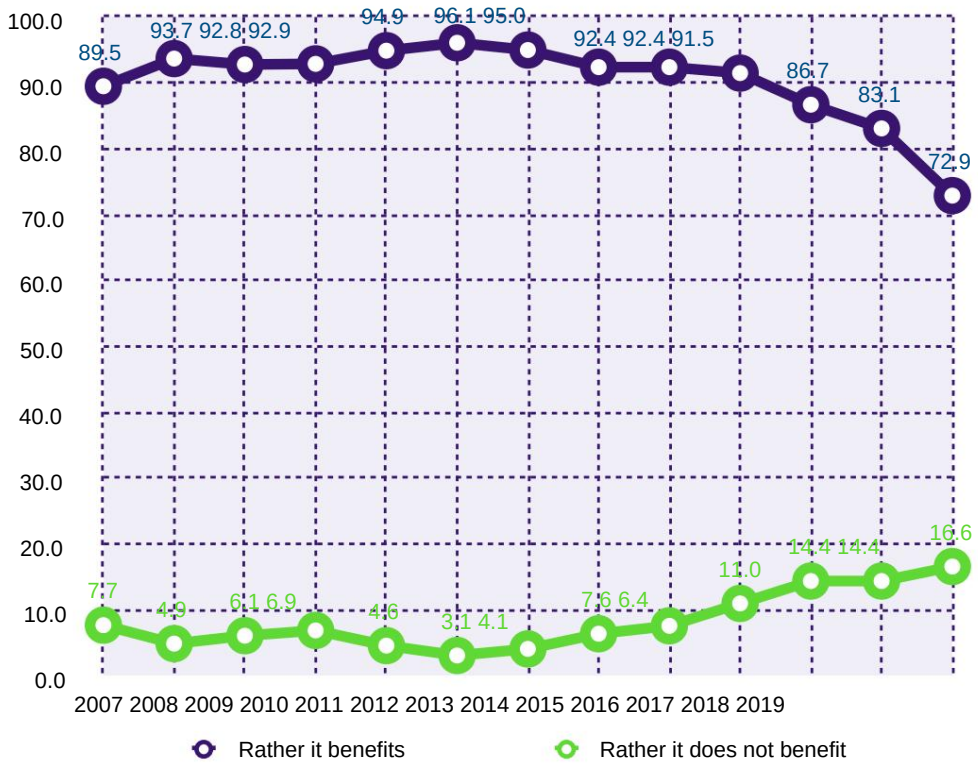
In 2019, a methodological modification was made, which rectifies the bias of the previous question, which was:

"Do you think that tourism is beneficial for Barcelona?"

Figure 58 shows the evolution of the question about the tourism balance according to the residents' perspective. There are two very obvious conclusions. The first is that the residents of Barcelona value that the balance between the negative impacts of tourism and the positive impacts is tipped in favor of the latter. For every citizen of Barcelona who makes a negative assessment, there are almost 4.5 who make a positive reading. The second reading is that in recent years the degree of disaffection has grown very obviously. For every resident of the city who had a negative balance in 2013, there were 4 in 2019. This evolution coincides with the previous point, when we detected the appearance of tourism on the agenda of the city's problems. However, this value fell in 2019, while it is the year in which the percentage of residents with a negative balance has increased the most; this reinforces the idea that in 2019 access to housing displaced tourism as the main problem, but residents partly blame tourism for this situation.

The balance is a very important factor because several authors (Andereck, et al.: 2005; Janusz K, Six S, Vanneste D.: 2017) have shown that there is a direct relationship between the cost-benefit analysis and the valuation overall on the effect of tourism on the perception of residents.

