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Evaluation of the Capacity of Polylepis Forest to Provide Cultural Ecosystem Services and Income for its Conservation Measures in the Framework of Chimborazo Natural Reserve's Landscape

Evaluarea capacităţii pădurii de Polylepis de a furniza servicii ecosistemice culturale şi venituri pentru conservarea sa în cadrul peisajului Rezervaţiei Naturale Chimborazo

ABSTRACT/REZUMAT

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Thank you!

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The Author.

CONTENT

CUPRINS

LIST OF ABBREVIATIONS

A – Age
AS – Agriculture and Livestock
BC – Bachelor Complete
BI – Bachelor Incomplete
BV – Bequest Value
C – Communities
CES – Cultural Ecosystem Services
CNR – Chimborazo Natural Reserve
CO – Commerce
CT – Construction
CV – Contingent Valuation
DO – PhD
DUV – Direct Use Value
e – Margin of Error
ESPOCH – Escuela Superior Politecnica de Chimborazo
ES – Ecosystem Services
EV – Existence Value
F – Female
G – Gender
GDP – Gross Domestic Product
I – Monthly Income
IUV – Indirect Use Value
L – Level of Education
M – Male
MA – Master
N – Number of Respondents
n – Sample Size
N – Study Universe
NE – No Education
NUV – Non-Use Value
O – Occupation
OT – Other
OV – Option value
p – Probability of Occurrence
PA – Protected Areas
PC – Primary Complete
PI – Primary Incomplete
q – Probability of Non-Occurrence
S – Specialization
SC – Secondary Complete
SI – Secondary Incomplete
SPSS – Statistical Product for Service Solutions
TEV – Total Economic Value
TO – Tourism
UV – Use Value
WTP – Willingness to Pay
z – Confidence Level

INTRODUCTION

Ecosystem services (***ES***) *are commonly understood to be those benefits that people obtain from the nature for consumption, use or enjoyment. According to several classification systems,* ***ES*** *belong to categories such provisioning, regulation, cultural and supporting services. The flow of these services depends on the existing biophysical conditions as well as on the spatial and temporal changes caused by human interventions, changes in land use and climate. The flow of cultural ecosystem services ensures nonmaterial benefits to users, but it seems to be particularly vulnerable to global change. This category of services is closely linked to personal and local values since they are frequently encompassing the human worldview, identity, aesthetic welfare, relaxation and ecotourism. A typical landscape to which people relate their values, beliefs and welfare is that of forest ecosystems. The type of forest ecosystem, however, may significantly differ among regions while the values and beliefs that people place on them may be also different. For instance, the Polylepis forests of Ecuador hold high scenic beauty and some of them are protected for many reasons and values. Nevertheless, the value of these* ***ES*** *is often overlooked when making decisions about the management of landscapes and particularly of natural resources. Studies addressing these issues are typically rare in the scientific literature and, therefore, only little is known about how the landscapes, their features and ecosystem's properties may contribute to people's perception, use and to a proper socio-cultural valuation of* ***ES****. In this sense,* ***ES*** *assessment has become an important tool in the development of sustainable practices related to land uses and to the management of natural resources. Particularity, the assessment of* ***CES*** *relies heavily on human perceptions; these perceptions should be integrated in the landscape management activities, enabling the identification of the* ***CES*** *and responsive interventions. However, few studies have attempted to develop measures of* ***CES*** *by considering their linkage to specific ecosystems or regions, an approach which is important since* ***ES*** *are increasingly reaching the economic management and decision-making by promoting market-based instruments for conservation. To this end, one of the main goals of the economic valuation is to assign quantitative values to the services provided by ecosystems a fact that may help in designing an alternate (sustainable) course of actions. Economic analysis may enable efficient strategies to support biodiversity conservation while the policy makers are now increasingly recognizing the role of environmental valuation in guiding and supporting nature's management. Placing monetary value on* ***ES*** *is a good approach to gain awareness and sustain conservation; lately, it became a fundamental step to improve the existing mechanisms and to enable funds for sustainable use, in the form of rewards or payment systems for ecological services, and it is often framed around the particularities of the region, diversity of landscapes, extinction rates of species, scope of in situ conservation and the distribution and connectivity of protected areas* (***PA***)*. As the humans develop their activities in natural landscapes, the need for management approaches based on perspectives that thoroughly incorporate ecosystem considerations into planning has become increasingly urgent. Ecuador is considered to be one of the most diverse countries in the world. The country manages a number of 56* ***PA****, a system that includes the Chimborazo Natural Reserve* (***CNR***)*, having a total area of 58,560 ha. It encompasses 10 tourist attractions directly associated with 5 of the 10 ecosystem types in the area; these ecosystems enable the sustenance of life through ecological functions and the supply of goods and services which are essential for human welfare. An important tourist hotspot in the area is the Polylepis relict forest which has an increased potential to provide a wide range of cultural services to locals and tourists, therefore, it could generate income for the protection and conservation of the landscape. Nevertheless, little is known about what is the real value of this forest and how the main stakeholders perceive it in the general framework of the* ***CNR*** *which holds other important landscapes and attractions. This work deals with the assessment of potential* ***CES*** *provided by the Polylepis Forest in the view of local and foreign stakeholders by placing the forest in the framework of the* ***CNR****'s landscape. This approach has been chosen to avoid the bias that could have been generated by only addressing the forest itself.*

CHAPTER 1. STATE OF ART ON MAPPING, EVALUATION AND VALUATION OF ECOSYSTEM SERVICES. CULTURAL ECOSYSTEM SERVICES. RELATIONS TO FORESTS, FORESTRY, FOREST-BASED TOURISM AND FOREST-BASED USE OF THE LANDSCAPES

1.1. Ecosystem: concept, functions and ecosystem services

1.1.1. Ecosystems

1.1.1.1. Concept

The ecosystem concept was defined for the first time by Tansley back in 1935, as the functional combination of organisms with environmental factors, thus introducing two types of interactive components in the ecosystem: the abiotic component (related to the environment) and the biotic component (related to living beings). From the anthropocentric point of view, ecosystems are usually understood as a natural capital, a view in which those ecosystems having ecological integrity and resilience are being capable of generating a flow of services to the human being through the maintenance of their functions (Montes, 2007; Martín-López et al., 2009). Furthermore, an ecosystem can be simply defined as a natural unit made of living beings, their physical environment, in which the elements work together as interdependent systems. Therefore, if a component is damaged, that impact can be extended to the entire system (DEFRA, 2007).

Ecosystems are able to provide a wide range of ecosystem services (***ES***), many of which are of high importance for the satisfaction of needs, health, livelihoods and survival (TEEB, 2010). In general, the world's ecosystems are considered to be a natural capital and, when properly managed, they produce a flow of crucial ecosystem services, such as the production of goods, life support processes and conditions of spiritual enrichments (Machicado et al., 2010). Therefore, people living within a certain area are using directly from ecosystems everything they need to live and appreciate it within their subsistence economies (Gómez and De Groot, 2007). On certain occasions, the approach to nature of ***ES*** is given from an anthropocentric perspective in which the ecosystems and biodiversity they hold is directly linked to human well-being (Martín-López and Montes, 2010). Therefore, ecosystems are often seen as an interlinked network featuring a start point in the form of ecological and evolutionary processes that provides inputs, through the final ***ES***, to the elements of the ecosystem from which humans are able to derive their goods and benefits (Mace et al., 2012). In this configuration, processes that take place into an ecosystem generally depend on the correct combinations between biotic and abiotic components. However, what matters sometimes is not only the presence of a particular element nor its richness, but also the variety of types, that is, biodiversity. Biodiversity is used along with the ***ES*** concept at all levels: it provides support for key processes, affects the provision of some ***ES*** and, in some cases, it may be the outcome under valuation (Mace et al., 2012). In this context, the management of ecosystems to guarantee ***ES*** is an important challenge in the field of applied ecology. In addition, the functional features received an increased attention as being the main ecological attributes used by different organisms or biological communities to influence the flow of ***ES***, through the effects on the underlying ecosystem processes (De Bello et al., 2010).

As some of the ecosystems are managed within protected areas (***PA***), according to Pabon et al. (2008) the benefits provided by ***PA*** are the following:

- Biodiversity – is the main benefit provided by ***PA*** by the conservation of biodiversity and of ecosystems important for the survival of man. These areas may contain rare, endangered or endemic species and habitats with little representation;
- Employment – ***PA*** can diversify the existing sources of employment for the local population by releasing new jobs on the market such as administrators, park rangers, wildlife keepers, guides and other direct and indirect jobs related to ecotourism services. Generally, these jobs provide educational opportunities in addition to the benefits and values;

- Food – ***PA*** provide a wide assortment of foods in the permitted categories. As such, traditional agriculture and its associated biodiversity are increasingly being protected, including locally adapted crops (*e.g.* coffee, cocoa etc.). ***PA*** that consider the integral management of the resources are also important for the pasture of the cattle and grass harvesting;
- Water – the vegetation in ***PA*** helps to maintain water quality and also to increase its availability through filtration, renewal of groundwater and natural maintenance of natural flows. ***PA*** water is important for subsistence agriculture, drinking, washing or cooking, and also for commercial uses such as large-scale irrigation, bottling, hydroelectric power or sources of community drinking water;
- Cultural and spiritual values – many of the oldest ***PA*** in the world were designated for their cultural and historical values. These may contain important features such as archaeological sites and historical buildings and they may protect other features such as pilgrimage routes or traditional customs. In addition, they may include sacred sites or landscapes. Increasingly, ***PA*** are among the last places where people can experience the feeling of the wild or other similar traditional values;
- Health and recreation – ***PA*** are recognized to be among the most important places that promote human health and recreational values. They stand out also for their medicinal resources that can be processed in useful medicinal products;
- Knowledge – ***PA*** can be used to promote the development of knowledge and education by dissemination of information and by hosting sites of value for ecological research and monitoring. Many of them play also a key role in the protection of important species, such as those related to wild crops, which offer important genetic heritage to fight diseases or to improve the productivity of regular crops;
- Mitigation of climate change – ***PA*** can play a role in both sequestering carbon and in amelioration of local climate;
- Disaster mitigation – as humans affect the ecosystems, the number and impact of disasters increase. ***PA*** can help to mitigate these events. Examples in this sense are the stabilization of the soil, avoiding floods and coastal protection;
- Pollination services – one of the values that is often overlooked is the process of pollination assisted by insects - if the insects do not proliferate, the crops will not proliferate either. Therefore, ***PA*** also play an important role in helping in the ecological cycle to pollinate crops by contributing to the occurrence of pollination and to its products;
- Materials – in many ***PA***, it is possible to access a wide range and assortments of natural products. Many communities worldwide use these resources for their sustenance.

In this context, ***PA*** also play an important role for ecosystems they contain, as they have been mainly promoted in order to maintain efficiency in the conservation of biodiversity, ***ES*** and associated values *in situ* (World Wildlife Fund, 2014). Therefore, Pabon et al. (2008), have shown some benefits provided by the ***PA*** in relation to the ecosystems.

1.1.1.2. Ecosystem functions

Researchers have been struggling to offer a consistent theory on the functioning of ecosystems recognizing that, in all circumstances, the complexity of ecosystems must be considered (Jørgensen et al., 2016). Ecosystem functions are commonly defined as being the result of natural processes of the environmental subsystem of which they are a part (De Groot et al., 2002). De Groot et al. (2010) pointed out that ecosystem functions characterize the capacity of ecosystems to supply goods and services that compensate human needs directly or indirectly. For instance, these functions may cover the physical, chemical and biological processes that take place within the ecosystem and contribute to the maintenance of terrestrial life (Kremen, 2005).

Processes and components of ecosystem functions contribute to the benefit of society (Willemen, 2010). The interactions that occur between the living and nonliving features in an ecosystem shape

the quantity, quality and reliability of ***ES***. Since the physical, chemical and biological features of ecosystems may change, changes will be triggered also in the associated processes, therefore, in the services provided (Mace et al., 2012). By providing the underlying interactional structure among species, ecological networks can help quantifying the connections existing between biodiversity and the functions of ecosystems; since changes in species diversity can affect in the same time multiple functions of interdependent ecosystems, an important challenge is to know when and how changes in species diversity influencing a function will also trigger the modification of other functions (Hines et al., 2015). In this sense, Mace et al. (2012), have shown that the species in a community are essential for the generation of various ecosystem functions which, in turn, are the biological basis of ***ES***. Nevertheless, stability of composition itself is not a crucial requirement for the resilience of these functions (Oliver et al., 2015).

