Technology
Arts Sciences
TH Köln

UNIVERSIDAD AUTÓNOMA DE SAN LUIS POTOSÍ
FACULTADES DE CIENCIAS QUÍMICAS, INGENIERÍA, MEDICINA
Y CIENCIAS SOCIALES Y HUMANIDADES
PROGRAMA MULTIDISCIPLINARIO DE POSGRADO EN CIENCIAS AMBIENTALES
AND
TH KÖLN - UNIVERSITY OF APPLIED SCIENCES
INSTITUTE FOR TECHNOLOGY AND RESOURCES MANAGEMENT IN THE TROPICS AND SUBTROPICS

TOURISM CARRYING CAPACITY AS AN INSTRUMENT FOR LOCAL SUSTAINABLE DEVELOPMENT IN PEÑA DE BERNAL, QUERÉTARO

THESIS TO OBTAIN THE DEGREE OF
MAESTRÍA EN CIENCIAS AMBIENTALES
DEGREE AWARDED BY UNIVERSIDAD AUTÓNOMA DE SAN LUIS POTOSÍ
AND
MASTER OF SCIENCE
NATURAL RESOURCES MANAGEMENT AND DEVELOPMENT
DEGREE AWARDED BY TH KÖLN – UNIVERSITY OF APPLIED SCIENCES

PRESENTS:

NATHALIE ALEJANDRA SUÁREZ FLORES

CO-DIRECTOR OF THESIS PMPCA
DR. VALENTE VÁZQUEZ SOLÍS
CO-DIRECTOR OF THESIS ITT
PROF. DR. JOHANNES HAMHABER
ASSESSOR:
DR. ÁLVARO GERARDO PALACIO APONTE

COLOGNE, GERMANY AUGUST 11th, 2019

PROYECTO FINANCIADO POR:
DEUTSCHER AKADEMISCHER AUSTAUSCH DIENTS (DAAD)
GERMAN ACADEMIC EXCHANGE SERVICE
FUNDING PROGRAMME: DEVELOPMENT-RELATED POSTGRADUTE COURSES 2017
COD: 57252260

PROYECTO REALIZADO EN:
ITT & PMPCA

INSTITUTE FOR TECHNOLOGY AND RESOURCES MANAGEMENT IN THE TROPICS AND SUBTROPICS

TECHNISCHE HOSCHULE KÖLN

FACULTAD DE CIENCIAS SOCIALES Y HUMANIDADES

UNIVERSIDAD AUTÓNOMA DE SAN LUIS POTOSÍ

CON EL APOYO DE:

DEUTSCHER AKADEMISCHER AUSTAUSCH DIENST (DAAD)

LA MAESTRÍA EN CIENCIAS AMBIENTALES RECIBE APOYO A TRAVÉS DEL PROGRAMA NACIONAL DE POSGRADOS

(PNPC - CONACYT)

Erklärung / *Declaración*

Name / *Nombre*: Nathalie Alejandra Suárez Flores

Matrikel-Nr. / *N° de matrícula*: 11124627 **(TH Köln), 286431 (UASLP)**

Ich versichere wahrheitsgemäß, dass ich die vorliegende Masterarbeit selbstständig verfasst und keine anderen als die von mir angegebenen Quellen und Hilfsmittel benutzt habe. Alle Stellen, die wörtlich oder sinngemäß aus veröffentlichten und nicht veröffentlichten Schriften entnommen sind, sind als solche kenntlich gemacht.

Aseguro que yo redacté la presente tesis de maestría independientemente y no use referencias ni medios auxiliares a parte de los indicados. Todas las partes, que están referidas a escritos o a textos publicados o no publicados son reconocidas como tales.

Die Arbeit ist in gleicher oder ähnlicher Form noch nicht als Prüfungsarbeit eingereicht worden.

Hasta la fecha, un trabajo como éste o similar no ha sido entregado como trabajo de tesis.

Köln /San Luis Potosí, den /*el* 11.08.2019

Unterschrift / *Firma*: 

Ich erkläre mich mit einer späteren Veröffentlichung meiner Masterarbeit sowohl auszugsweise, als auch Gesamtwerk in der Institutsreihe oder zu Darstellungszwecken im Rahmen der Öffentlichkeitsarbeit des Institutes einverstanden.

Estoy de acuerdo con una publicación posterior de mi tesis de maestría en forma completa o parcial por las instituciones con la intención de exponerlos en el contexto del trabajo investigación de las mismas.

Unterschrift / Firma: 

Acknowledgement

This thesis work is a result of the effort and support from many people in my life who have been encouraging me during this process. I would like to extend my sincere thanks to all of them.

To my family, especially to my parents and sister in Ecuador who have been with me in the distance since the beginning of my master until today. Thanks for standing unconditional and for helping me to achieve another goal in my life.

To Gustavo, for being my partner in these two years of adventures, for all your patience and effort and time invested in this process. You have been my pillar, force, and inspiration.

To my best friend Ana, for all the amazing moments, changes and surprises shared together in this stage of our lives. I am sure that we will keep conquering new challenges side to side.

To my teachers and directors, Dr. Johannes Hamhaber, Dr. Valente Vázquez Solís, and Dr. Álvaro Palacio Aponte. Thanks for all the insightful comments and dedication to making this study possible.

To the DAAD German Academic Exchange Service, for the opportunity to study abroad, which allowed me to expand my universe and look after new professional and personal experiences outside my country boundaries.

To my colleagues from the ENREM generation 2017-2019, who represent a fraternity of diverse countries and ideologies looking for one common goal: making this world a better place to live. Thanks for all the good moments, true friendship and love, it has been wonderful to have you as a second international family which I am sure will last beyond distance and time.

To all my new friends in Germany and Mexico. I will never forget you. To life.

ABSTRACT

Mexico has been positioned as one of the main tourist destinations worldwide, thanks to its vast natural and cultural diversity. One of the most exploited resources in this field is the cultural tourism, given that a large number of visitors are interested in knowing Mexican ancestral heritage. In this context, the Pueblos Mágicos stand out, so-called due to their symbolic attributes and history.

Referring to the Pueblo Mágico of San Sebastián Bernal, it has excellent tourist relevance given its privileged position in the middle of the touristic product called the Cheese and Wine route. Moreover, the village has been recognized for its geographical peculiarity thanks to the presence of Peña de Bernal, a monolith of 2,510 AMSL considered as a Natural Protected Area and declared as a Cultural Heritage of Humanity. The elevation attracts the attention of national and international tourists who are interested in experiencing its natural and cultural manifestations, memories and living traditions of past civilizations.

In this context, tourism in Bernal emerges as a development alternative for the inhabitants of the community whose primary economic support is based on the touristic services offered for visitors. However, over-tourism has affected the environmental conditions of the area and have revealed a gap in the established management plan for the allowed activities in the surroundings of Peña the Bernal. There is no real quantification of the acceptable volume of visitors that the place can afford. Furthermore, the lack of monitoring of the area, the disorganised urbanisation process, the deficient control of authorities as well as the overexploitation of the natural resources have led to the deterioration of the biodiversity and cultural resources of the place.

In this sense, the determination of the Tourism Carrying Capacity will help to plan the tourist activity of Peña de Bernal sustainably, in order to prevent adverse impacts on its ecosystem services and in its cultural heritage. By calculating the appropriate amount of visitors that can arrive at the place in high seasons, it would be possible to establish recommendations for the place management without leaving aside local development. Moreover, the analysis of the tourists' profile will also give a broader perspective of the current problems of the area and will strengthen the identification process of new suitable alternatives.

Keywords: Tourism, Peña de Bernal, Tourism Carrying Capacity, Local Development, Sustainable, Tourist Profile

RESUMEN

México se ha posicionado como uno de los principales destinos turísticos a nivel mundial, gracias a su gran diversidad natural y cultural. Uno de los recursos más explotados en este campo es el turismo cultural, dado que una gran cantidad de visitantes están interesados en conocer el patrimonio ancestral mexicano. En este contexto, se destacan los Pueblos Mágicos, llamados así por sus atributos simbólicos e historia.

Refiriéndose al Pueblo Mágico de San Sebastián Bernal, esta localidad tiene una relevancia turística excelente dada su posición privilegiada en medio de la ruta turística llamada Ruta del Queso y el Vino. Además, el pueblo ha sido reconocido por su peculiaridad geográfica gracias a la presencia de Peña de Bernal, un monolito de 2.510 AMSL considerado como Área Natural Protegida y declarado Patrimonio Cultural de la Humanidad. La elevación atrae la atención de turistas nacionales e internacionales quienes están interesados en experimentar sus manifestaciones naturales y culturales, recuerdos y tradiciones vivas de civilizaciones pasadas.

En este contexto, el turismo en Bernal surge como una alternativa de desarrollo para los habitantes de la comunidad cuyo principal apoyo económico se basa en los servicios turísticos que se ofrecen a los visitantes. Sin embargo, el turismo excesivo ha afectado las condiciones ambientales del área y ha revelado una brecha en el plan de gestión establecido para las actividades permitidas en los alrededores de Peña el Bernal. No hay una cuantificación real del volumen aceptable de visitantes que el lugar puede albergar. Además, la falta de monitoreo de la zona, el proceso de urbanización desorganizado, el control deficiente de las autoridades y la sobreexplotación de los recursos naturales han llevado al deterioro de la biodiversidad y los recursos culturales del lugar.

En este sentido, la determinación de la Capacidad de Carga Turística ayudará a planificar la actividad turística de Peña de Bernal de manera sostenible, a fin de evitar impactos adversos en sus servicios ecosistémicos y en su patrimonio cultural. Al calcular la cantidad adecuada de visitantes que pueden llegar al lugar en temporadas altas, será posible establecer recomendaciones para la gestión del lugar sin dejar de lado el desarrollo local. Además, el análisis del perfil de los turistas también dará una perspectiva más amplia de los problemas actuales de la zona y fortalecerá el proceso de identificación de nuevas alternativas.

Palabras clave: Turismo, Peña de Bernal, Capacidad de Carga Turística, desarrollo local, sustentable, perfil turístico

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF EQUATIONS

LIST OF ABBREVIATIONS

CEAG	Comisión Estatal del Agua Gobierno del Estado de Guanajato
CESOP	Centro de Estudios Sociales y Opinión Pública
CONABIO	Comisión Nacional para el Conocimiento y Uso de la Biodiversidad
CONANP	Consejo Nacional de Áreas Protegidas
DOF	Diario Oficial de la Federación
ECC	Effective Carrying Capacity
GDP	Gross Domestic Product
INAP	Instituto Nacional de Administración Pública
INEGI	Instituto Nacional de Estadística y Geografía
LGEEPA	Ley General del Equilibrio Ecológico y Protección al Ambiente
MC	Management Capacity
NPA	Natural Protected Areas
PCC	Physical Carrying Capacity
PND	Plan de Desarrollo

PPM	Programa de Pueblos Mágicos
PROSECTUR	Programa Sectorial de Turismo
RCC	Real Carrying Capacity
SECTUR	Secretaría de Turismo
SEDEMA	Secretaría del Medio Ambiente
SEDESU	Secretaría de Desarrollo Sustentable
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales
SNPD	Sistema Nacional de Planeación Democrática
TCC	Tourism Carrying Capacity
UAQ	Universidad Autónoma de Querétaro
UNWTO	World Tourism Organization
WCED	World Commission on Environment and Development

1 Introduction

1.1 Background and problem statement

Tourism is defined by UNWTO (2008), as the set of activities related to persons travelling and staying in places outside their usual environment for no more than one consecutive year for leisure, business or other purposes. Leiper (1979) adds that tourism comprises a system of transit routes, destination regions, and tourist businesses arranged in the spatial, functional and interconnected area to satisfy tourists needs. With modernization, new technologies have allowed emerging economies to use tourism as a progress strategy by building new transport options and infrastructure to improve their situation. These activities have resulted in a tourism massification, attracting more and more visitors to recreational areas each time.

According to UNWTO (2017), the arrival of international visitors in tourism destinations around the world has shown uninterrupted growth, reaching 1.235 million visits in 2016 despite the occasional crises. Likewise, income from international tourism worldwide reached 1.220.000 million dollars in the same year. Also in its Tourism Towards 2030 report, the UNWTO (2011) stated that the number of arrivals of foreign tourists worldwide would grow an average of 3.3% annually between 2010 and 2030.

The interest in tourism is related mainly on its meaningful influence in the place where it is developed. Indeed, tourism is strongly related to nature, given its dependence on high levels of environmental comfort for offering a satisfactory tourism experience. Its increase has aggravated the existing conservational problems in natural recreational areas. Moreover, tourism creates pressure on the resources of a site, affecting biodiversity and land-use habits of local communities.

Although nature has always been one of the most important motivations for visitors around the world, a new modality of experience patrimonial spaces has considerably increased over the last years. In this context, natural and cultural heritage represents the main attractions in several destinies, which makes them much more vulnerable to social pressure. Contamination in water due to urbanization, biodiversity loss, architectural pollution are just a few examples of the consequences of spontaneous tourism practices. Moreover, the adverse effects are generally cumulative, so there is an urgency among tourism managers to identify them, define limits and establish priorities in terms of development.

Then there is the immediate need of societies to strengthen actions in favor of environmental planning, working towards the development of new strategies for the proper management of their territories. In order to protect their natural heritage, some

governments establish NPAs defined as the portion of the territory whose purpose is to conserve representative biodiversity of different ecosystems and ensure the balance and continuity of the ecological processes. Additionally, the NPA watch over the sustainable exploitation of resources inside its territory to preserve flora and fauna of the area and promote the study of the ecosystem. These sites are also regulated under political instruments that control their activities under the framework of law (SEMARNAT, 2016).

An NPA gives an economic base to tourist attractions above its cultural or natural value; its educative function is doubtless since it promotes the conservation and preservation of similar urban spaces (Segrado Pavón *et al.*, 2013). However, the visitor's administration on an NPA must be rigorously planned to achieve the conservation objectives and ensure a satisfactory tourist experience. According to Ceballos Lascuráin (1998), every management plan of a protected area must have a monitoring program of the impacts of tourism to ensure that the environmental effects of this activity do not exceed the acceptable limits of change. This also implies a strict control of the scale of tourism, which must be reflected in the utilization of methodologies to regulate the visitors´ flows in the site.

This growing concern about the verification problems generated by the high influx of visitors initiated the research of adequate measurement tools for monitoring tasks on destinations. To face this situation, there are several frameworks for rational tourism planning and resilience that can be used: the Recreation Opportunity Spectrum (ROS), the Limits of Acceptable Change (LAC) framework, the Process for Visitor Impact Management (VIM), the Visitor Experience and Resource Protection (VERP) framework, the Management Process for Visitor Activities (VAMP) and the Tourism Carrying Capacity (TCC) (Nilsen and Tayler, 1997).

To develop this research and in the attempt to suggest modifications for the sustainable management of a tourist area, it is essential to choose the correct tool for analyzing its current situation. In this case, the concept of tourism carrying capacity has been chosen since it is based on a general statement that any form of development within the carrying capacity of an ecosystem means achieving a level of sustainability. In its very base, it looks at the maximum acceptable level of impact for an environment and its capability to persist over time which implies recovering its previous condition until the disturbance restarts the sequence (Hollings, 2013).

UNWTO states that TCC is used to establish in measurable terms, the number of visitors and the degree of development that is likely to be achieved without situations harmful to resources local community and culture or without harming the right balance between development and conservation (Echamendi Lorente, 2001). In this sense, the analysis of

tourism capacity is a technique of tourism planning and biodiversity management, but it can contribute to achieving sustainable development of a community in the long-term, by determining upper limits of growth of a site. Its integral vision of the reality of natural ecosystems with monumental enclosures makes it an adequate tool for establishing new optimal ways of using tourist resources.

Once the carrying capacity of an area has been established, various strategies may be implemented to prevent it from being exceeded. However, even if TCC could contribute to evaluating the effectiveness of control on a recreational site, it is not the solution to all the environmental problems of the territory. Its calculation is a complex process that must take into account the particularities of an area, but it should also be accompanied by a parallel decision process to identify strategies for transforming tourism into a real development promoter.

In this sense, this research attempts to answer the question of to what extent could TCC contribute to the local, sustainable development of NPA?

1.2 Objectives

1.2.1 General

To evaluate the potential contribution of Tourism Carrying Capacity calculation as an instrument for local, sustainable management of Peña de Bernal, Querétaro.

1.2.2 Specific

- To characterize the public use spaces of Peña de Bernal and determine the tourist profile.
- To calculate the Tourist Carrying Capacity of Peña de Bernal from a physical, real and effective perspective.
- To establish recommendations to optimize the sustainable management of Peña de Bernal.

1.3 Thesis scope and structure

A research applied approach has been applied in this study since it seeks the application of the TCC existing knowledge in the local, sustainable development of Peña de Bernal. The level of research of the study is descriptive given it aims to determine the characteristics of the tourist site, the most relevant public use areas, as well as establishing relationships between tourist profile and their primary motivations for visitation, the characteristics of the place and the existing TCC in its three dimensions: physical, real and effective.

For achieving it, this study has been divided into an introductory Chapter I, which presents the background and analyzed problem as well as the objectives established for developing this research. Chapter II relates to the existing relationship between tourism, sustainable development, the TCC, and describes the possible tools for managing tourism in a better way. Chapter III describes briefly the research approach of the study based mainly on the application of a TCC tool remarked by the determination of the tourist profile to support the assumptions of local development in the place based on tourism.

In the analytical part, Chapter IV describes the national, regional and local context of Peña de Bernal considering all the economic influences and factors that have made the village an important tourist center for the Mexican republic. Chapter V presents the results regarding the dynamic of the public use areas of Peña de Bernal, followed by the TCC calculations on its three dimensions and the tourist profile determination. Chapter VI presents the analysis of the results and recommendations for better management of Peña de Bernal in terms of sustainability, and finally, Chapter VII refers to conclusions of the study.

1.4 Justification

According to Fasio Moreno & Ibáñez (2013), about two-thirds of the inhabitants of Mexico live in extreme poverty. This condition is accentuated in rural areas, which represent a quarter of the population. In turn, many of these rural localities settle in natural areas subject of a regime of protection or conservation of the environment.

In the case of San Sebastian Bernal, the popularity of the place has grown nationally and internationally, thanks to its inherent ecotourism characteristics. Its privileged condition has aroused the interest of the local population, who have been dedicated to exploiting the cultural and natural potential of la Peña for a long time, transforming it into its main tourist attraction.

As a thriving rural town, its economy depends directly on the sources of employment as well as the income generated by this sector. However, the implementation of trails and guided tours do not have a comprehensive assessment of economic potential or an estimate of natural limits that allow sustainable tourism.

Based on the preceding, TCC will be used as an instrument to determine the quantity, type, and distribution of the use that can be made of a site without leading to unacceptable impacts on its physical and biological resources or in the recreational experience available. This indicator will establish the limit tourist numbers at the attraction to generate alternatives for understanding the existing interrelation between visitors and their impact on the site's environment (Pérez, 2016).

The determination of the carrying capacity will help to plan the tourist activity of Peña de Bernal sustainably, to prevent adverse impacts on its ecosystem and its cultural heritage by the entrance of tourist without any limit. It will guarantee the economic benefit of the local populations that depend on these resources to survive, improving their quality of life and the satisfaction of their visitors. Similarly, this research aims to be an input on environmental education issues to preserve the biodiversity of the place, involving the local population.

Through this research we can formulate concrete objectives and generate improvement proposals carrying out efficient management of resources and administration of the destination, increasing the popularity of the place and establishing lines of action that allow reaching a balance in the social, economic and environmental field.

2 Conceptual Framework

2.1 Tourism and Sustainable Development

Tourism is defined as the social, economic and cultural phenomenon of people moving to unknown places, for leisure, business or other motivations; generally carried out during their free time to change their routine for no productive tasks. It presupposes hospitality, technology utilisation, meeting new places and communication, generating varied experiences and diverse impacts in the surroundings (Panosso Netto and Guilherme, 2012). Moreover, as a condition for tourism, visitors must be outside their permanent place of residence for more than twenty-four hours and make at least one overnight stay (Ibáñez Pérez and Cabrera Villa, 2011). For most visitors, it comprises transportation activities, accommodation, motivations for travelling, lodging opportunities and the different recreational activities offered by a destiny. For local people, tourism is a development opportunity, a generator of employment and income as well as a mean of cultural diffusion. Still, none of these points of view expresses by themselves the complexity of this concept.

In this sense, researches often analyse tourism as a communication system, capable of transmitting useful information that can affect the harmony of human relations, which is why it must remain as a positive communication operator (Panosso Netto and Guilherme, 2012). As a system, tourism is formed by five main elements: tourists, generating regions, transit routes, destination regions, and the tourist industry. These five parts are arranged among them and generate different spatial and functional connections. Their interactions are influenced by external factors and their impacts on the physical, social, economic, political, technological and cultural environment can be evidenced to the extent of all the recreational area (Hall and Page, 2015).

Regarding sustainability, it arises as a response to the normal vision of development of the industrial age, which sees economic growth as the only alternative for improving humanity conditions. However, appealing to the term development implies a process that goes beyond economic growth purely. It also refers to structural change, the capacity of expansion, freedom, social progress and wellbeing, institutional modernisation and environmental balance of the countries (Mogrovejo Monasterios, 2000).

Thus, this vision did not cover the totality of possible dimensions and still left aside the environmental sphere. In this context, the term "eco-development" appears, arguing that prosperity implies modifications in both, growth models and strategies, so there is sustained use of resources without leaving aside the existing deadlines for biological regeneration of ecosystems (Fernando Estenssoro, 2014). Subsequently, the concept of

sustainable development was analyzed at the Stockholm Conference in 1972 and first used in 1987 by the United Nations Commission on Environment and Development who defined it as " the development that meets the needs of the present generation without compromising the ability of future generations to face their own needs"(ALER, FTPP and FAO, 1995).

Tourism does not work independently from the economic development of a country; then, it must contribute to the context by harmonising the goals of ecological sustainability with the expansion processes. According to UNWTO, sustainable tourism must meet the needs of current tourists and host regions while protecting and promoting opportunities for the future. It is defined as a guide for resources management, so they can achieve their economic, social and aesthetic needs while respecting cultural integration, essential ecological processes, biological diversity and the systems that sustain life (Acerenza, 2013).

The sustainable development of tourism demands strong leadership for achieving the active participation and collaboration of all the stakeholders and authorities. It should also achieve a high level of satisfaction from tourists through continuous monitoring of the impacts caused in the area to introduce preventive or corrective measures (UNWTO, 2017b).

Nowadays, tourism is considered a transformative factor given its complex nature that affects the structural component of a region. Considering their inhabitants are directly associated to the costs and benefits of the activity, the effects can be categorized into two groups: 1) the impacts caused by the interaction between tourists and the visited area, which can include affectations to the economic, social and environmental subsystems and 2) the impacts caused by the interrelation existing between the visitors and their decision processes. (Quintero Santos, 2004; Brida, Monterubbianesi and Zapata-Aguirre, 2011).

At the same time, this tourist sustainable initiative can be the key for improving the quality of a destiny community given it complements the development process of a locality by optimising its local economic benefits, protecting their natural and cultural heritage and building a long-term and robust linkage between its residents and the tourist industry. Due to the fact that green and cultural tourism alternatives imply a mentality change of the inhabitants‘ conception regarding the need of preserving their natural resources, a modification of the quality of the tourist services they provide may be reflected in benefits for the community in the future (López y Palomino, 2001 cited in Ortíz Liñán and Vázquez Solís, 2016).

As explained before, a reality of an imminent risk of deterioration of natural resources has arisen as a result of tourism with unsustainable practices for the ecosystem, an

infrastructure with unmeasured capacity and tourist circuit without access bounds. Both planners and tourist administrators are becoming aware of the impacts caused by unmeasured tourist and in the face of this situation, they have developed an increasing need to maintain the quality of recreative spaces. In this sense, through a sustainable tourist development that allows the conservation of resources it is possible to prevent the degradation of the environment through control standards that must be applied in all tourist areas, but above all, in the patrimonial and natural resources (HwanSuk and Sirakaya, 2006).

2.2 Sustainable Tourism

According to UNWTO cited in UNESCO (2009), Sustainable Tourism management is an approach designed to "meet the needs of present tourists and host regions while protecting and enhancing the opportunity for the future. It is envisaged as leading to management of all resources in such a way that economic, social, and aesthetic needs can be fulfilled while maintaining cultural integrity, essential ecological processes, biological diversity, and life support".

The term is derived from the general concept of Sustainable Development, which was first referenced by the WCED in the Brundtland report on 1987. The idea was used to describe the interactions between economic growth and environmental conservation, explaining that progress must not only attain monetary income but also achieve fairness of access to the resources for the present and the future generations. The conception of Sustainable Development highlights that the environmental impacts caused by economic activities must be attended in the first place, to achieve intergenerational equity (Garrod and Fyall, 1998).

This idea fits with the new conception of visitation of natural areas proposed by Ceballos Lascurain in 1987. He explains the importance of *ecotourism,* as a term that defines the interrelation existing between the environment, visitors and local cultures to find the different levels of interaction among them. It initiated as a response to negative impacts associated with mass tourism in places where economic growth has a considerable weight over ecological conservation and socio-cultural assets of host communities (Cobbinah, 2015). In this sense, the approach of ecotourism helped to increase the popularity of sustainable tourism itself, raising the awareness of respecting the fragile environmental balance that characterises many tourism destinations.

In this sense, sustainable tourism seeks to achieve a more balanced relationship between visitors, inhabitants and the tourist industry. For accomplishing this goal, it is vital to reach the involvement of all the stakeholders working on the field for reaching long-term viability

of proposed activities to improve the quality of both, natural and human resources. This condition must define limits to growth according to the place and its management practices. In this way, it recognises the importance of tourism as a tool for progress but also strives for ensuring that this development is done on an environmental-friendly way that helps in the return to sustain areas in which they operate through tourist satisfaction (Hughes, 1995).

2.3 Tourism Carrying Capacity

The growth of tourism in contrast with the debate of environmental sustainability forces planners and administrators to maintain the spaces in which tourism activities develop, controlling the degradation of the environment as well as guaranteeing the tourist experience of the visitors of the site. These standards should apply to all tourist sites, but above all, to those that enjoy natural and heritage resources (Orgaz Agüera, 2013).

With these antecedents, the search of regulations for recreational practices that allow reaching a sustainable model in these territories has given rise to new tools for natural resources management as it is the case TCC. This term has been used by researchers to refer to the maximum number of tourists that can be allocated at the same time on an area or destination (O'Reilly, 1986).

Regarding this concept, Platón was the first philosopher who referred to the carrying capacity. He argued that it is not possible to define an adequate quantity of citizens for a place without taking into account both its land and the neighbouring states near it. Moreover, he stated that the territorial extension in which they inhabit must have enough surface to house them modestly and comfortably (Morales Aymerich, 2009).

On the other hand, this concept has been used since antiquity in different branches of science to determine the limits related to population growth and the number of beings that can live in a physical space. According to Sayre (2008) among its main applications, there is the delimitation of transport in weight of vessels or the determination of qualities of living beings in the field of Biology to know the functioning of the natural systems.

The risks of overcrowding and its consequences in the deterioration of the natural environment of recreational areas were analysed by Wagar (1964), who indicates that the population prioritises the access facilities to tourist destinations instead of recognising them as a natural asset that must be managed in a sustained way. It also points out that when too many people use the same area, it loses part of its natural and cultural heritage and therefore, the quality of future visits is not guaranteed.

These studies constitute the starting point for the following definition of the concept of TCC that is used until the present. In the seventies, experts in the field got interested in the adverse effects that tourism activity possesses in the environment. In this sense, the researches focus not only on calculating the number of tourists that an area can support but also on the importance of generating alternatives in the determination of capacity from an economic, social and ecological perspective (Echamendi Lorente, 2001).

The trend continues in the eighties when the discussions regarding carrying capacity in the field of tourism focus on specifying the acceptable and necessary limits to generate a change. Among these investigations are the contributions from Mathieson and Wall (1982) who analyze the impacts of tourism, from Getz (1983) with the identification of essential variables for the analysis of the carrying capacity; and from Shelby and Heberlein (1986) with their study of social carrying capacity (Echamendi Lorente, 2001).

In the case of Latin America, the most recognized study is the one carried out by the Ecuadorian Miguel Cifuentes (1992) who argues that TCC does not represent a solution to the problems of visitation of protected areas given that this tool is only a planning instrument to sustain and take decisions associated with social, economic and political considerations. Its procedure recognises the lack of trained personnel, the lack of management capacity, the insufficient information and technological equipment in the case of developing countries which makes it a calculation methodology that can be easily adapted to all these realities.

2.3.1 Tourism Carrying Capacity at the international, national and local level

All types of tourism progress lead to changes in the natural environment in which it is developed. However, through the TCC, it is possible to identify the maximum number of tourists that an area houses through the integration of economic, social, physical and ecological criteria. Depending on the dynamics of the sector, it is possible to adapt this tool to each tourist scenario according to its characteristics.