Figure 58. Evolution of the balance of tourism by residents (%)



Source: Tourism perception survey

Not all spaces react in the same way. Table 73 shows the percentage of residents in each district of the city who consider tourism to be rather beneficial. The lowest values are given in the districts that have a higher tourist density and, conversely, the districts with a more favorable opinion are those that have less tourist pressure. This relationship is well documented in the scientific literature and in studies on the perception of residents

Table 73. Distribution of tourism assessment by district

He considers that tourism is rather beneficial for Barcelona	
Old City	64.9
extension	69.3
Sants - Montjuïc	71.7
The Courts	75.2
Sarrià Sant Gervasi	77.4
grace	55.9
Horta Guinardó	75.9
New Neighborhoods	85.6
Saint Andrew	74.3
Saint Martin	74.5
average	72.9

Source: Tourism perception survey

b. Load capacity

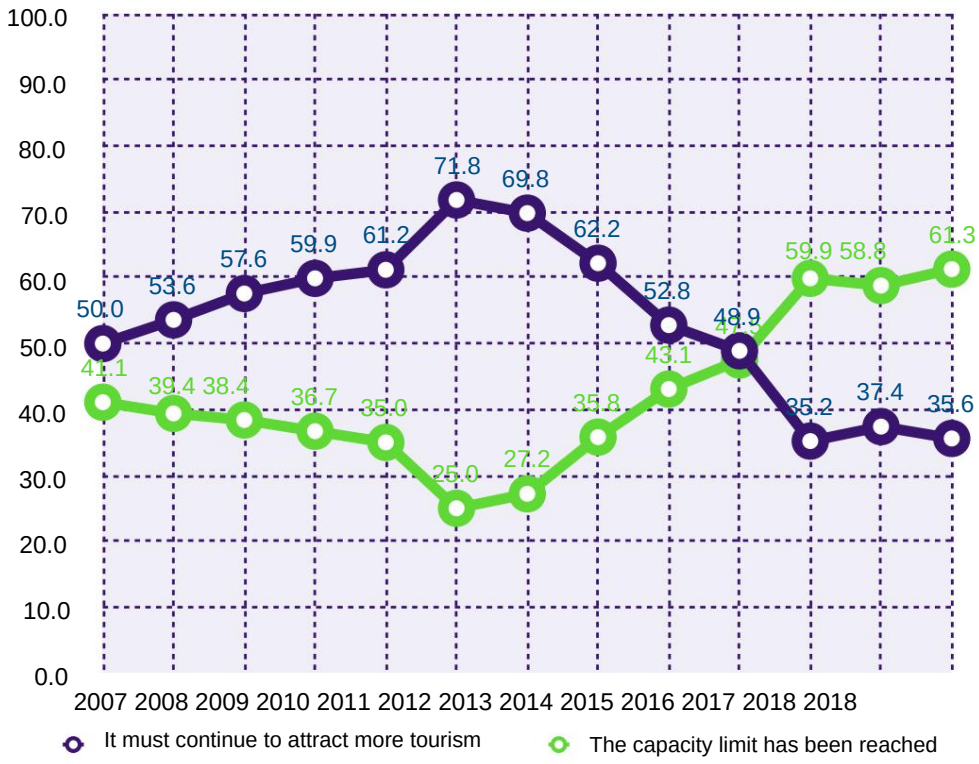
The second question that allows us to analyze the opinion of visitors is an explicit formulation about the load capacity. Specifically, residents are asked the following:

Which of these two opinions do you agree with the most?

a) Barcelona must continue to attract more tourism b) Barcelona is reaching or has reached the limit in the capacity to serve tourism"

Figure 59 shows the evolution of citizens' perception of the city's tourist carrying capacity. The starting point is very surprising: In 2007, when the city welcomed about 7 million tourists (less than half of those it receives in 2019), more than 40% of residents considered that the city had reached the threshold of capacity load From that date, the relative weight of residents who admitted the possibility of tourism growth climbed until 2012, when the maximum of the series was reached: At that time, almost three out of four residents considered that the city could absorb more demand. From this point, the situation has been reversed and in 2016 the supporters of stopping growth practically coincide with the supporters of increasing the number of tourists. In 2019, the relative weight of people who believe that the maximum tourist threshold has been reached exceeds 60%, the historical maximum of the series. Therefore, most residents believe that the city can no longer grow touristically, that it has reached the threshold of its carrying capacity.