In recent decades, a lot of effort has been given to the maintenance of spatial and economic synergy between the functions of ecosystems in rural areas as a part of development (Van Berkel and Verburg, 2014); it is thought that this allows local communities to better face the pressures threatening the livelihoods in these landscapes (O'Farrell and Anderson, 2010). To this end, Gómez and De Groot (2007), have characterized the functions, goods and services of the ecosystems, such as the *regulation functions* (*e.g.* atmospheric and climate regulation, damping of disturbances, water regulation and availability, ground support, soil formation, nutrient regulation, processing of waste, pollination and biologic control), *habitat functions* (*e.g.* shelter function), *production functions* (*e.g.* raw materials, food, genetic resources etc.), *information functions* (*e.g.* aesthetics, recreational function, artistic and cultural information, historical information and science and education) and *substrate functions* (*e.g.* housing, agriculture, energy conversion, mining, landfill, transport and tourist facilities). Having that in mind, Martín-López and Montes (2010) stated that, for diverse types of ecosystem functions it is possible to find different uses that man makes of ecosystems. According to them, these uses may be undertaken consciously or unconsciously as well as directly or indirectly. From these points of view, functions exist independently of their utility, and they are translating into services only when they are used. Therefore, the translation of a function into a service implies the identification of at least one beneficiary, the type of use, as well as the spatial and temporal location of its use.

1.1.2. Categorization of ecosystem services: systems, similarities and dissimilarities

For a better understanding of the categorization of ***ES*** it is important to define them. This is important as Czúcz et al. (2018) have shown that categorizing and describing ***ES*** shape the basis of measuring, mapping and valuing attempts. The following statements, coming from several authors, state the different definitions given to ***ES*** in a chronological order:

- Daily (1997): "*Conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life*";
- Costanza et al. (1997): "*The goods (such as the food) and services (such as the assimilation of waste) of the ecosystems, which represent the benefits that the human population obtains, directly or indirectly, from the functions of the ecosystems*";
- MEA (2003): "*The benefits that the population obtains from ecosystems*";
- Boyd and Banzhaf (2007): "*Components of nature, enjoyed, consumed or directly used to produce human well-being*";
- Fisher et al. (2009): "*They are the aspects of ecosystems utilized (actively or passively) to produce human well-being*";
- TEEB (2010): "*The direct and indirect contributions of ecosystems to human well-being. The concept of "ecosystem goods and services" is synonymous with* ***ES***";
- Burkhard et al. (2012): "*The contributions of ecosystem structures and functions to human well-being*".

- Peng et al. (2018): "*Benefits that people obtain from ecosystems, and compensations for **ES** have been widely applied to land development*".

For almost two decades, the scientific concept depicting the ecosystem services has gained an increasing momentum in the scientific community around the world (Burkhard et al., 2010). Therefore, the ***ES*** were characterized by a wide approach to clarify and evaluate the dependence that mankind places on ecosystems and landscapes (Bastian et al., 2012). According to the EUROSTAT (Commission for the European Communities, 2010), UNSD (United Nations Statistics Division, 2010), UNWTO (United Nations World Tourism Organization, 2010), and OECD (Organization for Economic Cooperation and Development, 2010), many initiatives were undertaken to support the difficult path towards an effective and harmonized use of the concept of ***ES***, as a key step towards the resource efficiency and as a common objective for policy actions. Therefore, lately, the concept of ***ES*** has emerged as a key approach that enabled the support for policy actions, aiming at sustainable development, biodiversity protection and planning strategies developed at multiple scales (Maes et al., 2013). Thus, the ***ES*** have become a well-known approach in conservation planning and environmental assessment, a framework that was needed to avoid the quality reduction of ecosystems (Burkhard et al., 2010).

In addition, some authors such as Fisher et al. (2010) and MEA (2005), have stated also that the supply of ***ES*** is also a social perception problem in terms of how the benefits that humanity take from nature are perceived to address the components of well-being. In relation to this problem, Burkhard et al. (2012) stated that the flow of ***ES*** is given by the capacity of an area to provide a set of ecosystem goods and services in a period of time. Rodríguez et al. (2018) indicated that the loss of this supply can be explained by the interaction between losses in area, patching and diversity loss. Furthermore, De Groot et al. (2002), argued that, the promotion of a wide range of ***ES*** has become a dominant paradigm that enabled conservation opportunities throughout the world. According to TEEB (2010), the growing importance of ***ES*** for global politics is sustained by the fact that it focuses on the economic part of ecosystems and their biodiversity. Thus, Rodríguez et al. (2018) have shown that the change in land use affects biodiversity and supply of ***ES***, and sound knowledge on this relationship is crucial to get the information needed by conservation strategies. This is also supported by Bai et al. (2011) who indicated that biodiversity and ***ES*** are interlinked, because human activities impact the environment both, intensively and extensively; it is, therefore, essential to understand the spatial relationships of conservation priorities.

To frame the wide range of ***ES***, several classification systems emerged over time. The most commonly known and used are the MEA (2005), TEEB (2010) and CICES (2013). A typical feature of these classification systems refers to the concepts and terms used to describe the provided ***ES***. Therefore, among the three classification systems described, there are both conceptual and terminology similarities and dissimilarities.

For a better understanding of ***ES*** in terms of concepts and terminology used, a comparison of the three different classifications as proposed by MEA (2005), TEEB (2010) and CICES (2013) is given in **Appendix 0** of the full thesis.

1.2. Cultural ecosystem services: importance and state of art

1.2.1. Definition and concepts

Humans have benefited from ecosystems through intangible assets defined later on as Cultural Ecosystem Services (***CES***) since the beginning of known history (Hernández et al., 2013). According to the MEA (2005), ***CES*** are understood as the "*non-material benefits that people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experience, including knowledge systems, social relations and aesthetic values*". In the same way, Chan et al. (2012), emphasized that ***CES*** are considered to be the contribution of ecosystems to "*the non-material benefits (experiences, capabilities) that people derive from human-ecological*

relationships". On the other hand, Boñón (2014), indicates that ***CES*** are appreciated through the opportunity they give for recreation, tourism and cognitive development as well as for expression of spirit and religion, that undoubtedly contribute to the improvement of well-being. Likewise, Van Berkel and Verburg (2014) have indicated that the ***CES*** are also related to the tourist experiences by recreation, aesthetics, cultural heritage, spirituality and inspiration gain in the landscape. In addition, Daniel et al. (2012) have mentioned that ***CES*** are of great importance in mobilizing the civic support for nature conservation.

Balvanera et al. (2009) have concluded that uses, resources and meanings are dynamically interlinked in different cultures. Today, there are many environments in which culture and nature are interlinked, starting from home gardens and ending with huge landscapes while these environments enable the achievement of important individual and social needs (Plieninger and Bieling, 2012). Leff et al. (2003) have pointed out that the traditional indigenous practices demonstrate sustainability, enabling the subject populations to remain in harmony and up-to-date with natural functioning of ecosystems and the flow of ***ES*** by the ecosystems they currently inhabit.

In this sense, Chan et al. (2011) recognize that ***CES*** arise from the contribution of ecosystems to experiences that are pleasurable or beneficial and include recreational and aesthetic benefits. **Appendix 0** gives the classification of ***CES*** by considering the 3 standardized approaches. La Rosa et al. (2016) have pointed out that among the most studied ***CES*** to date are the recreational and aesthetic types, followed by those of spiritual nature, cultural heritage and educational values. For this reason, they and other authors, recommended the development of more research that should enable the analysis of ***CES*** in different types of ecosystems. This would be also an opportunity to improve the methodologies used up-to-date.

1.2.2. Landscape use. Tourism and ecotourism. Relation between tourism and cultural ecosystem services

1.2.2.1. Landscape use

According to Pérez (2001), the landscape is always the unstable result of a dynamic in which biotic, abiotic and anthropic elements intervene, therefore, it cannot be seen only as something static but as something dynamic. Gobster et al. (2007) define the landscape as the physical patterns that we perceive and which compose our environment, being related to the aesthetic experiences that can lead people to change or not the landscape in a consistent manner, according to their ecological function. Also, Cladera et al. (2015) have indicated that the landscape is dynamic and changing, it works as an ecosystem and meets all the conditions to be considered heritage because it holds a natural, social, cultural, economic, scientific, and technical content. In relation to the importance of landscape, Criollo and Boolee (2019) have shown that it lies in the relationship of the natural and cultural components that make up a community or territory. For this reason, the concept of landscape refers to and contains notions of environmental conservation and cultural identity. To this end, Pavlis and Terkenli (2017) have mentioned that the construct of landscape affects the construct of identity and the appropriation of communities to a space. In this context, Subirós et al. (2006) have stated that the interpretation of changes in the landscape is based on the structural and morphological character of it, therefore the structural and morphological characteristics that make up the territory in a determined moment and (or) its evolution over time. According to Morláns (2005), each territory has particular characteristics and presents biological and anthropic processes that have developed within the respective areas. Fisher et al. (2009) have acknowledged that the ***ES*** that are generated within a landscape are diverse. In other words, ***ES*** are related to the spatial dimension of a defined area in which those services are provided (Busch et al., 2012), therefore, for local planning, sound knowledge on the economic significance of spatial distribution of ***ES*** is fundamental (Rodríguez et al., 2016). In particular, the spatial distribution provides important information when it comes to supporting those responsible for the definition and application of strategies which aim to plan the landscape in different parts of the territory. To this end, Chee

(2004) have indicated that the management of landscape is determined by articulating views on types of ***ES***, learning in decision-making, exploring the dynamics and possible outcomes, assessing uncertainty, facilitating discussion, deliberation and negotiation, and evaluating options for compromise solutions. Criollo and Boolee (2019) have argued that various types of correlated variables intervene in the landscape management process, as well as that the socio-cultural variables act differently in their influence on landscape attributes. With respect to the definition of attributes, Van Zanten et al. (2016) have established that they are a group of characteristics belonging to the landscape and given by the community-level socio-cultural assessments, standing, additionally, for the aesthetic and recreational values. Linked to the management, these characteristics take an approach that is defined as local environmental management actions to improve the ecological infrastructure and the well-being of the community (Tidball and Krasny, 2012).

1.2.2.2. Tourism and ecotourism

Tourism is known to have positive effects on human well-being and on the quality of life (Garcés et al., 2015). According to Agovino et al. (2017), the tourism has become a necessity as an effect of society development. Accordingly, Ji et al. (2015) have stated that tourism has a great socio-economic contribution by enabling significant developments in income and employment, infrastructure and business, in general. However, García et al. (2015) have indicated that tourism also causes a negative impact by a direct contribution to environment degradation, an increase in the cost of living for the local communities and by leading, sometimes, to conflicts between incomers and residents.

Having that said, the tourism and its related industry are widely recognized as engines of economic growth throughout the world. However, it has also been recognized to face many challenges related to continuous growth and development, needing new ideas to guarantee its future growth (Henderson et al., 2018). To bridge such challenges, Hjalager (2010), indicates that new tourism products and innovation are vital to ensure the continued growth of this industry and, consequently, its economic impact. According to the WTTC (2017), this growth can favor an increase in national and local income through different channels, such as the balance of payments and employment growth. In addition, the decision-makers can use the tourism as a policy instrument to reduce inequalities in well-being, because it enables the transfer of income across countries and regions. On the other hand, Sokhanvar et al. (2018) have pointed out that, as the tourism industry grows in many countries, the relationship between economic growth and tourism income is getting even more important for those responsible for formulating public policies. In this context, Cvelbar et al. (2016) have estimated that the contribution of the tourism industry to the global ***GDP*** (Gross Domestic Product) is expected to increase and to create approximately 380 million jobs by 2027, standing for 11% of the worldwide jobs; therefore, there is a continuous effort in most tourist destinations to strengthen the productivity of their tourism industry.

Tourism may be defined in several ways. The following statements formulated by several sources and authors explain the notion of tourism:

- ***WTO*** (World Tourism Organization, 2007): "*Tourism is a social, cultural and economic phenomenon which entails the movement of people to countries or places outside their usual environment for personal or business/professional purposes. These people are called visitors (which may be either tourists or excursionists, residents or non-residents) and tourism encompasses their activities, some of which imply tourism expenditure*";
- Minciu et al. (2010): "*Tourism, one of the most dynamic domains of the contemporary economy, has to be equally integrated in the sustainable development process, since, through its complex content, it can help attain a stable balance between the three major dimensions of evolution - environmental, economic and social cultural, thus insuring its long term sustainability"*;
- Zhong et al. (2011): "*It is a potential mean to create a larger social constituency to support the conservation of biodiversity*";

- Seetanah (2011): "*It is a good development strategy for the territories that have unique natural, cultural or social attractions that, in general, are highly valued through the activity*";
- Fan et al. (2013): "*It is a powerful activity that can have significant impacts on a nation, in terms of the economy, society, culture and environment of a country*";
- Pratt (2015): "*With respect to economic impacts, it is recognized as an important source of alternative income and employment opportunities for the local area, so that the development of tourism would boost the improvement of local infrastructures and facilities, which leads to the improvement of the quality of life in the local community*".

Some empirical studies have shown that tourism can have a positive effect on the people who take advantage of it (*e.g.* Eichorn et al., 2013). According to Mahanty et al. (2007), the commitment and development of local human capital, the links between tourists and the local community, the mechanisms of income distribution to improve the financial capital, the agreements and the law, social equity, as well as the local culture are important factors that affect the equitable distribution of benefits in different sites. In this direction, community participation has been considered to be a key element in tourism planning because it allows them to participate in the initiatives that have an effect on them (Jaafar et al*.,* 2015). To this end, Mayaka et al. (2018) have argued that the understanding of how the community participates in different environments is important to inform the possibilities of realizing and improving community development strategies led by tourism.