There are many examples of natural areas with great tourist affluence worldwide whose current conditions are indications that their carrying capacity has already been exceeded. This situation generates a decrease both, in the economic income received by its inhabitants and in the experience and satisfaction of the visitor. Below, some of these experiences at an international and national level are described.

In Asia, numerous studies have been carried out on tourism carrying capacity, especially in coastal areas that are widely visited, such as Khao Laem Ya-Mu Ko Samet, a marine park located in the Gulf of Thailand in front of the coast of Rayong. This park, together with Mae

Rampeung beach and other nine islands situated in its surroundings have been declared protected areas of Thailand since 1981 (Asean Center for Biodiversity, 2013).

The park has a high recreational use due to its popularity and proximity to the capital of Bangkok. However, the number of visitors has increased from 265.248 to 437.017 between 2003 and 2005. For this reason, the carrying capacity investigations were initiated in the zone based on the theory proposed by Shelby and Herberleins (1986), to mitigate the negative impacts of tourism. This methodological proposal analyses these impacts based on four main capacities: ecological, physical, social and ease of entry. The evaluation also involved the study of determinant problems according to the geomorphology of the site such as the loss of soil and exposure of roots, water quality, affecting vegetation and state of live coral reef coverage (Ruschano, Chettamart, and Nasa, 2006).

Another reference case is the municipality of Caravaca de la Cruz in the region of Murcia, Spain. This town has been declared as a city of high tourist interest internationally thanks to the beauty of its old town of medieval origin and its natural attractions. It is part of the Natural Trails Network of the country whose purpose is to recover, preserve and promote the landscape and cultural heritage of the community. Its regional parks, protected landscapes, and biosphere reserves constitute the territorial scope of these trails, which are susceptible to be used for tourism (Serrano and Alarte, 2009).

TCC studies have been carried out in this space to preserve its natural and cultural spaces. The research follows the methodology of (Cifuentes, 1992) to know the number of visitors suitable for the area but also to calculate the infrastructure that the place could support without causing negative impacts on the natural resources of the site or an adverse effect on the society that lives there. For this, the physical, biological and management conditions of the area have been taken into account for the research.

In Latin America, one of the most famous cases of study is the one of Galapagos National Park in Ecuador, which has been internationally recognised for the achievements obtained in the protection of wildlife, scientific activity and the management of an ecotourism policy that allows the promotion of educational tourism. In the year 1996, it was necessary to resume the research to acquire new knowledge of the actual park's tourism management. The researchers used the Cifuentes methodology as the basis of their study applying it to an insular reality (Amador, E., Cayot, L., Cifuentes, M., Cruz, E., Cruz, F., & Ayora, 1996).

There are some controls applied to preserve the characteristics of the biodiversity of the area. Among them, there are delimitations of regions of the National Park for public use on the large islands of the archipelago, visitation of sites in groups organised with an

authorised guide, implementation of specific transport systems for visitors through tourist boats, among others. Also, local governments have established explicitly on the four populated islands, sites with land access where admission is allowed without a guide (Amador, E., Cayot, L., Cifuentes, M., Cruz, E., Cruz, F., & Ayora, 1996).

A similar situation is one that crosses the Los Manglares de Tumbes National Sanctuary in the tourist circuit of Puerto Pizarro in Peru, whose mangrove as such is a tourist icon in the area and receives a large number of visitors. However, the site presents non-optimal management of recreational activity as the growth of the infrastructure has been carried out in a disorderly manner, endangering the endemic biodiversity. Moreover, the number of visitors that the place can receive was also unknown. It was possible to determine that although the loading capacity had not been exceeded, it was strongly recommended not to increase the number of visits to avoid considerable future alterations in the mangrove ecosystem (Prado Mendoza, 2012).

In Mexico, various studies have been carried out on tourist carrying capacity, both in recreational destinations of wild nature such as Piedra Herrada or in coastal areas such as the multiple investigations carried out to implement control strategies in Baja California, Quintana Roo and Cancun. The methodology of Cifuentes (1999) was established as a guideline for these evaluations. However, researches also recognize the importance of not only having a tourist reception capacity that determines a limit of maximum use of a place without damaging its natural resources, reduces levels of tourist dissatisfaction and negative impacts on local society, but the need for permanent monitoring the situation through other standards according to Saveriades (Coccosis, 2001).

A clear example of this is the study conducted on the island of Cozumel, where in addition to carrying out an analysis of TCC, indicators of a descriptive nature designed and adapted to the characteristics of the region were also used, focusing the study on analyzing the complexity of the tourist activity of the site (Segrado, Palafox-Muñoz, and Arroyo-Arcos, 2008).

Finally, in the state of San Luis Potosí, we found the load capacity research carried out at the Joya Honda Volcano, whose approach analyses both the physical characteristics and the visitors' perception of the site. This study adopts the methodological concepts of Cifuentes (1992) and also makes use of qualitative indicators, landscape indexes and interviews with local actors to infer the conditions of the site and propose management alternatives (Vázquez Solís Valente, Palacio Aponte Álvaro Gerardo, 2013).

Another relevant investigation is the comparative analysis of three sites of the state carried out by (Ortíz Liñán, 2017). This research looks into the characterization and study of different stages of management of Puente de Dios in the municipality of Tamasopo; the Caves of Mantetzulel in the buffer zone of the Protected Natural Area of the Sótano de las Golondrinas, in the municipality of Aquismón; and the valley of the Ghosts, which is part of the Protected Natural Area of the Sierra de Álvarez in the municipality of Zaragoza.

The purpose was to carry out a sustainability proposal based on the calculation of tourism carrying capacity, combining the methodology of Cifuentes (1999), Vázquez (2013) and García (2003) and considering both, the management measures and the information obtained with the support of geo-technologies to control the access of visitors. This analysis was possible thanks to the processing and synthesis of quantitative and qualitative data of spatial order associated with tourism.

2.4 Further Tools for Tourism Management

2.4.1 Interpretation and understanding of TCC results

In general, several studies and touristic programs have used TCC to strengthen sustainability-related programs at official international institutions (Guo and Chung, 2019). There are specific sustainable tourism markets such as sustainable geo-tourism that incorporate carrying capacity as fundamental dimensions in their management. TCC is then used to evaluate practices in this specific market (Guo and Chung, 2019).

McCool and Lime (2009) advocate stopping using a reductionist interpretation of TCC since there are many factors that affect the calculation of TCC and that cannot be modelled realistically. Moreover, there is no straightforward application from TCC; this is, the result from the TCC cannot be taken as granted and purely objective. For instance, local and regional governments, in an attempt to attract more visitors while conciliating the economic needs of local populations, push touristic infrastructure projects that may have negative consequences on the natural sites, especially those regarding tourist capacity (Ferreira and Harmse, 2014). Here, TCC results and applications can be co-opted in order not to disturb massive touristic projects under the argument that TCC calculations are objective and have scientific evidence.

There are no deterministic measurements to determine the limit of visitors that a natural touristic site can hold. A touristic site, especially those located in protected areas, is not a homogenous land. Some spaces are under-utilised and others that are over-utilised (Ferreira and Harmse, 1999). This means that the TCC has to be assessed according to specific sites, depending on the use. In this sense, TCC may throw a high number of visitor's

levels in some areas but almost none in others. Therefore, a proper redistribution of the touristic infrastructure would need to be carried out. Although TCC contributes by giving warning alerts about the current stress caused upon the protected area, caused by visitors, additional tools will seek a more favourable spatial distribution of visitors in order to mitigate their impact on the site (Kostopoulou and Kyritsis, 2006).

Other authors (e.g., Mccool and Lime, 2009) establish that boundaries and thresholds created for TCC are not achieved in complex-real scenarios. These authors claim for reframing in the focus of TCC. Instead of only assessing the number of visitors a place can support, it should be posted, which are the best conditions that meet natural conservation and care demands with high quality of visitors' experience.

Segrado-Pavón and Piña (2018) highlighted that oversimplification of calculation of TCC might lead to misunderstanding and misinterpretation at the policy level. However, TCC, together with other sustainable tourism management tools, is a form of cooperation among researchers, visitors, residents, and authorities, with the purpose to ensure a sustainable trajectory of the territory they want to develop but preserve at the same time. Haraldsson and Ólafsdóttir (2018) proposed a redefinition of TCC through the attractiveness of the site and its optimal infrastructure size. Moreover, these same authors also indicate that these quantitative and qualitative features of the touristic site evolve, and thus, the TCC changes over time as well. Other authors claim for reorientation in scientific research regarding TCC, re-evaluating which the conditions and scenarios are desirable in order to promote better sustainable management of a site (Mccool and Lime, 2009).

TCC deals with balancing and optimising management of visitors in order to avoid negative socio-environmental impacts but procuring a satisfactory experience to visitors. However, TCC is context-specific (Cupul-Magaña and Rodríguez-Troncoso, 2017). For instance, population dynamics of the touristic site and the areas that around conforms a complex picture in which there are conflicts of power regarding the use and ownership of the lands. Here it emerges the political dimension of TCC. The re-definition of the limits of the touristic site involves changes in the economic and cultural use of lands, which might be owned by particular specific interests. In this sense, accompanying TCC, as Bimonte and Punzo (2007) discuss, there must be parallel studies such as stakeholder analysis with participatory approaches.

Over time, research in TCC has evolved as it has incorporated other dimensions of sustainability such as the political, environmental and social (Salerno *et al.*, 2013). For instance, even though visitors' preference marks a destination as desirable, which would increment the economic gains of a touristic attraction, there is an environmental constraint

in the access and use of natural resources. Hence, a tension between environment, policy, and economy emerges. As indicated by Cupul-Magaña and Rodríguez-Troncoso (2017), TCC is a handy management tool and policy indicator for stakeholder in NPA's. However, the imposition of visitor's number in NPA's can also cause a conflict of interest in some authorities whose aim is to increase the touristic economic revenue.

2.4.2 Complementary methods and tools to TCC

Tourism carrying capacity should not be a method on its own. It must be integrated into a set of tools as a part of a holistic research project in sustainable tourism management. There are multiple factors, objective and subjective ones, that are involved in TCC calculation that go beyond its scope (Bimonte and Punzo, 2007). That is why TCC research must be complemented with relevant quantitative and qualitative information.

Castellani et al. (2007) developed an innovative method to assess TCC. As a management tool for sustainability, the method developed by these authors includes other dimensions (social and economic) besides the ecological one. However, adding more dimensions in the TCC calculations, it becomes more complex to apply, process data and interpret. This would also require multidisciplinary studies (some of them with a very technical emphasis) and the participation of local stakeholders.

Kostopoulou and Kyritsis (2006) remark that there are some sub-areas that are not in the frame of TCC methods and calculations. That is why these authors developed an indicator based on the spatial distribution of critical natural assets in order to evaluate the impact of tourism in protected areas. Based on this indicator, these authors discuss two ways of dealing with an increasing number of visitors in sensitive natural areas: the concentration and dispersal strategy. However, this is not an easy decision to make since tourist managers and decision-makers have to consider the specific landscaped of the touristic area. Depending on that, each approach has more benefits, although the concentration approach is not desirable in most cases.

Additional information that supports and strengthens TCC assessments is the comparative and longitudinal studies in order to see how visitor flows change over periods. Additionally, tourists' perceptions help by informing the profile of visitors and which spots or specific site are most valuable (Ferreira and Harmse, 1999).

Salerno *et al.,* (2013) have developed planning policy-drive frameworks derived from calculations of TCC in NPA. These range from the limits of acceptable change (LAC), experience and resource protection (VERP) to visitor impact management (VIM). These frameworks provide more integrated guidelines for appropriate sustainable management

of protected areas; however, there is a discussion whether these were built on a scientific basis or not.

Lobo *et al.*, (2013) highlight that management decisions on natural sites have been focusing on financial and sustainable support for the site through economic revenues from tourism. However, these sites have intrinsic ecological dynamics that limit tourism activities. These sites are located in areas where rural communities live. Therefore, the decisions on the limitations of the touristic site must consider the local people voice. This same author states that TCC studies should be complement with ecological and environmental monitoring process, that more than adding a quantitative correction factor, should put more qualitative limits on tourism. These limitations also consider cultural and economical use of resources located in the area. Adding to this, TCC calculations should be more flexible and more open, in the sense that TCC must go beyond numerical limitations. Lobo (2015) utilised a broader TCC approach, consisting in the delimitation of the tourists' trails, projection of tourist scenarios and the verification of them based on atmospheric parameters.

Specific longitudinal studies about the variation of environmental conditions in the touristic site should be taken into consideration in order to complement TCC research (Lobo, 2015).

Iliopoulou-Georgudaki *et al.*, (2016) proposed a system of indicators to assess the sustainability of tourist destinations combining TCC and other management tools such as Limit of Acceptable Change (LAC). They argue that the integration of these methods contributes to a flexible and fully operational sustainable management of touristic sites. Moreover, their framework also provides a scientific basis to integrate and support the participation of different stakeholders in decision-making processes. They also conclude that TCC research should move forward to a more flexible, sustainable planning rather than just defining static thresholds. Other TCC studies focus on specific activities that take place in the site of study. For instance, Cupul-Magaña and Rodríguez-Troncoso (2017) calculated the TCC of Islas Marietas, México, for each site and activity therein.

Other approaches to TCC, such as the studies on perceptions (Mokrý, 2013; Guo and Chung, 2019), consider visitors as the principal agents and their preferences as the main drivers that positions a place as touristic. In this type of research, audiovisual material of destinations is shown to potential visitors in order for they to value and rank which the best touristic places are, considering factors of overcrowding, accommodation, hazards, etc. A touristic destination such as abundant natural areas present a great attractiveness, according to perceptual carrying, however, it remains still unclear how the factor of overcrowded place affects the preferences of visitors (Mokrý, 2013).

2.4.3 Visitor and local resident perceptions

It is also essential to consider the perceptions, both of the visitors and local population, about the touristic activities. Many times, the institutions in charge of managing the touristic sites, take into account the perceptions of the visitors based on their subjective experience of the site. However, it is not clear yet how to assess and manage visitors' responses due to changes in touristic management, aiming to increase or change the tourist's experiences (Wahyuningputri, 2012).

Haraldsson and ólafsdóttir (2018) also investigated the visitors' perceptions concerning the harmful environmental damage of a natural destination, considering that the visitors' or tourist are constituted by different types, this is, it can be created a typology of visitors according to their purposes and activities. Moreover, based on the study of the perception, it is shown that not all visitors at their optimum level of experience; this is, they do not share the same qualitative sense of experience.

Still, it is yet not known how overcrowded touristic sites during vacations peak periods affect the perception of tourists (Ferreira and Harmse, 2014). Moreover, as a touristic site gains more popularity (due to social media, for example), there is a diversification in the profile of visitors, which affects the experiences of other and the impact on the site. Especially, as a touristic attraction, touristic managers have to take care of the fulfilment of visitors' expectations, since they are the providers of economic resources that maintain tourism as an essential economic activity in a specific region.

Visitors' experiences also have demanded more considerable attention in both research and practices of sustainable tourism management. Some touristic attractions are preferred by some visitors due to their natural and pristine landscape and beauty, mainly because they offer an escape from crowded environments such as cities. Nevertheless, these pristine sites over time become more and more popular and, in consequence, there are more visitors attracted to them. There is a particular group of tourists, which is those who preferred the quietness and unknown feature of some natural sites. There are specific destinations that have been becoming more popular, which is causing negative perception in this group, as mentioned above of tourists. That is why TCC needs to differentiate the types of visitors with the site. More and more, NPA's are attracting more visitors due to their inherently natural and pristine characteristics.

In this regards, Sæthórsdóttir (2013) recommends that for wilderness sites, TCC calculations must lead to: "(1) the monitoring of changes occurring in this particular popular wilderness destination, both regarding visitors and their effect on nature; (2) the exploration of the

effects a possible management decision will have on the area; (3) observing the effects of overflow of visitors to nearby areas; (4) the comparison with development in other destinations, both popular and lesser-known."

After conducting TCC investigations coupled with visitors' and residents' perception, long-term sustainable planning and management should be carried out in order to monitor the evolution of the sustainability performance of a site, without losing the attractiveness of the site (Haraldsson and Ólafsdóttir, 2018). In order to do so, these authors recommend the following guidelines (p. 12):

1. Define the type of tourism desired and the acceptable level of exploitation.
2. Define what constitutes attractiveness in terms of essential items at the natural destination concerning its surrounding environment and natural resources.
3. Have a clear understanding what the natural limitations (thresholds/carrying capacity) are (water supply, erosion risks, land availability, etc.) on overshoot on natural capital and irreversibility of environmental impact.
4. Define what visitor types are desirable for original site development according to the purism scale.
5. Define and understand what the popularity of the site is for the natural destination evolution in order to anticipate possible visitor types stage transition.
6. Stop and go approach to all tourism infrastructure development in order to minimise the risk of unnoticed irreversible encroachment in small steps on the natural destination threshold
7. Active monitoring of predefined items in order to avoid undetected encroachment in small steps of infrastructure development that is not according to the destination sustainable long-term plan.

2.4.4 Recommendations and strategies based on TCC

TCC entails the idea of proposing and recommending management actions in order to decrease the harmful effects of overcrowding touristic places with a high social and ecological value. In literature, there are reported recommendations that come after having assessed the TCC of a site; these include restriction to vehicles, management of the walking direction of trails, to build additional spaces for public use in order relieve other overcrowded areas (Ferreira and Harmse, 1999).

TCC research has its most potential application not only in natural protected areas but also in places with considerable cultural heritage value, balancing the economic dimension of

tourism activities, the preservation of the natural environment and the local lifestyles of communities that live there (Zelenka and Kacetl, 2014).

TCC results can derive a vital management decision of an NPA if it is integrated into a systemic policy framework. TCC has different components which require different approaches from other disciplines and actors (Salerno *et al.*, 2013). For instance, this same author investigated visitors' perception regarding their experience in the NPA, combining other participatory frameworks. As highlighted by Ferreira and Harmse (2014), tourism managers in natural protected areas should take a very sophisticated method and planning strategy in order to cope with the carrying capacity. The degradation and negative social consequences for the local population depend on these methods.

TCC studies should also provide recommendations about establishing time intervals between groups of visitors, and to adequate the time or schedule for visitors. Moreover, each season should have and specific carrying capacity. TCC studies do not exempt the tourist managers and another stakeholder from their responsibility, in other words, TCC needs a proper interpretation having in mind the context of each site and local, regional and national, as well as international agendas for economic development and sustainability (Lobo, 2015).

In literature, there is still a discussion regarding the most suitable recommendations that can be applied after conducting TCC studies. Consequence, Zelenka and Kacetl (2014), address this problem and provide some ideas that could guide a congruent application TCC findings:

- The tourism carrying capacity is multidimensional, and it does not have to solely focus on the touristic activities since the local contexts and the cultural and social practices carried out are of utmost importance.
- The TCC calculations vary according to variables of space and time (e.g. seasons, weather, atmospheric conditions). A single calculation is not enough to provide recommendations about sustainable management of the site. TCC should be a continuous monitoring process, and thus the limitations imposed to tourist visitors may also vary according to a specific season or year.
- TCC research should also consider that even being below the threshold, there are different types of visitors, carrying out different activities and, therefore, their impacts on the socio-ecological environment is different. Thus, the number of maximum allowed visitors should calculate according to different circumstances.

- TCC research has to consider that a natural protected area may comprise different ecosystems, with different energy and material flows and different ecological dynamics. In this sense, a single number of TCC for a whole NPA is inaccurate, since there should have been calculated specific TCC for each ecosystem, imposing different qualitative restrictions to visitors depending on the specific characteristics of the ecosystem.
- Resilience is an important concept to study in TCC research. Resilience may serve as a parameter to influence utilising managerial decisions regarding the optimisation of the visitor flow and crowding.
- The final number thrown by the end of TCC calculations is not fixed and static. Instead, the calculation should provide an interval or range, flexible and object of informed and evidence-based interpretations. Here, mathematical modelling appears as a powerful tool to monitor and evaluate TCC longitudinally.
- Natural touristic sites such as natural protected areas are not closed systems depending only upon the impacts of tourism. Local, regional, and national dynamics regarding industrial or other economic activities besides tourism also affect the sustainability impact of an NPA. In this sense, there is an overlap between tourism effects and local and regional growth effects. For instance, heat island and local climate change also have repercussions on the calculations of TCC.

3 Research design

3.1.1 Research approach: mixed-methods

The research conducted in this work is performed via a combination of qualitative and quantitative methods. The focus of qualitative research is "the human as an instrument" (Lincoln and Guba, 1985 cited in Jackson, Drummond and Camara, 2007), understanding that individuals are in a constant transformation due to their experiences and reflections based on those experiences. The central ideas that guide this kind of research include the appropriate choice of methods and theories, the recognition and analysis of all the different perspectives and possible variables as well as the considerations of the researchers about the results in the process of knowledge production (Flick, 2009).

On the other side, the quantitative approach helps the researcher testing a theory by specifying narrow hypotheses and collecting data to support or refute these hypotheses. It consists of an experimental research method that uses the information before and after an investigational treatment to prove a fact. All the data collected is analysed using statistical procedures and hypothesis testing tools (Creswell, 2014). Quantitative analysis can be carried out at different levels. Either descriptive which implies the utilisation of simple statistics related to the description of a sample of the population; or explanatory, using advanced statistical models and rates to understand why things happen as they do and how reliable is the data according to the variables established for the study (Herrmann and Schmida, 2000).

Qualitative data tends to be open-ended without predetermined responses while quantitative data usually includes close-ended answers such as found on questionnaires or psychological instruments (Creswell, 2014), this opens a third research option which is the mixed methods. During a research process, both ways can be combined, formulating research questions, then sampling, collecting data and finally making a proper data analysis. In this case, data collection and data analysis are both interrelated to a research process, giving a significant focus of the content (Bryman, 2006).

There is not a substantial exploration about this third approach, but results of studies made on multi-strategy research recognise that the outcomes may not be predictable considering the methods are quite the opposite. Then, it is crucial to understand the different outcomes that these research designs can show at the end of the study. Qualitative research will

emphasize an open-ended approach of the research process, which can produce some changes or even the apparition of new perceptions. On the other hand, quantitative research will not bring new ideas, but it will show different points of view of the field.

Therefore, the combination of both methods implies the recognition of a possible disjuncture of the obtained data at the end of the examination process which will allow this study to compare the situation from different perspectives and points of view. This social participatory diagnose establishes a vital base to inquire the existing social problems in the site and establish the responsibilities of the existing actors for creating suggestions to tackle socio-environmental problems, and building a communitarian frame for managing tourism more sustainably.

3.1.2 Fieldwork methods used

Among quantitative forms of research, we can find surveys and experimental research. In the case of survey research, it provides a quantitative or numeric description of trends, attitudes or opinions of a population (or a sample) with the help of questionnaires or structured interviews for data collection. It is mainly used when the researcher wants to know about individual attitudes, trends or opinions of a sample of a population. By its side, the experimental research seeks to determine if a specific treatment influences an outcome, so the researchers focus on giving a particular procedure to different groups to learn how they react related to an issue. Both designs will result in the report of generalisations made by a sample in the representation of a particular population (Creswell, 2014).

On the other hand, semi-structured interviews, suit better for exploratory research regarding complex problems that sometimes may include some sensitive topics (Barriball and While, 1994). In many cases and research employing qualitative research methods, semi-structured interviews appear to be one of the most used (Galletta, 2013). Semi-structured interviews allow the researcher to interplay with closed and opened questions in order to maintain a particular structure and congruent thread logic along with the interview, with the flexibility that open-ended questions provide (Whiting, 2008).

3.1.3 Applied research design

After a brief description of the leading research approaches that can be used, for choosing the methodology, it is essential to remember that the ultimate goal of this dissertation is to

formulate suggestions and recommendations for local development through sustainable tourism management of the resources of San Sebastián Bernal. Table 1 shows a general structure of the research designed applied in this work.

Research question	Objective	Data collection methods	Data source
What are the main touristic attractions that represent a significant load capacity in the area in terms of sustainability?	To characterise the touristic attractions and tourist practices that are carried out on Peña de Bernal	Online search Direct observation Surveys	Local institutions Tourism agencies
What is the maximum number of visitors per day that Peña de Bernal can hold?	To calculate the Physical Carrying Capacity of the tourist activity in Peña de Bernal.	GPS positioning	Google Earth
What is the sustainability impact in Peña de Bernal due to the incoming flow of visitors?	To analyse the sustainability state of Peña de Bernal based on the current of flow visitors.	Surveys Interviews	Local stakeholders Tourism agencies Visitors
How can the sustainable management of Peña de Bernal be best supported based on the calculation of the TCC?	To establish suggestions and recommendations, as well as improvement proposals that help optimise the sustainable management of the visit on the site.	Literature review Surveys Interview Synthesis of results	Local stakeholders Tourism agencies Visitors

Table 1 General research design
Source: Own elaboration

Table 1 comprises the specific objectives stated in section 1.2.2. For them, research questions that guide this objective are also shown in this table. It is important to note that the research questions shown above cannot be entirely answered in this work, in other words, the results and finding of this work will only contribute to answering some part of the complex dimension of TCC concerning sustainability.

Even though the structure in Table 1 may appear as linear, it is not. The steps in order to achieve every objective require parallel and simultaneous work. The appropriate methodology to conduct this study will be a set of qualitative and quantitative approaches,

which will include the combination of surveys, interviews, observation and documentary review to ensure the fulfilment of the established objectives. Figure 1 explains in a better way, the methodology to be used for each source of information chosen:

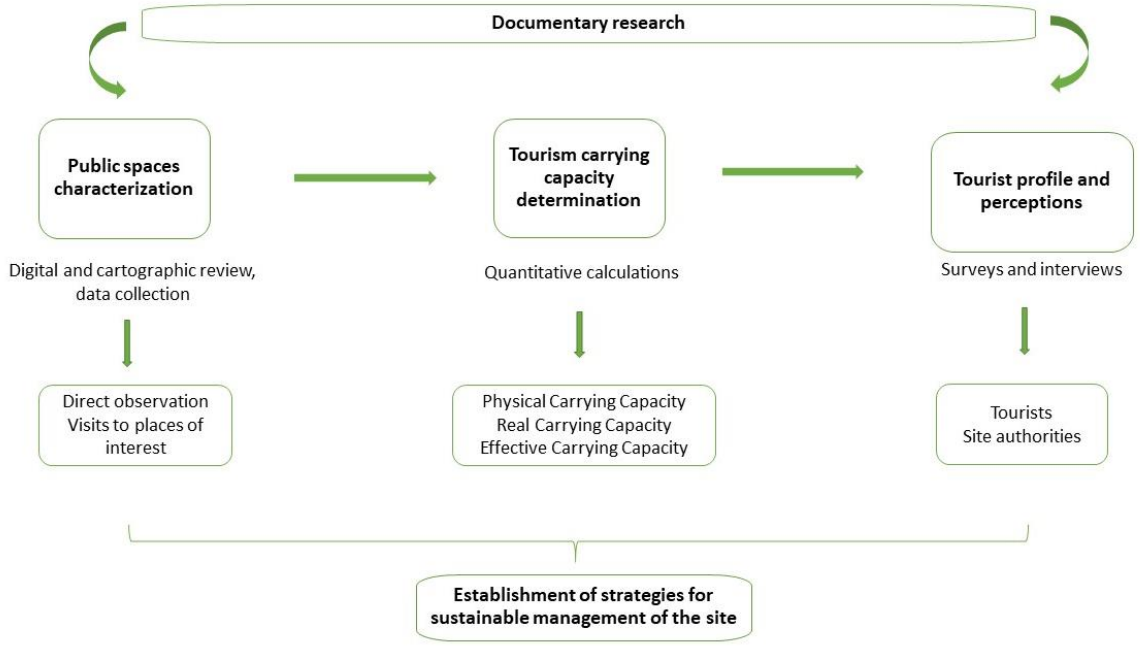


Figure 1 Proposed methodology
Source: Own elaboration

3.1.3.1 Documentary search

The information used during the research phase of this study comes from secondary sources, specifically through a review of the literature on scientific articles of various authors who have developed studies on carrying capacity and sustainability in the tourism field. On the other side, the data from the reality of San Sebastian Bernal was taken from official government sources such as SECTUR and Gobierno Municipal de Ezequiel Montes who are in charge of continuously monitoring the economic profile of the site.

3.1.3.2 Public areas characterisation

The first stage of the described research process is the site characterisation, which comprises the determination of the attractiveness and primary tourist practices that are carried out in San Sebastian Bernal and its surroundings. The identification process was

made through the visit to the study area in the period between March and June 2019. The visits were programmed according to the needs of the field research, during from 2 or 3 days each time, and they were carried out mainly in Peña de Bernal. The tour consisted of the existing path from the recreational areas located in the bottom of the rock through the top of the monolith. These journeys were also useful to establish the main spaces for public use in the area and its infrastructure.

The direct observation of the status of the site allowed to validate the information recovered from bibliographic sources. The visits were accompanied by photographic recording as well as data collection through interviews.