Figure 59. Evolution of the perception of the carrying capacity of tourism by residents



Source: Tourism perception survey

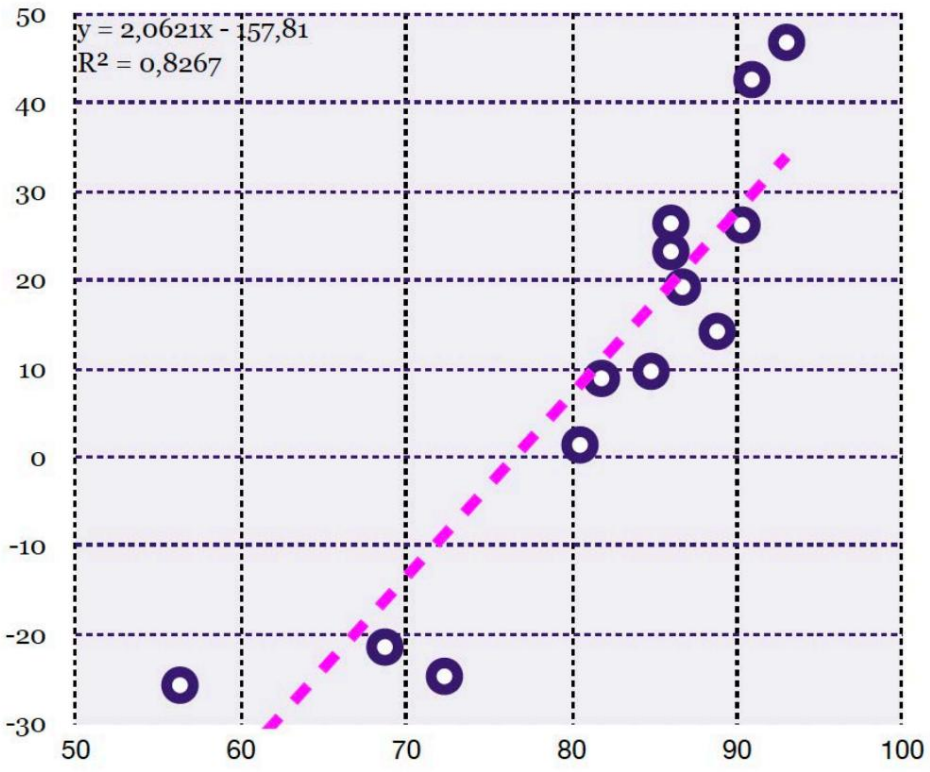
Usually, the criterion of Shelby and Heberlein (1987) is used according to which the saturation threshold has been reached when two thirds of the population detect that the maximum possible growth has been reached. This threshold has been criticized for its arbitrariness, but despite everything it has been widely used for example by Klanjšÿek et al.: 2018; Navarro et al.: 2012 or Zhang, Li and Su, 2017. If we used this threshold, the city of Barcelona would be at the limit of its carrying capacity.

The opinion about the limits of tourism varies due to the effect of two variables, which coincide with those detected in other similar studies. First, people who work in the tourism sector have a significantly higher percentage of supporters of attracting more tourism (42.4%) than those who do not work in the sector (34.2%) or do not work (35, 2%). Secondly, residents in districts with greater tourism pressure are much less in favor of expanding the number of tourists than those who live in areas without tourist activity.
The districts with the least predisposition are Gràcia (24.4%), Ciutat Vella (31.2%), Sant Martí (32.8%) and Eixample (33.5%), which are the four districts with the most tourist activity; on the contrary, the districts most in favor of increasing the number of visitors are Nou Barris (52.5%), Sants Montjuïc (37.7%), Les Corts (36.7%) and Horta Guinardó (35%).