Tourism and landscape seem to interact in many ways (Liburd and Becken, 2017). Levin et al. (2013) have indicated that the interaction between tourism and landscape can be understood under the umbrella of socio-ecological systems. This perspective frames the concept of an integrated system which includes as components the human society and the ecosystems. An good example of such a system is the one given by McCool and Spenceley (2014), who have pointed out that, the tourism developed to access the nature contributes not only to the economic development of local communities but and also to the understanding of culture and heritage and to raising support and funds for conservation. In this sense, studies on the tourism impact on the environment have brought to light how the financial support generated by tourism may contribute in promoting the conservation of natural resources, improving the environment and shaping the environmental education; however, the development of unregulated tourism is known to cause environmental degradation and geographic problems (Andereck and Nyaupane, 2011). The effects are even sharper in ***PA***, where the development of tourism infrastructure, extraction of natural resources and other tourist activities developed in sensitive areas are of a big concern for the local management (Figueroa and Rotarou, 2016).

Based on above, it worth addressing what the sustainable tourism means. For instance, Briassoulis (2002) has pointed out that sustainable tourism seeks to be an activity that promotes local development and protects the resources that make up its productive base, based on social, economic and environmental sustainability criteria, and it is increasingly important in the development of ecological economies (He et al*.*, 2018). Achieving a sustainable tourism, however, is a process that involves benefit maximization and cost saving while satisfying tourists and engaging the community in decision-making (Cottrell et al*.*, 2013). The development of sustainable tourism in the ***PA***, needs to be approached by a continuous improvement of quality in relation to the management of ***PA*** considered for such activities, as well as in the products of ecological tourism, commercialized by the touring agencies (Minciu et al*.,* 2010). In addition, one should count on the support of residents that shouldn't be omitted to be able to guarantee the development of sustainable tourism, given the fact that the locals are crucial agents for memorable experiences (Tolkach and King, 2015). Finally, the local institutions may play an important role in ensuring the sustainability at least by providing the formal and informal rules, shaping the accepted practices and enforcing the control by incentives and disincentives (Liu et al*.*, 2017). Likewise, they can contribute to the sustainability of this economic sector as the mass-tourism may be discouraged or prevented by restrictions on the volume of incomers or by deliberate underdevelopment of physical

infrastructure (García et al., 2015). In addition, strong local institutions enhance the resistance of local communities to adverse changes and ensure the equitable distribution of benefits (García et al., 2015). In this approach, institutional arrangements are required to ensure an equitable distribution of tourism benefits among different stakeholders (Badola et al., 2018).

Basically, the ecotourism is seen to be as a useful strategy for local development (Mensah, 2016). In this framework, Nilsson et al. (2016) have mentioned that ecotourism remains the best tool to promote sustainability in the industry, by creating employment and by promoting local heritage and economy. Its potential is shaped within the framework of the United Nations Sustainable Development objectives that are aiming to design and implement policies that support the improvement of local livelihoods and promote environmental sustainability. This is consistent with the statements of Anim et al. (2013) who have indicated that the development of ecotourism has generated numerous political, economic, environmental and sociocultural impacts. These impacts can constitute a way of complementary approaching the resources as well as the development of the local economy (Santarém and Paiva, 2015). Cobbinah et al. (2015) have argued that it is the responsibility of ***PA*** to preserve the environment and to maintain the well-being of locals, features that are known as a sustainable development for the tourism industry, since the distribution of ecotourism benefits is important at least in the developing countries. Accordingly, Abdurahman et al. (2016) have indicated that ecotourism is one alternative to bring money and job opportunities in rural communities by integrating resources that combine culture, nature and adventure. To be able to offer sustainable mechanisms for the needs of local communities while preserving the environmental conservation, Adu-Ampong (2017) has argued that ecotourism should be comprehensively conceptualized and adapted to the local environments to explore and exploit the socio-environmental system. In ***PA***, tourists find more valuable experiences given by healthy ecosystems, which contribute to the maintenance of the quality and quantity of ***ES*** that support ecotourism activities (Bovarnick et al., 2010).

Based on those discussed above, the benefits of ecotourism may rest in many things including those described by Popa and Bann (2012) such as the implementation of self-financing as mechanisms for conservation, development of local jobs, stimulation of local economy as infrastructure, services and traditional products and the improvement of inter-cultural relations. According to Candrea and Hertanu (2015) there are also several potential ecotourism opportunities: generation of income by fees, concessions and donations, employment creation, a stronger economy and environmental education.

On the other hand, Zhang and Lei (2012) have indicated that the participation of local communities in ecotourism can be motivated by having adequate management strategies that aim to improve local understanding of environmental problems, stimulate favorable attitudes towards this activity and developing environmental plans. Therefore, in many rural areas, the creation of ***PA*** and the development of ecotourism resulted in changes in local livelihoods (Cobbinah et al., 2017).

1.2.2.3. Tourism and the use of ecosystem services

De Groot et al. (2002) have indicated that tourism bases a large part of its offer on goods and services related to information functions of ecosystems, that is, those considered as reference for human health through recreation and aesthetic experience (among others) and provided by diverse ecosystem units. These functions can also be referred directly as cultural functions. According to Villa (2010), the landscape richness is the cradle for protection of cultural expressions and ancestral spiritual values, which are considered to be amongst the most important services provided by a territory. Here, activities related to the enjoyment of scenic beauty can be offered along with other environmental services such as thermal waters, lakes and lagoons, camping sites, outdoor horse riding, hiking as well as other activities related to the local culture, focused on the appreciation and enjoyment of artisanal production and culinary culture of the area. García (2013) has pointed out

that recreation is a key cultural service since the scenic beauty of its landscape attracts visitors interested in enjoying it. Briassoulis (2002) have stated that culture and nature are resources of shared or common property where property rights and free access are not well defined, that is, in addition to tangible resources and services, tourists "consume" resources and intangible services, including local culture in the form of norms, habits and behavior, local smells and tastes, and more broadly the sense of belonging.

Daniel et al. (2012) have found that it is very important to recognize the interlink between different ***CES***, human societies and ecosystems. In this conceptual framework, landscapes are linked to cultural identity and traditions, because people value the local landscapes also for their shape and meaning, which in most cases tends to vary taking into account the emotions and attitudes that people build relative to their natural environment (Scholte et al., 2015). This is also supported by De Groot et al. (2002) who have stated that socio-cultural values shape many opportunities for spiritual enrichment, cognitive development, recreation, education and science while the natural environment enables multiple opportunities for recreational activities. Therefore, the problem on how to ensure that ecological and (or) cultural tourism activities are developed in a way that avoids overexploitation of free access to resources that sustain ecosystems and biodiversity and native culture is to be analyzed to allow an efficient economic use of ***ES*** by those who demand and use them (Figueroa and Álvarez, 2002).

1.3. Identification, evaluation and valuation of ecosystem services: concepts, methods and steps

1.3.1. Identification of ecosystem services

Bolund and Hunhammar (1999) have proposed that, under a methodological perspective, the identification and valuation of ***ES*** could be considered as inputs to a Cost-Benefit Analysis (***CBA***) which would enable a more efficient land-use. In addition, Partidario and Gomes (2013) have mentioned that the identification of ***ES*** must be done through the commitment of the interested parties of a territory. Accordingly, Nedkov and Burkhard (2012) have indicated that ***ES*** identification studies have offered policy makers a perspective of the priority places for the provision of services. In particular, the information that can be obtained from the identification of ***CES*** favors the understanding of impact on the ancestral practices that the communities maintain. That's because, in spite the existence of potential ***ES*** that occur in an area, it is the intrinsic meaning of the people that contribute to a true value of the cultural ecosystem service (Daily et al., 2000). According to Boyd and Banzhaf (2007), the procedure for identifying ***ES*** consists in developing, in a first step, of an inventory of natural well-being sources, followed by their understanding. In another approach, the identification and classification of ***ES*** in an area can be done through the review of secondary information to establish those ***ES*** that can be subject of valuation (Partidario and Gomes, 2013). Of real help may be the making of a pre-selection that should take into account the appreciations of different local social actors through memories of workshops. As a supporting tool, La Roca (2010) has indicated that the first task that must be undertaken is to visualize or map the ***ES***. Then, ***ES*** lists should be made based on the different classifications and these lists should give in detail the possible provisioning, regulation, habitat and cultural services related to the ecosystems, identifying the ***ES*** present in an area. For this purpose, written sources are used to reconstruct the relationship between the local society and the ecosystems related to the area; from this first exploration emerges the need to classify the services according to their relationship with the society settled in the study territory and in other territories to be able to make the distinction between appropriate services that are either enjoyed in situ and (or) exported. In this context, Popa et al. (2013) have presented some criteria for the identification of ***ES*** which were related to the risk of the ***ES*** flow decreasing, importance for local livelihoods, importance for traditions and opportunities for development and investment.

1.3.2. Evaluation of ecosystem services

De Groot et al. (2002) indicate that the evaluation of a landscape is carried out in an integral way by the means of goods and ***ES***, which implies an ecological complexity in its structure and processes. According to Koschke et al. (2012) the evaluation is an important instrument to face the current difficulty of systematically considering ***ES*** in landscape and land use management. To this end, Fagerholm et al*.* (2012) have stated that the evaluation of the ***ES*** essentially deals with the relationships between society and its environment, instead of simply the ecosystems themselves; therefore, the knowledge on beneficiaries is essential, because the evaluations and existing landscape data disclose only few information on the benefits that landscapes bring to local stakeholders. According to Syrbe and Walz (2012), ***ES*** approach is an established framework that should be used for balanced assessment of the three-pillar resources: ecological, economic and social landscape. In this view, ***ES*** assessments need to be tailored to respond to the scale of analysis and the objectives of the case studies (Muller et al*.*, 2010). Often, this requires an effective analytical framework to map and evaluate ***ES*** within a basic conceptual structure, in addition to including spatially explicit models and indicators that are needed for a holistic and coherent vision when evaluating and reporting multiple ***ES*** (Grizzetti et al., 2017). For mapping approaches, Lautenbach et al*.* (2012) have argued that the existing assessment methods are often directed to the model-based expansion of monitoring data that has been evaluated at different spatial or economic scales. To support evaluation and mapping at landscape level, Rodríguez et al. (2018), have shown the utility of many resources and tools including satellite data and landscape metrics, spatially-explicit models and generalized linear models. Regarding the cultural landscape, Plieninger et al. (2013) have demonstrated the use of the mapping tools for the evaluation of cultural landscapes (ecosystems). Their approach enabled the evaluation of "critical focal areas" for the management of ***CES***; however, such methods require elements that allow progress in the conservational management of these landscapes. Furthermore, De Groot et al*.* (2002) have proposed 3 conceptual scales of landscape evaluations: ecological, socio-cultural and economic. In their opinion, the first is related to utility, which must have a sustainable level shaped by regulations that act as parameters for the care of the landscape based on its complexity, diversity and rarity. On the other hand, socio-cultural assessment is associated with values, where the ecosystem is related to the function for human society. Finally, the economic evaluation is associated with market value by the ***CV*** (Contingent Valuation) and group valuation. Nevertheless, Van Berkel and Verburg (2014) have mentioned that the studies that evaluated ***CES*** have been often limited to quantifying recreation and tourism, leaving out the important qualities that are interlinked with tourism. According to Burkhard et al. (2014) the biggest difficulties of evaluating ***CES*** are those relating to their intangible nature as well as those related to several methodological problems. As a result, integrated approaches are needed across several dimensions to provide information for decision makers and land planners (Tenerelli et al., 2016). To this end, García et al. (2015) have shown that a form of evaluation of the ***ES*** could be that based on the opinions of the direct users of ***ES***, since these opinions are based on long-term interaction with local ecosystems, including the use of ***ES***. Arguably, the direct users of ecosystems are the ones that can best evaluate the benefits taken from nature, a fact that has been proven to be particularly true when dealing with highly subjective cultural services (Hernández et al*.,* 2013). Such a statement is also supported by the work of Gobster et al. (2007) who have indicated that perception is an important process defined by the interaction between people and their environment. However, such an approach needs to have a strong statistical background. To this end, Affek and Kowalska (2017) have argued that the evaluation should be framed around a representative sample of stakeholders that could provide the information needed to infer things while the stakeholders should be the direct beneficiaries of ***ES***. This approach may be used to cover all types of ***ES***, since research about the social awareness on the ***ES*** has shown that people are often able to identify and value such services. Further on, Burkhard et al*.* (2014) have pointed out that given the possible applications of environmental assessment in planning, priority should be given not only to the evaluations of actual service flows, but also to the potential of ecosystems to supply ***ES***. In this sense, the ***SEA*** - Strategic

Environmental Assessment - as a strategic decision support instrument can be used in ensuring ***ES*** consideration when assessing spatial and land use plans. Therefore, ***SEA*** and ***ES*** are synergic because both can be used at strategic levels and share human well-being to promote sustainability (Partidario and Gomes, 2013). Evaluation of ***ES*** should be backed up by relevant data available or collected by standardized approaches. According to Burkhard et al. (2012), to evaluate the demands of ***ES***, data on their use is needed while this kind of information can be provided by statistics, models, socioeconomic monitoring or interviews, indicators of ecological integrity and ***ES***. On the other hand, Partidario and Gomes (2013) have indicated that the ***ES*** assessment should be more standardized in using criteria and scales that form the basis for comparison and interpretation as well as that both qualitative and quantitative approaches could be employed whether appropriate, under the provisions that they enable comparability. To this end, Syrbe and Walz (2012), have indicated the methodological steps to evaluate the ***ES***: differentiation and delimitation of areas providing from those benefiting from services including the connection areas, assessment of data on ecosystems, resources, structure, existing trends and performance over time, establishment of services relative to the areas that provide services not used, determination of real services based on the areas that benefit the service according to the land use, monetary evaluation, if needed, and division of methodological approach in relation to the renewal capacity.