3.1.3.3 Tourism carrying capacity determination

For calculation of the TCC, the central methodology to be applied for the research will be the one proposed by (Cifuentes, 1992), adapting the stages, indicators, and variables to the reality of the site. The author explains as a tool that addresses the question of how many people can be permitted into an area without risk of degrading the site and the visitors' experience of it. However, the application of this methodology is considered a complex process is given in TCC there is the intervention of diverse aspects such as personal appreciations, scientific considerations as well as impact parameters. Therefore, the procedure for calculating the TCC must be adjusted to the particular conditions of each area.

In order to evaluate it, it is necessary to look at the feasibility of tourist activities on a specific site considering three levels:

- Physical Carrying Capacity (PCC): The maximum limits of visits that can be made to a site with a defined space during a specific time.
- Real Carrying Capacity (RCC): The maximum limit of visits, determined based on the CCF of a site, after applying different correction factors.
- Effective Carrying Capacity (ECC): The maximum amount that can be allowed on a natural or patrimonial tourist site in order to be correctly managed. It is obtained by comparing the RCC with the Management Capacity (MC).

The existing interrelation among these three different levels is shown in Figure 2 and is expressed in the following relation:

PCC≥RCC≥ECC

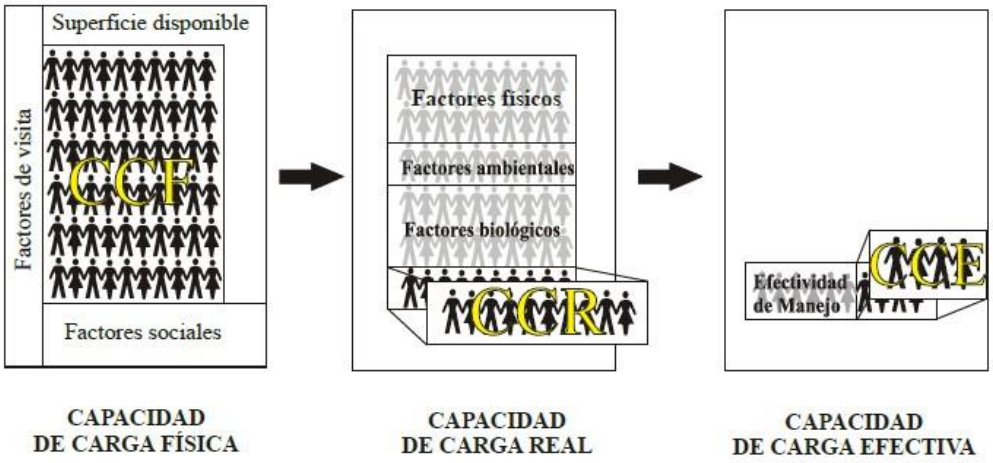


Figure 2 Carrying Capacity
Source: Cifuentes, 1999

This means that each one of the capacities is defined by the correction of the calculation of the previous one. The equation also shows that CCF will always be higher than CCR and CCR could be greater or equal to CCE.

3.1.3.4 Tourist profile and perceptions

Visitors were asked about infrastructure and the situation of the tourist services in the place. Questionnaires were applied to visitors of San Sebastian Bernal on May 4th during the festivities of the Santa Cruz and on June 16 during the Feria Nacional del Queso y el Vino given the affluence of visitors in these dates. The questionnaires consisted of thirteen reactive, which include multiple options and dichotomy questions to obtain data about the visitors' perceptions of Peña de Bernal, considering the diverse typology of visitants assisting to the town. The questionnaires were divided into four sections: general data of the tourist, motivations of the visit, length of the stay and perception of the general services of the site and level of satisfaction of the visit.

This tool also provided data about the seasonality of the place, time of stay of people, the degree of information received at the time of entry, perception regarding services, infrastructure and general state of the site, as well as in terms of levels of security and accumulation of people in the place, presence of waste, among others. These interviews

were conducted with those who enter Peña de Bernal to make a tour of the site according to the data needs presented in Table 1.

3.1.3.5 Strategies for sustainable management of Peña de Bernal

To achieve this purpose, it is necessary to analyse three main situations in the field: the existing tourist attractions that motivates the tourism activity in the area, the actual carrying capacity for establishing limits to avoid environmental damage to its natural and cultural heritage and the perception of tourist about the existing conditions in the site.

Making suggestions of improvement will only be possible by understanding the whole tourist situation of the area, the diverse tourist attractions existing in the field as well as the perception of the different groups of people impacting or participating in its reality.

4 Case Study: San Sebastian Bernal as a Mexican tourism destination

4.1 National context: Tourism in Mexico

4.1.1 National Tourism Policies

In recent years, Mexican legislation and government programs have established tourism as a national priority to promote economic growth and employment. The actual system follows different lines of action, attempting to promote cultural tourism beyond the traditional tourist centres to diversify the offer and stimulate regional development. It is created to establish new patterns of use of rurality resources, helping local economy improvement at the same time. In this sense, we find the PND 2013-2018 created to face the new challenges of a stagnant economy.

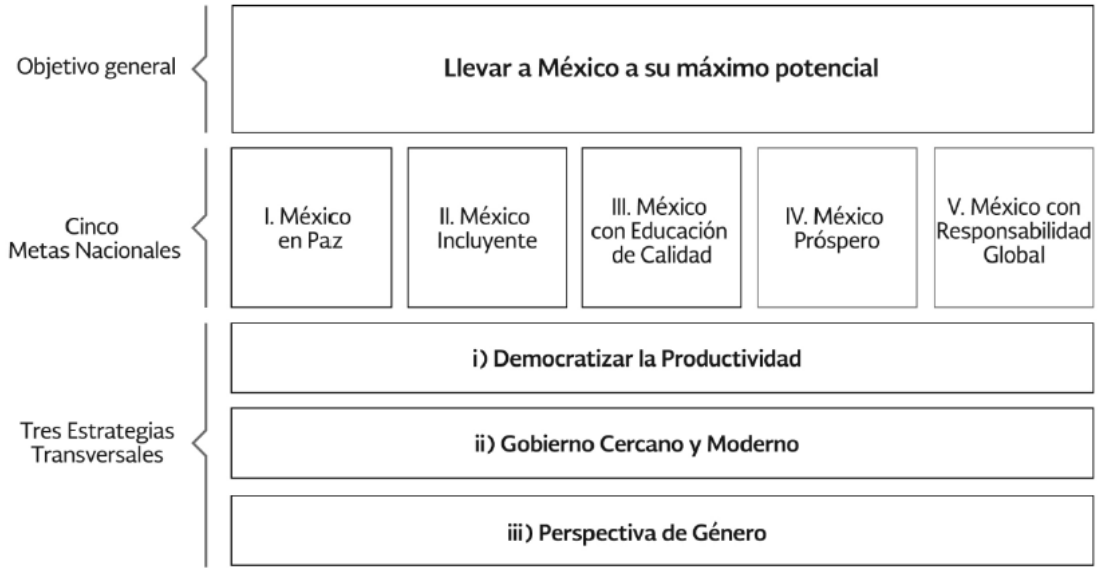


Figure 3 Scheme of the PND 2013-2018
Source: DOF, 2013

Over the last decade, Mexican productivity has not been sufficient enough to increase people´s living conditions, and the obtained revenues have not had a significant impact on the poverty level reduction in the long term. To break the barriers and face these limitations the PND proposed by government establishes five national goals: achieve peace and institutional strength, increase human capital and equality of opportunities, improve economic development and quality of life of the population and achieve an international

projection of the country. The main objective is to and brings Mexico to its maximum potential, enhancing the chances for Mexicans to be more productive, to innovate and to fully develop their aspirations. The PND also establishes three transversal strategies integrated into the national goals. They must be taken into consideration in the actions taken to achieve the proposed goals (Figure 3) (DOF, 2018).

A new policy of financial promotion is needed to exploit the existing opportunities in the Mexican territory. It must create the appropriate conditions for the strategic sector to acquire the capacity for generating employment, compete successfully abroad democratise productivity between industrial segments and geographical regions, and make high value through their integration with local productive chains. This fact gives place to the PROSECTUR through the SNPD. It coordinates efforts and determines actions among the agencies and entities of the federal administration to achieve the established national goal of having a more strategic and integrated approach policy for this sector. This program also gives continuity to the Programa Nacional de Turismo and maintains the model of a policy-oriented to empower the tourism activity for achieving national development through active promotion of recreational destinations (DOF, 2018; Gobierno de la República Mexicana, 2018).

The objective that determines the PROSECTUR 2013-2018 is to make Mexico a leader in the tourism activity, through the transformation of the existing schemes to exploit to the maximum its potential. The proposed strategies include strengthening their competitive advantages, supporting market diversification, developing a more integrated transport system to move visitors and service providers quickly around the country and getting new financing sources for potential tourism projects that encourage sustainable development and help to increase the social and economic benefits of the receiving communities (Gobierno de la República Mexicana, 2018). It also originates the Pueblos Mágicos Programme (PPM) to encourage small destinies as a complementary process for rural expansion.

4.1.2 Natural Protected Areas

As a result of the exploitation of its natural resources over the years, Mexico started to be aware of the damage and began to restrict the access and use of different natural areas.

The reasons have been different, including economic (reserves for forest or ecotourism), spiritual (religious sites), recreational, conservation of species (flora and fauna) and ecological restoration. In this sense, Natural Protected Areas has been established since 1917 alongside the Mexican territory as an environmental policy instrument for implementing natural management strategies more measurably.

They are defined as terrestrial or aquatic portions of the national territory with representative types of ecosystems where original environments have not been significantly altered by anthropogenic activities, and need to be preserved and restored because of their importance for biodiversity protection and ecological balance. Its eco-geographic characteristics, content of species and environmental services provided to the population such as the recharge of the aquifer, generation of oxygen, improvement of air quality, regulation of the climate, provision of leisure and recreation areas among others; have made their conservation a national priority (CONANP, 2019; SEDEMA, 2019).

These zones under the framework of the General Mexican Law of Ecological Equilibrium and Environmental Protection and being subject to special regimes of protection, conservation, restoration and development according to categories established in the Law.

The regulation advocates that the establishment of an NPA must preserve representative natural environments of the region in which it is established, as well as the genetic diversity of wild species, particularly those that are in danger of extinction, endangered, endemic, rare and that are subject to special protection. At the same time, the intention is to also protect the natural surroundings of archaeological, historical and artistic zones, monuments and ruins, as well as tourist areas, and other areas of importance to recreation, culture or indigenous identity. Likewise, the NPAs are intended to monitor that the use of resources within the area is carried out sustainably, to allow and promote research and study of ecosystems with the aim of generating knowledge and transmitting those practices or technologies that may facilitate the sustainable use of them (SEMARNAT, 2016).

Types and categories of protected areas

Depending on what level of government, there are three types of NPA: those of federal, state or municipal responsibility. There are also Ramsar sites, which are an international wetland conservation structure.

In this way, all the reserves and protected areas belong to different orders of the Mexican government, as shown in Table 3 below:

Categories of the NPAs in different orders of the Mexican government		
Federal	**State**	**Municipal**
Biosphere reserves	Ecological reserves	Ecological and urban parks, scenarios
National parks	State parks	Areas of scenic or recreational value
Natural monuments	Biological corridors	
Areas of natural resources protection	Restoration areas	
Areas of protection of flora and fauna	Regeneration and conservation gardens	
Sanctuaries	Private conservation areas	
State parks and reserves		
Areas of protection of flora and fauna		

Table 2 Categories of the NPAs in different orders of the Mexican government
Source: Vázquez Torres, Carvajal Hernández and Aquino Zapata, 2010

As we can see, the central protection system for protected natural areas in Mexico is federal. In order to be considered as federal protected, an area should be declared by presidential decree, and the activities that can be carried out in them are established following the LGEEPA.

In terms of classification, Mexico has a national system that involves NPAs with different management categories defined according to the objective for which they were created as well as the specific regulations that must be established to regulate the activities in the territory taking into account its physiographic, biological and socioeconomic characteristics.

In congruence with LGEEPA, the NPAs are divided into nine main categories (SEMARNAT, 2016):

- **Biosphere reserves**: These are representative areas formed by one or more ecosystems which has not been altered by the action of human being and that require to be preserved and restored given the representative species of the

national biodiversity that lives here, including those considered endemic, threatened or in danger of extinction.

- **National parks**: Areas with one or more ecosystems that stand out for its scenic beauty, it is scientific, educational and historical value due to the existence of endemic flora and fauna, for his aptitude for tourism development or other reasons of general interest. In these parks, it is prohibited the utilisation of natural resources and the settlement of human groups.
- **Natural monuments:** These areas contain one or several natural elements of unique character. Besides, they must be incorporated to an absolute protection regime given their aesthetic, historical or scientific value. They do not have the variety of ecosystems nor the surface needed to be included in other management categories.
- **Areas of natural resources protection:** These areas aim to the preservation and protection of the soil, the hydrographic basins, water conditions and in general of the natural resources located on lands with forest aptitude.
- **Areas of protection of flora and fauna:** There are established under the general decrees of the LGEEPA and other laws applicable to places that contains vital habitats for the preservation, existence, transformation, and development of wild species of flora and fauna.
- **Sanctuaries:** They are established in areas characterised by a considerable wealth of flora or fauna or by the presence of species, subspecies, and habitats of restricted distribution. They cover ravines, plains, relicts, grottos, caverns, cenotes, Caletas and other topographic or geographical units that require to be preserved or protected.
- **Ecological conservation zone:** They are representative areas formed by one or more ecosystems that have not been altered by anthropogenic actions and require preservation and restoration. In these areas, we found representative national and state flora and wildlife, including endemic, threatened or endangered species.
- **State parks:** Biogeographic and ecological representations at the state level with the great scenic beauty; scientific and historical value protected by their tourism aptitude or other analogous reasons of general interest. In statal parks, only activities related to the protection of their natural resources, the increase of their flora and fauna, the preservation of ecosystems and their elements, research, recreation, tourism, and ecological education are allowed.

- **Historical gardens:** Areas bordering historical monuments of the state, populated by non-native flora.

4.1.3 The Pueblos Mágicos Programme

As explained before, New Rurality is a concept that refers to a complementary process for countryside progress by considering social, cultural and environmental resources of a locality as transformative elements of its economy. In this sense, Mexican tourism policy is establishing new strategies to integrate political-economic processes with sustainable rural development, accelerating the social changes and activities in its territory. This is the case of the PPM, a worldwide scale product which comes up in 2001 through SECTUR to diversify the Mexican tourism offer through the promotion of small recreative destinies with potential tourism profile (Hoyos Castillo and Hernández Lara, 2008; CESOP, 2017).

According to the SECTUR (2018), a Pueblo Mágico is a locality that has symbolic attributes, legends, history, transcendent facts, magic that comes from its socio-cultural manifestations. Its heritage has been preserved through time and represents an excellent opportunity for economic growth since its characteristics create an opportunity to establish their tangible and intangible patrimony as a tourism icon of Mexico. The PPM aims to contribute to revalue the group of the Mexican population that has always been left aside by the majority of the country, and that can be seen as new attractions for national and foreign visitors. In this way, the program intents promote the recognition of the inhabitants of these places as well as exploring the cultural and historical richness they have following the existing governmental policies.

For this, the main objectives of PPM include (Fernández Poncela, 2015):

- To structure a complementary and diversified tourist offer based on the historical-cultural attributes of Mexican singular localities.
- To take advantage of the uniqueness of the localities for the generation of tourist products based on the different local expressions such as culture, crafts, festivities, gastronomy, traditions, extreme sports, ecotourism among others.
- To value, consolidate and reinforce the attractions of the localities with tourism potential to generate:
    - More significant revenues for the benefit of the host community
    - The creation and modernisation of local tourism businesses

- The establishment of tourism as a tool of local, sustainable development and support to the municipal management.
- The participation of localities as beneficiaries from tourism (Fernández Poncela, 2015).

The objectives of the PPM consider the convenience that tourism activity must develop sustainably. They take into account the impact that recreational activities may have on a rural area and at the same, time focus on guaranteeing the maintenance of biodiversity and cultural authenticity of the place. The need for offering the best tourist experience for the visitors is also mentioned without compromising the standards of life of the local population. Moreover, to be part of the PPM, a locality should accomplish with specific criteria which include (Covarrubias Ramírez, Vargas Vázquez, and Rodríguez Herrera, 2010):

1. Involvement of society and local authorities
2. Planning and regulation instruments
3. Boosting municipal development offer of attractions and services
4. Unique value "The Magic of the Locality."
5. Conditions and territorial spaces
6. Impact of tourism in the locality and area of influence
7. Development of local capacities

4.2 The regional context of San Sebastián Bernal

Peña de Bernal is a tourist destination located in Querétaro, a state that has an unbeatable position in the geographical centre of the Mexican Republic. It is situated in the coordinates north 21°40', south 20°01' north latitude; east 99°02' and west 100°36'; and borders to the north with Guanajuato and San Luis Potosí; to the east with San Luis Potosí and Hidalgo; to the south with Hidalgo, Mexico, and Michoacán de Ocampo; and to the west with Guanajuato. It has an extension of 11.769 km^2 and occupies the 27th place nationwide in terms of importance given its strategic economic localisation and well-developed industry (INAP, 2017).

Referring to its political division, Querétaro was constituted by eleven municipalities until 1940. After that, the six largest cities of the state were divided, resulting in seven new independent localities. From that date the municipal structure of Querétaro has remained formed by eighteen municipalities: Amealco de Bonfil, Arroyo Seco, Cadereyta de Montes,

Colón, Corregidora, Ezequiel Montes, Huimilpan, Jalpan de Serra, Landa de Matamoros, El Marqués, Pedro Escobedo, Peñamiller, Pinal de Amoles, Querétaro, San Joaquín, San Juan del Río, Tequisquiapan and Tolimán.

Besides the state has six localities declared as magical towns in its territory, a situation that contributes to its tourist attractiveness? These towns are Amealco, Bernal, Cadereyta de Montes, Jalpan de Serra, and San Joaquín and can be seen in Figure 4.

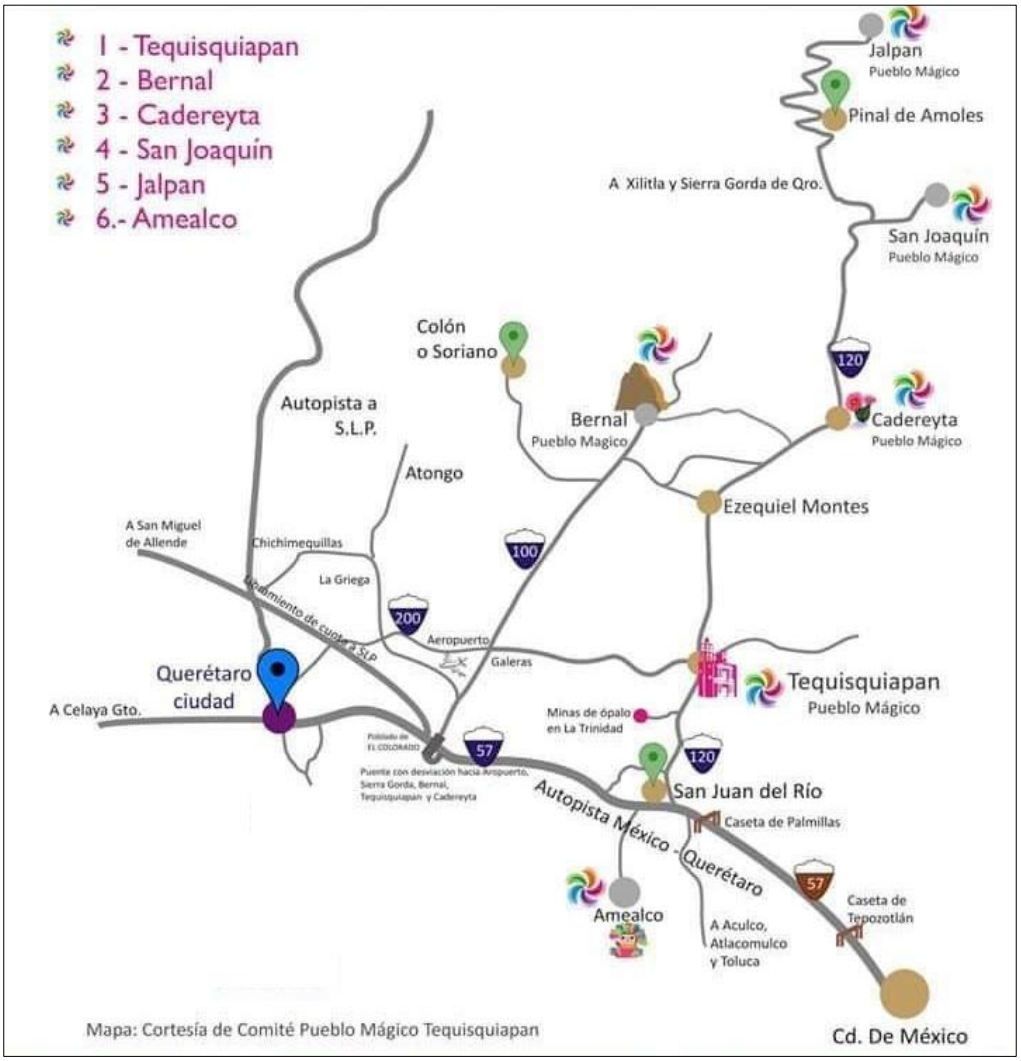


Figure 4 Magical towns of the State of Querétaro
Source: Comité del Pueblo Mágico de Tequisquiapan, 2019

4.2.1 Geographical and geological aspects

Most of the territory of Querétaro belongs to the Cenozoic, composed of 88% from extrusive and alluvial igneous rocks. The remaining 11% is formed by sedimentary rocks of the Mesozoic, and 2% of limestones and limestones-shales located in the northern part of the municipality, specifically in the town of El Raspiño.

The landscape of the state is defined by mountains and hills, both from the volcanic and sedimentary origin. In here we can distinguish three central geographical regions: the Neovolcanic Axis, the Sierra Madre Oriental, and the Mesa Central. The Neovolcanic Axis comprises plains filled by alluvial or lacustrine deposits of the Quaternary, which have an altitude between 1.780 and 2.000 masl. Besides, there are some plains of soft slope and rocky floor in the area, mainly formed by acidic tuffs and breccia or basalt, which are often around mountain ranges and volcanic zones and date from the Pliocene epoch. It is characterised by the presence of favourable agricultural conditions such as flat terrains and aquifers, which promote the development of small and major cities. On the other side, the Sierra Madre Oriental is formed by limestone rocks which are already dissolving. This situation generates large cavernous formations and variable weather given the altitude differences. The existence of jungle areas can also be evidenced in this geographical region (INEGI, 2010).

The volcanic mountain ranges of the Mesa Central are older than the Neovolcanic Axis ones and have abrupt slopes which are sharply dissected. Their altitude varies between 2.600 and 2.900 m, and they also present plateaus whose rocky surfaces are around 2.500 masl. The predominant rocks in these geo-forms are rhyolites and acid tuffs of the Upper Tertiary. Its land is characterised by dry weather, which allows the apparition of desert biodiversity in the zone (Centro Queretano de Recursos, 2002).

The northeastern zone is made up of mountains with altitudes of 2.720 m above the sea level such as the Tejocote hill and Pinal de Amoles, where amazing landscapes can be found. There is also another kind of landscapes such as the canyon of Jalpan de Serra with a height of 200 m. In the north-centre part of the state, we can appreciate plateau-shaped mountain ranges where El Zamorano hill is located with an altitude of 3.360 m above the sea level. In the central part, there are two mountain ranges separated by plains where the municipalities of San Juan del Río and Ezequiel Montes are sited (SECTUR, 2014a).

According to INEGI, in the state of Querétaro, there are eleven main types of soil, where the leptosol soil (35.7%) stand out for their coverage area, followed by phaozems (25%) and vertisols (17.7%). The rest of the soil is occupied by smaller extensions of regosol, cambisol, gipsisol, chernozem, kastañozem, fluvisol, luvisol, and eplanosol type.

4.2.2 Climate

The climatology of the region is conditioned to several geographical factors: on the one hand, the different altitudes and on the other hand a minimal maritime influence, considering the Sierra Madre Oriental acts as an orographic barrier and does not allow the passage of humid winds from the Gulf. Considering these aspects, three climate areas can be defined for the state: first of all, the southern portion, which comprises part of the Neovolcanic Axis where the climates are temperate and concentrate more humidity in the south and decreases as moving towards the north. Secondly, the central region which covers areas from the three physiographic provinces and where the prevailing climates are semi-dry and may vary from warm to temperate depending on the altitude. Finally, the northern zone which corresponds to a portion of the Sierra Madre Oriental, where the climates vary from warm to temperate also depending on the altitude (Figure 5) (Musalem López *et al.*, 2007).

Taking into account these climate areas, the average annual temperature is 19°C, the average maximum temperature is 28°C during April and May, and the average minimum temperature is 6°C during January. Regarding the rain presence in the territory, the average annual rainfall is 287,44 mm, and it is more abundant from May to October. However, there are intense droughts from November to April (SECTUR, 2014a).

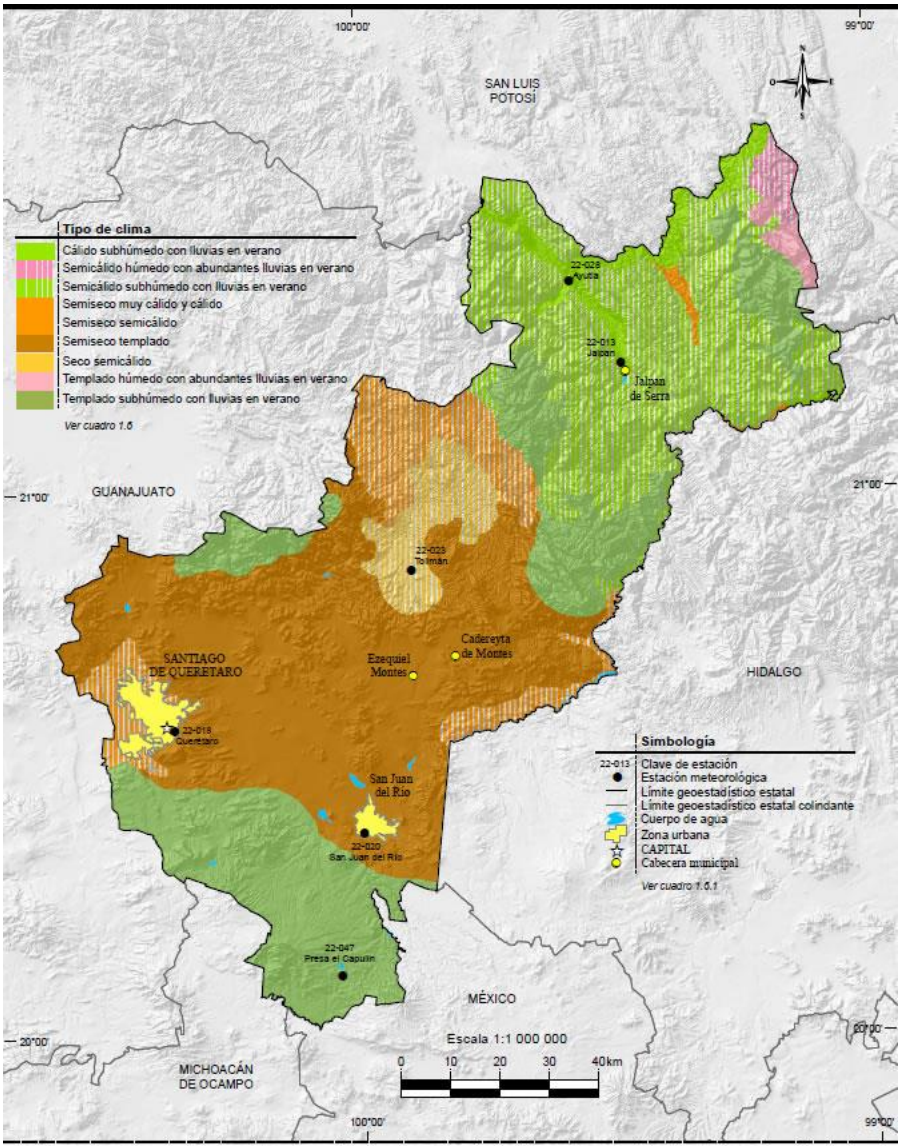


Figure 5 Climatological map of the State of Querétaro
Source: INEGI, 2018

4.2.3 Hydrology

Querétaro hydrological system is composed by fourteen rivers: Moctezuma, Santa María, San Juan, Extóraz, Ayutla, el Pueblito, Jalpan, Victoria, las Zúñigas, Yerbabuena, Los Amoles, el Macho and el Concá. These rivers and other twelve water bodies are part of the principal basins of the state (UAQ and CONABIO, 2017).