There is a direct relationship between the two variables: As the balance on the benefits of tourism is more unfavorable, the idea that the carrying capacity threshold has been reached increases, which is a relationship detected in most of studies on the social load capacity. Figure 60 relates the difference between those who believe that tourism benefits the city and those who believe that it rather harms it (x) with the difference between those who believe that the city can welcome more visitors and those who believe that the city has reached its maximum threshold (y); when the value of y is negative it means that people who believe that the carrying capacity threshold has been reached exceed those who believe that more visitors can be accommodated. The relationship between the two variables is linear, with an R2 coefficient of 0.827 which shows the high relationship between them. The line that best explains the cloud of points is y = -157.81. 2.062x. This means that each point of difference in the balance affects two points in the perception of the load capacity.

Conversely, there is no variable that can explain the evolution of the number of tourists and the balance or the perception of carrying capacity. Until 2012, the increase in tourists generated a more favorable balance and an increase in the perception of the carrying capacity; from 2013, new tourists generate the reverse effect, but without being able to identify a statistically significant relationship between these two processes

Figure 60 Relationship between the balance difference (x) and the load capacity difference (y)



x. Diferència entre els qui creuen que el turisme aporta beneficis i els qui consideren que genera perjudicis
y. Diferència entre els qui creuen que la ciutat pot acollir més visitants i els qui creuen que s'ha arribat al llindar. El valor és negatiu si predominen els segons.

c. Impacts of tourism

The survey on the perception of tourism makes it possible to identify the positive and negative impacts. The positive effects have been identified belong to those residents who believe that the balance of tourism is positive, while the negative effects belong to those residents who decant the balance on the side of harm. This means that there are many more answers in the first case than in the second, and surely the question should be universal to broaden the perspective on tourism valuation.

Figure 61 shows the results for the 2019 survey. We could group the responses into four broad categories:

- **Massification (37.2%).** Massification is a concept linked to density and exceeding carrying capacity. The majority link tourism with generic overcrowding and 3.4% specify the excess supply of accommodation.

- **Tourist practices (32.1%).** The answers focus on tourism habits and incivility. 12% denounce the low quality of tourism (low cost). Those who denounce the types of tourists and their practices criticize more the tourist profile that, according to their vision, arrives in Barcelona than the tourist activity. Rather than limiting the number of tourists, they seem to propose a change in the type of tourists.

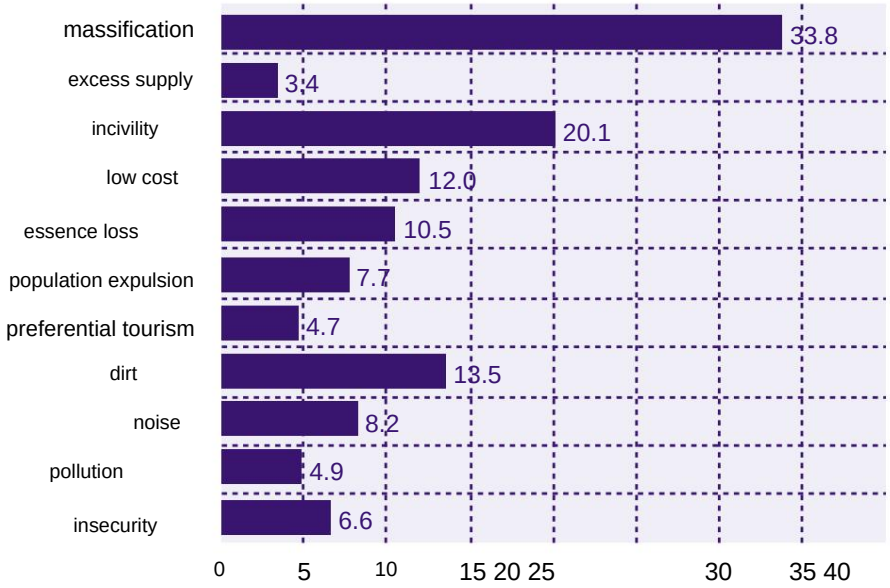
- **Identity crisis (23.9%).** These answers focus on the cultural impact of tourism, especially on the loss of the city and its neighborhoods. Part of the answers focus on "la

loss of essence", another alludes to gentrification processes and a third group of answers consider that the interests of tourists prevail over those of residents. In this case, the answer is not only to limit the number of tourists but to alter the pre-eminence of tourism over the needs of residents.