Further on, Laterra et al*.* (2011), have proposed a set of procedures for the non-monetary evaluation and modeling of spatial distribution of ***ES*** as well as the environmental vulnerability associated with their loss. According to them, the procedure for the evaluation and mapping of ***ES*** could be the following:

- Selection of relevant ***ES***;
- Spatial distribution of types of dominant ecosystems and other biophysical factors;
- Models and maps of ***ES*** provision;
- Estimation of the social value of ***ES***;
- Calculation and mapping of the ***ES*** offer.

1.3.3. Valuation of ecosystem services

According to Camacho and Ruiz (2012), tangible and intangible benefits are integrated in ***ES***, which are derived from nature for the benefit of human beings and which, according to certain criteria, can be valued economically in order to equate them, to some extent, with economic activities that involve changes in land uses and thus have additional arguments for their conservation and management. On the other hand, Braat and De Groot (2012) have argued that the general assessment of ***ES*** that humans get from ecosystems is the final goal of the research carried out within the concept of ***ES***. Based on the neoclassical economic view, the WWF (2014) indicates that the valuation is a measure of the ecosystems' capacity to satisfy essential necessities for life. Therefore, the ecosystem can be assessed from two different perspectives: one based on the human being and the value that it assigns to ***ES***, and the other based on the characteristics of each ecosystem. These approaches help in the evaluation of benefits that ecosystems bring to human well-being, supporting the decision on different forms of ecosystem management and evaluation of consequences of other possible decisions. For the human-oriented approach, Collins et al. (2011) stated that the ***ES*** valuation outcomes differ as a result of variability given by those valuing them, in direct relation to their socio-economic and cultural context, framed around their preferences, needs, values, norms and aspirations. Despite the recurrent attempts to establish the foundations of an objective valuation approach, Farber et al*.* (2002) have indicated that subjective approaches are now prevalent, that is, economic valuation refers explicitly to the preferences of individuals. To do so, socio-economic valuations reflect the importance of ***ES*** for people and are crucial because the flow of ***ES*** is placed under the umbrella of both, capacity of the given ecosystems to provide and the required amount of service provision to society (Scholte et al*.,* 2015).

According to MEA (2005), the measure of ecosystems' value and their services can be expressed in several ways and, up-to-date, three values have been identified: ecological value, social and cultural value and the economic value. Ecological value is strongly related to the health status which can be measured by the use of some ecological indicators; social and cultural values refer to the importance that people place on given ***ES***. For the economic value, two broad types of values are recognized: use value, which includes values of direct use (*e.g.* value of wood, fish or other resources) and the value of non-use, which stands for the value of direct use of ***ES*** but not for direct consumption (*e.g.* recreation and aesthetics) and the indirect use values (***ES*** such as the purification of air and water, prevention of erosion and pollination of crops). In addition, Chan et al. (2012) have indicated that of real importance is the quantification and evaluation of the existing or forecasted offsets in the value of ***ES***, approaches that can be undertaken based on valuation in monetary or on non-monetary terms.

Valuation by monetary methods results in estimates of the marginal changes of ***ES*** expressed in common monetary units (for example, dollars), while in the case of non-monetary valuation the researchers are dealing with a range of ***ES*** values to provide important data for decision makers or for other interested parties. This approach finds its usefulness also in the case of those ***ES*** for which a value expression in money is difficult, a reason for which the data results of some ***ES*** or benefits metrics estimates can be quantitative, such as the number of species saved or the number of people affected, or qualitative such as expressions of state (*e.g.* "poor", "good", "excellent").

According to TEEB (2010), in the last period, several methods have been used to characterize the economic value of ***ES***. De Groot et al. (2010) have mentioned that such valuation methods can include the market prices in case of many of the ***ES***. These methods are particularly helpful in the valuation of provisioning services (*e.g.* timber and non-timber forest products); in addition, the values of other ***ES*** are often expressed by a market approach, but using rather an indirect way, such as the cost of damage (avoided) which is applied to regulation services, hedonic pricing methods, travel prices, which is applied to some ***CES*** such as those related to aesthetics, contingent valuation which is based on preference measurement methods and the benefit transfer which uses data from comparable studies. According to Lomas et al. (2005), values are studied and given as use value (***UV***) which encompasses the direct use value (***DUV***), indirect use value (***IUV***) and option value (***OV***) and nonuse value or passive use (***NUV***) which refers to the bequest value (***BV***) and existence value (***EV***).

According to DEFRA (2007), methodologically, the attempt to place economic value on the benefits coming from the ***ES***, can be carried out by using the primary valuation or the transfer of value, the latter being the first option if the funds allow it. The existing indicators and methods that could be used for the primary valuation are the market prices, cost-based approaches, methods of revealed or declared preference, as well as the methods used in relation to the deliberative assessment.

De Groot et al. (2010) have pointed out that the sum of use and non-use values that can be associated with a resource or an environmental feature stand for the Total Economic Value (***TEV***). As such, the direct, indirect, option and quasi-option values, as well as non-use or passive values of ***ES*** are added to be able to estimate the ***TEV*** (Lomas et al., 2005). Having that in mind, Emerton et al. (2011) have indicated that the concept of ***TEV*** provides a useful framework to identify the diverse values associated, for instance, with the ***PA***. Therefore, the ***TEV*** of a ***PA*** has become the most used approach to identify and categorize ***ES*** as it approaches not only the direct values of the provisioning ***ES*** but also the indirect values that are the results of ecological functions, option values which are related to the maintenance of ecosystems, and the existence values which are associated to the intrinsic value of ecosystems, the objective being to determine economically valuable assets and to foresee the benefits that investment in the ***PA*** provides to the economy.

According to TEEB (2010), the recent preoccupations within the scientific and policymaking communities have shaped the vision according to which understanding the value of ***ES***, and incorporating it into the process of decision is essential to ensure conservation policies into a more

equitable, profitable and sustainable approach. As such, estimates on the value of preservation will help policy-makers to address the current problems related to the sustainability, in order to make well-informed decisions about future compensation (De Groot et al., 2010). In this context, ***ES*** payments aim to remunerate land managers for the activities they carry out to protect the identified ***ES*** (Brouwer et al., 2011). For such an attempt, DEFRA (2007) emphasized that the valuation approach used should be correlated with the type of valued ***ES*** and the type of available data, including its quantity and quality.
According to DEFRA (2007) the choice of valuation methods for different ***ES*** could be framed around the following options:

- Market prices for direct and indirect use;
- Cost-based for direct and indirect use;
- Production functions for indirect use;
- Hedonic pricing for direct and indirect use;
- Travel cost for direct and indirect use;
- Random utility for direct and indirect use;
- Contingent valuation for use and non-use value;
- Choice modelling for use and non-use value.

Also, the methodological steps for the assessment of the ***ES***, as indicated by DEFRA (2007), could be the following:

- Establishment of the environmental baseline, which aims at identifying and categorizing the ecosystems and their associated ***ES*** to establish a starting point for the location identification and type of ***ES*** affected by policy and option changes;
- Identification and provision of a qualitative evaluation on the potential impacts of policy changes on ***ES***, a step that aims to provide a preliminary baseline evaluation on how the policy options impact the ***ES***. This approach is often based on existing evidence or expert judgement and results in highlighting the positive and negative impacts as well as in the emphasizing of the evidence gaps and takes into consideration all of ***ES***;
- Quantification of the policy options impacts on specific ***ES***, which aims to measure the relative effect of policy option changes on ***ES***;
- Assessment of the effects on human wellbeing, by linking the impacts to the society; in this step, the economic analysis is the last phase and it considers often a detailed quantitative and qualitative assessment;
- Valuing the changes in ***ES***, which is based on the use of economic valuation methods.

In relation to ***CES***, Zoderer et al. (2016), have emphasized that knowledge about qualities assigned to space can put in light which landscapes bring more to the values (feelings and emotions) that people have and, therefore, it offers invaluable data for landscape planning. In this sense, Van Berkel and Verburg (2014) have indicated that, the quantification and spatial valuation of the ***ES*** is a great approach to document the importance of the ecosystems' conservation. In their opinion, the steps for the assessment of ***ES*** could be the following:

- Empirical data are collected (through a questionnaire survey);
- Statistical analysis is used to group the respondents based on their similarities in appreciations relative to the functioning of the landscape and to evaluate their preferences for the features, structure and evolution of the landscape;
- The preferences are translated into maps of investigated preferences;
- Maps are used to help respondents indicate important places of service provision;
- An independent t test and ANOVA are used;
- The revealed preference method includes travel costs and hedonic prices, as well as some methods to replace expenses related to the improvement of service flow in question.

Finally, and based on the above, the identification, evaluation and valuation of ***ES*** is of vital importance for an ecosystem. As such, DEFRA (2007) state that the assessment should be considered as one of the inputs needed in decision-making. To this end, Martin and Mazzotta (2018) have mentioned that the incorporation of ***ES*** in the decision making process is a central and motivating theme of the current research because it enables the understanding of how ecosystems provide ***ES*** as well as the understanding on how people value ***ES***, emphasizing the links between the flows and social use.

1.4. Problem identification and definition

The National System of Protected Areas of Ecuador was established in 1976, with the purpose of conserving biodiversity and the historical cultural heritage, as well as the vestiges, archaeological sites and settlements of the country (IAE and MEE, 2007). The protected natural areas in Ecuador face critical situations in their administrative management, in the control of the use of resources by neighboring populations, and by the presence of extractive non-renewable natural resources activities Mendoza (2009). Ecuador holds 56 ***PA*** and one of them is the ***CNR***. The objectives of this protected area are to: i) recover and manage the ecosystems and species that are part of the Reserve's biodiversity, ii) control and promote the reduction of anthropic interventions that affect the state of conservation of the Reserve, iii) contribute to the education of population on the benefits of the Reserve's conservation and iv) promote the Reserve as an area of recreation and internal and external tourism (MEE, 2014).

The Ecuadorian Ministry of Environment announced in 2014 that the ***CNR*** provides several benefits within and outside the area, namely: i) the water supply of the snow-covered Chimborazo and Carihuairazo for agricultural activities, human and animal consumption, ii) hydrological regulation, allowing to have good water flows during the dry season and to avoid excessive flows in intense periods of precipitation, iii) carbon storage of high Andean wetlands ("bofedales") to balance the emissions and, by this, to contribute to the mitigation of climate change, iv) recreation and tourism services and v) improvement of water quality. The same institution also stated that the main problems of the Reserve revolve around: i) the lack of area delimitation in regard to the activities of surrounding populations, ii) the development of unsustainable productive activities within the area, iii) the scarce valuation of wild species by the communities that live in the Reserve and iv) the lack of a monitoring system for ecosystems, flora and fauna species.

In this context, in its Management Plan for 2014, the Chimborazo Provincial Environment Direction states that the Reserve has 10 tourist attractions, which also present certain problems:

- *Chimborazo Mountain*, which is in the process of deterioration because the ecosystems of the surrounding areas are constantly affected by forest fires, soil erosion, wind erosion and anthropogenic pressure;
- *Carihuairazo Mountain*, which is in the process of deterioration due to the extraction of medicinal plants such as chuquirahua, architect, as well as trampling vegetation cover;
- *Machay Temple*, which is in a state of deterioration since there are graffiti made on the walls of the cave by irresponsible tourists;
- *Solitary Tree*, which is in the process of deterioration because it is affected by the increase of grazing llamas;
- ***Polylepis Relict Forest***: the environment of the resource is in the process of deterioration due to the progress of the agricultural frontier and wind erosion in the surroundings;
- *Route of the Ice Makers*, which is in the process of deterioration due to the accelerated growth of the agricultural frontier, the grazing of cattle, sheep, horses and the evident population growth;
- *The Chorrera*, which is in the process of deterioration due to the grazing of wild cattle in the area which causes contamination of the site and also due to the advance of the agricultural frontier;

- *Fortress of the Incas*, which is in the process of deterioration mainly due to pine plantations that increase in the surroundings;
- *Kunuk Yaku Hot Springs*, which is in process of deterioration since it is an attraction with low influx of tourists and is managed by the community which has little knowledge about quality standards for the construction and maintenance of this type of attractions, in addition to having a very low budget to improve tourist activity and,
- *Whymper's Needles*, which is in the process of deterioration due to the variation in the state of vegetation cover by trampling and poor practices of interpretation of the natural heritage.