There are two main basins and two sub-basins in the semi-desert region. The first one is mainly formed by the current of Moctezuma river and has its origin in the State of Mexico. It occupies 4.400 km², has an average runoff of 444 million m^3 per year and marks the limit between Querétaro and Hidalgo. Moreover, the Moctezuma river is first known as San Jerónimo, later as Zarco and finally as San Juan river whose sub-basin occupies 2.840 km² and contributes with an average runoff of 184 million m^3 per year. The second basin is mainly formed by the current of Laja river, has its origin in the State of Guanajuato and occupies the western portion of Querétaro, where dry and semi-dry climates determine the presence of small currents. This basin has an annual runoff of 40 million m^3 and covers an area of 2.800 km². Finally, the intermediate sub-basin is one of the Apaseo el Alto River, which is in the border with Guanajuato (see Figure 6) (Musalem López *et al.*, 2007; INEGI, 2010).

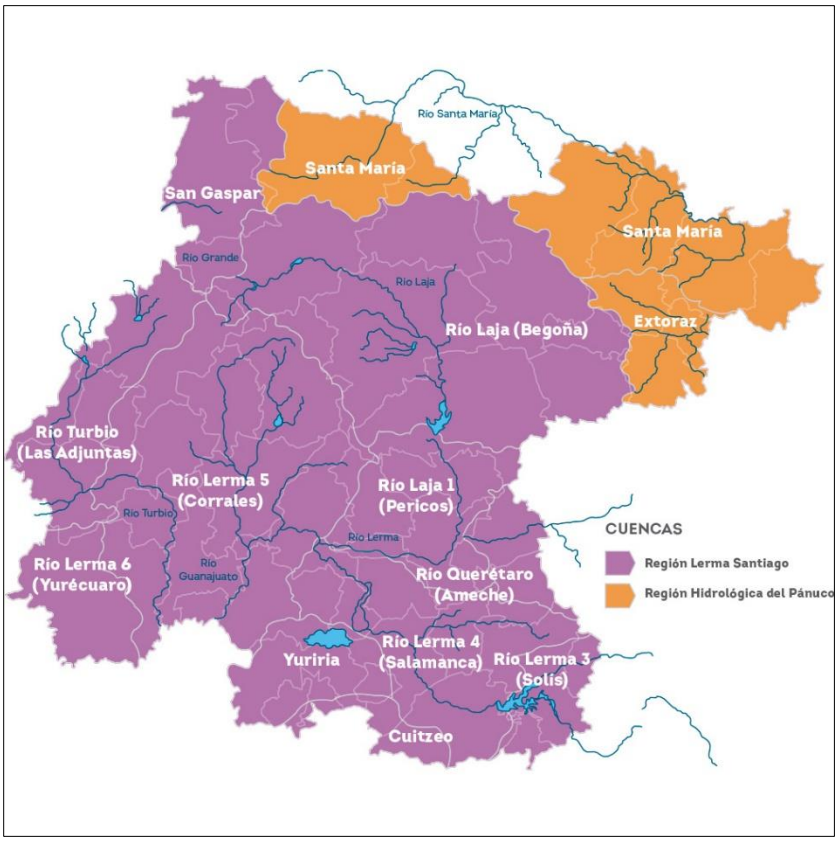


Figure 6 Basins in the State of Querétaro and Guanajuato
Source: CEAG, 2018

In this way, the state is part of two major national hydrological regions: the Lerma-Santiago and the Panuco. The Lerma-Santiago region is formed by the Lerma-Toluca and the Laja basins; while the Panuco region is formed by the Tamuín and Moctezuma basins (Figure 6). In the western part, the Querétaro and Pueblito rivers break through the currents of several tributaries from the Zamorano volcano in Colón, passing by the opposite part of the Calamanda hill in Pedro Escobedo to nourish the Laja River. On the other side, the Lerma River has an average annual runoff of 9 million m^3 per year pours the currents of the municipalities of Amealco and Huimilpan. Finally, the Santa María river has 257 million m^3 of annual runoff and goes into the State through the municipality of Arroyo Seco acting as a northern border with the State of San Luis Potosí (SECTUR, 2014a).

4.2.4 Vegetation

The municipality and its metropolitan area belong to the Floristics Province from the Altiplano, and the predominant vegetation is the xerophytic scrubland, with areas of grassland and spiny forest. Other characteristic species are the crasicaule scrub surrounded by relics of tropical deciduous forest, especially in mountainous areas where the native vegetation is better conserved. The flora present in the territory is estimated at around 2.421 vascular plant species, included in 170 families and 937 genres. If we classify this vegetation in order of importance, we can find first scrubs that are mainly located in the central part of the State. Then we have coniferous and oak forests located in the high northern regions, and dry forests located in the centre and north of the state. Finally, the so-called grasslands are located in areas near forests and rainforests Moreover, the Ministry of Sustainable Development advocates that 64 of the mentioned species are included on a risk category according to the NOM-059-SEMARNAT-2010, from which 26 belong to the family Cactaceae, and 24 are endemic of the state (UAQ and CONABIO, 2017).

Specifically, in the NPA of Peña de Bernal, it is common to observe the crasicaule thicket, which reaches a height of 4 to 5 m, settling on slopes, and usually on shallow and stony soils. Grasslands are developed near the town of Bernal, which extend to the municipalities of Colón and Tolimán, while in the surroundings of the Peña de Bernal there are grassland and temporary agriculture areas.

Referring specifically to the NPA, the predominant vegetation type is scrubland occupying the 66,69% of the land distributed in almost all the protected area, followed by disturbed

submerge scrubland with 26,51% that extends mainly to the northeast, east and southeast. Areas without vegetation correspond mainly to the rock and represent about 3.67% of the total area. It is also common to observe crasicaule thicket settling on slopes, and usually on shallow and stony soils. Grasslands are developed near the town of Bernal and occupy 22,47% of the area while in the surroundings of the Peña de Bernal there are temporary agriculture areas which occupy 0.66% (Gobierno del Estado de Querétaro, 2009).

4.2.5 Natural Protected Areas of Querétaro

Given the accelerated growth dynamic of Queretaro, several legal instruments have been established in answering the integral vision needed for the protection of its natural resources. Queretaro has an Environmental Protection Law for Sustainable Development that defines NPAs as within its territory to preserve and conserve its natural environments, safeguard biodiversity and improve the quality of the environment through the defence of its ecosystem services (El Universal, 2014).

In this sense, the Ecological Management Program of the State of Querétaro establishes that the NPAs must be classified into four groups that correspond to its environmental policies and objectives. This classification is described below: (table 3):

Classification criteria for the PNA of the State of Querétaro	
Protection	It corresponds to the proposed and decreed natural protected areas and the core areas for biodiversity conservancy
Conservancy	It corresponds to those areas that describe the vegetation, water, park, and conservation priority areas
Sustainable exploitation	It corresponds to those areas of irrigation agriculture, temporary agriculture, and temporary and irrigation agriculture
Urban	It corresponds to urban areas according to current urban development plans and programs

Table 3 Classification criteria for the PNA of the State of Querétaro according to the Ecological Management Plan
Source: SEDESU, 2018

Moreover, the NPA of the state are also divided according to the type of administration. Queretaro is divided into fifteen natural protected areas from which four are federal; six are located in the state, and five are municipally distributed in thirteen of the eighteen municipalities. This classification is shown in Table 4 and can be seen in Figure 7:

Natural Protected Areas of the State of Querétaro						
Regime	**Name**	**Category**	**Municipalities**	**Decree date**	**Surface**	**% state**
FEDERAL AREAS (4)	Sierra Gorda	Biosphere reserve	Arroyo Seco, Jalpan, Landa de Matamoros, Pinal de Amoles and Peñamiller	19.05.1997	383.567,44	32,82
	Cerro de las Campanas	National Park	Querétaro	07.07.1937	3,80	0,00
	El Climatario	National Park	Querétaro, Corregidora and Huimilpan	21.07.1982	2.447,87	0,21
	Forestal Protection Area	Areas of natural resources protection	San Juan del Río and Amealco	04.11.1941	23.255	1,99
STATE AREAS (6)	Mario Molina Pasquel "El Pinalito"	State Reserve	El Marqués	07.02.2003	1.592,52	0,14
	El Tángano	Ecological conservation zone	Querétaro, El Marqués and Huimilpan	22.03.2005	717,68	0,06
	Bordo Benito Juárez	Ecological preservation zone, population center with intra-urban park subcategory	Querétaro	13.02.2009	27,61	0,00
	Tángano II	Ecological reserve zone	Huimilpan and El Marqués	22.05.2009	137,59	0,01
	Peña de Bernal	Protected landscape	Ezequiel Montes and Tolimán	05.06.2009	263,91	0,02
	El Batán	Ecological reserve zone	Corregidora	06.06.2013	3.341,57	0,29
MUNICIPAL AREA	Occidental Zone of Microbasins	Ecological conservation zone	Querétaro	22.09.2005	12.234,05	1,05

	Jurica Poniente	Ecological preservation zone, population center with intra-urban park subcategory	Querétaro	25.09.2006	224,11	0,02
	Cañada Juriquilla	Ecological preservation zone, population center with intra-urban park subcategory	Querétaro	19.05.2009	22,06	0,00
	Sierra el Raspiño	Ecological preservation zone, population center with intra-urban park subcategory	Querétaro	25.09.2012	4.104,17	0,35
	Cerro Grande	Ecological preservation zone, population center with intra-urban park subcategory	Querétaro	25.09.2012	2.989,18	0,26
TOTAL					**434.928,56**	**37,21**
Total Surface of the State of Querétaro (in ha)						**1.168.768,83**

Table 4 Natural Protected Areas of the State of Querétaro
Source: SEDESU, CONANP (2018)

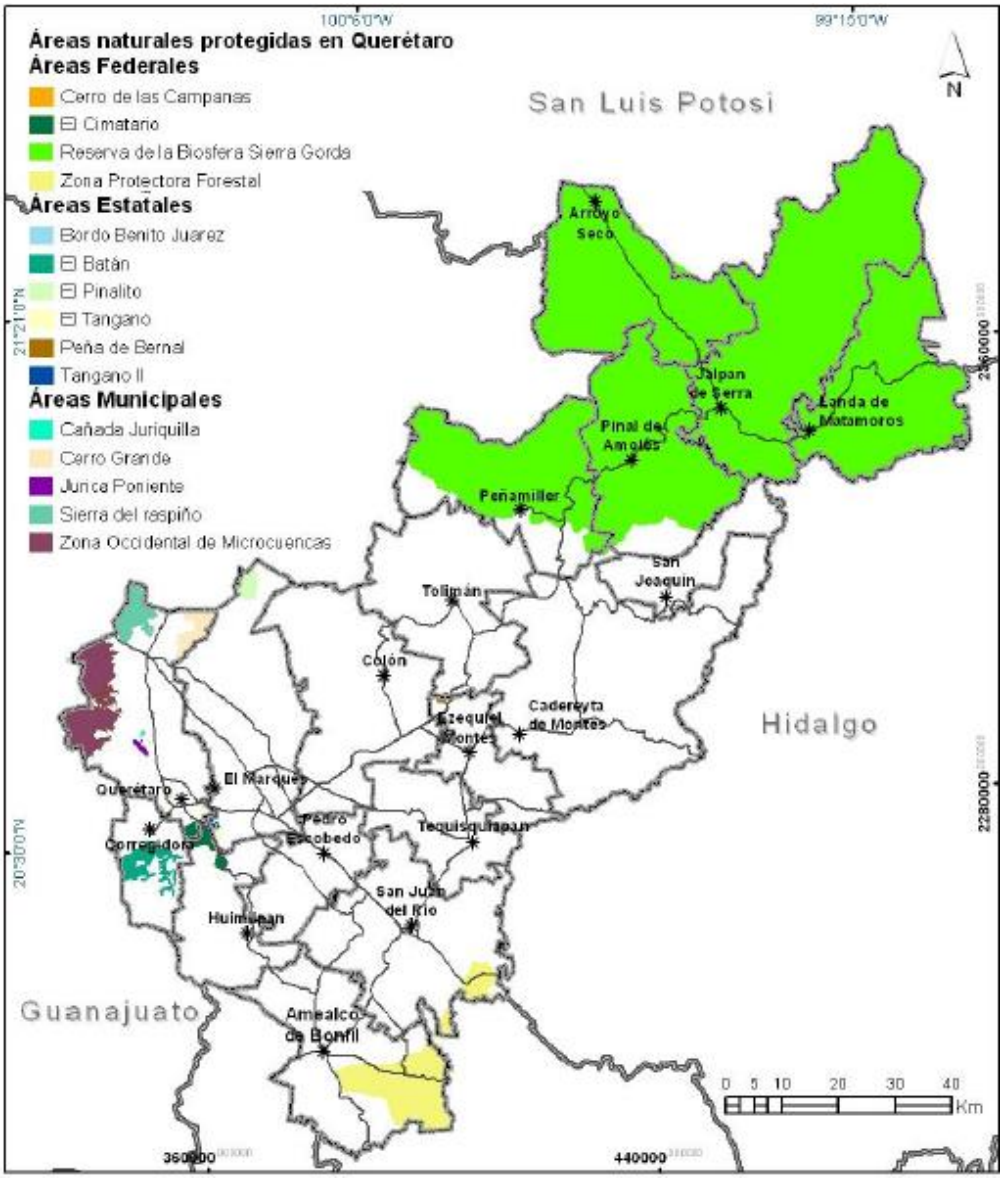


Figure 7 Natural Protected Areas of the State of Querétaro
Source: SEDESU, 2018

4.2.6 Historical context

In 1446 the mountains of Santiago de Querétaro were inhabited by Otomi and Purépechas, which were the last indigenous groups managing these lands before the appearance of the European conquerors. With the arrival of the Spaniards, on July 25th, 1531, the capital of

the state was baptised as Santiago de Querétaro, after the Apostle Santiago el Mayor, patron of Spain. During this transition process only pames and jonaces (both Chichimeca groups) opposed resistance to the occupation, the other indigenous tribes willingly participated in the economic and cultural transition process.

Due to its importance, Querétaro became the capital of the Mexican Republic in 1848. By this reason around 3000 of the most beautiful colonial buildings preserved until today date from the Viceroyalty Epoch. Moreover, the state was very visited and took a massive step towards economic development, given its situation as a city of passage. Thanks to its privileged location between Mexico City and the Zacatecas mines, Querétaro was also called "Garganta de Tierra Adentro" (*Fundación de Querétaro*, 2018).

The state of Querétaro also played a very representative role in the history of Mexico. The conspiracies of the libertarian independence movement took place in its territory at the beginning of the 19th century. Later, during the Reformation and the French Intervention, there were continuous battles between liberals and conservatives. Querétaro was also the scenery of the execution of Maximiliano de Habsburgo and his leading conservative generals by order of Don Benito Juárez, the legitimate president of Mexico at that time. Once the revolutionary movement was consolidated in 1917, the theatre of the Republic located in the city of Querétaro was the seat of the Constituent Congress that promulgated the Political Constitution of the United Mexican States, which is in force until today (Miró Flaquer and Urilla Sarmiento, 2018).

4.2.7 Economic context

Querétaro is characterised by the high dynamism of its economy. Its development was catapulted through the earthquake of 1985 when a strong migration movement from the capital of the country was registered. The population growth caused a change in the economic sectors, where the secondary and tertiary activities gained importance over the primary sector, due to their percentage of contribution to the Gross Domestic Product. Moreover, its proximity to Mexico City, to the main ports and other tourist areas located in the surroundings of Guanajuato and San Luis Potosí, has also increased its economic revenues over the last 40 years.

According to INEGI data, in 2015 the State's GDP showed a 7.7% growth which was considered the highest of the year in the Mexican nation, while the rest of the country grew

on average 2.5%. The state GDP in that year was 314.978,9 million pesos, which represented 2.3% of the national GDP. Besides, in 2017, Querétaro contributed 53% of the total production of the territory (SEDESU, 2018).

The importance of its economic growth lies in the diverse activities developed by its human settlements. The capital of the state concentrates a large part of the state's industry; thus, San Juan del Río and its surroundings are specialised in industrial and commercial activities. In the same way, the municipality of Tequisquiapan, Cadereyta and Ezequiel Montes are well-known for the development of agricultural and livestock activities. Moreover, in Ezequiel Montes and Tequisquiapan, tourism has transformed the economy thanks to the numerous attractions existing in the area such as thermal waters, spaces dedicated to art, archaeological sites, nearby places to practice ecotourism, visits to colonial haciendas, magical towns, and vineyards, fairs, traditional celebrations among others. Thanks to it, the state has a great touristic offer attracting national and international visitors every year (INEGI, 2010).

4.3 Local context

4.3.1 The Peña de Bernal, the Pueblo Mágico and their location

After having seen the regional context which surrounds Bernal, the analysis of its local context has to be done by broadening the scope of the study without reaching regional limits. First of all, Peña de Bernal is located in one of the states with the highest economic growth in Mexico, as shown in the Figure 8 below. This situation directly impacts into the number of visitors that the town receives given its privileged location in the center of the state of Querétaro, surrounded by other picturesque municipalities such as Tequisquiapan and Cadeyreta, and well-developed industrial localities, such as the case of San Juan del Río.

The existing road infrastructure between Mexico City, Querétaro, Bernal and the nearby localities put Bernal in the centre of the tourist attractions of the area, making it a necessary stop for the incoming visitors. In the first place, Bernal is located at 52 km northeast from Santiago de Querétaro, going through the federal highway No. 4. This highway also communicates Bernal with the municipality of Tolimán.

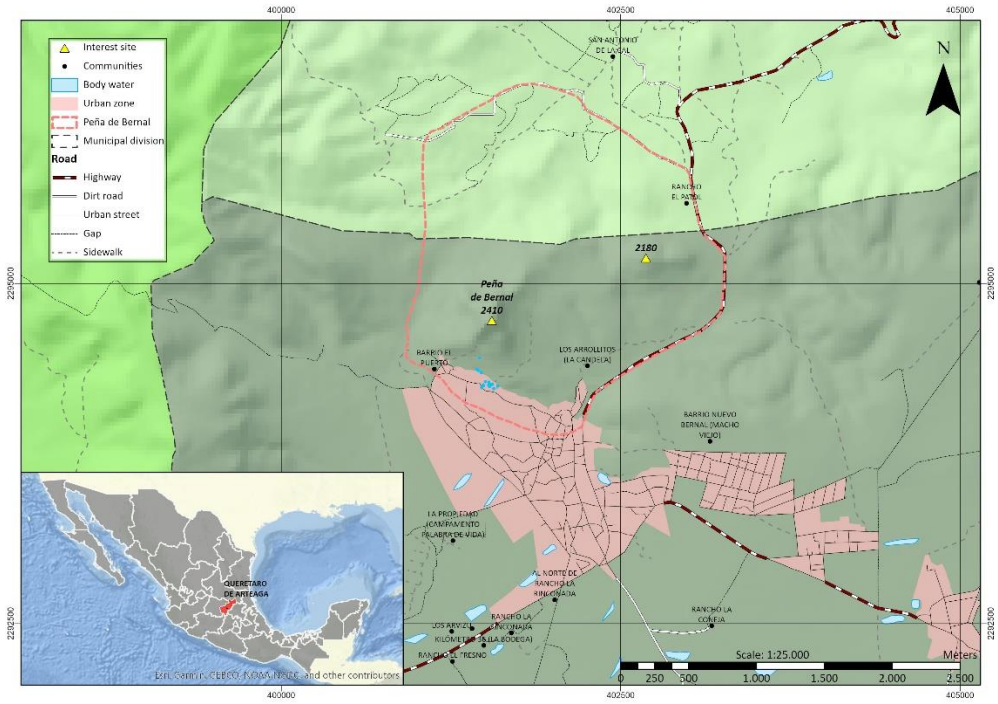


Figure 8 Localization of Peña de Bernal in the State of Querétaro
Source: Centro Queretano de Recursos Naturales, 2019

Secondly, there is 237,4 km from Mexico City to Bernal going through the highway No. 57, which is one of the most important highways of Mexico given it also connects the area with the Querétaro International Airport. It also crosses through the cabecera municipal of San Juan del Río and Pedro Escobedo and intersects with the Federal Highway No. 111, corresponding to the Querétaro-San Luis Potosí main road.

Another relevant situation to consider is the proximity of Bernal to the municipality of San Juan del Rio. Thanks to its geographical location between Mexico City and Querétaro; San Juan del Río has become a focal point for the commercial exchange between the centre, the Bajío area and the north of the country. Furthermore, the existence of an Industrial Park between Querétaro and San Juan del Río, located in the south-eastern part of the municipality has increased the economic activity in the region. The access to the industrial park can be achieved from two points: to the west by the sewer passage of the Railroad, which connects the Industrial Park with the road to Tequisquiapan and the city of San Juan

del Río; and to the south, through the federal highway No. 57 (El sol de San Juan del Río, 2018).

Among the main industrial activities developed, we found the fabrication of water-based emulsion resins for paper, cardboard, paints, cleaning products, coatings, construction material, adhesives, textiles, auto-parts, among others. In this region, we can also find a Regional Supply Center which benefits the entire Bajío area, including the municipalities of Hidalgo and the State of Mexico. There are several self-service and department stores; the most important are: Walmart, Bodega Aurrera, Bodega Aurrera Express, Sam's Club, Coppel, Office Depot, Soriana Hiper, Soriana Express, Chedraui, Comercial Mexicana, Home Depot Express and Liverpool. Finally, its annual fair is one of the most recognised from Mexico, which attracts hundreds of visitors every year (Crónica Regional Querétaro, 2019).

Finally, in terms of the importance of the place, San Sebastián Bernal was included in the national touristic product of Pueblos Mágicos and was added to it in 2005 thanks to its historical heritage represented by its symbolic attributes, legends, history, obscure facts and socio-cultural manifestations. The inclusion on the program gave Bernal consolidated popularity on the national and international scale. Moreover in 2006 UNESCO awarded Bernal the distinction as "Intangible Cultural Heritage of Humanity" given it is considered a place of memory and living traditions of the Otomí-Chicimecas de Tolimán (Gobierno del Estado de Querétaro, 2009).

4.3.1.1 Ezequiel Montes

Peña the Bernal is located in the municipality of Ezequiel Montes in the east of Querétaro. The surface area is 298.277 km2, representing 2,4% of the State. It borders with the state of Hidalgo in the Southeast, Tequisquiapan in the southwest, Toliman in the north, Cadereyta in the east and northeast, and with the municipality of Colón in the west. It has a political-administrative division formed by a cabecera municipal, two delegations (Bernal and Villa Progreso), which comprise 27 towns with a population higher than 100 inhabitants and 107 human settlements. Based on the above, the territory is divided into three zones or sub-regions: Ezequiel Montes, Bernal, and Villa Progreso (Figure 9).

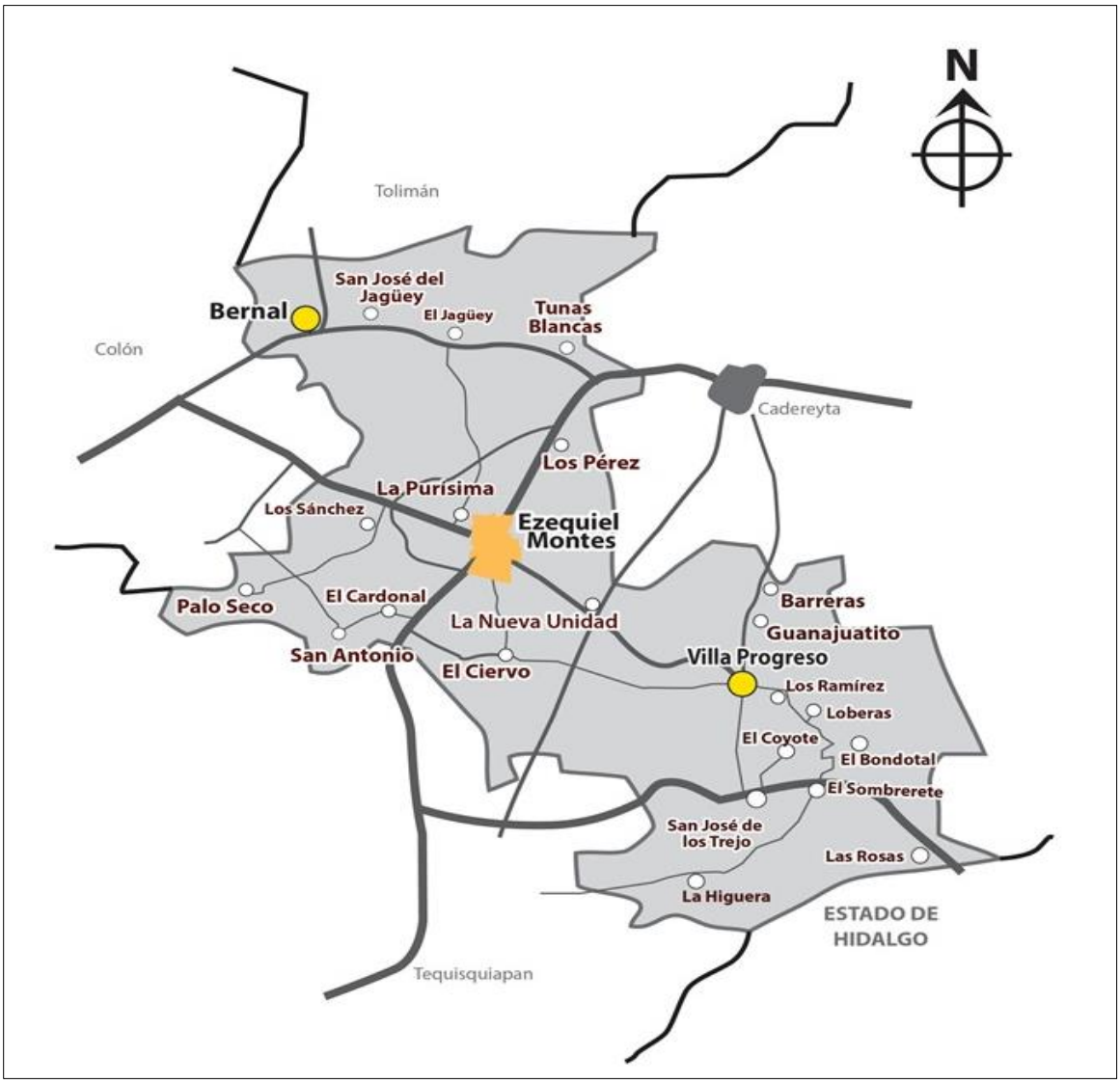


Figure 9 Location of Bernal in the municipality of Ezequiel Montes
Source: Gobierno Municipal de Ezequiel Montes (2015)

4.3.1.2 Sociodemographic profile

Ezequiel Montes has a total of 38.123 inhabitants, from which 18.21 (52%) are male and 19.910 (48%), female (Table 5). In terms of population, Bernal has the third place among the municipality with 3.965 inhabitants. It is surpassed by Villa Progreso and Ezequiel Montes which have 5.604 and 14.053 inhabitants respectively.

	1990	1995	2000	2005	2010
Men	10.517	12.230	12.983	16.373	18.213
Women	11.342	13.375	14.615	18.356	19.910
Total	21.589	25.605	27.598	34.729	38.123

Table 5 Population of the municipality of Ezequiel Montes for the period 1990-2010
Source: INEGI Population and Housing Census, 2010

In Table 3, we can see that the majority of inhabitants of Ezequiel Montes are in the range of 30-59 years, divided into 6.999 men (45,49%) and 8.387 women (54.51%). This means that the municipality is mainly represented by a group of the young and economically active population, from which the majority are women (Table 6):

Age group	Men	Women	Total	% Men	% Women
0-14	6.235	6.012	12.247	50,91%	49,09%
15-29	3.686	3.935	7.621	48,37%	51,63%
30-59	6.999	8.387	15.386	45,49%	54,51%
65 and more	1.252	1.535	2.782	44,92%	55,08%

Table 6 Age groups in the municipality of Ezequiel Montes
Source: INEGI Population and Housing Census, 2010

Moreover, another aspect to consider about the population of Ezequiel Montes is that there are still small but representative groups of people who speak indigenous languages. In this case, Otomí and Mazahua dialects are positioned as the most spoken languages y population in the area (Gobierno Municipal de Ezequiel Montes, 2015). This information is shown in Table 7 below:

Indigenous language	Total	Men	Women
Otomí	155	79	76
Unspecified Indigenous language	20	16	4
Mazahua	10	6	4
Population that speaks indigenous languages	200	110	90

Table 7 Indigenous population of the municipality of Ezequiel Montes divided by spoken languages
Source: INEGI Population and Housing Census, 2010

4.3.1.3 Economic activities

The economic context of Ezequiel Montes can be divided into five main sectors: agriculture and wine production, livestock, commerce, industry, and tourism.

Referring to agriculture, Ezequiel Montes is recognised for the quality and fertility of its lands, which combined with the climate of the area benefit the production of endemic crops. The population fosters mainly sorghum, corn, beans, tomatoes, wheat, nopal, and alfalfa divided into eight different ejidos (social property lands), as shown in Table 8. The higher production is reached in the spring-summer cycle due to the abundant rains that decrease the production costs (SECTUR, 2014c).