- **Aggravation of structural problems (27.2%).** The last group of answers focus on those structural problems of metropolitan spaces motivated by congestion and the concentration of activities. Tourism would not be directly responsible for these problems, but would aggravate a structural problem: noise, pollution, insecurity or dirt (which can also be considered bad tourism practice). In this case, the answer could be the limitation of tourism or better management of the negative effects linked to overtourism (more cleaning, more security, greater control of noise points, regulation of pollution).

Apart from this question addressed to those who think that the harms of tourism outweigh the benefits, there is an explicit question about the effect of tourism on inflation and city prices. In 2019, 82% of residents consider that tourism has a direct effect on prices, especially in the field of leisure and culture (47.8%) and rental and housing prices (45.8%) .

Figure 61. Main negative effects of tourism according to residents



Source: Tourism perception survey

6.1. The perception of tourists

In recent years, studies have multiplied on the perception that tourists have of the destination and the effect of overcrowding on their assessment of the visit. The results show a relative tolerance of tourists to tourist density and a different response to congestion according to tourist profiles. The survey on the profile and habits of the tourist allows us to see the evolution of the general assessment that visitors make of the city. Figure 62 shows that tourists have always been in a bracket between 8 and 9, with the exception of the years 2008 and 2009, when the assessment levels were below 8. These are the two years connected with the economic crisis, which affected both the city's ability to offer quality tourist services and the mood of visitors. Seen in perspective, the assessment made by visitors to the destination has increased by more than half a point and has reached its historical maximum in the last three years, with an assessment very close to 9.