The research problem lies in understanding how the direct beneficiaries - locals and tourists (nationals and foreigners) - use and perceive the ***CES*** provided by the tourist attractions present in the different types of ecosystems of ***CNR*** with emphasis on the touristic attractions characterized by the presence of trees and/or forested areas. Also, another issue was that of getting to know if the beneficiaries are willing to pay to conserve these resources by an approach that reflects their different ways of ordering their reality. While the emphasis of this work is on the ***Polylepis Relict Forest***, to avoid the bias related to getting data only for this tourist attraction, a more integrative approach was required and framed around the landscape as the sum of the attractions present in the area of ***CNR***.

CHAPTER 2. RESEARCH AIM AND OBJECTIVES

2.1. Research aim

In the previous chapters, the reader was introduced to the global importance of conserving the ecosystem services and the interrelation they have with anthropogenic activities. This is the global earth - humanity problem we are dealing with. Ecuador, in general, and the province of Chimborazo, in particular, hold several cultural ecosystem services; however, knowledge about the perception on landscapes to provide ***ES*** and on the ***WTP*** for these services is limited. This is even more so important for that services provided by forests, given the situation in which the forests in the area (*i.e.* ***Polylepis Relict Forest***) are spread as small patches over large territories and are subjected of land use change and other degrading factors. Since many of the landscapes in the area are likely to provide cultural services, this work tries to identify, and evaluate the ***CES*** provided by the ***Polylepis Relict Forest***, in an integrative approach extended at the major landscape level and tourist attractions from the area of the Chimborazo Natural Reserve (***CNR***). Assessments were carried out using the concepts of "frequency of use" and the "perception on the capacity to provide" of the direct beneficiaries that were both, local inhabitants and tourists. Based on these assessments, an additional emphasis was placed on the evaluation of ***WTP*** for conservation of ***CES***, as a basis to formulate, later on, innovative tourist products and to enable the conservation of *Polylepis* forests.

2.2. Research objectives

To fulfill the purpose of the research, a list of specific objectives was developed. The specific objectives of this work are defined in the following:

i. *To identify the cultural ecosystem services in the Chimborazo Natural Reserve by a tourist attraction/landscape level approach;*
ii. *To identify the stakeholders (locals and tourists) that are benefiting from the identified cultural ecosystem services in the Chimborazo Natural Reserve;*
iii. *To evaluate the frequency of cultural ecosystem services use within the Chimborazo Natural Reserve at tourist attraction/landscape scale and to estimate the frequency of cultural ecosystem services use in the* ***Polylepis Relict Forest****;*
iv. *To evaluate the perceptions of stakeholders on the capacity of assessed tourist attractions/landscapes to provide cultural ecosystem services in the area of Chimborazo Natural Reserve;*
v. *To evaluate the tourists' willingness to pay to support conservation of tourist attractions/landscapes of the Chimborazo Natural Reserve, and to evaluate the potential value placed on the* ***Polylepis Relict Forest*** *in the general landscape framework;*
vi. *To evaluate the perceptions and attitudes of tourists on the main tourist attractions/landscapes within Chimborazo Natural Reserve.*

CHAPTER 3. MATERIALS AND METHODS

3.1. Study area

3.1.1. Geographic location

The present research was framed to be carried out in the ***CNR*** (**Figure 1**), with emphasis on the ***Polylepis Relict Forest*** available in the area.

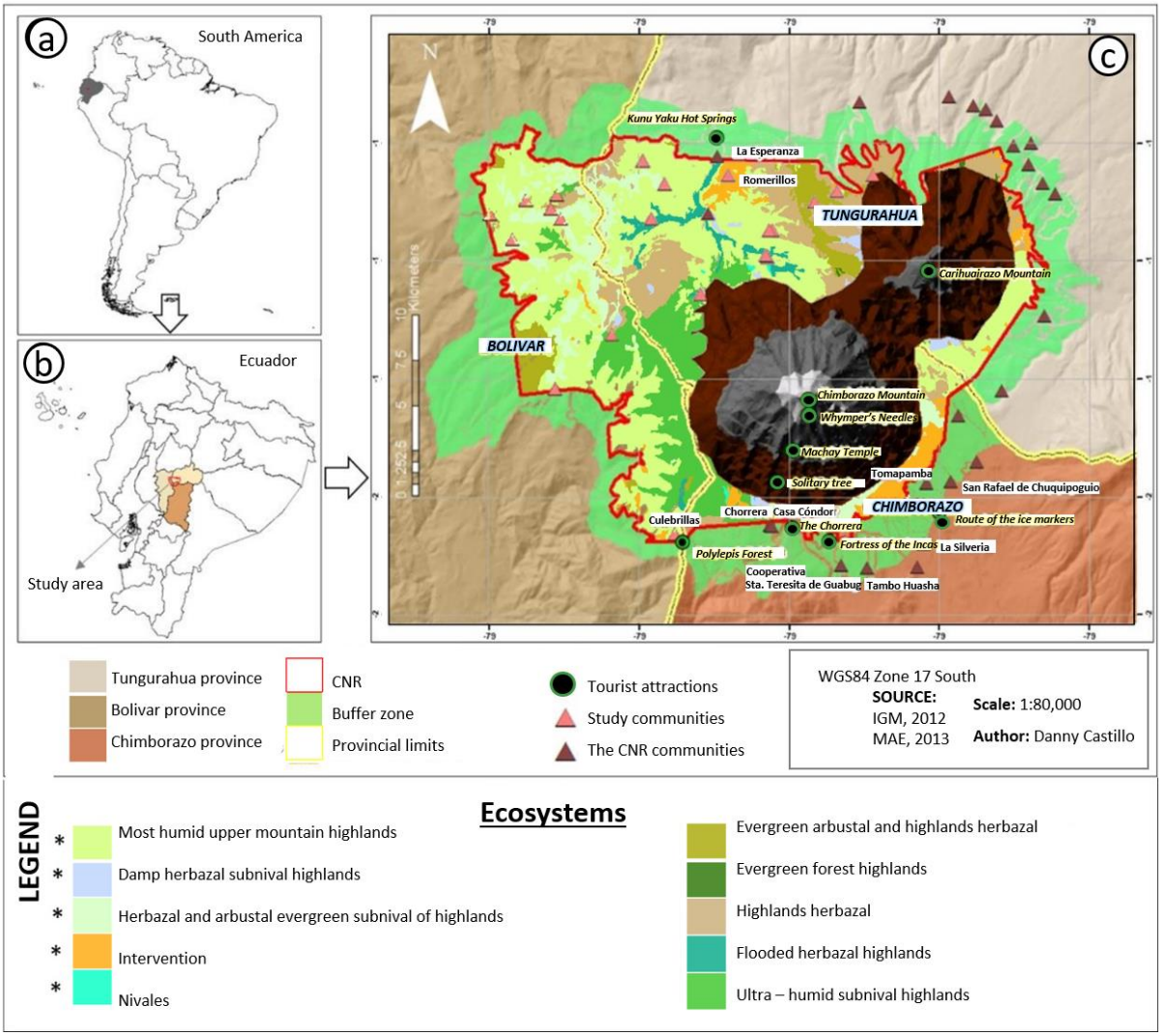


Figure 1. *Chimborazo Natural Reserve* (*CNR*) *- study area. Location of the local communities and tourist attractions including the Polylepis Relict Forest*

The study covered an area that is located at -1°25'32.86'' S - 78°50'34.29'' W, 3,800 to 6,310 m above sea level (**Figure 1**) which is one of the 59 protected areas of Ecuador, a country located in the South America (**Figure 1a**) near the Chimborazo volcano, at the boundary of the Bolivar, Tungurahua and Chimborazo provinces, in the "Reserva de Producción de Fauna Chimborazo" - ***CNR*** (**Figure 1b**). ***CNR*** was created with the objective to ensure the sustainable management of local natural resources and wildlife (MEE, 2014). A map of the ***CNR*** showing, in detail, the tourist attractions and local communities taken into study is given in **Figure 1c**.

3.1.2. Geo-physical description

Table 1 shows the three most important geological formations of the ***CNR***, which are the Chimborazo, Carihuairazo and Puñalica. Geomorphology of the ***CNR*** is characterized by slopes of concave and convex hills that contrast with the topography of peaks, hills, volcanic buildings,

glaciers, subglacial plains, mountainous reliefs, terraces and slopes, whose landscape is defined by volcanic lava and pyroclastic products of the volcanic effusions of Chimborazo, which due to the effect of the wind tend to soften the morphology to gentle slopes in some sectors (MEE, 2014).

Table 1. *Geological formations of the Chimborazo Natural Reserve. Adapted from MEE (2014)*

Geological formations	Photography	Description
Chimborazo		6310 m.a.s.l., and a base diameter of approximately 20 kilometers. The volcanic activity originated in the Pleistocene on a formation platform known in the area as "Pisayambo" and the product of the eruptions is porphytic mesocratic and fine-grained pyroxene andesites.
Carihuairazo		5020 m.a.s.l., covering an approximate area of 10,673.4 hectares; has a caldera of 2 kilometers in diameter, whose circumvallation has been broken in the Pleistocene by glacial erosion. A huge gap opens to the northeast, and the cusps of the limit of the caldera are irregular, rocky, and covered with snow and ice.
Puñalica		3996 m.a.s.l. It is a small volcano of 113.6 hectares, which originated in the eastern foot of the Carihuairazo, that has an olivine feldspathic basalt cone, due to the last eruptive phase.

In what regards the hydrography and hydrology, according to The NWSE (National Water Secretary of Ecuador, 2010), the ***CNR*** is located between the Hydrographic Demarcations (***HD***) of Guayas and Pastaza, precisely at the headwaters of the hydrographic units of level 5 described by the codes 14499 and 14498 ***HD*** Guayas, 49969 and 49968 ***HD*** Pastaza. According to the EIMH (Ecuadorian

Institute for Meteorology and Hydrology, 2018), within the ***CNR*** the temperature varies according to the altitude, with extreme average temperatures that vary between a minimum average of - 0.11 °C in the upper part of Chimborazo and a maximum average of 8.81 °C in the foothills to the east and west of the ***CNR*** in the highlands. The minimum temperature recorded in the ***CNR*** is -4.80 °C in the month of December and the maximum is of 11.40 °C, recorded in the month of November (MEE, 2013). According to data presented by the MEE (2013), it is revealed that within the ***CNR***, in the coldest and wettest days, precipitation occurs in form of snow or frost in the highest areas, where an annual average of 998 mm is recorded. Precipitation varies from 809 mm in the less rainy areas to 1,300 mm in the wetter areas. The months of February, March and April are the rainiest ones and the months of June and August are those characterized by the lowest average rainfall. The main soils and other surface types in the area of ***CNR*** are, according to the Ministry of Agriculture of Ecuador (2002), the following:

- **Entisoils**: in ***CNR*** there are 6,762.32 hectares of entisoils which are known to be young soils, having a composition which is similar to the rocky material that gave rise to them and on which they rest. They usually occur in any climatic regime and on slopes where soil losses occur faster than their formation;
- **Wasteland or rocky outcrop:** in ***CNR*** this type of land houses 10,158.9 ha. They are areas in which the surface of the land is constituted by layers of surfaced rock, lack of vegetation, steep slopes, escarpments and cliffs, as well as rocky areas generated by the volcanic or glacier activity. One can find deposits of fine and coarse sediments, blocks or ashes;
- **Histosoils:** thick soils spread on 434.49 hectares, being characterized by a high concentration of organic matter which is the product of river deposition for long periods. They have a great ecological importance, since they store large amounts of organic carbon. However, they provide poor conditions for vegetation grow since they retain water for a long time. Most are acidic and practically lack mineral nutrients;
- **Inceptisoils:** young soils spread in ***CNR*** on 28,516.05 hectares, being characterized by an incipient development of horizons. They have no accumulation of organic matter, iron or clay. These soils are poorly drained and are generally used for reforestation;
- **Mollisoils:** soils with good development that cover 133.19 hectares in ***CNR***. In their case, the surface layer is deep and has a high concentration of organic and nutrient matter, so they have a high fertility. They are considered to be the most productive agricultural soils in the world;
- **Snow and ice:** Glaciers located at high heights, usually on the tops of the volcanoes that form the inter-Andean mountain system. In ***CNR*** this type of land constitutes 6,572.7 ha being distributed between the Chimborazo and the Carihuairazo Mountain.

3.1.3. *Polylepis* forest

The endemism exhibited by the flora of the ***CNR*** is evidenced by the presence of 145 endemic species. Some of the plants of the families *Asteraceae*, *Geraniaceae* and *Bromeliaceae* are in the category of threatened species (Rangel and Orlando, 2009). The paper tree (*Polylepis reticulata* Hieron) and the "*quishuar*" (*Buddleja incana*) are representative species of this category. The ***Polylepis Relict Forest*** of ***CNR***, is located in an area characterized by steep slopes and irregularities, on a large rock wall of non-volcanic material that exhibits an arid soil given the low presence of rain (MEE, 2014). It has an area of 0.35 hectares. Its name comes from the fact that inside this forest there are small remnants (individuals) of *Polylepis reticulata* Hieron (1896), (Castillo et al., 2017).