Ejido	Number of producers	Type of crop
Ezequiel Montes	242	Corn, sorghum, alfalfa and beans
Villa Progreso	72	Corn interspersed with beans
Liberal	36	Corn and beans
El Bondotal	20	Corn and beans
La Higuera	18	Corn
El Ciervo	66	Corn, sorghum, alfalfa and beans
Los Pérez	20	Corn and beans
Las Rosas	23	Alfalfa, corn and vegetables

Table 8 Main products grown in Ezequiel Montes divided by ejidos
Source: Gobierno Municipal de Ezequiel Montes, 2018

These ejidatarial lands occupy an approximate total area of 8.342 ha of the state, from which 33,3% is already cultivated, and the rest is landed with natural pastures. In 2015, the municipality had 4.082 ha of the planted surface, with water availability for irrigation. Most of this hydraulic infrastructure used for agriculture is concentrated in the western part of the municipality, in the limits with Tequisquiapan. Additionally, the cultivation of the vine and derivate products has become an important economic activity of the municipality. The vine production is carried out in two vineyards: La Redonda y Freixenet of Mexico (Gobierno Municipal de Ezequiel Montes, 2015).

Another outstanding economic activity in the municipality is livestock thanks to its topographic and climatological characteristics. It is represented by the municipal Livestock Association of Ezequiel Montes which is integrated by more than 300 associates and has 157.000 heads of cattle, 25.000 pigs, 10.000 sheep, 3.000 goats, and 3.000 horses. The main product is beef representing 34% of the total meat production of Querétaro. The next is chicken meat with 27%, followed by eggs production with 22% and finally swine meat with 10% of the state production (SECTUR, 2014c).

The commercial activity in Ezequiel Montes is also thriving. It is extensive compared with other municipalities in the region since it benefits from its geographical location as well as from the existing roads and infrastructure. In this sense, commercial activities in Ezequiel Montes are divided into two sub-categories: big commerce, which includes self-service shopping centers, hardware stores, shoe stores, pharmacies, wineries, greengrocers, foragers, hotels and restaurants; and small commerce, in which we find grocery stores, stationeries, butchers, restaurants, fruit shops among others. By the end of 2015, 1.132 stores were registered with a license; however, it is estimated that there are still 1.855 small and medium businesses without a license or in the middle of a registration process.

In the same branch of commercial activities in the municipality is the buy and sell of grains, fodder and cattle feed, due to the importance of livestock activities in the municipality as well as the massive production of meat. In this sense, the intra-communitarian commerce has increased thanks to the support societies, and cooperatives that have helped to create shared spaces of distribution such as popular markets which are visited by local and external merchants. There is a register of 654 merchandisers, and 52 local tenants have been registered (Gobierno Municipal de Ezequiel Montes, 2015).

The industrial activity of the municipality mainly covers the operation of lime banks, clothing manufacturing companies, spice processing, and plastic products companies, as well as plants producing feed for livestock. There are also minor industries dedicated to furniture manufacturing and the metal-mechanical industry (Gobierno Municipal de Ezequiel Montes, 2018).

Another critical economic field for the municipality of Ezequiel Montes is tourism. Its principal attractions are the vineyards, the spas of the area and the Peña de Bernal, which is considered a symbol of the State. The monolith can be seen from more than 80 km away, it is considered a natural attraction of excellent tourist importance and as a point of reference for the visitors that arrives at the state. There are guided tours through the base of the monolith and high-level climbing to the top of the Peña. Besides in the town of Bernal tourist can find traditions, legends, local cuisine, and handicrafts.

4.3.1.4 Historical context

The town was established in 1647 under the name of Bernal, whose origin comes from the Basque word "vernal", which means place of stones or rocks. It was a territory adjacent to

Great Chichimeca until the middle of the 18th century. The jonaces and pames that lived there opposed resistance to the Spanish colonisation. By this reason, its principal founders who came from Cadereyta de Montes, arrived at the place by request of the landowners to defend the territory. In this way, the first inhabitants where the soldiers were guarding the region.

After these events, new families also established in Bernal, and new buildings were built primarily in Villa Progreso. They were called royal houses because of their castle shape. In the same way, new constructions with portals and internal arches were made and nowadays are considered the cultural heritage of the town, since their age varies between 200 and 300 years. Finally, in 1725, the name of Congregation of San Sebastián Bernal is granted to the town and the construction of the temple of three ships begins, which takes its name in honour to San Sebastián Mártir, patron of the Spanish military that colonised the territory (Gobierno Municipal de Ezequiel Montes, 2015).

4.3.1.5 Peña de Bernal

Description and origin

Peña de Bernal is one of the main attractions of Ezequiel Montes and Villa Bernal. It is one of the tallest monoliths of the world with a maximum height of 433 m and 2.500 m of altitude. It covers an area of 4,8 km^2 and its located in the municipality of Ezequiel Montes at the intersection of three major geologic provinces: the Miocene Quaternary Mexican Volcanic Belt, the mid-Tertiary Sierra Madre Occidental ignimbrite-dominated sequence and the Mesozoic Sierra Madre Oriental fold-thrust belt; which in this area corresponds to the Sierra Gorda sector (Figure 10).

It is a highly crystalline and very resistant rock, grey to light grey when fresh and brown when weathered. Its texture is porphyritic, nearly holocrystalline (80 vol% crystals and 20 vol% glass), composed by a mineral assemblage of pyroxene, hornblende, biotite, plagioclase, and quartz, plus accessory apatite and zircon. According to its composition, Scientifics consider that the rock formation has passed through a cooling process of the Peña de Bernal magma, with resorption of phases and disequilibrium and re-equilibration conditions, mainly recorded in the plagioclase (Aguirre-Díaz et al., 2013).

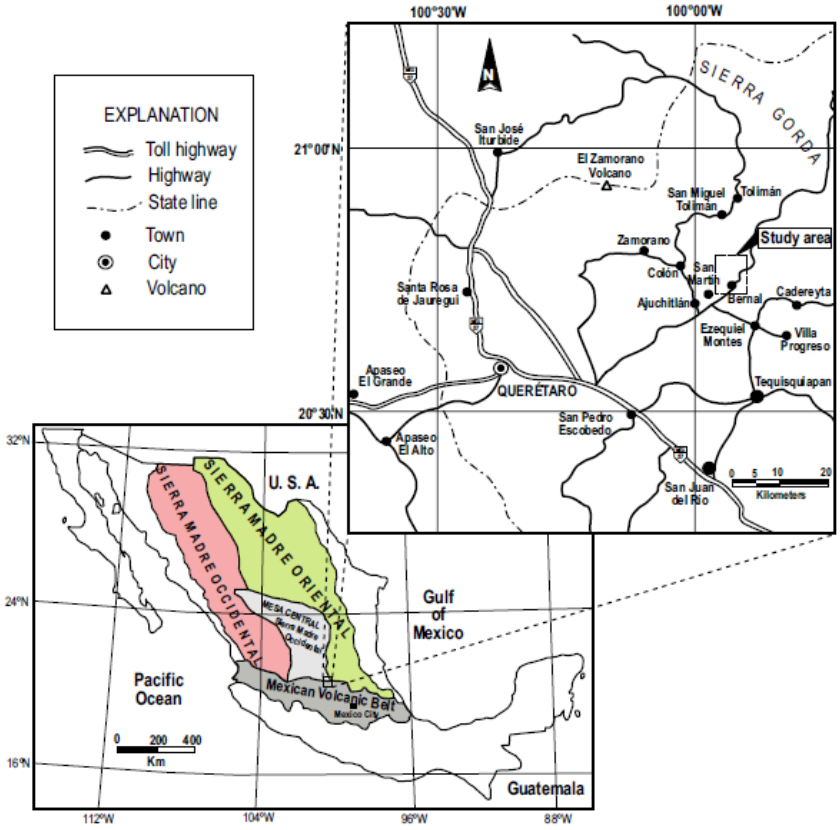


Figure 10 Index map showing the position of Peña de Bernal respect to some of the geological provinces of Mexico and the geography of the local area
Source: Aguirre-Díaz et al., (2013)

According to this studies, Peña de Bernal dacite has approximately 8,7 Ma of age, and it was intruded as a spine dome which did not form inside a crater of a volcano but originated through a marine Mesozoic sedimentary sequence. It has probably retained its peculiar steep peak shape since its formation. In Figure 11 we can see from (A) the intrusion of the dacitic magma body at depth, (B) the ascent and crystallisation of magma body to form and endogenous lava dome near the surface, and (C) the forceful intrusion of the nearly solid plug as a spine-type lava dome.

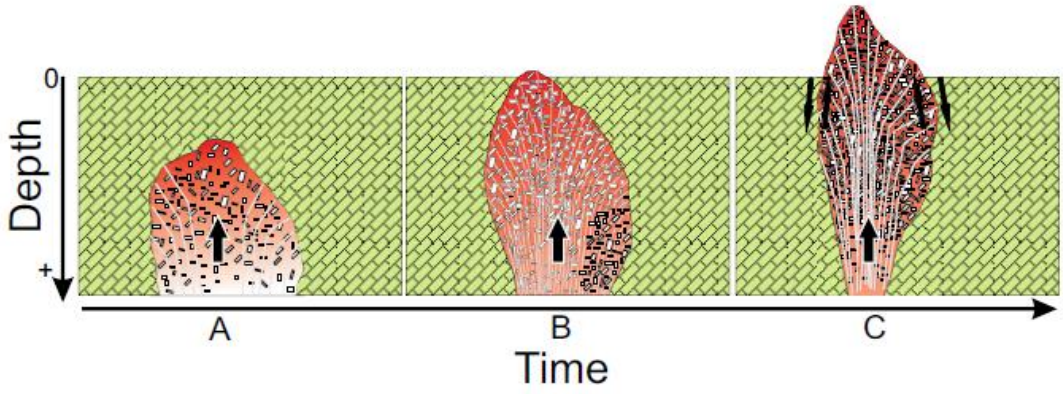


Figure 11 Schematic model showing the emplacement evolution of Peña de Bernal dome
Source: Aguirre-Díaz et al., 2013

Soil type and erosion

The urban spot of the town of Bernal and the lands that extend to the south are located on calcareic feozem soils which characterises for being rich in lime and nutrients for the development of vegetation. The layer near to the surface is regosol, a slightly acidic to alkaline soil with less fertility, while to the northwest area where the Peña is located is lithosol, a shallow soil limited by the presence of rock.

The 111.451 ha that constitutes the NPA is affected by erosion. About 42.23% has a current erosion that goes from 50 at 200 tons per ha per year, which is considered high. It is followed in extension, with a 24.72% of the area with erosion from 200 to 500 tons per year and finally 11.30% present a very marked current erosion with a value under the 500 tons per ha per year.

4.3.2 Touristic offer

Bernal is one of the six enchanting towns of the state of Querétaro. Each magic town does not represent a relevant touristic destination itself but combined they set up a new touristic product called the Wine and Cheese Route of Querétaro which attracts national and international visitors to the state attracted by the enological and cultural offer.

The idea started as a private initiative based on the union of several wine and cheese producers who saw the potential of the area and had the necessary capital to invest in a local development project. Consequently, they established a tourist route within the municipalities of San Juan del Río, Ezequiel Montes, Bernal and Tequisquiapan aiming to integrate the natural resources exploitation with the tourist experience.

The journey has 100 km and consists of going over all the cheese factories and vineyards in the area learning about its fabrication processes, tasting them and buying local products at excellent prices. However, the visits are interchangeably according to the tourists' choices. The route is formed by 11 cheese factories and 18 vineyards (Figure 12). Among the most visited of the route there, the leading cheese factories are VAI Cheeses, La Hondonada Ranch, San Josemaría Ranch, Santa Marina Ranch and Néole Cheeses. As for the vineyards, the leading wine centres visited are the Freixenet Caves, and Azteca Vineyards (Alpízar Padilla, 2011).

The route also offers a cultural tourist experience by promoting the visits to the towns near the route where people can enjoy from traditional crafts and local gastronomy. They can also admire important natural and cultural sites of the state during their tour. Among the main attractions, there are several internal roads to visit the magic towns including Peña de Bernal, historical monuments and buildings of the region, traditional haciendas, museums, the possibility of practising adventure sports in specific areas, hot air balloon rides, paragliding; among other tourist services (SECTUR, 2019).

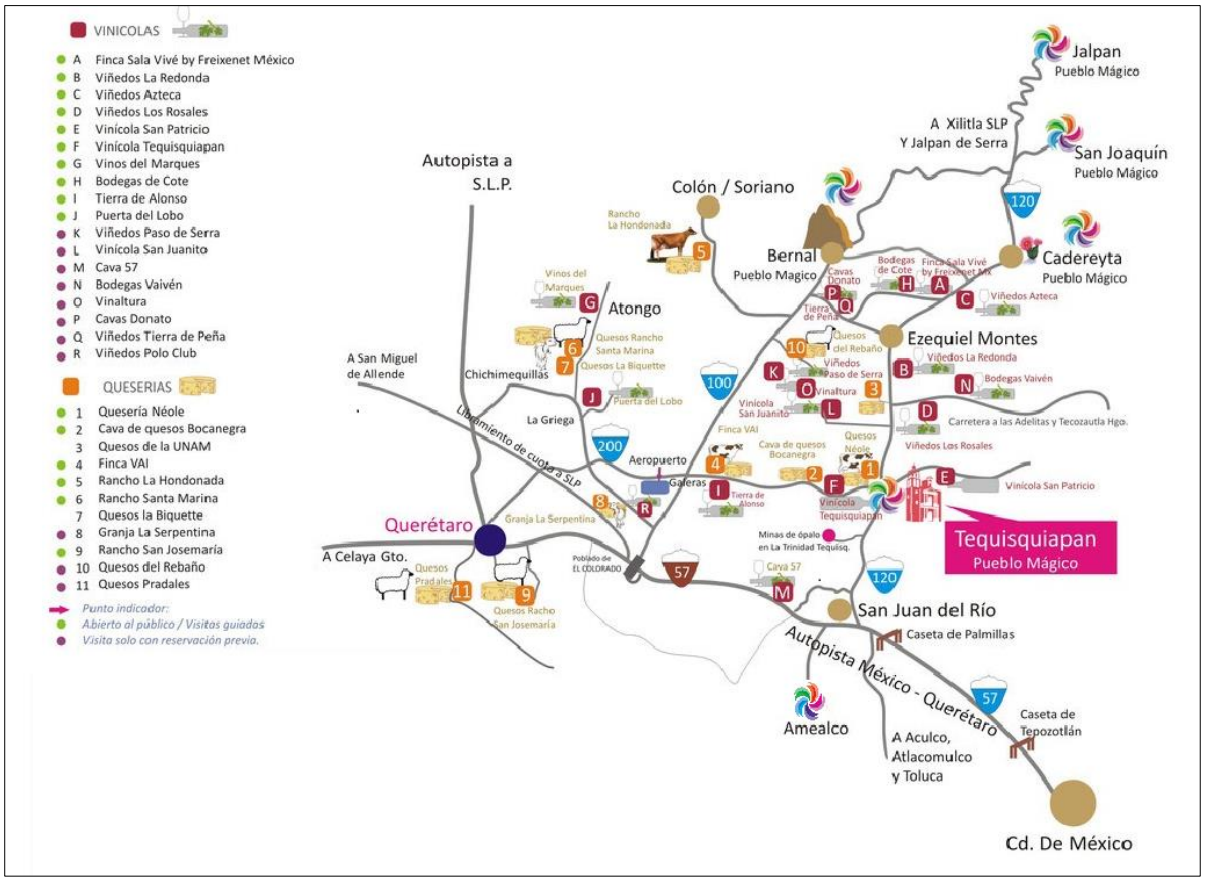


Figure 12 Map of the Wine and Cheese Route in the state of Querétaro
Source: Comité del Pueblo Mágico de Tequisquiapán, 2019

The Wine and Cheese Route of Querétaro not only promotes tourism in the area but also contributes to local development of the region by establishing a tourist cluster in the state. The demanded cooperation between different areas, actors and processes that works in the field of cheese and wine and serve as interconnection to stimulate economic development through tourism. Its main objective is offering a variety of activities related to wine cultures such as tours to vineyards, festivals, and alternative activities to generate a new tourist service based on the enjoyment of experiences. Moreover, it stands out for being the closest wine route to Mexico City, which is one of its main markets. Thanks to its location in the centre of the republic the route can be considered as the best located in the country.

Given the variety of activities included in the route, visitors generally do not stay long in a single place. Instead, they travel alongside the attractions stopping at different places according to their preferences and desired tourist experience. In this sense, the tourist services provided in Ezequiel Montes are placed in two main sites: in the cabecera municipal and the locality of Bernal. In the first case, there are ten lodging establishments with a total of 135 rooms available. From these hotels, most representatives are: El Queretano qualified with 1 star, La Capilla, and Real del Monte qualified with two stars(Gobierno Municipal de Ezequiel Montes, 2015).

In the second case, in Bernal, there are 12 hotels with 120 rooms, as mentioned in Table 4. The most characteristic is Parador Vernal, Casa Tsaya, El Centenario, Hostal Medieval, catalogued with four stars, hotel San Isidro and Feregrino with three and two stars respectively, and the Hotel Posada Peña classified with one star. In the case of food and drinking establishments with tourist category, there are 22 restaurants, eight bar-restaurants, three coffee shops, and 2 bars in the area (SECTUR, 2014a)

On the other side, the number of visitors in Ezequiel Montes concentrates in Bernal, and they are mainly represented by visitors coming from other states who visit the site but do not spend the night there. It is estimated that Bernal is visited by some 135.000 people per year and that the visits are done on weekends and holidays. Tourists overnight in one of the establishments previous defined and have short stays of no more than 1.5 nights on average. Besides, the hotel occupancy rate estimated for high-visited seasons is 59.2% (SECTUR, 2014b).

Some of the previous indicators from the tourism situation in Bernal are summarised in Table 9:

	Tourist-related competitively indicators of Bernal (2014)	
Tourists profile	Number of tourists that visit the locality	135.000 visitors per year
	Tourist or visitor profile	96,73 % nationals; 3,27% foreigners
	Reasons/Purpose of traveling	78,18% for vacation; 6,91% for cultural tourism
	Tourist subject satisfaction after visiting (scale 1 for minimum satisfaction and 10 for maximum)	8

Tourist demand	Tourist average expense per day (in pesos)	50 to 75
	Average nights spent in Bernal by tourists	1.5
	Occupancy rate	59,2%
	Seasonality demand (weeks per year)	16
Touristic services	Number of hotels/rooms for overnight accommodation	12 hotels, 120 available rooms
	Number of commercial establishments (Beverages and food)	251 establishments
	Number of travel agencies	2
	Number of local touristic guides	5
	Number of archaeological zones	4
Natural and cultural resources	Number of declarations on material heritage	1
	Number of natural protected areas	1

Table 9 Tourist related indicators of Bernal competitively.
Source: SECTUR, 2014

4.3.3 Management Program of Peña de Bernal

The Management Plan of Peña de Bernal was elaborated by the SEDESU based the environmental and biological analysis carried out by the Department of Conservation and Protected Natural Areas, from the review of the studies carried out by the School of Biology of the Autonomous University of Querétaro, the National Institute of Anthropology and History and on the direct contact with the localities which expressed the need to protect and conserve the biotic and abiotic resources present in the area. It entered into force on 2009, and since then Peña de Bernal is considered an NPA under state jurisdiction and have been placed into a Protected Landscape category following the LGEEPA of the state of Querétaro. This category considers Peña the Bernal as a mixed and modified natural site with the relevant aesthetic, cultural and recreational value that must be protected. Based on it, the Management Program advocates that all the activities of previously settled communities in its territory may be authorised. Recreational and cultural activities, preservation and restoration of ecosystems are also approved as long as they are consistent with the established needs of the managed area (Gobierno del Estado de Querétaro, 2009).

In this sense, the program covers four priority lines of interest specified in table 10 below:

Program management priority lines	Orientation
Urban footprint control	The avoidance of the modification of the uses of the area
Preservation of environmental services	The maintenance of biodiversity and aquifers recharge. Protection of the infrastructure of the communities in Bernal
Sustainable use of ecosystems	The preservation of habitats and species that are classified as endangered, endemic
Archaeological remains	The protection of remains for their study, rescue and tourism promotion

Table 10 Bernal Management Plan main criteria
Source: Gobierno del Estado de Querétaro, 2009

4.3.3.1 Objectives of the Management Program

The main objective of the Management Program of Peña de Bernal is to conserve, protect and recover the ecosystems present in the NPA through the proper management and responsible administration of their natural resources, with the participation of the governmental and social sectors involved in the area.

In order to achieve it, several specific objectives have also been established (Gobierno del Estado de Querétaro, 2009):

- To protect sites of historical, cultural, archaeological and traditional management of natural resources in harmony with their surroundings.
- To protect the scenic beauty sites to ensure the quality of the environment and promote tourism.
- To ensure a sustainable of ecosystems and natural resources present in the area to ensure the preservation of the habitat of species that are subject to special protection.
- To protect the site for its study, scientific research and monitoring of ecosystems and their balance.
- To promote environmental awareness and education.
- To generate, rescue and share knowledge and technologies that allow sustainable use of natural resources within the area.
- To provide areas for recreation to the population, in order to contribute to forming ecological awareness about the value and importance of natural resources.
- To control the progress of urban stain and prevent the modifications of the area

4.3.3.2 Sub-programs

The subprograms within the NPA are carried out according to the priority lines of interest to develop operational programs and projects with a sustainable management approach in the area. This program prioritises the analysis of the ecosystem, its biodiversity, the socio-economic problems of the area, the management needs to be detected in terms of natural resources exploitation, production activities and administrative aspects. To attend these needs, the Management Program of Peña de Bernal consists of six subprograms: protection, administration, restoration, knowledge, culture and natural resources management (Gobierno del Estado de Querétaro, 2009).

4.3.3.3 Peña de Bernal Zoning

According to the LGEEPA, Zoning is a technical planning instrument that can be used in the establishment of protected natural areas, which allows organising its territory according to the degree of conservation and representativeness of its ecosystems, the natural vocation of the land, and its current use and potential. The main areas that must be delimited in an NPA are the core zone and the buffer zone, which may also be formed by sub-zones (Congreso de la Unión, 2014).

In this sense, the NPA is divided into two main zones: the Core Zone, formed by a Protection and a Restricted Use Subzone; and the Buffer Zone, subdivided into a Recovery and the Public Use Subzone (table 11).

Zone	Sub-zone	Extension (ha)	Total (ha)
Core Zone	Protection	97,17	139,85
	Restricted Use	48,68	
Buffer Zone	Recovery	113,65	124,06
	Public Use	10,41	
Total NPA Surface			**263,91**

Table 11. Zones that form the NPA of Peña de Bernal
Source: Gobierno del Estado de Querétaro, 2009

On the other hand, the nature of the activities that can be carried out in the NPA is defined according to their frequency and magnitude of practice in the different subzones. Thus, the proposed intensity of use for each subzone is divided into three categories:

- High: Established for areas which have been affected by human presence and show evident and permanent impacts year after year.
- Medium: Established for surfaces with some modifications as a result of human use, with tangible and controlled impacts; many of them are recoverable.
- Low: Established for almost smooth surfaces with recoverable character.

In this sense, the activities allowed in each subzone, as well as their intensity of use, are described in table 12 below:

Zone	Subzone	Intensity of use	Allowed activities
CORE ZONE	Protection	Low	Attention to plagues and forest diseases that have economic and ecological effects, habitat improvement, scientific research and monitoring, ecosystem recovery and restoration. Activities to prevent forest fires, low-impact temporary infrastructure to support signalling, surveillance or scientific research. Permanent infrastructure to support natural conservation
	Restricted Use	Medium	Attention to plagues and forest diseases that have economic and ecological effects, habitat improvement, scientific research and monitoring, ecosystem recovery and restoration. Activities to prevent forest fires, low-impact temporary infrastructure to support signalling, surveillance, scientific research and alternative tourism. Permanent infrastructure to support natural conservation. Natural resources utilisation for traditional uses and self-consumption with strict control measures. Ecotourism activities such as interpretative hiking, observation of flora and fauna, environmental education workshops, camping, among others. Adventure tourism activities such as rock climbing, mountain biking and rappelling. Other environmental education activities according to what is established by the Environmental Education Program issued for the area.

BUFFER ZONE	Recovery	Medium	Attention to plagues and forest diseases that have economic and ecological effects, habitat improvement, scientific research and monitoring, ecosystem recovery and restoration. Activities to prevent forest fires, low-impact temporary infrastructure to support signalling, surveillance, scientific research and alternative tourism. Permanent infrastructure to support natural conservation. Natural resources utilisation for traditional uses and self-consumption with strict control measures. Ecotourism activities such as interpretative hiking, observation of flora and fauna, environmental education workshops, camping, among others. Adventure tourism activities such as rock climbing, mountain biking and rappelling. Other environmental education activities according to what is established by the Environmental Education Program issued for the area.
	Public Use	High	Attention to plagues and forest diseases that have economic and ecological effects, habitat improvement, scientific research and monitoring, ecosystem recovery and restoration. Activities to prevent forest fires, low-impact temporary infrastructure to support signalling, surveillance, scientific research and alternative tourism. Permanent infrastructure for tourist services and attention (parking, camping or shelter areas, cabins, ecological toilets, information modules, collection and surveillance booths, trade, among others that are needed in this segment. Camping, agricultural tourism activities (such as mystical experiences and artisan workshops). Environmental education activities according to what is established by the Environmental Education Program issued for the area.

Table 12 Allowed activities per subzone of the NPA of Peña de Bernal
Source: Gobierno del Estado de Querétaro, 2009

5 Results

5.1 Dynamic of the public use areas of Peña de Bernal by tourists

The dynamic of the Peña de Bernal and the public use spaces developed to attend the tourists can be divided into several stages depending on the different services offered to satisfy the demands of visitors.

5.1.1 Stage 1: Arrival to San Sebastián Bernal

The first stage will comprise the arrival of Peña de Bernal. From several states of the country, the central point will be Santiago de Querétaro. From here, tourists can travel to Bernal using different transport options. Travelling by bus will be the more accessible way, given there are several bus lines departing from several states to the city terminal such as Futura, Anáhuac, Chihuahuense, Pacífico, Élite, Primera Plus, and Frontera. The cost from the single ticket may vary from 252 and 550 pesos depending on the starting point of the tourist. In the Querétaro Bus Terminal, one must arrive at the B section and take another bus who travel to the locality of San Sebastián Bernal. This takes around one hour.

To arrive at Bernal in private vehicle, the main highroad to directly leads to the place is the No. 57. All the road is correctly signposted to get to the place quickly in 30 minutes. A taxi can also be taken from the Terminal, but in general, there is no public transport that provides a direct tourist service to facilitate the visit of the site. However, there are several tour operators around the Cheese and Wine route that considers Peña de Bernal as a meaningful stop during their tours.

5.1.2 Stage 2: arrival to Peña de Bernal touristic site

Once in Bernal, there are several parking options to leave the vehicle in town and walk around the village to the Peña. Another option is driving through the town until the two official parking of Peña de Bernal and then start the trail by foot. Tourists can also rent a moto-taxi conducted by local guides from the centre of San Sebastián Bernal. Walking to the Peña from the village is also a feasible option, always considering a duration period of the walk between 20 and 30 minutes on a slope of medium difficulty. During this trail, the visitors can find some commerce, principally of traditional handicrafts. They consist of products derived from wool such as blankets and sarapes made by local artisans; still, not

typical handicrafts had been introduced and can also be found. They are mainly mud and rhinestones products from the nearest localities.

Once in the first official parking of the site can be found. In here, there are three access paths that can be taken to arrive at an intermediate handicraft and food site and then to the first loft on the first stage of the Peña. In this area, there is also the infrastructure for diverse commerce mainly focused on food services for tourists as well as rest and sanitary areas. There is also small commerce of handicrafts near the second parking area which leads directly to the loft. In here, visitors generally stay for long periods, taking pictures with family given the privileged view to the top of the Peña and consuming local products. Another situation to note through the visit is that several people arrive until this point, take a picture, rest for some time and then go back to the village given the level of difficulty to arrive at the top of the Peña.

5.1.3 Stage 3: Ticket point

The third stage of the visit is formed by a path of 227 m between the loft and the ticket office, and it also presents several informal commerce of handicrafts attended by residents. The infrastructure of these shops has been developed in a more disorganised way compared to the ones in the loft. Nonetheless, they do not block the primary access to the Peña. This path takes around 20 minutes and ends in a restaurant beside the ticket point. In the restaurant, tourists also have some rest and get local food and drinks.

In the ticket point, the access is controlled by staff from the Gobierno Municipal de Ezequiel Montes who ask visitors to register voluntarily and give general information about the trail to the top of the Peña. Moreover, since 2019 the access costs 30 pesos per adult visitor, while it is free for children under the age of 10 and people over 60 years. This amount is used for the maintenance of the environmental services of the place as well as for the infrastructure required for receiving visitors in the Peña. It is essential to mention that people do not agree with the new cover regulations given they do not see significant changes in the place. By this reason, some visitors arrive at this point, stays in the restaurant for a while, then go back to the loft and handicrafts site and do not hike through the Peña.