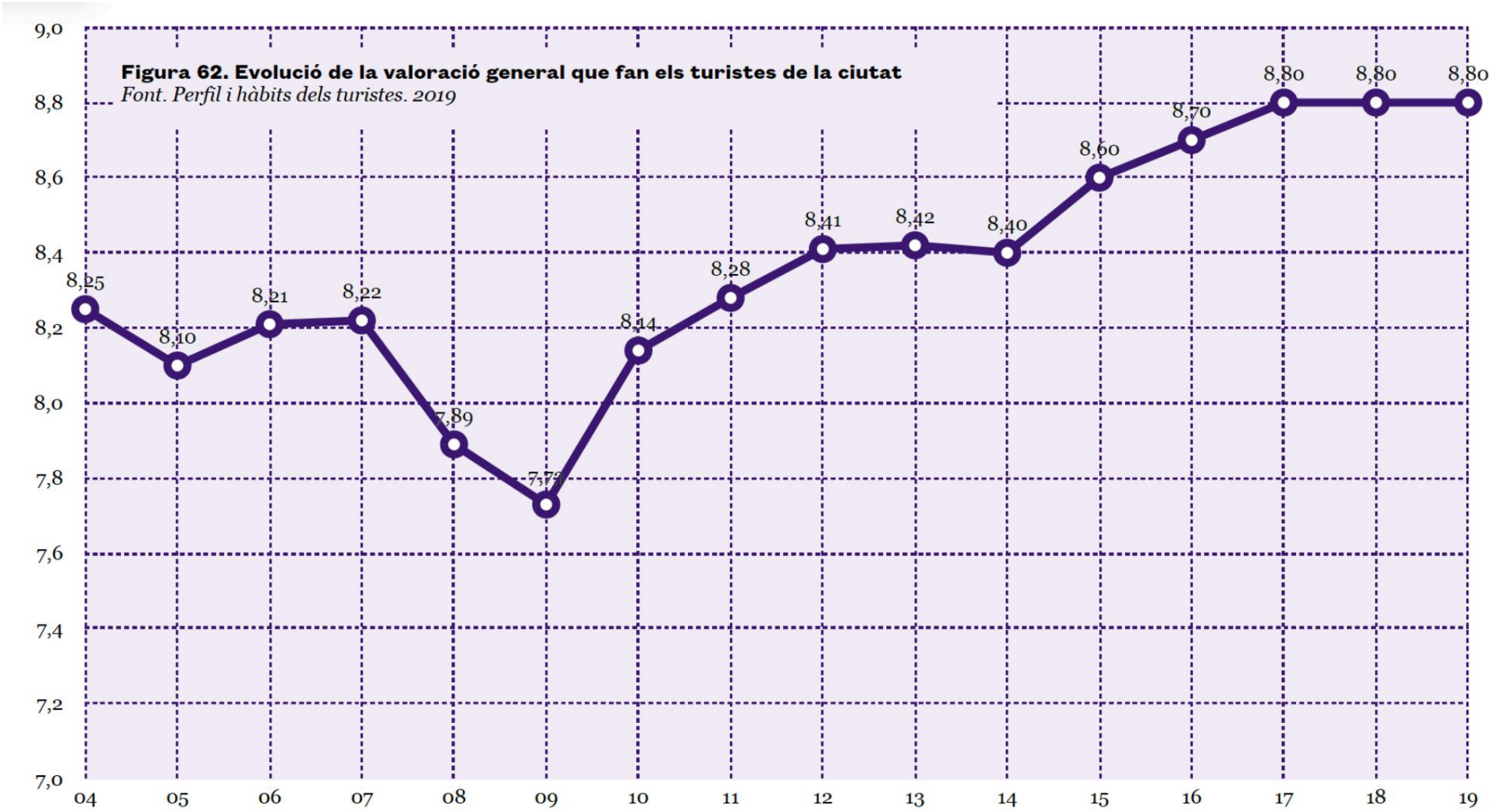
There is, therefore, a very different trajectory between the citizen's assessment of the city, which has fallen significantly since 2004, and the tourists' assessment of the city, which has conversely increased during the same period. Indeed, the success of the destination
Barcelona can be explained, among other factors, by the good assessment made by visitors and which is disseminated through social networks, as demonstrated by the study on the tourist reputation of the city online, published in 2018 (Barcelona City Council, 2018).

Since 2015, a series of questions has been incorporated on the perception that tourists have of high densities and high prices, which would have a correspondence with the two main problems detected by residents: overcrowding and inflation. Specifically, the survey asks visitors about their degree of agreement with these two statements (What is their degree of agreement with each of the following statements based on whether or not they fit the city of Barcelona?):

"There are too many people for sightseeing"

"The prices are too high for the quality"

In the first case, although the concept of "too many people" can be equated with the idea of saturation or high density, the question makes explicit the sightseeing, that is, the attractions of the city. It may be that visitors detect too many tourists in the main sights of Barcelona, but that their overall experience (restaurants, open spaces, accommodation, night peak...) is not so conditioned by this concentration. As for the price question, it establishes the relationship between price and perceived quality, as is usual for this type of question.



Figures 63.1. and 63.2 show the evolution of the answers to the two questions raised.

Tourists consider from the beginning of the series that the number of tourists is excessive. The highest value was given in 2015, when the respondents who showed their agreement with the statement reached practically 60% and those who disagreed represented only 27%. This difference has narrowed significantly in recent years and in 2019, those who consider that the city has too many tourists are below 50%. Even so, it is the majority group and is, therefore, the majority opinion among tourists in Barcelona. We could consider that most tourists perceive that the city has exceeded its carrying capacity because the densities are too high. However, this perception does not influence their assessment of the city which continues to be very positive and which has reached its historical maximum during the year of study, 2019.