3.1.4. Activities in the area of study

The MEE (2014) indicates in its Management Plan of the Reserve that the communities of the ***CNR*** have traditionally subsisted on agricultural activities, and such activities have been the fundamental element for the development of their productive activities. In addition, it indicates that the existence of domestic camelids has allowed the locals to generate some income for their families. The plan

also points out that ***CNR*** has programs, such as the "*Socio Bosque*" and "*Socio Paramo*", that enabled the locals to generate additional income by conserving their forests and the highlands through plantations of native forest species. Finally, this document indicates that the locals have economic income through the provision of tourism services, recreation activities and sports, among others (MEE, 2014).

In the ***CNR***, there is a number of permitted and a number of not allowed activities. A list of such activities was adapted from the recommendations of Dudley (2008). Allowed activities consist of:

- Scientific research on biodiversity;
- Scientific collection of material with the corresponding permits and backed by research projects;
- Tourism and environmental education and interpretation activities with the authorization of the MEE and the agreements or concessions implemented under public, private, community or civil society initiatives;
- Biological monitoring of biodiversity.

Accordingly, the activities which are not allowed in the ***CNR*** are:

- Extraction of fauna, flora and other living beings (fungi, bacteria, microorganisms, other);
- Hunting and fishing with explosives, electricity or poison;
- Tourism without planning or control;
- Construction and operation of infrastructure for mass tourism;
- Productive activities and expansion of crops and pastures for commercial purposes;
- Exploration and stony, metallic, mineral or hydrocarbon mining;
- Forest harvesting;
- Introduction of exotic species of flora and fauna;
- Public and industrial infrastructure works, except for tourism infrastructure and basic signage to support permitted activities;
- Urban development.

3.2. Data collection

To respond to the study's objectives, several steps were implemented. As a first step, a bibliographic research was carried out using all the available on-line databases, printed literature as well as the internet. Then, a database was constructed to contain key issues for the identified studies and a critical analysis was undertaken to identify the importance and spread of the Polylepis forests in all the Andean landscape. Then, to identify the ***ES*** in relation to main tourist attractions, a documentary review was carried out based on the Management Plan of the ***CNR*** (MEE, 2014) from where information was collected about the different types of ecosystems and tourist attractions located inside the ***CNR.*** From the documentary information, 5 types of ecosystems and 10 tourist attractions were identified (**Table 2**).

A following step consisted of the identification and categorization of the ***ES***, based on a documentary review of the international classification systems: MEA (2005), TEEB (2010) and CICES (2013). Resulting information was systematized in a matrix. Using the matrix generated, the data on the identified ***ES*** was validated by the means of a workshop that was organized with representatives of the 9 communities that were part of this study (**Table 3**). Finally, a validation based on expert view was carried out with the participation of Park Rangers of the ***CNR*** and academic experts of Natural Resources Faculty from ***ESPOCH*** (Escuela Superior Politécnica de Chimborazo). The final results are enlisted in **Table 5**. Based on the matrix generated on the ***ES*** of the study area, the relevant ***CES*** were selected and a list of 27 cultural ecosystem services was obtained (**Table 5**). For a better understanding of this topic, they were grouped into 4 categories: 1) recreational, 2) inspiration, 3) education and study and 4) spiritual experience, respectively (**Table 6**).

Table 2. *Types of ecosystems and list of tourist attractions*

Local name	Short description
Whymper's Needles	Whympers's Needles. Rock formation at an altitude of 5,283 m a.s.l. Named after Edward Whymper who climbed Chimborazo (January 4, 1880).
Chimborazo Mountain	Chimborazo Mountain. Volcano, 6,310 m a.s.l. Considered by the actual descendants of Puruháes civilization to be the Father God. Inspiration for Simón Bolivar to write the poem "The delirium on the Chimborazo". Climbed by Alexander von Humboldt in 1802. One of the most visited tourist destinations of the Province of Chimborazo.
Carihuairazo Mountain	Carihuairazo Mountain. Three-peaked volcano, 5,020 m a.s.l., accessible by four-wheel drive cars or buses. Characterized by the presence of many lagoons created by ice melting.
Machay Temple	Machay Temple. A cave of natural geological formation that the ancients of the region have used as a ceremonial and veneration center for the Chimborazo God. They believed that it is the gateway to enter Chimborazo. Currently used by the mountaineers and the local people to leave thanking offerings for the good behavior of the Chimborazo.
Solitary tree	Solitary Tree. A large shrub of 5 m in height and a diameter of 6m surrounded by very little vegetation. Scholars have not identified to which species it belongs, but it is believed that it belongs to the Quishuar family.
Fortress of the Incas	Fortress of the Incas. The traditional name of the site is Cuartel de Inca, and it was, most likely, a ceremonial center. Could be the place where the Chasqui (long distance messengers/deliverers) family lived, or it could be a place to store food, weapons etc.
Polylepis Forest	Polylepis Relict Forest. Remnant of a protected forest vegetating on a rocky formation, providing a visual contrast to the surrounding landscapes characterized by herbaceous vegetation.
Route of the ice markers	Route of the ice makers. Attraction related to the local ancestral practice to cut ice blocks from Chimborazo and to deliver them to the local people/markets surrounding it. There is only one icemaker in the area - Baltazar Ushca - still living and practicing today.
The Chorrera	Chorrera Canyon. Rocky formation characterized by the presence of a water drop of approximately 25 meters in height. The site presents rock formations used in climbing.
Kunu Yaku Hot Springs	Kunuk Yacu Hot Springs. Used for taking hot baths. Thermal water is provided by the surrounding mountain.

The related stakeholders that benefit from the ***CES*** in the ***CNR*** are the local inhabitants of the communities surrounding the tourist attractions as well as the national and foreign tourists (MEE, 2014) (**Table 3**). For the identification of the communities, a map was designed (**Figure 1**) (MEE, 2014). The main criterion for the selection the communities to be taken into study was that of their proximity to the selected tourist attractions of the ***CNR***.

Table 3. *Stakeholders benefiting from the cultural ecosystem services provided by the tourist attractions of the Chimborazo Natural Reserve*

Stakeholders: Communities and tourists		
Community ID	**Community name**	**Total number of local inhabitants per community**
1	C1. Casa Condor	18
2	C2. La Chorrera	18
3	C3. Culebrillas	60
4	C4. La Esperanza	22
5	C5. Tambohuasha	30
6	C6. Santa Teresita de Guabug	25
7	C7. La Silveria	201
8	C8. Tomapamaba	23
9	C9. San Rafael	60
	Total	**457**
Tourist group	*** Number of tourists in 2017**	**Sample size used in this study**
National	106,118* / 92,323**	208
Foreign	21,735* / 18,909**	42
Total	127,853* / 111,232**	250

** tourists attending the **CNR** in 2017, out of which 83% were nationals and 17% were foreigners (MEE, 2017).*
*** tourists > 18-year-old attending the **CNR** in 2017 (MEE, 2017).*

To evaluate the frequency of use and the perceptions on the capacity to provide ***CES,*** the study sample was estimated based on the data shown in **Table 3**. A questionnaire was designed and

administrated to the inhabitants of the 9 communities taken into study over a period of three months (May to July 2018). The aim of survey was to reach the entire population of the local communities, excluding the minors (age < 18 years old). Due to the presence of children and of some locals who did not agree to participate in this study, the final sample size contained a number of 356 respondents accounting for approximately 78% of the total population size (**Table 3**). In the case of the communities a "door-to-door" data collection method was used as described, for instance, by Affek and Kowalska (2017). In the case of the tourists, the Lubov's formula (1974) was applied to estimate the sample size, resulting in a number of 208 surveys for national and 42 for foreign tourists respectively. The questionnaire was administrated to the tourists over three months (May to July 2018).

The questionnaire was designed in three parts to account for cultural services derived from tourist attractions and related activities carried out in the associated ecosystems for locals and tourists. The first part aimed to collect socio-demographic data by features such as the place of residence, gender, age, education level, occupation and monthly income. This questionnaire was applied to tourists and locals (**Appendix 1**, given in the full thesis). This data was required for various analysis tasks such as those describing the socio-demographic condition of locals and tourists and for testing the effects of various socio-demographic variables on the perceived capacity of the local landscapes to provide ***CES***. The second part of questionnaire aimed to collect data on the frequency that locals and tourists use cultural features provided by local landscape by directly using them in different kind of leisure activities. Responses to this part were treated as "the demand" for such ecosystem services. Acknowledging that people may have a more holistic view on their landscapes, and since a perfect delimitation between the touristic attractions and the associated landscape is difficult to design and implement, this study focused rather on particular, punctual spots of the landscape and on their significance for locals and tourists. To this end, a matrix containing two major groups of ***ES*** and 27 related activities describing the use of particular ***ES*** was built by considering the general guidelines of existing ***ES*** classification systems to enclose the 5 types of ecosystem complexes present in the area and their corresponding touristic attractions (**Table 5**). In the absence of data documented in detail, expert opinions are valuable in identifying the types of ***ES*** that may be provided by a given area (Garrido et al., 2017). To have an idea on the possible ***CES*** provided by the area taken into study and to build the questionnaire, a brainstorming workshop was organized to account for the expertise on the subject of ***CNR*** park rangers and local field experts (**Figure 3b**). The response section of this questionnaire part was constructed in a way similar to that described by Affek and Kowalska (2017), enabling the respondents to evaluate the frequency of self-use by using a 5-point attitude (Likert) scale (0 to 4, where 0 stands for "have no idea/not applicable", 1 - "never", 2 - "once", 3 - "sometimes" and 4 - "frequently"), in the case of locals (**Appendix 1**, given in the full thesis). In the case of tourists, the scale was adapted to their context since it was likely for some of them not to have any idea or knowledge on some of the tourist attractions taken into study. Therefore, the scale was built to contain 4 items, graded from 0 to 3, where 0 stands for "have no idea/not applicable", 1 - "never", 2 - "once" and 3 - "frequently" (**Appendix 1**, given in the full thesis). Anticipating that most of the respondents could have been developing their work in the studied landscape, as well as most of them probably would have been not familiar with the specific terminology of ecosystem services assessment, two measures were designed for a better understanding of concepts. The term of "ecosystem services" was replaced by the Spanish version of the "benefits/gifts of nature" words as generally described in MEA (2005) and argued and explained by Affek and Kowalska (2017). This was necessary to align the used language to the respondents' understanding and to suggest them that the evaluated features need to obtained from nature for free. In addition, all the items enclosed into the questionnaire were translated into Spanish and their meaning was explained to the respondents in full detail. This approach was used for local inhabitants and for national tourists, as well as for the foreign tourists for which the native language was Spanish. For the rest of respondents, an English version of the questionnaire was administrated.

The last part (**Appendix 1**, given in the full thesis), was designed to get data on perception of locals and tourists on the capacity of local landscapes to provide cultural ***ES***. To this end, a more concise matrix containing the ecosystem types, their encompassed tourist attractions and a list of four categories of cultural services (recreation, inspiration for creative work, education and study and spiritual experience) (**Table 6**), associated to each one was adopted based on the methods used by Affek and Kowalska (2017) to be evaluated in a way similar to the second part of questionnaire. The exception here was that zero values were attributed to those cases in which the respondents felt that the analyzed landscape had no capacity to provide any cultural service attributed to a category in question. Prior to field data collection the questionnaire was checked for consistency then, for testing and refining purposes, it was shown to couple of people working for the Escuela Superior Politécnica of Chimborazo. The refined version was printed in the needed number of copies then it was administrated in the field by a door-to-door or by a face-to-face approach (**Figure 2 a,c,d**).

To estimate the value of ***WTP*** to support the conservation of the ***CNR*** and of the ***Polylepis Relict Forest*** the study sample was estimated using the same approach, based on the number of 111,232 tourists that attended the ***CNR*** in 2017 (MEE, 2017). Similarly, in the sample used to collect the data, only the tourists older than 18 years were retained (**Table 5**) and the questionnaire was administrated to them over three months (May to July 2018). For this, the questionnaire was designed in two parts to be able to estimate the ***WTP*** for the conservation of ***CNR***, ***Polylepis Relict Forest*** and for the rest of touristic attractions in the area.

Figure 2. *Field data collection activities.* Legend: *a) - collecting data near the Polylepis Relict Forest* of the *Chimborazo Natural Reserve b) - workshop for validation of cultural ecosystem services with the park rangers, c) - collecting data by interviewing the inhabitants of the local communities d) - collecting data by interviewing the tourists in the Chimborazo Natural Reserve*

This part of the questionnaire aimed to collect the minimum amount, expressed in US dollars, that the tourists were willing to provide for the conservation of ***CNR*** and ***Polylepis Relict Forest*** (**Appendix 1**, given in the full thesis). This data was required for various analysis tasks such as those describing the ***WTP*** condition of tourists, as well as the reasons they provided for not willing to pay. The last part aimed to get data on the attitudes and perceptions on the main tourist attractions of the ***CNR***, with the main objective to evaluate which of the attractions should receive funding for conservation and to what amount (**Appendix 1**, given in the full thesis). The study sample was

determined in a way similar to that of the first part of questionnaire on ***WTP***. The exception, however, was that in this section all the tourists were considered (**Table 3**).