5.1.4 Stage 4: Trail to the top of the Peña

This stage is comprised between the ticket access and the path that tourists must walk to arrive at the top of the Peña de Bernal after the ticket point. This path has between 1 and

4 m width and cannot be made by groups of more than 5 people. It consists of 570 m of footpath mainly formed by rocky ground and with ropes like a handrail. The walk generally takes from 45 minutes to one hour depending on the physical state of each individual as well as on the climate conditions which may difficult hiking fast to the top of the Peña given the path has no vegetation cover. Another condition to consider is the difficulty of the slope, which may influence in the time of arrival too.

There are two viewpoints in the path but given just one of them is available for public use, just this one will be considered in the description. There are also several areas among the rocks that are used by tourist as rest areas, but they do not have official spaces for getting rest during the walk. Another point to state is that even if the person of the municipality argued that there are local people looking after tourists' security in all this path, there are no help providers to protect and control visitors in the area.

Based on this information about the visit to the tourist place, 20 public use areas have been defined in order to calculate the TCC of the place. They are described and shown in table 24 and Figure 13 below:

Public use area	Description
Parking 1	Area of 871,97 m^2 with available space for approximately 60 vehicles.
Path 1	First foot access to the handicrafts site from the parking located on the left side of it.
Handicrafts and food site 1	First infrastructure area used for food and handicrafts commerce. It is composed of 10 official establishments.
Path 2	Secondary road and principal foot access to the touristic loft of Peña de Bernal. It shows the necessary information about the place and its unique characteristics.
Loft	The main square of the place where tourists generally stay and take pictures of the monolith.
Handicrafts and food station 2 (loft)	The area located in the main square of Peña de Bernal, where diverse food commerce offers their services for tourists. It is composed of 16 official establishments. It also has public chairs and tables for visitors.
Toilet area	Sanitary services for tourists located in the main entrance of the place with a cost of 5 pesos.
Handicrafts site 3	Following the infrastructure area used for handicrafts commerce. It is located at the entrance of parking 2 and is composed of 8 official establishments.
Parking 2	Area of 2941,83 m^2 with available space for approximately 200 vehicles.

Path 3	Third foot access to the food station three from the parking located on the right side of it.
Food station 3	Third infrastructure area for food commerce. It is composed of 7 official establishments.
Trail 1	It is the first path that leads to the ticket office to access the top of the Peña. It has a length of 227.52 m.
Handicraft site 4	The area located all along the Trail 1 with irregular infrastructure for handicrafts commerce installed by inhabitants of the locality. It is formed by six small establishments.
Viewpoint 1	The area located before the handicraft site 4. From this site, a panoramic view of Bernal can be achieved.
Handicraft site 5	Unofficial infrastructure located in the first part of Trail 1. It is formed by seven small establishments.
Handicraft site 6	Unofficial infrastructure located in the second part of Trail 1. It is formed by four small establishments.
Handicraft site 7	Unofficial infrastructure located in the last part of Trail 1. It is formed by five small establishments.
Restaurant	The most significant and last food establishment in the path to the top of the Peña. It opens from 10:00 to 17:00 hours.
Ticket office	Official area installed by the Gobierno Municipal the Ezequiel Montes to control and regulate the access of visitors to the top of the Peña.
Trail 2	Official path to the top of the Peña de Bernal.

Table 13 Public use areas identified in Peña de Bernal
Source: Field research work

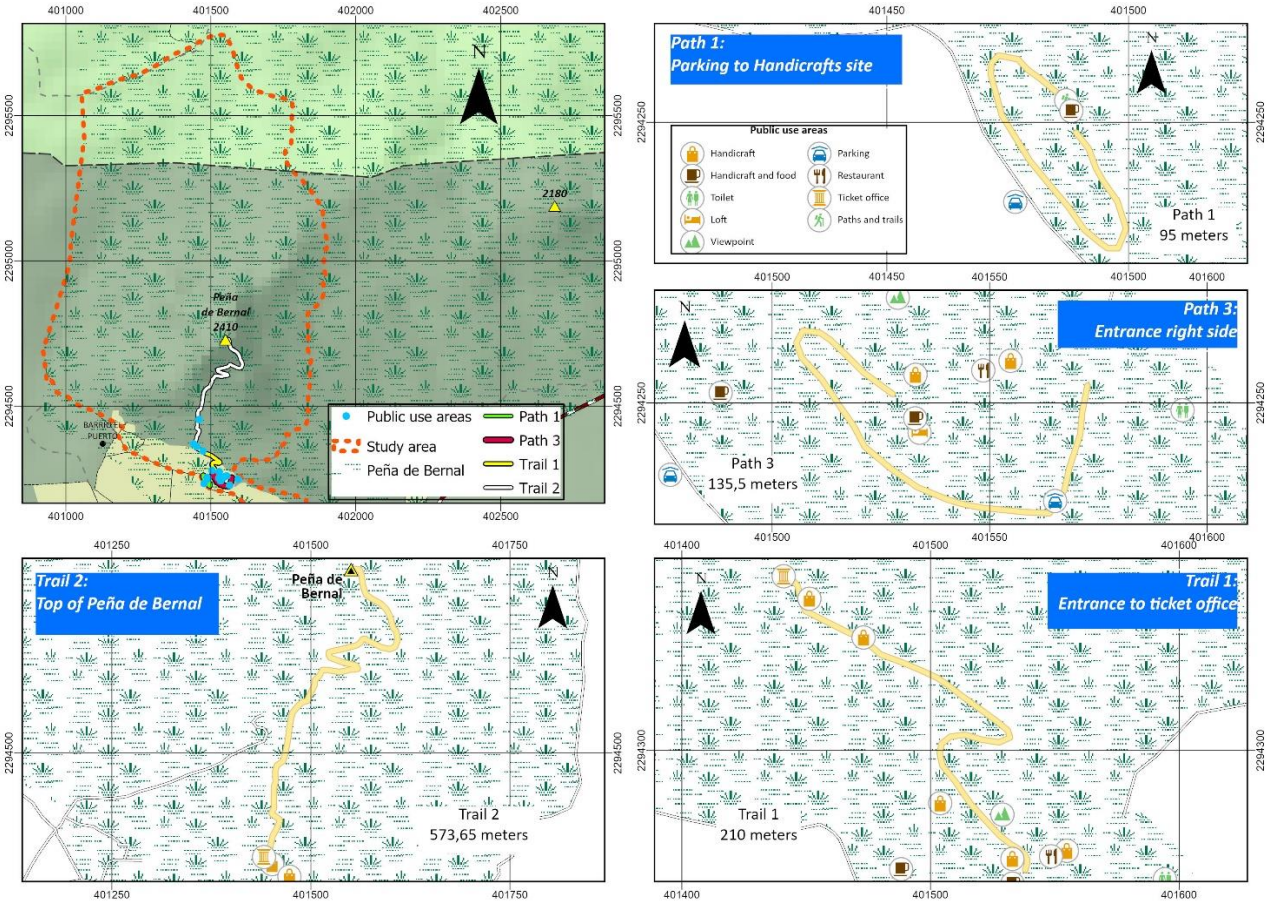


Figure 13 Trails and public use spaces of Peña de Bernal
Source: Own elaboration

5.2 Tourism Carrying Capacity calculation

Based on the observation of the site as well as interviews with the personnel in charge of the management of Peña de Bernal, several criteria have been established in order to calculate the Tourism Carrying Capacity of the area as described in Table 25 below:

	Peña de Bernal
Visitors flow	The flow of visitors on the trail is one way
Space required per person in the public use areas	The needed space is 1 m^2. In the case of trails, it is one linear meter, provided that the width of the path is less than 2 m.
The time required per visit	3:00 hours. Minimum time needed for a visit: 1 minute for visiting the Peña. In high season: 4 hours depending on the sun intensity and visitors' affluence.
Established visiting schedule	Typically 08:00-17:00. In high season the schedule is extended from 08:00-18:00 h.
Available path	The length of the available path in the monolith for practising trekking is 1.4 km (1/3 of the rock).

Table 14 Criteria used in the calculation of the TCC in the study site
Source: Field research work and Miguel Cifuentes, 1992

All the equations for the calculation have been taken from the Cifuentes (1992) methodology.

5.2.1 Physical Carrying Capacity

For its calculation, it takes into account the existing relation between the visit factors such as visit hours, time for the visit and the needed space for each visitor.

It is obtained through the following formula:

$$\boldsymbol{PCC = \frac{S}{Sp} \times NV}$$

Equation 1 Physical Carrying Capacity formula

Where:

S= represents the available surface stated per public use area and is calculated for each one of them (see table 25)

Sp= is the area used per person to move freely = 1 m in the case of trails, and 1 m^2 in case of areas

NV= is the rotation factor, which is the number of times the site can be visited by the same person on the same day. It is calculated dividing the open hours of the place (Hv) by the required time to walk every trail (Tv) and is expressed by the following equation:

$$NV = \frac{Hv}{tv}$$

Equation 2 Rotation factor formula

In the case of Peña de Bernal, this time may vary according to the tourism season, given the place is open one hour more in the time of year when the most significant number of people visit the monolith. The information obtained in the interviews made to the personnel at the entrance of Peña de Bernal and the one got by observation of the trail realised in the fieldwork will be used as the primary basis. Thus, the collected data is shown in Table 26.

Type of season	Average visit time	Occasion
High	10 hours per day	Easter week, Santa Cruz festivities, summer vacations (from June 25th to August 31)
Low	9 hours per day	Rest of the year

Table 15 Average visit time in the study area
Source: Field research work and Miguel Cifuentes, 1992

In the base of the information above, results are presented in Table 27:

PCC calculation in Peña de Bernal in high season					
Visiting schedule (Hv): 08:00 - 18:00 (10 hours per day)					
Public use areas	**Tv**	**NV (Hv/Tv)**	**S**	**Sp**	**CCF**
Parking 1	0,33	30	871,97	1	26159,10
Path 1	0,17	60,00	25,13	1	1507,80
Handicrafts and food site 1	0,92	10,91	872,01	1	9512,84
Path 2	0,17	60,00	60,59	1	3635,40
Loft	0,92	10,91	633,17	1	6907,31

Handicrafts and food station 2	0,83	12,00	140,56	1	1686,72
Toilet area	0,33	30,00	45,16	1	1354,80
Handicrafts site 3	0,58	17,14	638,5	1	10945,71
Parking 2	0,33	30,00	2941,83	1	88254,90
Path 3	0,92	10,91	44,59	1	486,44
Food station 3	0,75	13,33	142,68	1	1902,40
Trail 1	0,58	17,14	227,52	1	3900,34
Handicrafts site 4	0,25	40,00	107,67	1	4306,80
Viewpoint 1	0,42	24,00	58,39	1	1401,36
Handicrafts site 5	0,25	40,00	107,31	1	4292,40
Handicrafts site 6	0,42	24,00	89,68	1	2152,32
Handicrafts site 7	0,25	40,00	85,37	1	3414,80
Restaurant	0,58	17,14	394,58	1	6764,23
Ticket office	0,58	17,14	15,42	1	264,34
Trail 2	1,25	8,00	570	1	4560,00

Table 16 PCC calculation in Peña de Bernal in low season
Source: Field research work and Miguel Cifuentes, 1992

5.2.2 Real Carrying Capacity

According to Cifuentes (1992) it is fundamental to identify all the characteristics and particularities of the dynamic of the site, which can vary from one place to another and have a direct influence on the calculations. Based on this, the different factors are previously defined according to the particular characteristics of the area, considering physical, ecological, climate, social and managerial variables. The general equation applied for its calculation is:

$$\boldsymbol{RCC = PCC \times FCx}$$

Equation 3 Real Carrying Capacity formula

Where FCx is the corrective factor of variable "x". These factors are expressed as a percentage and calculated based on the function:

$$\boldsymbol{FCx = \frac{Mlx}{Mtx}}$$

Equation 4 Corrective factors general formula

In this case, Mlx is the limiting magnitude of the variable "x" and Mtx is the total magnitude of variable "x".

Several corrective factors must be applied to the CCF, according to the reality and the specific characteristics of Peña de Bernal. In order to determine them, it was necessary to realise the first visit to the place, to observe and identify the most relevant variables that may affect the visitation flows and tourist experience of the area. Consequently, the corrective factors considered for this study were:

- Social factor (FCsoc)
- Erodability (FCero)
- Accessibility (FCacc)
- Solar brightness factor (FCsol)

5.2.2.1 Social Corrective Factor (FCsoc)

This factor focuses on improving the quality of the visit by posing the need for managing the visitation in groups. In this way, the social factor aims to guarantee the tourist satisfaction by controlling the visitor's flux. The appropriate number that must be established per group, as well as the proper distance between each other, may vary according to the path width, to avoid the interference among each other and not affect the experience.

Then the following formula is used to calculate the number of groups (NG):

$$\boldsymbol{NG = \frac{Total\ length\ of\ the\ path\ (M)}{Total\ distance\ required\ (D)}}$$

Equation 5 Number of groups formula

At the same time, the total distance required per group (D) is formed by two variables. The distance required per group (Sg) and the actual distance between groups (Dg) as shown in the equation:

$$\boldsymbol{D = Dg + Sg}$$

Equation 6 Total distance required per group formula

Moreover, it is necessary to know the number of people that can be simultaneously in each path (P):

$$\boldsymbol{P = NG \times number\ of\ persons\ per\ group\ (Npg)}$$

Equation 7 Number of people per path formula

Finally, in order to get the FCsoc, it is necessary to define and calculate the limiting magnitude (Ml) which in this case will be the relation between the magnitude of the path and the number of persons allowed per group to guarantee the space for each visitor on the site. This was calculated with the following equation:

$$\boldsymbol{FCsoc = 1 - \frac{Ml}{P}}$$

Equation 8 Social Corrective Factor formula

The results are presented in Table 28:

Calculation of the Social Corrective Factor for the trails of Peña de Bernal

Paths and trails	M	Npg	D	NG (M/Dg)	P (NG*Npg)	MI (M-P)	FCsoc
Path 1 (Parking 1 to crafts site)	25,13	4	7	3,59	14,36	10,77	0,25
Path 2 (Principal)	60,59	5	9	6,73	33,66	26,93	0,20
Path 3 (Right side)	44,59	3	5	8,92	26,75	17,84	0,33
Trail 4 (From loft to ticket office)	227,52	4	7	32,50	130,01	97,51	0,25
Trail 5 (To the top of the Peña)	570	3	5	114,00	342,00	228,00	0,33

Table 17 Calculation of the Social Corrective Factor for the trails of Peña de Bernal
Source: Field research work and Miguel Cifuentes, 1992

5.2.2.2 Erodability Corrective Factor (FCero)

This factor measures the susceptibility or risk to erode that may have the tourist site based on the slope. According to the methodology, the significant zones are the trails that have a medium or high risk of erosion, and that must have use restrictions. According to the selected tool, the erosion risk of a path is measured, taking into account the following references (Table 29):

Erodability degree	Slope	Weighing values
Low	<10%	Non-significant
Medium	10 – 20%	1
High	>20%	1,5

Table 18 Degrees of probability according to the slope and its assessment
Source: Miguel Cifuentes, 1992

For Peña the Bernal, the main trails leading to the ticket office and the top of the Peña were selected for the calculation. The correction factor of erodability was calculated by obtaining the relation between the number of path m with erodability problems (mpe) with the total m of the path (M) as follows:

$$\boldsymbol{FCero} = 1 - \frac{\boldsymbol{mpe}}{\boldsymbol{M}}$$

Equation 9 Erodability Corrective Factor formula

Finally, the weighting values for the medium (mem) and high level of erodability (mea) paths are applied according to the equation:

$$\boldsymbol{FCero} = \mathbf{1} - \frac{(\boldsymbol{mem} \times \mathbf{1})\ (\boldsymbol{mea} \times \mathbf{1,5})}{\boldsymbol{M}}$$

Equation 10 Erodability Corrective Factor weighted formula

The results for Trails 4 and five are shown in tables 30 and 31:

Calculation of the Erodability Corrective Factor for the trail 4 of Peña de Bernal			
Length	**Width**	**Slope**	**Erodability**
25	2	7,98	Low
25	4	15,87	Medium
25	3	11,94	Medium
25	2	7,98	Low
25	2	7,98	Low
25	2	7,98	Low
25	1	4,00	Low

Calculation of the Erodability Corrective Factor for the trail 4 of Peña de Bernal			
Length	**Width**	**Slope**	**Erodability**
25	1	4,00	Low
25	1	4,00	Low
19	2	10,49	Medium
mem		69	
mpe		69	
Fcero		0,72	

Table 19 Calculation of the Erodability Corrective Factor for the trail 4 of Peña de Bernal
Source: Field research work and Miguel Cifuentes, 1992

Calculation of the Erodability Corrective Factor for the trail 5 of Peña de Bernal			
Length	**Width**	**Slope**	**Erodability**
75	15	19,74	Medium
150	25	16,51	Medium
225	17	7,54	Low
300	12	4,00	Low
375	17	4,53	Low
450	18	4,00	Low
525	9	1,71	Low
mem		225	
mpe		225	
Fcero		0,65	

Table 20 Calculation of the Erodability Corrective Factor for the trail 5 of Peña de Bernal
Source: Field research work and Miguel Cifuentes, 1992

5.2.2.3 Accessibility Corrective Factor (FCacc)

This corrective factor measures The level of difficulty that the visitors experience for moving between the paths due to the slope. It is measured according to the categories shown in Table 32.

The difficulty of the slope	Range	Weighing values
Low	<10%	Non-significant
Medium	10 – 20%	1
High	>20%	1,5

Table 21 Degrees of difficulty according to the percentage of the slope
Source: Miguel Cifuentes, 1992

For this, the following formula was applied:

$$\boldsymbol{FCacc = 1 - \frac{mdd}{M}}$$

Equation 11 Accessibility Corrective Factor formula

Where (mdd) is the length of the pat with difficulty of displacement.

Finally, the weighting values for the medium (mm) and a high level of difficulty (ma) paths are applied according to the equation:

$$\boldsymbol{FCero = 1 - \frac{(mm \times 1)\,(ma \times 1,5)}{M}}$$

Equation 12 Accessibility Corrective Factor weighted formula

The results for Trails 4 and five are shown in tables 33 and 34:

Calculation of the Accessibility Corrective Factor for the trail 4 of Peña de Bernal			
Length	**Width**	**Slope**	**Accessibility**
25	2	7,98	Low
25	4	15,87	Medium
25	3	11,94	Medium
25	2	7,98	Low
25	2	7,98	Low
25	2	7,98	Low
25	1	4,00	Low
25	1	4,00	Low
25	1	4,00	Low
19	2	10,49	Medium
mm		69	
FCacc		0,72	

Table 22 Calculation of the Accessibility Corrective Factor for the trail 4 of Peña de Bernal
Source: Field research work and Miguel Cifuentes, 1992

Calculation of the Accessibility Corrective Factor for the trail 5 of Peña de Bernal			
Length	**Width**	**Slope**	**Accessibility**
75	15	19,74	Medium
150	25	16,51	Medium
225	17	7,54	Low
300	12	4,00	Low
375	17	4,53	Low
450	18	4,00	Low
525	9	1,71	Low
mm		225	
FCacc		0,65	

Table 23 Calculation of the Accessibility Corrective Factor for the trail 5 of Peña de Bernal
Source: Field research work and Miguel Cifuentes, 1992

5.2.2.4 Solar Brightness Corrective Factor (FCsol)

The corrective factor for solar brightness refers to the intensity of the sun between 10:00 and 15:00 hours, where there is more solar radiation and making uncomfortable and dangerous the visits to places where there is no vegetation cover.

It is calculated by obtaining the relation between the limiting hours of solar brightness per year (Hsl), the hours that the site is open and gives service to the public per year (Ht) and the m of the trail without cover. This is expressed through the equation:

$$\boldsymbol{FCsol = 1 - \left(\frac{Hsl}{Ht}\right) \times \left(\frac{Ms}{M}\right)}$$

Equation 13 Solar Brightness Corrective Factor formula

Table 35 shows the results for this corrective factor:

Calculation of the Solar Brightness Corrective Factor for Peña de Bernal			
Summer			
Criteria	**Daily**	**Monthly**	**Annually**
Solar brightness hours	13	390	4680
Service hours	10	300	3600
Limiting hours	4	120	1440
Winter			
Criteria	**Daily**	**Monthly**	**Annually**
Solar brightness hours	13	390	4680
Service hours	9	270	3240
Limiting hours	2	60	720
Total limiting hours		2160	
Total service hours		6840	
Fcsol		0,68	

Table 24 Calculation of the Solar Brightness Corrective Factor for Peña de Bernal
Field research work and Miguel Cifuentes, 1992

Once all the selected corrective factors for all the public use areas have been calculated, the total RCC of Peña the Bernal is defined through the formula:

$$RCC = PCC\ (FCsoc \times FCero \times FCacc \times FCsol)$$

Equation 14 Real Carrying Capacity formula

The results obtained are shown in Table 36 and Figure 14:

Calculation of the Real Carrying Capacity for Peña de Bernal							
Public use areas	**S**	**CCF**	**Fcsoc**	**FCero**	**Fcacc**	**Fcsol**	**CCR**
Parking 1	871,97	2179,93	0,25	NA	NA	0,68	370,59
Path 1	25,13	1507,80	NA	NA	NA	0,68	1025,30
Handicrafts and food site 1	872,01	9512,84	NA	NA	NA	0,68	6468,73
Path 2 (Principal)	60,59	3635,40	0,20	NA	NA	0,68	494,41
Loft	633,17	6907,31	NA	NA	NA	0,68	4696,97
Handicrafts and food station 2	140,56	1686,72	NA	NA	NA	0,68	1146,97
Toilet area	45,16	1354,80	NA	NA	NA	0,68	921,26
Handicrafts site 3	638,5	10945,71	NA	NA	NA	0,68	7443,09
Parking 2	2941,83	7354,58	NA	NA	NA	0,68	5001,11
Path 3	44,59	486,44	0,33	NA	NA	0,68	110,26
Food station 3	142,68	1902,40	0,33	NA	NA	0,68	431,21
Trail 1	227,52	3900,34	0,25	0,72	0,72	0,68	341,07
Handicrafts site 4	107,67	4306,80	NA	NA	NA	0,68	2928,62
Viewpoint 1	58,39	1401,36	NA	NA	NA	0,68	952,92
Handicrafts site 5	107,31	4292,40	NA	NA	NA	0,68	2918,83
Handicrafts site 6	89,68	2152,32	NA	NA	NA	0,68	1463,58
Handicrafts site 7	85,37	3414,80	NA	NA	NA	0,68	2322,06
Restaurant	394,58	6764,23	NA	NA	NA	0,68	4599,68
Ticket office	15,42	264,34	NA	NA	NA	0,68	179,75
Trail 2	570	4560,00	0,33	0,65	0,65	0,68	430,90

Table 25 Real Carrying Capacity Calculation for Peña de Bernal
Source: Field research work and Miguel Cifuentes, 1992

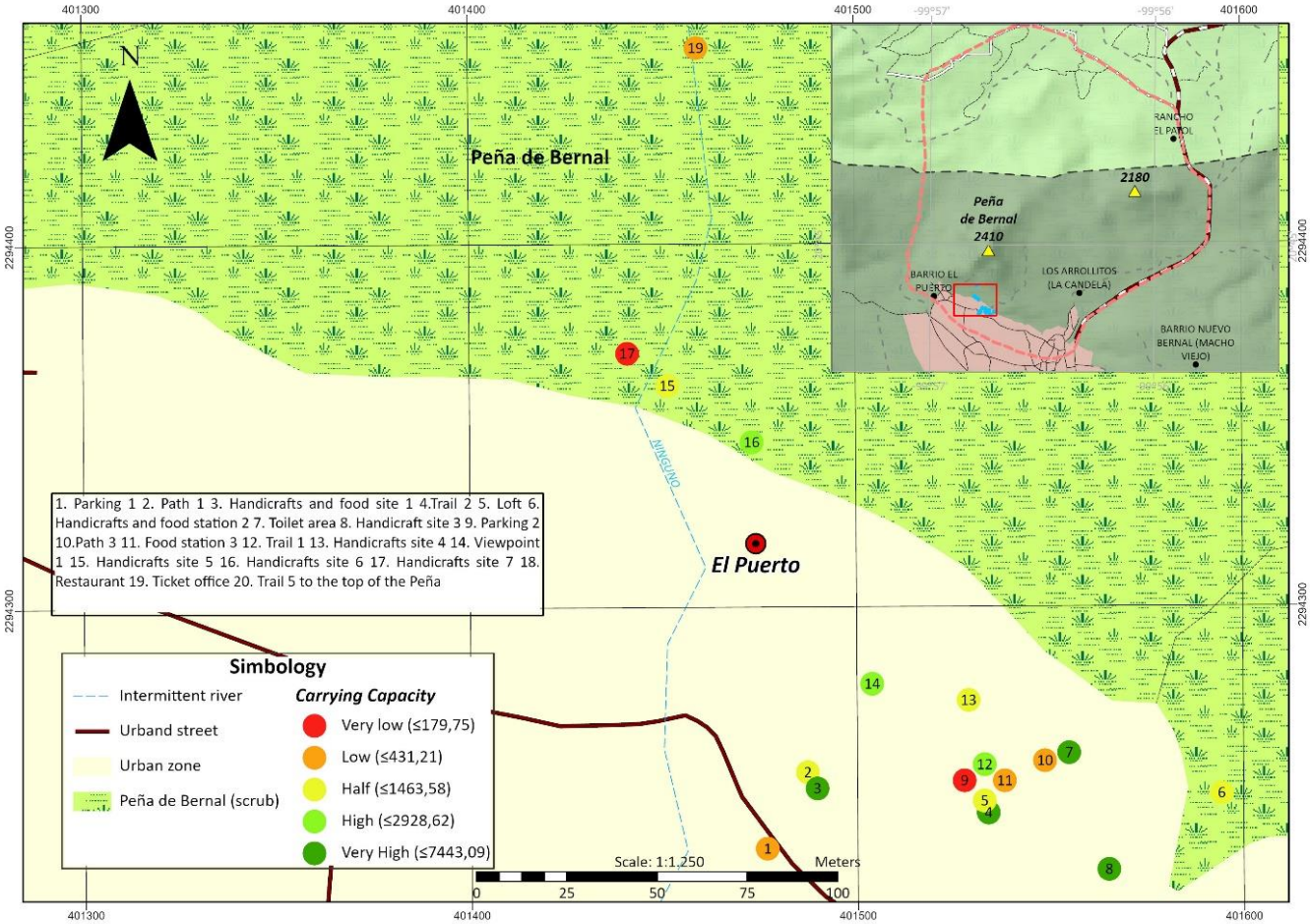


Figure 14 Real Carrying Capacity of Peña de Bernal by public use areas
Source: Own elaboration

5.2.3 Management Capacity

The MC comes from the administration of the area and is defined as the sum of conditions that the administration of a protected area must fulfil in order to satisfactory achieve the objectives of the management plan. It also represents the optimal administration status that a protected area must have to offer and excellent tourist experience to the visitors that comes to the place.