Conversely, tourists do not perceive that the city has a higher price level than the service provided. In the first year alone, in 2015, people who agreed with the statement outnumbered those who were against it. But in the rest of the records, the number of people who disagree is higher. In 2019, only 35% of tourists agreed with this statement. Therefore, from this source we can consider that tourists have a very positive overall assessment of the city, that they do not perceive an impact of tourism on the level of tourist prices and that, on the contrary, they do consider that the number of tourists is excessive and that this high density makes tourism difficult.

This allows us to have the last five measurement indicators related to the perception of residents and tourists.

INDICATOR 8. EVALUATION OF RESIDENTS AND TOURISTS

% of residents who consider that in the last year the city has gotten worse	67.65
% of residents who consider tourism to be the city's main problem	3.56
% of residents who consider that tourism generates more harm than good	16.60
% of residents who consider that the city has reached the limit of its tourist carrying capacity	61.30
Global assessment of tourists	8.80
% of tourists who think the city has too many tourists for sightseeing	49.50

Figura 63.1. Resposta dels turistes a l'afirmació *"Hi ha massa gent per fer visites turístiques"*

Font. Perfil i hàbits dels turistes. 2019

Figura 63.2. Resposta dels turistes a l'afirmació *"Els preus són massa elevats en relació a la qualitat"*

Font. Perfil i hàbits dels turistes. 2019

LCA

synthesis

1. Carrying capacity studies call into question the possibility of fixing with a 'magic number' the growth capacity of a tourist space, especially in cities because they are spaces accustomed to high densities.

2. This study proposes the alternative of the Limit of Acceptable Change, as a tool for making decisions about the changes that the city is willing to undertake taking into account the variations in the number of tourists. To set this limit, it is first necessary to know what the effects would be on the control indicators of the proposed scenarios.

3. The study is based on the year 2019, because it is the last year before the pandemic. The covid-19 has affected mobility and in recent years all variations have to incorporate into the equation the exceptional fact of the restriction of mobility due to the disease. We still don't know the structural effects of covid, but the first symptoms point to a reduced impact.

4. In 2019, Barcelona welcomed 17.3 million national and international tourists. A part of these tourists is clearly identified and recorded in the tourist registers, but another (unregulated HUTs, private houses...) is not part of the official statistics and its real volume must be estimated. There is, therefore, a margin of uncertainty in the definition of the volume of visitors.

5. We estimated around 10.5 million excursion tourists in the city of Barcelona, which are those tourists who do not spend the night in the municipality This typology is made up of three categories: Metropolitan tourists are those who are staying in the Metropolitan Area of Barcelona and carry out all their activities in Barcelona (2.4 million). The most numerous is the group of excursion tourists, who come from other tourist brands and make a one-off visit to the city (6.3 million). Excursion cruisers are cruisers who do not stay overnight in the city (1.7 million).

6. The calculation of hikers is based on the UNWTO criterion: Visitors outside the usual environment who do not stay overnight. We have delimited the usual environment with the Metropolitan Area of Barcelona and have considered all personal motivations, and not just leisure, in the same way as is done with tourism. With this criterion, Barcelona welcomes around 29 million hikers annually, which is by far the most important group.

7. We have considered the day criterion and not the overnight criterion, which is what has been commonly used. A day is the number of nights plus 1, because it includes the day of departure, which is part of the tourist stay. This significantly increases the number of tourist stays in the city in relation to overnight stays. As a whole, tourists make 62 million days. Every day there are an average of 171,000 tourists in the city.

8. Every day there are also about 79,000 hikers and about 29,000 hiking tourists. The city welcomes an average of 280,000 visitors per day, of which 80,000 are hikers,

residents of Catalonia who visit the city for personal reasons.

9. Barcelona is a small municipality, which greatly increases the pressure on space by its users. As a whole, the city has a density of 1,700 tourists per square kilometer, which approaches 2,000 if we consider both tourists and excursion tourists. The group of visitors (the previous two plus hikers) have a density of 2,750 individuals per square kilometer on average. If we use the 80th percentile criterion (the highest value if we do not consider the extremes), the density of tourists is 2,400 and that of visitors 3,200 in the city as a whole.