3.3. Data processing and analysis

Data processing procedures consisted of several steps that were required to obtain the initial databases needed for statistical analysis. In this work, most of the data was collected using Likert scales which are the common methods used to measure the respondents' attitudes. Likert (1932) used in his original work a bipolar scale whose underling psychometric model stood for a continuous latent construct with opposite feelings expressed at the endpoints (*e.g.* Willits et al., 2016). The problem with human perception and its ranking is that one cannot always assume that among a population of individuals the differences between the items provided on a Likert scale are really equal. Therefore, for scales constructed such as in the second part of this study's questionnaire it could be wrong to assume an equidistance between the responses even if the grades assigned to may be equidistant (*e.g.* Sullivan and Artino, 2013). To balance this, the categories included there were quite specific and explained to the respondents in advance. Then, the third part of questionnaire was built to resemble somehow a continuous scale for rating the capacity of ecosystems to supply ***CES***. Nevertheless, the use of numbers produced by Likert scales in statistical analysis is a different thing compared to the psychometric constructs of given respondents, therefore parametric statistics can be employed for such data, coming even from very small samples, characterized by variances which are not equal or distributions that fail normality check, to build pertinent conclusions (Norman, 2010). At the same time, parametric statistics are more powerful and robust, and they produce similar results when analyzing ordinal data (*e.g.* Norman 2010, Murray 2013).

Having these in mind, the statistical approach of this study used parametric statistics. First, the field-collected data was transferred into a Microsoft Excel® sheet. Then the socio-demographic data was analyzed. In the case of the locals, the socio-demographic data was analyzed using the ***N*** (number of respondents) and their share per ***C*** (communities) and per ***G*** (gender), ***A*** (age), ***L*** (level of education), ***O*** (occupation) and ***I*** (monthly income). This was necessary to characterize the sample size at study and community level and it was done after recoding the items of each socio-demographic feature. The community abbreviations were extracted from **Table 3,** gender was coded as ***M*** (male) and ***F*** (female), age was categorized in classes **1** (18-28), **2** (29-40), **3** (41-51), **4** (52-63) and **5** (64-75), following the recommendations of NISC (2016), level of education was coded as ***NE*** (for those declaring to have no education), ***PI*** (for those declaring to have primary education incomplete) and ***PC*** (for those declaring to have primary education complete) respectively, ***SI*** (for those declaring to have secondary education incomplete) and ***SC*** (for those declaring to have secondary education complete) respectively, ***BI*** (for those declaring to have bachelor education incomplete) and ***BC*** (for those declaring to have bachelor education complete) respectively, ***S*** (for those declaring to have a specialization), ***MA*** (for those declaring to have a master) and ***DO*** (for those declaring to have a PhD) respectively, and ***OT*** (other) by assuming the local learning system (MEE, 2014). Occupation was categorized as ***AS*** (agriculture and livestock), ***CO*** (commerce), ***TO*** (tourism), ***CT*** (construction) and ***OT*** (other) based on the provisions of NISC (2016). Finally, the income was categorized in classes based on National Assembly of Ecuador (2018), and NISC (2016) in six categories: ***1*** for income of 386-708 $, ***2*** for 709-1030 $, ***3*** for 1031-1353 $, ***4*** for 1354-1676 $, ***5*** for 1677-2000 $ and ***6*** for those not willing to declare any income. In the case of the tourists, the socio-demographic data was analyzed using the number of respondents and their share per tourists type and per gender, age, level of education and occupation. This was necessary to characterize the sample size at study and tourists' level and it was done after recoding the items of each socio-demographic feature taken in study: **gender** (male and female), **age** (stepwise classes, <= 30, 31-40, 41-50, 51-60 and 51-60 years old) following the recommendations of NISC (2016), **level of education** (no education, primary, secondary complete, technician, technologist, bachelor, and master and PhD) (MEE, 2014).

Occupation (unemployed, retired, student, freelancer, private and public) was categorized based on the provisions of NISC (2016).

Then, the data on ***CES*** frequency of use was processed and analyzed. The frequency of using the 27 ecosystem services was categorized on items such as: ***a*** (observation of flora and fauna), ***b*** (experimental use of flora, fauna and land, ***c*** (creative work inspired by nature), ***d*** (visit to places of worship in nature), ***e*** (praying or meditation near the attractions, ***f*** (science), ***g*** (environmental education), ***h*** (environmental interpretation, ***I*** (interpretative talk and exchange of experience), ***j*** (observation of traditional practices), ***k*** (aesthetics), ***l*** (spiritual and religious values), ***m*** (historical and cultural information), ***n*** (ecotourism), ***ñ*** (ethnotourism), ***o*** (cultural tourism), ***p*** (experiential tourism), ***q*** (agritourism), ***r*** (hiking), ***s*** (photography), ***t*** (cycling), ***u*** (mountaineering), ***v*** (climbing), ***w*** (visits to archaeological sites), ***x*** (rest, relaxation), ***y*** (entertainment) and ***z*** (landscaping) and, afterwards, it was analyzed as the share of ratings per types of activities and per tourist attractions (Whymper's Needles, Chimborazo Mountain, Carihuairazo Mountain, Machay Temple, Solitary Tree, Fortress of the Incas, Polylepis Forest, Route of the Ice Markers, The Chorrera and Kunuk Yaku Hot Springs) for both, locals and tourists. Then the data was aggregated and analyzed as the means per types of activities for locals and tourists and as aggregated uses per tourist attractions per locals and tourists. In these last cases, data analysis began with checking the completed questionnaires for consistency in answers. Statistical analysis was implemented in Microsoft Excel (version 2013) software fitted with the Real Statistics® add-in.

Data on the perceived capacity to provide ***CES*** was processed and analyzed in the following steps. The perceived capacity to provide ***CES*** was analyzed by data aggregation as the arithmetic means on 4 categories of cultural services which were: ***a*** (recreation), ***b*** (inspiration for creative works), ***c*** (education and study) and ***d*** (spiritual experience). This approach was implemented both, at the local community and tourist groups level by considering a distribution in the categories described and, as well, on the tourist attractions taken into study.

Following the analysis of ratings on the frequency of use and perceived capacity, parametric statistical tests such as Student's t and ANOVA ($\alpha=0.05$, $p<0.05$) where carried out to explore which of the socio-demographic variables affected the perceived capacity to provide cultural ecosystem services. The mentioned tests were carried out for the data covering all the tourist attractions. All the tasks related to statistical analysis were carried out in Microsoft Excel (version 2013) fitted with the Real Statistics® add-in. The same software was used to produce the graphics needed in this study.

To extend the analysis of data on the similarities of responses provided by the communities and tourists in relation to the tourist attractions and the perceived capacity to provide services, a dendrogram, as specific to the hierarchical cluster analysis - (parameters: Ward's method, and squared Euclidean distance as a measure of similarity) - Gower (1966), was built out to explore which attractions conformed groups with similarity or difference features. This approach was used as the aim of cluster analysis rests in dividing the observations into distinct, homogeneous groups. All the steps related to cluster analysis were carried out in the ***SPSS*** statistical analysis software (IBM Statistics, version 23.0).

WTP to support the conservation of ***CNR***, ***Polylepis Relict Forest*** and of the rest of tourist attractions in the area of ***CNR*** data was processed and analyzed by the Contingent Valuation Method (***CV***) as suggested by Ciriacy-Wantrup (1952). As such, the ***CV*** is a direct method of evaluating the ***WTP***. The analysis took into consideration the data provided by each tourist following the field interviews which produced data on the availability to allocate a share of their annual income to support the conservation of ***CNR***, ***Polylepis Relict Forest*** and the rest of tourist attractions. Therefore, the positive response (**Yes**), were complemented by responses on the amounts of ***WTP*** per month and per year while the negative answers (**No**) were complemented by reasons for not willing to contribute (**Not enough money**, **Distrust**, **Not interested**, **State** and **Other reasons**). Then, the total

WTP was evaluated by considering the mean value computed based on the above data, which was then multiplied by the total number of tourists over 18-year-old. All the computations and graphics needed in this study were developed using the Microsoft Excel software (version 2013).

The last step of data processing and analysis was that framed around the perceptions and attitudes towards the conservation of punctual tourist attractions. To do so, the data collected via Likert scales was recoded by a binary approach on three categories of support such as low support (red, 1 and 2), neutral support (yellow, 3) and high support (green, 4 and 5). This framework of data organization enabled the computation of shares per tourist attractions in relation to the support that should be given. The same software was used to compute the shares (Microsoft Excel, version 2013).

CHAPTER 4. RESULTS AND DISCUSSION

4.1. Importance and spread of *Polylepis* forests

4.1.1. Importance of *Polylepis* forests for South America

The Polylepis forests provide many ecological services that have been underestimated for centuries due to a lack of knowledge (Andrade et al., 2013). The following statements show some characteristics of the importance of Polylepis forests based on the available literature on the topic. These forests hold a high biological diversity, including several species of epiphytes, vascular plants, mosses and lichens (Lugo and Scatena, 1992; Fjeldsa et al., 1996; Smithers and Atkins, 2001) and they contribute to the protection of water sources (Fjeldså et al., 1996). They also have a significant role in the fragile high Andean ecosystems, especially those that grow in foggy areas, cases in which they sustain the formation of soils, the accumulation of water and the regulation of water sources (Fjeldså and Kessler, 2004). In addition, they reduce the soil erosion and retain sediments and nutrients (Fjeldså and Kessler, 2004; Renison et al., 2010). Also, they provide shelter for hundreds of plants and animals (birds, mammals, reptiles and insects) many of them endemic (Lugo and Scatena, 1992; Fjeldså et al., 1996; Smithers and Atkins, 2001). An important adaptation is that of having the leaves grouped at the end of the branches, a fact that enables them to collect water from the mist and their relationship with mosses and lichens helps to control the flow of water (Andrade et al., 2013). In addition, a lot of atmospheric carbon is captured in the forests and their soils (Aranibar, 2015). Through the roots, leaves and branches that fall, the trees provide organic matter to the soil, fertilizing them and increasing their volume and water absorption capacity (Cuyckens and Renison, 2018). They also regulate the runoff and improve the catchment of water (Cuyckens and Renison, 2018). Also, the trees, the associated vegetation and the soils in good condition improve water quality that reaches the rivers and streams and makes its potabilization more economical for human consumption (Cuyckens and Renison, 2018). Polylepis forests play also an important social role. They support the increase of landscape's quality in the area and offer a better product to tourism (Cuyckens and Renison, 2018). Also, they cover areas used for the grazing of native domestic (lamas, alpacas) and introduced (sheep and cows) livestock (Renison et al., 2013). In addition, they have social and cultural relevance, especially for the human populations that inhabit these areas, who use forests as a source of fuel, as roosts for livestock or for agroforestry (Fjeldså et al., 1996).

4.1.2. Spread of *Polylepis* forests in South America

For a better understanding about the spread of *Polylepis* forests in Ecuador is important to show the distribution the *Polylepis* forests in the Andean landscapes. **Appendix 3** (given in the full thesis) shows the distribution of the *Polylepis* genus in 7 Andean countries, covering a number of 49 *Polylepis* species.

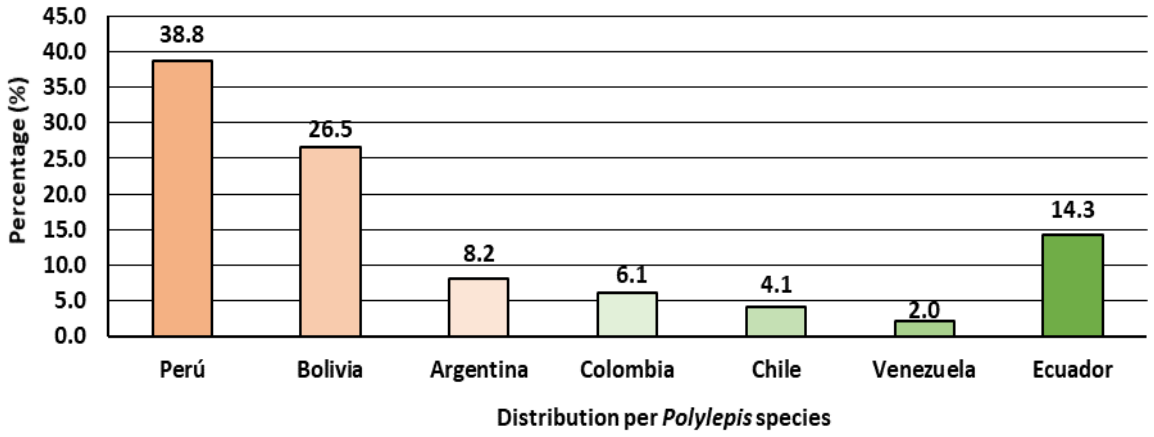


Figure 3. *Distribution of Polylepis species in the South America*

Figure 3 shows the distribution of *Polylepis* species in the South America expressed as shares. The highest concentration was found in Peru (38.8%), followed by Bolivia (26.5%) and Ecuador (14.3%); this fact is probably associated with the fact that these countries share an altitudinal distribution range of *Polylepis* that goes from 3000 to 4100 m.a.s.l. as well as climatic factors suitable for the reproduction of these species. To a lesser extent such forests may be found in Argentina (8.2%), Colombia (6.1%), Chile (4.1%) and Venezuela (2.0%).