The MC is calculated using the mean value provided from the conditions of the place presented as a percentage. In the case of Bernal, the calculation was made through the evaluation of three main variables selected through the available information: infrastructure, equipment, and personnel. To get the data Interviews were made to the visitors who assisted to the Peña and to residents that develop commercial activities in its surroundings. The instrument was oriented to determine the current situation of each variable, taking into account four main criteria: quantity, status, localisation, and functionality, as shown in table 37:

Percentage	Value	Score
≥ 35	*0*	Unsatisfactory
36 - 50	*1*	Less satisfactory
51 - 75	*2*	Fairly Satisfactory
76 - 89	*3*	Satisfactory
≤ 90	*4*	Very satisfactory

Table 26 Criteria for evaluating the Management Capacity in Peña de Bernal
Source: Field research work and Miguel Cifuentes, 1992

A qualification has been given to each of these four criteria under a satisfactory-no satisfactory scale. The total qualifications obtained were compared to the optimal value (the maximum achievable value if each criterion was rated with the highest value of 4). The calculation for obtaining the status in an average of the three chosen variables are shown in tables 38, 39 and 40 below:

INFRASTRUCTURE	Existing quantity (A)	Needed quantity (B)	Relation A/B	Status	Location	Functionality	Sum	Factor (%)
Parking	3	3	4	3	4	4	15	0,94
Ticket office	1	2	2	3	4	4	13	0,81
Staff shed	0	1	0	0	0	0	0	0,00
Luggage lockers	0	30	0	0	0	0	0	0,00
Trails to the top enabled	1	1	4	2	3	3	12	0,75
Toilet areas	3	4	3	1	2	2	8	0,50
Restaurants	1	2	3	3	4	3	13	0,81
Food stations	8	8	4	3	4	4	15	0,94
Signposting	6	6	4	3	3	4	14	0,88
Crafts sites	20	20	4	3	3	3	13	0,81
Trash cans	4	8	2	2	2	3	9	0,56
Rest chairs	8	16	2	4	2	4	12	0,75
Railing	5	15	2	2	2	3	9	0,56
Viewpoints	2	4	2	1	1	1	5	0,31
			Average					**0,62**

Table 27 Calculation of the variable Infrastructure
Source: Own elaboration

EQUIPMENT	Existing quantity (A)	Needed quantity (B)	Relation A/B	Status	Location	Functionality	Sum	Factor
Vehicle	0	2	0	0	0	0	0	Factor (%)
Radio	2	6	2	3	4	3	12	0,75
Telephone	0	2	0	0	0	0	0	0,00
Fire extinguisher	0	6	0	0	0	0	0	0,00
First kit aid	1	3	2	3	4	4	13	0,81
Computer	1	1	4	4	4	4	16	1,00
Visitors' register book	1	2	3	3	4	4	14	0,88

Emergency climbing equipment	0	4	0	0	0	0	0,00
Average							**0,49**

Table 28 Calculation of the variable Equipment
Source: Own elaboration

STAFF	Existing quantity (A)	Needed quantity (B)	Relation A/B	Status	Location	Functionality	Sum	Factor (%)
Ticket point administrator	1	2	3	4	4	3	14	0,88
Environmental education	0	1	0	0	0	0	0	0,00
Guides	0	6	0	0	0	0	0	0,00
Civil protection staff	0	6	0	0	0	0	0	0,00
Local staff ("escaloneros")	2	6	2	2	3	3	10	0,63
Average								**0,30**

Table 29 Calculation of the variable Staff
Source: Own elaboration

Finally, the MC was established from the average of all the criteria applied to the evaluated variables. The equation used for its estimation is expressed as follows:

$$\boldsymbol{MC = \left(\frac{Personnel + Infrastructure + Equipment}{3}\right) \times 100}$$

Equation 15 Management Capacity formula

Then the final MC is summarised in Table 41:

Management Capacity of Peña de Bernal		
Variables	**MC**	**Score**
Staff	0,30	Unsatisfactory
Infrastructure	0,62	Fairly satisfactory
Equipment	0,49	Less satisfactory

Total Management Capacity	**46,90**	**Less satisfactory**

Table 30 Management Capacity of Peña de Bernal
Source: Own elaboration

5.2.4 Effective Carrying Capacity

It is obtained by comparing the RCC with the MC, and it is calculated using the following equation:

$$\boldsymbol{ECC = CCR \times CM}$$

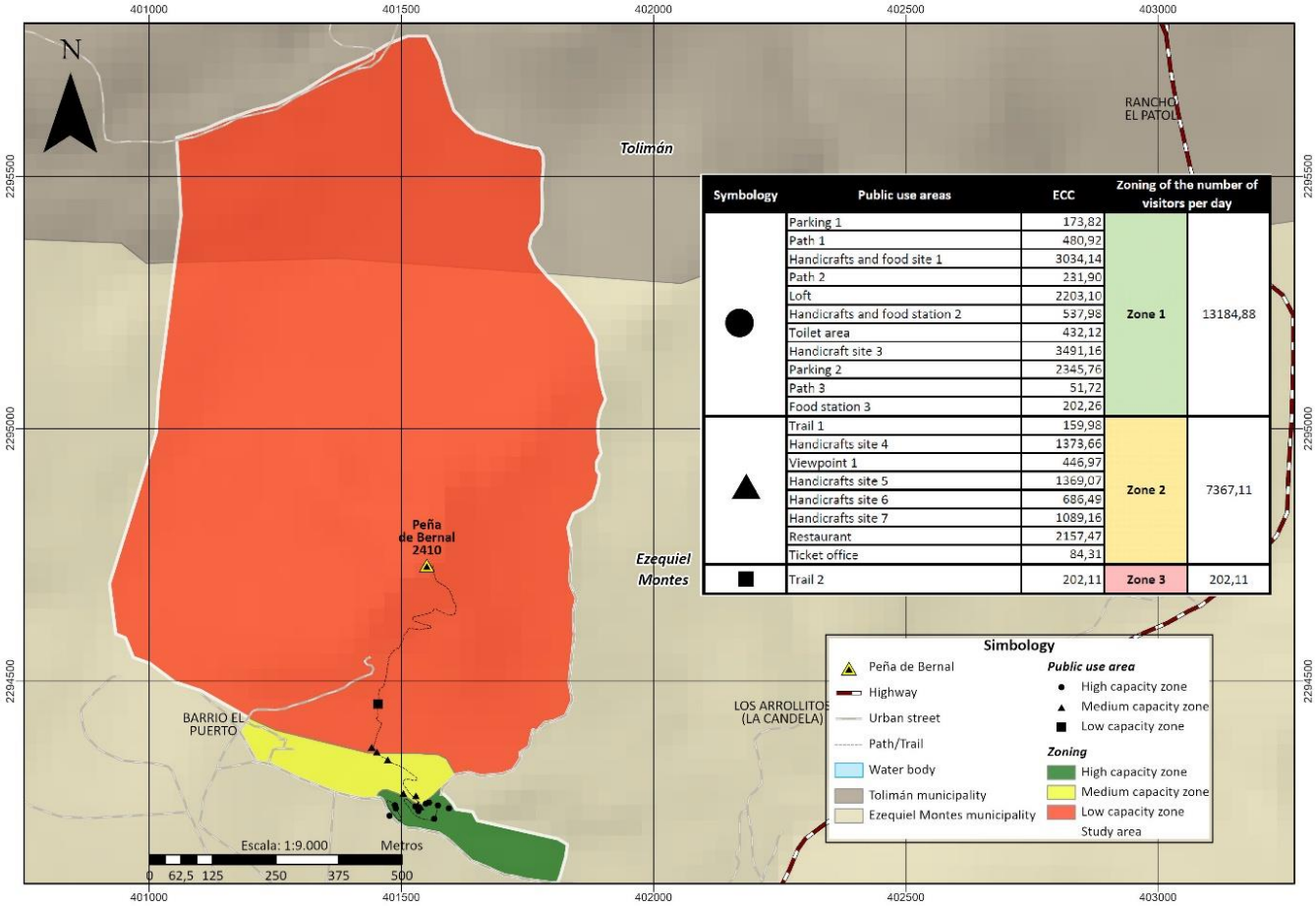
Equation 16 Effective Carrying Capacity formula

Finally, the calculation of the total CCT was obtained from the sum of all the values, and its representation can be seen in Table 42 and Figure:

Calculation of the Effective Carrying Capacity for Peña de Bernal					
Public use areas	**CCR**	**CM**	**CCE (CCR*CM)**	**Zoning of the number of visitors per day**	
Parking 1	370,59	0,47	173,82		
Path 1	1025,30	0,47	480,92		
Handicrafts and food site 1	6468,73	0,47	3034,14		
Path 2	494,41	0,47	231,90		
Loft	4696,97	0,47	2203,10		
Handicrafts and food station 2	1146,97	0,47	537,98	Zone 1	13184,88
Toilet area	921,26	0,47	432,12		
Handicraft site 3	7443,09	0,47	3491,16		
Parking 2	5001,11	0,47	2345,76		
Path 3	110,26	0,47	51,72		
Food station 3	431,21	0,47	202,26		
Trail 1	341,07	0,47	159,98		
Handicrafts site 4	2928,62	0,47	1373,66		
Viewpoint 1	952,92	0,47	446,97		
Handicrafts site 5	2918,83	0,47	1369,07		
Handicrafts site 6	1463,58	0,47	686,49	Zone 2	7367,11
Handicrafts site 7	2322,06	0,47	1089,16		
Restaurant	4599,68	0,47	2157,47		
Ticket office	179,75	0,47	84,31		

Trail 2	430,90	0,47	202,11	Zone 3	200,11

Table 31 Calculation of the Effective Carrying Capacity for Peña de Bernal
Source: Own elaboration



Symbology	Public use areas	ECC	Zoning of the number of visitors per day	
●	Parking 1	173,82	Zone 1	13184,88
	Path 1	480,92		
	Handicrafts and food site 1	3034,14		
	Path 2	231,90		
	Loft	2203,10		
	Handicrafts and food station 2	537,98		
	Toilet area	432,12		
	Handicraft site 3	3491,16		
	Parking 2	2345,76		
	Path 3	51,72		
	Food station 3	202,26		
▲	Trail 1	159,98	Zone 2	7367,11
	Handicrafts site 4	1373,66		
	Viewpoint 1	446,97		
	Handicrafts site 5	1369,07		
	Handicrafts site 6	686,49		
	Handicrafts site 7	1089,16		
	Restaurant	2157,47		
	Ticket office	84,31		
■	Trail 2	202,11	Zone 3	202,11

Figure 15 Effective Carrying Capacity Zooning in Peña de Bernal
Source: Own elaboration

5.3 Tourist profile and perceptions

To carry out a sustainable tourism strategy of Peña de Bernal, it is necessary to know the profile of the tourist who visits the site, to better plan the needed actions for managing the environmental resources involved. There are several variables of the tourists' behaviour and characteristics that have been considered for the study including age, place of origin, type of companions, knowledge of the place, perceptions, interests, among others. These variables were obtained through interviews to tourists in the place and are analysed individually by category below.

5.3.1 Place of origin

Place of Origin	Percentage of visitors
Foreign countries	2%
Guanajuato	4%
Hidalgo	18%
Mexico City	27%
Mexico State	3%
Morelos	19%
Puebla	12%
Querétaro	8%
San Luis Potosí	7%
Grand Total	**100%**

Table 32 Place of origin of the visitor of Peña de Bernal
Source: Field research work

As shown in Table 32, Peña de Bernal is a national touristic destination attracting tourist only from the direct and indirect adjoining areas. Although Queretaro state is next to San Luis Potosí, Guanajuato, Mexico State and Hidalgo, many visitors come from Morelos and especially from México City, and not that many from Guanajuato or Michoacán. The case that most visitors come from México City is due to the direct connection between Querétaro (the capital city of the state of Querétaro) and México City, through the federal highway 57.

Moreover, the highways infrastructure connecting all the cities in the middle region of México provides great terrestrial accessibility to Peña de Bernal. From this situation, it is also visible that not many people come from other regions such as the south (e.g., Chiapas, Yucatán) or the north (e.g., Chihuahua, Baja California). Despite the closeness of the Querétaro airport to Peña de Bernal, it is not a driver or via that used to visit Peña de Bernal.

5.3.2 Type of companions

Even though there are other attractions related to climbing and other extreme sports, Peña de Bernal is more a destination for families and couples. The attractions, the monolith and the magic town, are for purposes of amusement. Peña de Bernal does not offer active night life compared to other magic towns such as San Miguel de Allende, but it is a place for enjoying the moderate physical activity of climbing and its gastronomy (Table 33).

Type of companion	Percentage of visitors
Alone	2%
Couple	34%
Family	50%
Friends	14%
Grand Total	**100%**

Table 33 Type of companions of the visitor of Peña de Bernal
Source: Field research work

5.3.3 First approach to the place

Mean of discovery	Percentage of visitors
Internet or social networks	24%
Other	2%
Recommendation from another person	67%
Television or radio	1%
Travel agency	6%
Grand Total	**100%**

Table 34 Information on how the visitors discovered the place for the first time
Source: Field research work

According to the results shown in Table 13 we can see that nowadays Peña de Bernal is gaining more and more attention from social media and networks, however, because Peña de Bernal is a regional destination, visitors know the place because of others' people recommendations based on their experiences. This is interesting that, despite the efforts to spread to a broader range of locations, Peña de Bernal remains enclosed as a regional-local destination.

5.3.4 First time of visit

Is it the first time you visit the place?	Percentage of visitors
No	38%
Yes	62%
Grand Total	**100%**

Table 35 First time of the visit of tourist to Peña de Bernal
Source: Field research work

As shown in Table 35, most of the visitors have visited Peña de Bernal more than once. Besides, to its local and regional characteristic, visitors do not need much time to travel or drive from its place of origin to Peña de Bernal. This makes that Peña de Bernal can be visited for many times. Moreover, Peña de Bernal is not commonly a place of overnight staying. Many of the visitors rather stay in Tequisquiapan or Querétaro, or others just drive round trip in one single day.

5.3.5 Range of age

Range of age	Percentage of visitors
Between 30 and 60	62%
Less than 30	25%
More than 60	13%
Grand Total	**100%**

Table 36 Range of age of the visitor of Peña de Bernal

Source: Field research work

Attached to the above mentioned, most of the visitors are adults between 30 and 60 years old (Table 36). This supports the statement that Peña de Bernal is a touristic attraction for "soft" activities and family amusement, or romantic trips for young adults couples.

5.3.6 Interest for travelling and visiting Bernal

Reason of going to Bernal	Percentage of visitors
Interest in knowing the magic town	26%
Occasional tour	56%
Vineyards	17%
Grand Total	**100%**

Table 37 Table of the interest in travelling and visiting Bernal
Source: Field research work

Most of the visitors go to Peña de Bernal without specific interests or purposes. This means that, because of its regional and local closeness, one can quickly wake up during Saturday morning and come up with the idea of driving to Peña de Bernal and other nearby places. Getting to know the magic town of Bernal and the surrounding vineyards are also part of spontaneous weekend plans among friends, families and couples. This means that visitors do not have to put much effort into planning a trip to Bernal (Table 37).

5.3.7 Transportation

Means of transport	Percentage of visitors
Private car	86%
Public transport	9%
Touristic bus or van	6%
Grand Total	**100%**

Table 38 Table of transportation to arrive at Peña de Bernal
Source: Fieldwork research

Since the majority of visitors are constituted by families and couples, most of them have their vehicle. Also, due to its nearness and good terrestrial connections, driving one's car is the most efficient option. Interestingly, not many people use public transport, such as regional or interregional buses. This is since they are no many and not frequent bus services connecting main cities to Peña de Bernal. People without their means of transport find hard times in moving in and out from Peña de Bernal since they depend on the tight schedules of buses. The other option is to take a taxi, but it is quite expensive.

5.3.8 Duration of the visit

Duration of the visit	Percentage of visitors
Less than one day	44%
One day	23%
Three or more days	14%
Two days	18%
Grand Total	**100%**

Table 39 Table of a total duration of the visit to Peña de Bernal
Source: Fieldwork research

One does not need much time to carry out the main activities in Peña de Bernal, which are to climb half path of the monolith and to visit the town (just for eating in a restaurant). That is why most of the visitors do not stay longer than one day. This is also since Peña de Bernal is not a significant and unique spot in the region. Visitors, as part of one spontaneous or occasional weekend-drive to Bernal, also visit Tequisquiapan, Cadereyta, the vineyards and the city of Querétaro. Even people staying overnight with hotel/hostel bookings may choose Peña de Bernal as their base in order to visit the region, the vineyards and Tequisquiapan.

5.3.9 Accommodation

Place of accommodation	Percentage of visitors
NA	17%
Other nearby towns	2%
Querétaro	17%
San Sebastián Bernal	40%

Tequisquiapan	24%
Grand Total	**100%**

Table 40 Table of a place of accommodation preferred by tourists when visiting Peña de Bernal
Source: Fieldwork research

Related to the above explanation, visitors rather stay overnight in Tequisquiapan, Queretaro, or they definitively go and return to their homes. Although the hotel/hostel infrastructures have grown in Bernal, it is still not the first option when visiting the area or the town.

5.3.10 Level of satisfaction of the visitors regarding Bernal

Level of satisfaction	Percentage of visitors
Regular	2%
Satisfied	64%
Very satisfied	34%
Grand Total	**100%**

Table 41 Table of the overall subjective level of satisfaction of the visitors regarding Bernal
Source: Fieldwork research

In general, visitors are satisfied with their experience in Peña de Bernal. It is not a place where the tourists are amazed when seeing and climbing the monolith and walking through the town. Compared to other sites such as the Riviera Maya and its Cenotes, Peña de Bernal is a modest destination. That is why, is not an international tourist attraction or even a national one, where even people from states at the northern and southern border of México were willing to visit Peña de Bernal.

5.3.11 Perception of Peña de Bernal by tourists

Aspect/Valuation	Excellent	Good	Regular	Bad	Terrible	NA	Total
Traffic signs and trails	4%	76%	16%	4%	0%	0%	100%
Received information	0%	44%	28%	28%	0%	0%	100%
Hotel infrastructure	8%	44%	20%	0%	0%	28%	100%
Hygienic services	8%	76%	8%	8%	0%	0%	100%

Visiting hours	0%	76%	4%	0%	0%	20%	100%
Pricing and costs	8%	60%	28%	4%	0%	0%	100%
Safety	16%	64%	12%	8%	0%	0%	100%
Food and beverages	8%	84%	8%	0%	0%	0%	100%
Medical services	0%	4%	4%	80%	0%	12%	100%
Cleanliness of the site	12%	44%	28%	12%	4%	0%	100%

Table 42 Table of the perception of Peña de Bernal by tourists
Source: Fieldwork research

About the general satisfaction of the tourist, they perceived as “good” or “regular” the quality of services and infrastructure in Peña de Bernal. The only thing that visitors highlighted as a necessity in the site is the provision of emergency and medical services at the bottom of the monolith and in the town. However, these perceptions may not be accurate in the sense that they do not portray the real situation of Peña de Bernal. During the fieldwork of this research, and through careful observation of these aspects, there is a lack of proper traffic signs, both in the town and at the monolith. Moreover, the safety signs and other services related to it are scarce when climbing the monolith. There are many risks for the visitors regarding the loose rocks on the trails, high intensity of UV radiation, dehydration, among others.

6 Discussion

6.1 Making sense of visitors' profile and TCC calculations

There are two different types of results accordingly to the two first specific objectives stated in chapter one. The first one is of quantitative nature: the calculations of the tourism carrying capacity (physical, real and effective). The second specific objective includes quantitative information and also qualitative information in order to provide an integrated perspective of the tourists' profile and their perception about the site. In this chapter, the discussion will start with the profile of visitors in order to gain a more comprehensive understanding of the whole TCC calculation.

The profile of the tourist was constructed according to nine categories: the place of origin, type of companions, the first approach to the place, first time of visit, interest/reason or motivation for the visit, transportation used, duration of the visit and accommodation. Although data concerning the age and gender were considering, these are not representative in terms of constructing the profile of the visitors. Briefly, it can be said that slightly more than 50% of the interviewees were male and the majority of the range of age was among 30 and 60 years old. This means that most of the visitors are adults, families, and couples.

At an overall glance, it can be affirmed that Peña de Bernal is a tourist destination for families and middle-aged couples coming from the same regional area, that is, Querétaro states and its surrounding states and most proximal cities (e.g., Hidalgo, Morelos, México City, Guanajuato, etc.). This makes also a sense with the fact that most tourists reach Peña de Bernal by car. The main purpose for most of the visitors is to have an occasional weekend holiday, without any specific or direct objective, that is, they do not visit Peña de Bernal in order to climb the monolith or explore in-depth the magic town of Bernal. In fact, some of the tourists have already been there. This type of occasional visit is also supported by the fact that more than half of the tourist rather stay overnight in other places (e.g., Querétaro and Tequisquiapan), or they just go and return to their home cities. Therefore, the number of days tourists spend in Bernal is just one day or less.

Regarding the perception of the quality of the visitors' experience is that Peña de Bernal offers a pleasant and modest experience. Peña de Bernal fulfills the expectations. This means that Peña de Bernal is not the tourist destination that is meant to provide exorbitant

experiences compared to those offered in exotic places, rather it is a place where families, couples, and friends can have time off of their cities, without spending too much. Although the perceptions regarding the services provided in Peña de Bernal are satisfactory, there are some elements that have to be considered, such as the lack of medical assistance or lack of signs regarding risks to the visitors. There are some zones in Peña de Bernal where people can get hurt easily or people can just suffer from insolation or dehydration. but still, there are not sufficient signs or personnel to support that, especially when the trails are overcrowded during high seasons.

In this sense, the actual status of the area was also evaluated through the CM through visitors who were asked about the appropriate level of infrastructure, staff, and equipment that the place may have in order to fulfill effectively their levels of satisfaction of the visit. The results showed that in terms of Staff and available personnel, Peña de Bernal has 30% of MC compared to 62% in infrastructure and 49% in equipment. In average, Peña de Bernal Management Capacity arrives at a 46,90% of management capacity in a range from 0 to 100% where 100% represents the most satisfactory scenario.

Even if the opinions about the needs of Peña de Bernal is diverse, most visitors agree in the urgent need of improvement in terms of infrastructure, taking into consideration the characteristics of the last trail of the place which is not correctly insured and lacks railing in many parts of the route. Moreover, the staff is not correctly distributed alongside the visit and tourists advocates that the place must have guides or civil protection staff in intermediate points of the trail 2 (to the top of the Peña) for security. In terms of equipment, it is also remarkable the absence of enough aid kits, vehicles, climbing equipment, and in general measures that will help in case of an emergency during the visit to the Peña. Moreover, the site does not have an immediate emergency point for attention to tourists and staff in case of injuries. In general, the administration of the area has several improvement opportunities in order to increase the tourist level of satisfaction that may be considered in terms of investment

As related by (Wahyuningsputri 2012), tourists' perceptions may also change due to changes in the management, especially if the management of a site depends directly on the local and regional government. For the case of Peña de Bernal, this change in perception may apply. According to the interviews to some local residents and workers at the stands on the trails, the new local government of Ezequiel Montes (the municipality to which Peña

de Bernal belongs) that entered last year implemented a ticket office in order to charge a fee of 30 pesos to those visitors willing to climb to the top of Peña de Bernal (trail 2). According to inhabitants and local merchants in the area, the established tariff is a new regulation in force since 2018. This entrance fee was supposedly implemented with the purpose to collect money for the conservation of the site. Although visitors perceive that the actual state of the site do not reflect a real investment of this amount. On the other side, even if the cost is not elevated compared to other tourist attractions in the state and the prices are acceptable, people mainly come to Peña de Bernal in groups of 4 or 5 people which represents a total investment of 150 pesos for walking to the top of the monolith. Consequently, the workers on the stands perceive a decrease in the number of visitors, especially during the last high season ("semana santa" or holly week). This situation has also affected the local economy of the place, given the level of consumption of visitors in handicrafts and local gastronomy has also reduced. Therefore, more attention should be put in how future visitors, especially those who have been there more than once, perceive this entrance fee.

One challenge that remains is to translate the perception of tourists into recommendations for better sustainable management of the place. Another challenge for future work is to create a robust typology on visitors, not only relying on those tourists that can be found at the skirts of the monolith. In other words, there may be other profile of tourists beyond the one described here. This is important since different type of tourist may be encountered in other zones of Peña de Bernal and have a different perception. As Haraldsson & Ólafsdóttir (2018) said, different groups, do not have the same type of experience.

Perceptual carrying capacity (see Ferreira & Harmse 2014). could also contribute to strengthening research in sustainable tourism management. For instance, it is not clear how the internet and social networks (e.g. Facebook, Instagram, YouTube, Pinterest) influence visitors' decision in going to a certain place or to another. Nowadays, due to incredible access to the internet, it is possible to know how a touristic experience in a certain place would be. For example, there are abundant YouTube videos that show which are the best places to book accommodation, where to eat, what to visit, which routes to take. Additionally, GPS based applications, such as Google Local Guides, serve visitors as a big database that helps visitors in deciding which destination to go. Apparently, more data is needed in creating evidence to answer to what extent the attractiveness of a touristic site

on the internet influences visitors' choices, and consequently, how this affects the incoming flow of visitors.

The flux of incoming visitors to Peña de Bernal is an important factor in assessing the sustainability performance of Peña de Bernal, as a National Protected Area. However, Peña de Bernal is not only located next to a folkloric town but also embedded in a network of touristic destinations in the state of Queretaro (e.g. the vineyards and the town of Tequisquiapan).

Let's take a broader perspective of Peña de Bernal. Its position is privileged since it is not located in a remote area of difficult accessibility (e.g. an island). Peña de Bernal is right in the middle of México, between three great economic and industrial zones: the Bajío zone and the Valle de México zone. Indirectly, Peña de Bernal is near to one of the most overcrowded highways in México: the 57th federal highway, which, in a regional scale, connects the cities of Querétaro and México City (and the whole metropolitan area of Mexican valley). This means that more and more visitors may be able to reach Peña de Bernal by car through this main highway.

Furthermore, small-medium touristic spots such as vineyards are located near Peña de Bernal. These sites attract more and more visitors each time by offering a new typology of tourism which combines the enological experience with the visitation of natural, cultural and historical resources located in the surroundings. The development of this proposal represented by the Wine and Cheese route have consolidated the region as a tourism referent on the national scale and has increased its level of popularity abroad. The intensification of visitors embodies a development opportunity for small villages in the area such as Bernal, San Juan del Río, Cadereyta and Tequisquiapan whose main income is based on tourist's consumption on local businesses and products.

Massive tourism demands an important transformation in infrastructure, commerce dynamic, transport and equipment to satisfy the rising demand of services required by visitors. However, it also implies an urbanization process that it is not well managed and can cause severe impacts on the tangible and intangible heritage of the area. In the case of Peña de Bernal, the visitation level raised with the inclusion of Bernal in the PPM in 2005 as well as its declaration as Cultural Heritage of Humanity in 2006. This situation added to the constant development of the Wine and Cheese route in its surroundings has significantly

increased the level of visits of the village and consequently the infrastructural needs which have also aggravated the problems around the central attraction of town: the Peña.

In this situation, a sustainable tourism approach emerges as an alternative for managing visitations without leaving aside the importance of the touristic sector. The proposal considers the rational use of local resources, maintaining the cultural essence and the biodiversity of ecosystems and satisfying the social and economic needs of the region at the same time. The inclusion of management tools for environmental sustainability may be the most feasible option to broaden tourism management from a sustainable perspective to applied optimal solutions to face the new challenges of the current reality.

In the case of Peña de Bernal, the Gobierno del Estado de Querétaro has already established a Management Plan for controlling the economic activities developed in the NPA of Bernal in 2009. The plan includes a variety of management policies aimed to protect its environmental resources and services, a zoning proposal for land management divided by activity and a first consideration about the TCC as a useful tool for controlling the over-tourism reality of the area. Though there is no specific study with TCC for Bernal yet, the accelerated urbanization process left aside the protection needs and the plan itself has not been updated since then.

Tourism policies in México regarding Tourism Carrying Capacity in protected areas are underdeveloped. TCC is seen as a mitigation and restoration tool, only necessary when the natural area has visible negative impacts (Cupul-Magaña & Rodriguez Troncoso 2017). In this sense, TCC should be positioned as a planning and management tool with high priority in sensitive ecological areas such as coral reefs.

In the specific situation of Peña de Bernal, a TCC study will help to improve this reality by providing real data to control the access of people that may visit the tourist destination to prevent the destruction of its physical and socio-cultural environment. The extent of its contribution may vary according to the particularities of the place but also to the level of control of local authorities who directly manage the entrance to the NPA. According to SECTUR staff located in the ticket area access, Peña de Bernal visitation level has increased around 90% after its inclusion on PPM. Still, controls for visitors are almost inexistent in the village and in Peña de Bernal even if a standard number of 2000 visitors in high season / 500 daily visitors have been established, the real amount of people visiting the monolith may

vary from 800 to 1000 up to 2500 visitors per day in high season. On the other side, based on the TCC calculations applied to the place, if we add together the number of visitors that Peña de Bernal can receive in all its public use spaces, the total amount will be 20754 persons per day, considering that the place is open to public seven days per week, al weeks for a period of 10 hours each day and the required time for completing the visit will be1 hour 15 minutes.

Still, the particularities of Bernal may vary the way of interpreting the results given the current structure of the visit. As established in Figure 16, the visitors of Peña de Bernal concentrate in Zone 1 were the main food and handicrafts sites are located. This area allocates around 13184 persons per day, mainly interested in enjoying the gastronomic and cultural experience of the place. Then we have Zone 2 where people starts to ascent to the main entrance of the Peña and can enjoy from a wide variety of handicrafts through the ascent. In here the calculations shows that the pertinent limits of visitors are currently in 7367,11 persons per day alongside the path through the main attraction. Finally, in the main trail of Peña de Bernal, which is considered from the ticket office as a starting point to the available area on the top of the monolith, the amount of visitors per day is 202,11.

This amount of people also takes into consideration essential factors such as the seasonality of the place, the specific characteristics of the area in terms of climate, width, length, and slope of the trail as well as the needed level of accessibility for visitors in order to not compromise their satisfaction of the visit. In this sense the ECC tells us that even if the total amount of visitors does not surpass for long the existing data of the institutions in charge, if we analyze the situation from a territorial management perspective, the major concentration of visitors is mainly staying in the common area of the Peña which for the study purposes was denominated as loft.

Going back to the visitors' profile, most of the interviewed tourists traveled to Peña de Bernal with their couple or families. Their main motivations to visit the place varies between the gastronomic experience, knowing the Pueblo Mágico and seeing the monolith. Still, not all the visitors are interested in actually climbing the area which is why the amount of people in Zone 3 is lower compared to the attached areas that form Bernal's tourism system. Another reason may be the entrance cover mentioned before.