10. On an average day, there are 6.4% of tourists in the city; the rest of the city's users are other forms of visitors, residents, commuters or metropolitans. If we include excursion tourists, they represent 7.5% of the city's users and 10.4% if we take all visitors. The 80th percentile of the relative weight of tourists in the city is 9.1% and visitors is 12%.

11. Tourism in Barcelona is extremely concentrated in a few districts. 60% of tourists are located in Ciutat Vella and the Eixample, which have a very high density, 60,000 and 50,000 tourists per square kilometer on average. On average, 30% of the time tourists are in the secondary districts, which are absorbing part of the new tourism movements in the city: Sants Montjuïc, Gràcia and especially Sant Martí.

12. In Ciutat Vella, tourists are a very high part of the number of users in the district. On an average day, almost 30% of the people in this space are tourists (a third if we take the 80th percentile). In the Eixample, which has a similar tourist density, tourists represent 10% of the total number of users (12% in the 80th percentile). The density is similar but the relative weight of tourists in the Eixample is diluted by the strong presence of the rest of the city's users who occupy it en masse, while in Ciutat Vella tourists predominate, who are at times the main users of the space. It could be said that tourist activity has displaced part of the urban uses in Ciutat Vella, while the Eixample maintains its capacity to attract.

13. Tourism is a large consumer of water, which is concentrated in the hotel, but which also affects areas with high traffic or restaurants. Tourism demands 15% of the city's water consumption, well above its relative weight, with around 15 million cubic meters. If Barcelona had a behavior similar to that of Valencia, this direct consumption would represent 14%, so the water footprint of tourism would approach 700 cubic hectometres.

14. The energy consumption of tourists is similar to their relative weight in the city. Tourists consume 6.6% of the municipality's final energy. Although accommodation establishments have a high energy consumption (especially the higher categories), tourist activity does not require large energy contributions and mobility is essentially active or with very low means

emissions Excursion tourists have a very small impact in relation to their volume (0.6%).

15. It is very difficult to estimate the impact of tourism on the generation of urban solid waste. Following the method of the Study on the environmental externalities of tourism (which has been the guide for the environmental footprint chapter), in 2019 tourism could have generated 10% of the city's MSW, well above its relative weight . 1

16. The main environmental impact of tourism is emissions, especially emissions derived from accessibility. If we use the criterion of imputing the GHG emissions generated during travel to the destination, international tourism would be responsible for 8.6 million tons of CO2 equivalent, cruises would generate 2.9 million, and tourists from Spain as a whole would emit 172,000 tons. Barcelona's tourist model is characterized by its international projection and especially by the high weight of long distances, which are responsible for a very high volume of emissions. Global emissions from tourism are three times higher than emissions from the city as a whole.

17. Travel represents 96.7% of emissions if we do not consider cruises and 97.5% if we consider them. Emissions per tourist are 436 kg per tourist and 166 kg per person per day. If we do not consider the trip, the emissions of a tourist are 10 Kgs. of CO2 equivalent.

18. The direct expenditure of tourists can be estimated at around 6,800 million euros, i.e. 7.8% of the city's GDP in 2019, which reaches 8.7% if we also consider excursion tourists and 10.3% if we include hikers.

19. Tourism has lost weight as the city's main problem, because it has been displaced by other problems that can partially be explained by tourism (overcrowding, access to housing...). On the contrary, in recent years the number of tourists who consider that the harms outweigh the benefits of tourism has increased.
In 2019, 61% of residents believe the city has reached its carrying capacity threshold, which is the threshold commonly used to define the upper limit. There is no relationship. statistics between the evolution of tourism and the evolution of tourism valuation.

20. The overall assessment made by tourists of the city remains at very high levels, which have grown in recent years. However, close to half of tourists believe that there are too many tourists.

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