6.2 Recommendations

TCC research cannot be conducted by individual researchers, isolated from an integrated research and policy program for sustainable tourism management of natural protected areas. The measurements and calculations needed only for the physical carrying capacity and other corrections factors are very time consuming and demand a lot of effort in fieldwork in order to collect data. That is why, as a recommendation, TCC should not be placed in isolated research programs, that is, TCC should be integrated into broader inter- and transdisciplinary research programs for sustainable tourism management. Researchers from different areas of knowledge such as geographers, sociologist, psychologists, anthropologist, engineers, economists, etc., are needed plus the integration of another stakeholder such as policy-makers, tourism managers, local people, etc. All of them should conform bodies of research with strong financial and institutional support, otherwise, the complexity inherent in TCC and sustainable tourism managements will not be addressed.

In this sense for improving the reality of Peña de Bernal based on the previous analysis, there are several recommendations that should be pointed.

First of all, considering the TCC as a multidimensional approach is basic for achieving a real change in the sustainable management of the place. In this sense it is recommended to promote the active participation of local institutions, universities and research centers to combine efforts and resources in the aim of analyzing the real dynamic of the place, establishing new alternatives to expand the touristic offer of the area and deconcentrated the actual demand in the already crowded touristic sites of Queretaro (e.g. Peña de Bernal).

The conjunction participation of multidisciplinary actors may also be the base for an update of the Peña de Bernal management plan which has not actual data and may need the intervention of governmental and private institutions to establish a new management strategy much more realistic in terms of the current reality of the site.

It also essential to get local actors involved into further research studies considering all the external factors that may affect the touristic dynamic of the site. In this sense it is recommended to develop a TCC monitoring system of Bernal considering the seasonality of the place. A strict control of visitant access must be established, especially in high season dates. In this case, local actors will be placed at the main entrance of the Peña and will establish an obligatory register in the main entrance to the top of the Peña. Another register

point has to be set in the Zone 1 of the Peña where some visitors spend time with their families but don't necessary goes to the top of the reserve. In this way there would be possible to establish indicators about the real visitation of the Peña as the monolith itself and to the gastronomical and cultural offer in the surroundings. Basic data about tourist profile can also be taken in a more random way in order to not disturb the visitors.

These indicators about the quantity and tourist profile may be the base for further TCC research studies which may have a sampling base to reach a deeper analysis based on a more accurate sample of visitors. Next studies may also be able to consider the different typologies of visitants than a touristic place have which may also be scientific support for developing new touristic products for the state to prevent further impacts in places that are very affected by anthropological activities.

There is an urgent need to update the land use plans of the state to establish a differentiation among the ecosystems that are currently being used as touristic centers to create new regulations regarding the activities that can and cannot be developed in the place (e.g. quantity of food commerce and handicrafts). In the specific case of Bernal, there is also the need to establish restrictions in terms of objects and external food that the tourists may bring to the NPA to avoid collateral damages in the place for pollution and contamination.

In order to recover the ecosystem from the already existing damages because of massive tourism, it is recommended to establish a Recovery Plan on the area which must include closure periods of the NPA for helping to the biodiversity conservation. These periods must be established in accordance with local leaders and must considerate the seasonality too in order to not affect the economy of the locality. In this case, the surroundings of the area may stay open to visitors. However, the specific access to the hiking zone would not allow access during this time.

It is also recommended to define a specific number of tourists that the area can allocate and respect it. In order to do it, it would be a good idea to create an online ticket pre-sell, in order to manage the number of visitors that will assist to the place in high seasons where over-tourism can damage the environment and cultural heritage of Peña de Bernal.

It is needed to have awareness and educational plans for tourists and inhabitants about the importance of maintaining the local resources of the area and controlling the impacts that

visitors and tourist infrastructure itself may have in their natural and cultural heritage, reinforcing that currently in Bernal it is the base of the local economy.

Finally, in terms of infrastructure, it is needed to re-evaluate the current situation of the place and reinforce the investment on security during the path to the top of the Peña and in the touristic zone. An emergency point is urgently needed as well as equipment for treating medical injuries that visitors may suffer during the visit.

7 Conclusions

More integral research and systemic approach to sustainable tourism management in Peña de Bernal is needed. It has to be acknowledged that Peña de Bernal along with the magic town ("pueblo mágico") of Bernal is embedded in a greater touristic area, namely, the one that comprises the cheese and wine route. Visitors do not only go to Bernal, they even may spend half of the day there and the other half in some vineyards or in Tequisquiapan.

The touristic influx dynamic exceeds the system of Bernal. For local visitors, those who inhabit the capital city of Querétaro state, probably Bernal could the aim for a one-day visit. However, for the rest of visitors coming from the surrounding states, the main attraction to see is the city of Querétaro as such, and the area of Peña de Bernal can be only an addition to the route. Therefore, some questions remain regarding the influence of Tequisquiapan and the surrounding vineyards in the visitor's influx in Bernal; how the local and regional economic and industrial development directly or indirectly affects the sustainable conservation of Peña de Bernal.

To answer the interdisciplinary research groups, have to be confirmed in order to portray a better picture of the sustainable development of the regions, considering not only touristic activities but also industrial ones. Moreover, an urban-regional socio-ecological metabolism research approach is needed with the purpose to see the material and energetical flows in the region and how these impact Bernal. Together with these new integrated approaches, better recommendations can be provided and holistic sustainable development programs for the entire region can be designed, implemented and evaluated.

8 References

Acerenza, M. Á. (2013) *Desarrollo sostenible y gestión del turismo*.

Aguirre-Díaz, G. J. *et al.* (2013) 'Geologic setting of the peña de bernal natural monument, querétaro, méxico: An endogenous volcanic dome', *Geosphere*, 9(3), pp. 557–571. doi: 10.1130/GES00843.1.

ALER, FTPP and FAO (1995) *La Radio y Procesos Participativos de Desarrollo Sostenible en la Región Amazónica*. Available at: http://www.fao.org/docrep/x5600s/x5600s00.htm#Contents (Accessed: 20 October 2017).

Alpízar Padilla, V. A. (2011) *Desarrollo de un producto innovador para el turismo enológico: la Ruta del vino en el estado de Querétaro*.

Amador, E., Cayot, L., Cifuentes, M., Cruz, E., Cruz, F., & Ayora, P. (1996) 'Determinación de la capacidad de carga turística en los sitios de visita del Parque Nacional Galápagos', *Servicio Parque Nacional Galápagos, Ecuador.*, p. 42.

Asean Center for Biodiversity (2013) 'Asean Biodiversity'.

Barriball, K. L. and While, A. (1994) 'Collecting data using a semi-structured interview: a discussion paper', *Journal of Advanced Nursing-Institutional Subscription*. Oxford: Blackwell Scientific Publications, 1976-, 19(2), pp. 328–335.

Bimonte, S. and Punzo, L. F. (2007) 'The evolutionary game between tourist and resident populations and Tourist Carrying Capacity', *International Journal of Technology and Globalisation*, 3(1), p. 73. doi: 10.1504/ijtg.2007.012361.

Brida, J. G., Monterubbianesi, P. D. and Zapata-Aguirre, S. (2011) 'Impactos del turismo sobre el crecimiento económico y el desarrollo. El caso de los principales destinos turísticos de Colombia'.

Bryman, A. (2006) 'Integrating quantitative and qualitative research: how is it done?' doi: 10.1177/1468794106058877.

Ceballos Lascuráin, H. (1998) 'Elaboración de inventarios de atractivos ecoturísticos'.

Centro Queretano de Recursos (2002) *Uso actual y potencial del suelo en los municipios conurbados de Querétaro*.

CESOP (2017) 'Programa de Pueblos Mágicos : valorización turística de la cultura'.

Cifuentes, M. (1992) 'Determinación de capacidad de carga turística en áreas protegidas', *Turialba (Costa Rica): CATIE*, p. 23. doi: 9977-57-129-5.

Cobbinah, P. B. (2015) 'Contextualising the meaning of ecotourism', *Tourism Management Perspectives*. Elsevier Ltd, 16, pp. 179–189. doi: 10.1016/j.tmp.2015.07.015.

Coccosis, H. (2001) 'Defining, measuring and evaluating carrying capacity in european tourism destinations', *Methodology*, (December).

CONANP (2019) *Áreas Naturales Protegidas decretadas*. Available at: http://sig.conanp.gob.mx/website/pagsig/datos_anp.htm (Accessed: 21 July 2019).

Congreso de la Unión (2014) 'Ley General de Equilibrio Ecológico y la Protección al Ambiente en materia de Áreas Naturales Protegidas', pp. 1–53.

Covarrubias Ramírez, R., Vargas Vázquez, A. and Rodríguez Herrera, I. (2010) 'Satisfacción de residentes con el desarrollo de la actividad turística en los Pueblos Mágicos de México: un indicador de competitividad. Casos de Comala en Colima y de Real de asientos en Aguascalientes', pp. 33–54.

Creswell, J. (2014) *Research design: qualitative, quantitative and mixed methods approaches*. Fourth edi.

Crónica Regional Querétaro (2019) *San Juan del Río*. Available at: https://cronicaregional.com.mx/san-juan-del-rio/ (Accessed: 28 July 2019).

Cupul-Magaña, A. L. and Rodríguez-Troncoso, A. P. (2017) 'Tourist carrying capacity at Islas Marietas National Park: An essential tool to protect the coral community', *Applied Geography*, 88, pp. 15–23. doi: 10.1016/j.apgeog.2017.08.021.

DOF (2018) 'Plan Nacional de Desarrollo México 2013-2018'.

Echamendi Lorente, P. (2001) 'La capacidad de carga turística. Aspectos conceptuales y normas de aplicación', *Anales de Geografla de la Universidad complutense*, 21, pp. 11–30. doi: 10.1016/j.tmp.2012.05.001.

Fasio Moreno, L. and Ibáñez, R. (2013) 'Percepción comunitaria del turismo de naturaleza como alternativa económica en comunidades rurales biodiversas', *TURyDES revista de investicaion en turismo y desarrollo local*, 6(15).

Fernández Poncela, A. M. (2015) 'Una revisión del programa pueblos mágicos'.

Fernando Estenssoro (2014) *El Ecodesarrollo como concepto precursor del Desarrollo Sustentable y su influencia en América Latina*. Available at: http://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0718-23762015000100006 (Accessed: 7 November 2017).

Ferreira, S. and Harmse, A. (2014) 'Kruger National Park: Tourism development and issues

around the management of large numbers of tourists', *Journal of Ecotourism*, 13(1), pp. 16–34. doi: 10.1080/14724049.2014.925907.

Ferreira, S. L. A. and Harmse, A. C. (1999) 'The social carrying capacity of Kruger National Park, South Africa: Policy and practice', *Tourism Geographies*, 1(3), pp. 325–342. doi: 10.1080/14616689908721325.

Flick, U. (2009) *An introduction to qualitative research*. Fourth edi.

Fundación de Querétaro (2018). Available at: http://transparencia.municipiodequeretaro.gob.mx/contenido.aspx?q=voJvX0R/treTvifX0c9d956t9vPSruW0gVoqKjX25JWRCz/lzCfjlg3te76koQhV (Accessed: 26 July 2019).

Galletta, A. (2013) *Mastering the semi-structured interview and beyond: From research design to analysis and publication*. NYU press.

Garrod, B. and Fyall, A. (1998) 'Beyond the rhetoric of sustainable tourism?', *Tourism Management*, 19(3), pp. 199–212. doi: 10.1016/S0261-5177(98)00013-2.

Gobierno de la República Mexicana (2018) 'Programa Sectorial de Turismo 2013-2018'.

Gobierno del Estado de Querétaro (2009) 'Programa de Manejo del Área Natural Protegida con categoría de Paisaje Protegido denominada "Peña de Bernal"'.

Gobierno Municipal de Ezequiel Montes (2015) 'Plan Municipal de Desarrollo de Ezequiel Montes 2015-2018'.

Gobierno Municipal de Ezequiel Montes (2018) *Informe de Gobierno Ezequiel Montes 2015-2018*.

Guo, W. and Chung, S. (2019) 'Using Tourism Carrying Capacity to Strengthen UNESCO Global Geopark Management in Hong Kong', *Geoheritage*. Geoheritage, 11(1), pp. 193–205. doi: 10.1007/s12371-017-0262-z.

Hall, C. M. and Page, S. (2015) 'The contribution of Neil Leiper to tourism studies', pp. 37–41. doi: 10.1080/13683500.2010.482652.

Haraldsson, H. V and ólafsdóttir, R. (2018) 'Evolution of tourism in natural destinations and dynamic sustainable thresholds over time', *Sustainability (Switzerland)*, 10(12). doi: 10.3390/su10124788.

Herrmann, T. and Schmida, U. (2000) 'Rainwater utilisation in Germany: efficiency, dimensioning, hydraulic and environmental aspects', *Urban Water*. Elsevier, 1(4), pp. 307–316. doi: 10.1016/S1462-0758(00)00024-8.

Hollings, C. S. (2013) 'Resilience and Stability of Ecological Systems', 4(1973), pp. 1–23.

Hoyos Castillo, G. and Hernández Lara, O. (2008) 'Localidades con recursos turísticos y el programa de pueblos mágicos en medio dle proceso de la nueva ruralidad. Los casos de Tepotzotlán y Valle de Bravo en el estado de México'.

Hughes, G. (1995) 'The cultural construction of sustainable tourism', *Tourism Management*, 16(1), pp. 49–59. doi: 10.1016/0261-5177(94)00007-W.

HwanSuk, C. C. and Sirakaya, E. (2006) 'Sustainability indicators for managing community tourism', 27, pp. 1274–1289. doi: 10.1016/j.tourman.2005.05.018.

Ibáñez Pérez, R. and Cabrera Villa, C. (2011) *Teoría General del Turismo : un enfoque global y nacional*.

Iliopoulou-Georgudaki, J. *et al.* (2016) 'Sustainable tourism management and development of a Greek coastal municipality', *International Journal of Sustainable Development and World Ecology*, 23(2), pp. 143–153. doi: 10.1080/13504509.2015.1102780.

INAP (2017) 'Centro de información Estratégica Territorial del municipio de Querétaro'.

INEGI (2010) 'Síntesis geográfica, nomenclátor y anexo cartográfico del Estado de Querétaro'.

Jackson, R., Drummond, D. K. and Camara, S. (2007) 'What Is Qualitative Research?', (October). doi: 10.1080/17459430701617879.

Kostopoulou, S. and Kyritsis, I. (2006) 'A tourism carrying capacity indicator for protected areas', *Anatolia*, 17(1), pp. 5–24. doi: 10.1080/13032917.2006.9687024.

Leiper, N. (1979) 'The framework of Tourism'.

Lobo, H. A. S. *et al.* (2013) 'Projection of tourist scenarios onto fragility maps: Framework for determination of provisional tourist carrying capacity in a Brazilian show cave', *Tourism Management*. Elsevier, 35, pp. 234–243. doi: 10.1016/j.tourman.2012.07.008.

Lobo, H. A. S. (2015) 'Tourist carrying capacity of Santana cave (PETAR-SP, Brazil): A new method based on a critical atmospheric parameter', *Tourism Management Perspectives*. Elsevier Ltd, 16, pp. 67–75. doi: 10.1016/j.tmp.2015.07.001.

Mccool, S. F. and Lime, D. W. (2009) 'Journal of Sustainable Tourism Carrying Capacity : Tempting Fantasy or Useful Reality ? Tourism Carrying Capacity : Tempting Fantasy or Useful Reality ?', *Journal of Sustainable Tourism*, (September 2011), pp. 37–41. Available at: file:///C:/Users/Rodriguez/Dropbox/TCC Ardilla/TCC_McCool 2001.pdf.

Miró Flaquer, M. and Urilla Sarmiento, B. (2018) 'La ciudad de Querétaro y la construcción de la idea de patrimonio. De los últimos años del Porfiriato a la estabilidad

posrevolucionaria'.

Mogrovejo Monasterios, R. J. (2000) 'Desarrollo: enfoques y dimensiones'.

Mokrý, S. (2013) 'Concept of perceptual carrying capacity and its use in the creation of promotional materials of tourist destination', *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 61(7), pp. 2547–2553. doi: 10.11118/actaun201361072547.

Morales Aymerich, J. P. (2009) 'La capacidad de carga: conceptos y usos', *Recursos Naturales y Ambientales*, (63), pp. 47–53. Available at: http://www.sidalc.net/repdoc/A10980e/A10980e.pdf.

Musalem López, F. J. *et al.* (2007) 'Estudio regional forestal region centro "Semidesierto"'.

Nilsen, P. and Tayler, G. (1997) 'A Comparative Analysis of Protected Area, Planning and Management Frameworks', pp. 49–57.

O'Reilly, A. M. (1986) 'Tourism carrying capacity. Concept and issues', *Tourism Management*, 7(4), pp. 254–258. doi: 10.1016/0261-5177(86)90035-X.

Orgaz Agüera, F. (2013) 'La capacidad de carga como instrumento para garantizar la sostenibilidad en el ecoturismo', *Revista de investigacion en turismo y desarrollo local. TURyDES*, 6(15), pp. 1–11.

Ortíz Liñán, M. E. (2017) 'Capacidad de carga turística como método sustentable de gestión ambiental, en sitios seleccionados del estado de San Luis Potosí, México'.

Ortíz Liñán, M. E. and Vázquez Solís, V. (2016) 'Turismo y comunidades indígenas. apuntes para una alternativa de desarrollo sustentable en las Cuevas de Mantetzulel, San Luis Potosí, México', 4(101), pp. 125–139.

Panosso Netto, A. and Guilherme, L. (2012) *Teoría del Turismo: conceptos, modelos y sistemas*.

Pérez, R. I. (2016) 'Capacidad de Carga Turística como base para el manejo sustentable de actividades ecoturísticas en Unidades de Manejo Ambiental de Baja California Sur'.

Prado Mendoza, M. R. (2012) 'Capacidad de carga turística de los circuitos turísticos del Santuario Nacional Los Manglares de Tumbes y del circuito turístico de Puerto Pizarro', pp. 1–6.

Quintero Santos, J. L. (2004) 'Los impactos económicos socioculturales y medioambientales del turismo y sus vinculos con el turismo sostenible'.

Ruschano, R., Chettamart, S. and Nasa, M. (2006) 'Recreation carrying capacity analysis at Khao Leam Ya – Mu Ko Samed National Park, Thailand', (September), pp. 13–17.

Sæthórsdóttir, A. D. (2013) 'Managing popularity: Changes in tourist attitudes in a wilderness destination', *Tourism Management Perspectives*. Elsevier Ltd, 7, pp. 47–58. doi: 10.1016/j.tmp.2013.04.005.

Salerno, F. *et al.* (2013) 'Multiple Carrying Capacities from a management-oriented perspective tooperationalize sustainable tourism in protected areas', *Journal of Environmental Management*. Elsevier Ltd, 128, pp. 116–125. doi: 10.1016/j.jenvman.2013.04.043.

Sayre, N. F. (2008) 'The genesis, history, and limits of carrying capacity', *Annals of the Association of American Geographers*, 98(1), pp. 120–134. doi: 10.1080/00045600701734356.

SECTUR (2014a) 'Agenda de competitividad del destino turístico estado de Querétaro', *Agendas de competitividad de los destinos turísticos de México*, Mazatlán, pp. 1–958. doi: 10.3865/j.issn.1001-3547.2009.20.004.

SECTUR (2014b) 'Indicadores de Competitividad y Sustentabilidad de Pueblos Mágicos. "Bernal"', p. 11.

SECTUR (2014c) *Programa Municipal de Desarrollo Urbano de Ezequiel Montes, Querétaro*.

SECTUR (2018) *Módulo de Información de Pueblos Mágicos*. Available at: http://www.datatur.sectur.gob.mx/SitePages/PueblosMagicos.aspx (Accessed: 26 February 2018).

SECTUR (2019) *Ruta del Arte, Queso y Vino*. Available at: https://www.queretaro.travel/es/region/5/ruta-arte-queso-y-vino/ (Accessed: 29 July 2019).

SEDEMA (2019) *Áreas Naturales Protegidas y áreas de valor ambiental*. Available at: https://sedema.cdmx.gob.mx/programas/programa/areas-naturales-protegidas (Accessed: 21 July 2019).

SEDESU (2018) 'Programa de Ordenamiento Ecológico Regional del Estado de Querétaro'.

Segrado-Pavón, R. G. and Piña, I. I. C. (2018) 'Sustainable tourism development in parque nacional lagunas de Montebello, Mexico', *WIT Transactions on Ecology and the Environment*, 227, pp. 83–93. doi: 10.2495/ST180091.

Segrado Pavón, R. G. *et al.* (2013) 'Estrategias de control de impactos turísticos en las áreas naturales protegidas y zonas arqueológicas de Quintana Roo, México'.

Segrado, R., Palafox-Muñoz, A. and Arroyo-Arcos, L. (2008) 'Medición de la capacidad de carga turística de Cozumel', *El Periplo Sustentable*, (13), pp. 33–61.

SEMARNAT (2016) *Áreas Naturales Protegidas*. Available at: https://www.conanp.gob.mx/regionales/.

Serrano, M. L. T. and Alarte, A. I. G. (2009) 'Capacidad de carga turística en cuatro senderos de Caravaca de la Cruz (Murcia)', *M+A. Revista Electrónica de Medioambiente*, (6), pp. 1–20. doi: -.

El sol de San Juan del Río (2018) *Atractiva tierra industrial*. Available at: https://www.elsoldesanjuandelrio.com.mx/local/atractiva-tierra-industrial-1926925.html (Accessed: 28 July 2019).

UAQ and CONABIO (2017) *Guía ilustrada de la flora del valle de Querétaro*.

UNESCO (2009) 'Sustainable Tourism Development in UNESCO Designated Sites in South-Eastern Europe', *Ecological Tourism in Europe (ETE)*, (0), pp. 1–43.

El Universal (2014) *Las áreas naturales protegidas*. Available at: http://www.eluniversalqueretaro.mx/content/las-areas-naturales-protegidas (Accessed: 24 July 2019).

UNWTO (2008) 'Understanding Tourism: Basic Glossary'.

UNWTO (2011) *Tourism Towards 2030 Global Overview*, *UNTWO General Assembly, 19th Session*.

UNWTO (2017a) 'Panorama Turismo Internacional'.

UNWTO (2017b) *Sustainable Development of Tourism*.

Vázquez Solís Valente, Palacio Aponte Álvaro Gerardo, L. P. L. M. (2013) 'Capacidad de carga turística en el volcán Joya Honda, San Luis Potosí, México: una perspectiva física y perceptiva', pp. 71–80.

Wagar, A. J. (1964) 'The carrying capacity of wild lands for recreation', *Forest Science*, Monograph, pp. 1–24. Available at: papers2://publication/uuid/7FBAC054-C714-4043-B26B-0EBFC87F0FD0.

Wahyuningputri, R. A. (2012) 'Ancol Jakarta Bay City as a sustainable destination park: Assessing crowd based on tourism carrying capacity', *WIT Transactions on Ecology and the Environment*, 161, pp. 217–229. doi: 10.2495/ST120181.

Whiting, L. S. (2008) 'Semi-structured interviews: guidance for novice researchers', *Nursing Standard*. Royal College of Nursing Publishing Company (RCN), 22(23), pp. 35–41.

Zelenka, J. and Kacetl, J. (2014) 'The concept of carrying capacity Objective', *Economic Interferences*, 16(36), pp. 641–654. Available at: file:///C:/Users/Rodriguez/Dropbox/TCC

Ardilla/Zelenka & Kacetl 2014.pdf.

9 Annexes

UNIVERSIDAD AUTÓNOMA SAN LUIS DE POTOSÍ
PROGRAMAS MULTIDISCIPLINARIOS DE POSGRADO EN CIENCIAS AMBIENTALES
TH KOLN – UNIVERSITY OF APPLIED SCIENCES

Technology
Arts Sciences
TH Köln

ENCUESTA PARA MEDIR LA PERCEPCIÓN DEL VISITANTE EN SAN SEBASTIÁN BERNAL, QUERÉTARO

Estimado visitante: su opinión es muy importante ya que nos permite proponer recomendaciones y sugerencias para hacer más agradable su permanencia en San Sebastián Bernal.

Marque su respuesta con una X:

1. Sexo:
( ) Masculino
( ) Femenino

2. Edad: _____

3. Procedencia
Si es mexicano/a indique su el estado: _____
Si es extranjero/a indique el país: _____

4. ¿Con qué persona viaja?
( ) Familia
( ) Pareja
( ) Grupo religioso
( ) Solo
( ) Amigos
( ) Grupo escolar
( ) Otros

5. ¿Cómo supo de la existencia de este lugar?
( ) Internet o redes sociales
( ) Televisión o radio
( ) Agencia de viajes
( ) Recomendación de otra persona
( ) Otros

6. ¿Es su primera visita al Pueblo de San Sebastián Bernal?
( ) Si
( ) No

7. ¿Cuál fue el motivo principal de su visita?
( ) Paseo ocasional sin un fin en particular
( ) Interés por conocer el pueblo mágico
( ) Interés por los viñedos
( ) Gira de estudios
( ) Visita de investigación
( ) Práctica de deportes extremos
( ) Otros

8. Cuál fue el medio de transporte que utilizó para llegar al lugar:
( ) Auto propio o rentado
( ) Autobus o van turística
( ) Transporte Público
( ) Otros

9. ¿Hace cuánto tiempo que llegó Peña de Bernal?
( ) Acabo de llegar
( ) Hace unas horas
( ) Un día
( ) Más de un día

( ) Alteraciones de sus costumbres y tradiciones
( ) Hay mucho ruido
( ) Otros

9. ¿Ha notado usted cambios en el pueblo a consecuencia de la actividad turística?
( ) Si
( ) No

En caso de que su respuesta sea afirmativa, ¿cuáles serían estos cambios? (puede haber más de una respuesta):
( ) Incremento de ruido
( ) Incremento de basura y residuos
( ) Escasez de agua
( ) Exceso de autos en las calles
( ) Otros

10. ¿Durante qué periodos (o/y días específicos) ha observado una saturación de turistas en lugar?
( ) Semana Santa
( ) Celebración de la Santa Cruz
( ) Celebración del Equinoccio en Bernal
( ) Feria del Queso y el Vino
( ) Eventos deportivos
( ) Otros

11. Desde su perspectiva, ¿en qué condiciones se encuentra el pueblo de San Sebastián Bernal?
( ) Excelente
( ) Buena
( ) Regular
( ) Mala

12. ¿Se ha beneficiado usted de la actividad turística?
( ) Si
( ) No

En caso de que su respuesta sea afirmativa, ¿cuáles serían estos beneficios? (puede haber más de una respuesta):
( ) He tenido más oportunidades de trabajo
( ) Tengo mejores ingresos
( ) He aprendido de gente proveniente de otros lugares
( ) Siento que tengo mejor calidad de vida
( ) Considero que el pueblo se encuentra en mejores condiciones
( ) Existen más opciones para comer y divertirme
( ) Otros

Gracias por su colaboración

UNIVERSIDAD AUTÓNOMA SAN LUIS DE POTOSÍ
PROGRAMAS MULTIDISCIPLINARIOS DE POSGRADO EN CIENCIAS AMBIENTALES
TH KOLN – UNIVERSITY OF APPLIED SCIENCES

Technology
Arts Sciences
TH Köln

GUIA DE ENTREVISTAS PARA PRESTADORES DE SERVICIOS EN SAN SEBASTIÁN BERNAL, QUERÉTARO

Estimado habitante: su opinión es muy importante ya que nos permite proponer recomendaciones y sugerencias para mejorar las condiciones actuales de San Sebastián Bernal.

Nombre del establecimiento:
Giro del negocio:
Tipo de prestación:

1. ¿Su establecimiento es propio o pertenece a alguna empresa?
2. ¿Cuánto tiempo lleva su negocio en funcionamiento?
3. ¿En qué temporada recibe más visitas?
4. ¿Su clientela es en su mayoría del estado de Querétaro o de las afueras?
5. ¿Cuántas personas considera usted que puede recibir en su negocio?
6. ¿Cuáles considera que son las motivaciones de los turistas para visitar el pueblo de San Sebastián Bernal?
7. En su opinión, ¿por qué cree que Peña de Bernal es tan atractiva al turismo?
8. Desde su declaración como Pueblo Mágico, ¿Su negocio se ha visto beneficiado por la actividad turística?
9. Durante la temporada vacacional, ¿cuenta con alguna estrategia como apoyo frente al aumento de turistas en el sitio (horarios más amplios, incrementa sus productos o servicios)?
10. Ha recibido alguna capacitación para la atención a los turistas?
11. ¿Ha percibido impactos negativos, en lo social o en lo ambiental debido a la actividad turística?
12. ¿Considera usted es que el pueblo de San Sebastián Bernal debe tener un límite de turistas? Si/ no y por qué