4.1.3. Importance of *Polylepis* forests for Ecuador

Ecuador has a great variety of ecosystems that have favored the process of species diversification (Rafael, 1992). The great biodiversity of Ecuador is also the result of the country location in the neotropical region, but also the result of other factors such as the presence of the andean mountainous range, the Humboldt cold current and the Niño warm current (Figuero and Rafael, 2011). In this regard, research on the biodiversity of flora and fauna has revealed that, despite being a relatively small country in its extension, Ecuador is one of the highest biologically diverse states on the planet (Mittermeier and Mittermeier, 1997). Polylepis forests are contributors to this biodiversity (Figuero and Rafael, 2011); the species are known as “paper trees” that are composing small forests growing on very wet, but well-drained soils, often with a thick layer of moss (Beltrán et al., 2009). Their distribution is dispersed in the form of forest fragments that grow on mountainous slopes, rocky creeks and streams (Kessler, 2006) located in high places (Simpson, 1979; Simpson, 1986; Kessler, 1995; Kerr, 2004). Those forests that are located in more humid areas and with less access have a better state of conservation, while those located in driest and more accessible valleys are more affected (Toivonen et al., 2011).

4.1.4. Spread of *Polylepis* forests in Ecuador

In Ecuador, there are 7 species of *Polylepis* genus (**Appendix 3**, given in the full thesis) which are distributed in those provinces that contain the Andean mountains, in an altitudinal stratum which starts from 2700 and ends to 4300 m.a.s.l. More precisely, these species are distributed in Carchi, Cotopaxi, Imbabura, Napo, Pichincha, Azuay, Cañar, Bolívar, Chimborazo, Loja, Tungurahua and El Oro provinces (Calderón and Lozada, 2010). In Ecuador, Polylepis species are often found in small stands spread on rocky and steep slopes or open thickets on mountain slopes (Kessler, 2006).

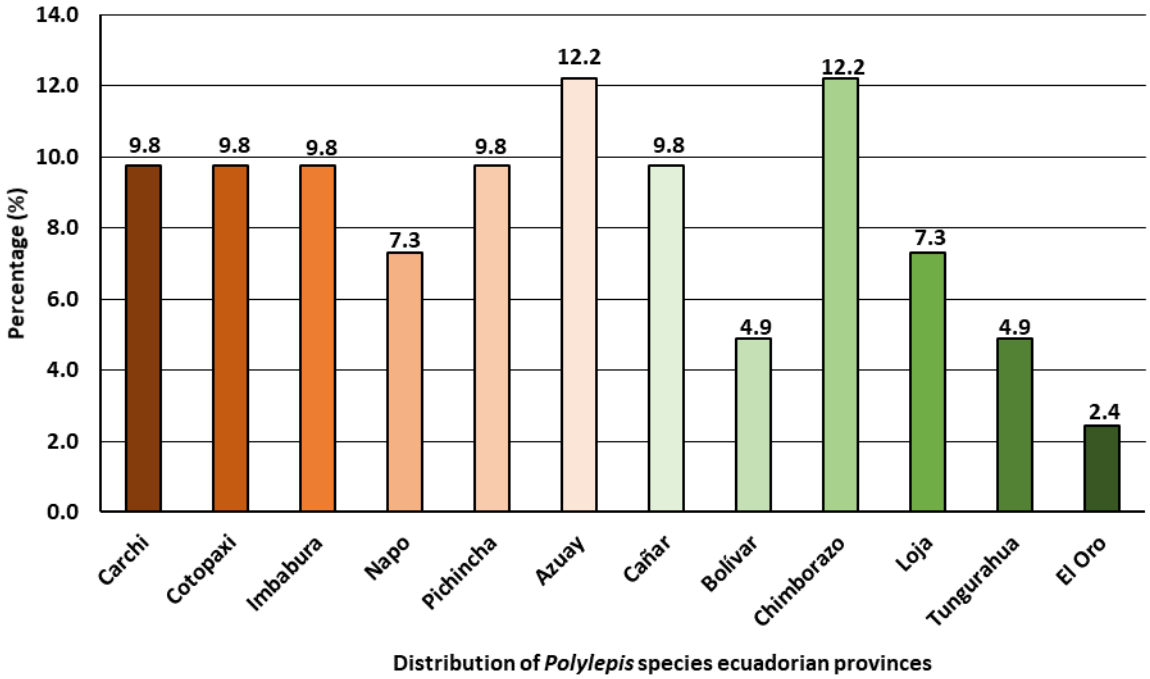


Figure 4. *Distribution of Polylepis species in the Ecuadorian provinces*

Figure 4 shows the distribution of the *Polylepis* genus by provinces in Ecuador. The highest concentration is found in the provinces of Chimborazo and Azuay (12.2%), respectively, followed by Carchi, Cotopaxi, Imbabura, Pichincha and Cañar (9.8%), Napo and Loja (7.3%). This fact could be attributed to the unique conditions of geological and microclimatic adaptation of this species to these places. On the other hand, the lowest concentration is found in the provinces of Bolivar and Tungurahua (4.9%) and El Oro (2.4%), which is associated with anthropogenic activities, especially in recent years, such as, for example, the extraction of firewood, burning of the forest, introduction of other species, increase of the grazing areas and plantings in the patches of existing forests.

4.1.5. Spread of *Polylepis* forests in the Chimborazo Natural Reserve

Appendix 3 (given in the full thesis) contains the number of species that can be found in the ***Polylepis Relict Forest*** of the ***CNR***. According to Castillo et al. (2017) in this forest, 19 species of flora are recorded, belonging to 11 families. *Polylepis reticulata* Hieron is the dominant species, which is native to the Ecuadorian Andes. The highest concentration is that of *Polylepis reticulata* Hieron species (38.3%), followed by *Bomarea glaucesces* (12.3%), *Hypochaeris sessiliflora* (8.9%), *Castilleja fissifolia* (7%), *Pernettya prostrata* (5.2%), *Lachemilla orbiculata* (5.1%), *Lachemila afanoidea* (4.9%) and *Paepalanthus alpinus* (3.7%), which is attributed to resistance through physiological adaptations, allowing them to survive in an environment of high altitude climatic conditions. The lowest concentration is found in the species of *Laciocephalus ovatus* (3%), *Aetheolaena lingulata* (2.8%), *Conyza cardaminifolia* (1.6%), *Arcytophyllum sp* (1.3%), *Dalea coerulea* and *Monnina aestuans* (0.6%), *Hypochaeris radicata* and P*olystichum orbiculatum* (0.5%), a factor associated with the fact that many of these species have not developed physiological adaptations and simply take the advantage of microclimates created by the rest of the vegetation. **Appendix 3** (given in the full thesis) shows the fauna species present in the ***Polylepis Relict Forest*** of the ***CNR***; according to Castillo et al. (2019), there are only 6 species of birds, a fact attributed to their physiological adaptations to withstand the extreme conditions of low temperatures. As for mammals, there are 2 species, a factor associated with the low coverage of grassland, less food, unfavorable climatic conditions and the pressure on the site by the visits made by tourists. It is important to mention that the absence of other species such as amphibians is probably an effect of the lack of water bodies in this area and near its surroundings.

4.2. Types and list of ecosystem services in the Chimborazo Natural Reserve

Due to the cultural importance of the area and the large influx of visitors, among the main beneficiaries of the ecosystem services of cultural heritage are both, the community members and the tourists from various groups. ***CNR*** encompasses at least 12 regulation services, 8 provision services and 27 cultural services. This list, and in particular the category of ***CES*** was further used for categorization and for field research.

Table 4 shows the list of ***CES*** identified for the ***CNR*** per categories. Out of these, and based on their categorization, the recreation (sports) accounted for 63%, education and study (observation of nature, research) for 22.2%, spiritual experience for 11.1% and inspiration for creative works for 3.7% of the total number of ***CES*** identified in the area.

This study is one of the few existing ones related to the evaluation of ***CES***, in general, and to their evaluation for ***CNR***, in particular. In fact, to date, there have been few ***ES*** assessments that cover all the ecosystems in areas similar to that of this study (*i.e.* Plieninger et al., 2013). The potentials to provide services by addressing the direct users offered, in previous studies, a comprehensive list of 18 ***CES***, adapted to some local conditions and practices and divided into two categories: 1) Education, Inspiration, Spiritual life and 2) Sport and recreation (Affek and Kowalska, 2017).

Table 4. *List of cultural ecosystem services on categories, as specific to the Chimborazo Natural Reserve*

Ecosystem services in *CNR*	Recreation (sports)	Inspiration for creative works	Education and study (observation of nature, research)	Spiritual experience
1.1. Observation of flora and fauna	X			
1.2. Experimental use of flora, fauna and land			X	
1.3. Creative work inspired by nature (*e.g.* writing, painting, handcrafting etc.)		X		
1.4. Visit to places of worship in nature (*e.g.* roads of Calvary, places of ancestral power, etc.)				X
1.5. Praying or meditation near the attractions				X
1.6. Science (research activities)			X	
1.7. Environmental education			X	
1.8. Environmental interpretation			X	
1.9. Interpretative talk and exchange of experience			X	
1.10. Observation of traditional practices	X			
1.11. Aesthetic values (beauty, balance, harmony)	X			
1.12. Spiritual and religious values				X
1.13. Historical and cultural information			X	
2.1. Ecotourism	X			
2.2. Ethnotourism	X			
2.3. Cultural tourism	X			
2.4. Experiential tourism	X			
2.5. Agritourism	X			
2.6. Hiking	X			
2.7. Photography	X			
2.8. Cycling	X			
2.9. Mountaineering	X			
2.10. Climbing	X			
2.11. Visits to archaeological sites	X			
2.12. Rest, relaxation	X			
2.13. Entertainment	X			
2.14. Landscaping	X			

4.3. Use of cultural ecosystem services in the Chimborazo Natural Reserve

4.3.1. Social and demographic characteristics of local communities

As shown in **Table 3** of the materials and methods chapter, the total population size in the analyzed communities amounted 457 inhabitants and the aggregated response rate was of approximately 78%, resulting in a number of 356 valid questionnaires. The inter-community response rate varied between 50 and 100%. Females dominated in the sample size (N=218, 61%) compared to males (N=138, 39%) because six out of 9 communities had a female share greater than 50%. More than half of the respondents (N=199, 56%) were aged between 18 and 40 years and given the self-employment practice in the area, probably more than 90% (age up to 63 years) of the respondents were still active in their work at the field survey time. The majority of the respondents have declared that they completed their primary education (31%). Still, an important share of the respondents has not finalized their first level of education (39%). Completion of higher education was almost absent in the sampled population with only 5% of the respondents indicating that they are following or have finalized a bachelor level. Based on the analyzed data, the occupations in the area of study seem to be strongly focused on the typical land use such as agriculture, cultivation and cattle breeding. In fact, 80% (N=284) of the questioned inhabitants have declared that they are working in this category and 63 to 100% of them were included in this category at the community level also. Taken together, occupations from commerce, tourism and construction accounted for only 6% of the data pool. The rest of 14% was shared between different kind of occupations such as being employees in the public and private industries outside the study area. In what concerns the income level, more than 71% of

the asked persons have stated that their salary was in between 386-708 US$ while a share of 26% were not willing to declare their income.

4.3.2. Frequency of use by the local communities

The frequency of cultural services use was analyzed both, in terms of responses shares per item types, type of ecosystem service-related activity and tourist attraction, as well as in terms of aggregated data which considered the average responses per types of activities and tourist attractions. **Figure 5** shows the share of responses per types of activities related to the cultural ecosystem services. Almost 70% of the responses were rated by "0" meaning that those respondents had no idea about a given type of cultural ecosystem service (***CES***). This feature was probably related to the non-attendance of part of the respondents in some of the analyzed tourist attraction (landscapes). Excepting the observation of flora and fauna (1.1.), hiking (2.6.), rest and relaxation (2.12.), entertainment (2.13.) and landscaping (2.14.) which were the most rated as being used more than once, the rest were mostly rated either as non-used or not having any idea about them (87-99%). Even if ratings like "sometimes" and "frequently" seemed to be very low in terms of share in the analyzed sample, apparently the locals are enjoying more to observe the flora and fauna (15.1%), hike (15.8%), use the landscape (15.5%), entertain (16.3%) and, most of all, to relax in the nature (16.7%).

The places in which they are frequently enjoying such ecosystem services (**Figure 6**), however, seem to be strongly associated with iconic mountains, in particular with the Chimborazo Mountain (14.7%). To a less extent (0.5-6%) were other places found to be frequented for cultural ecosystem services.

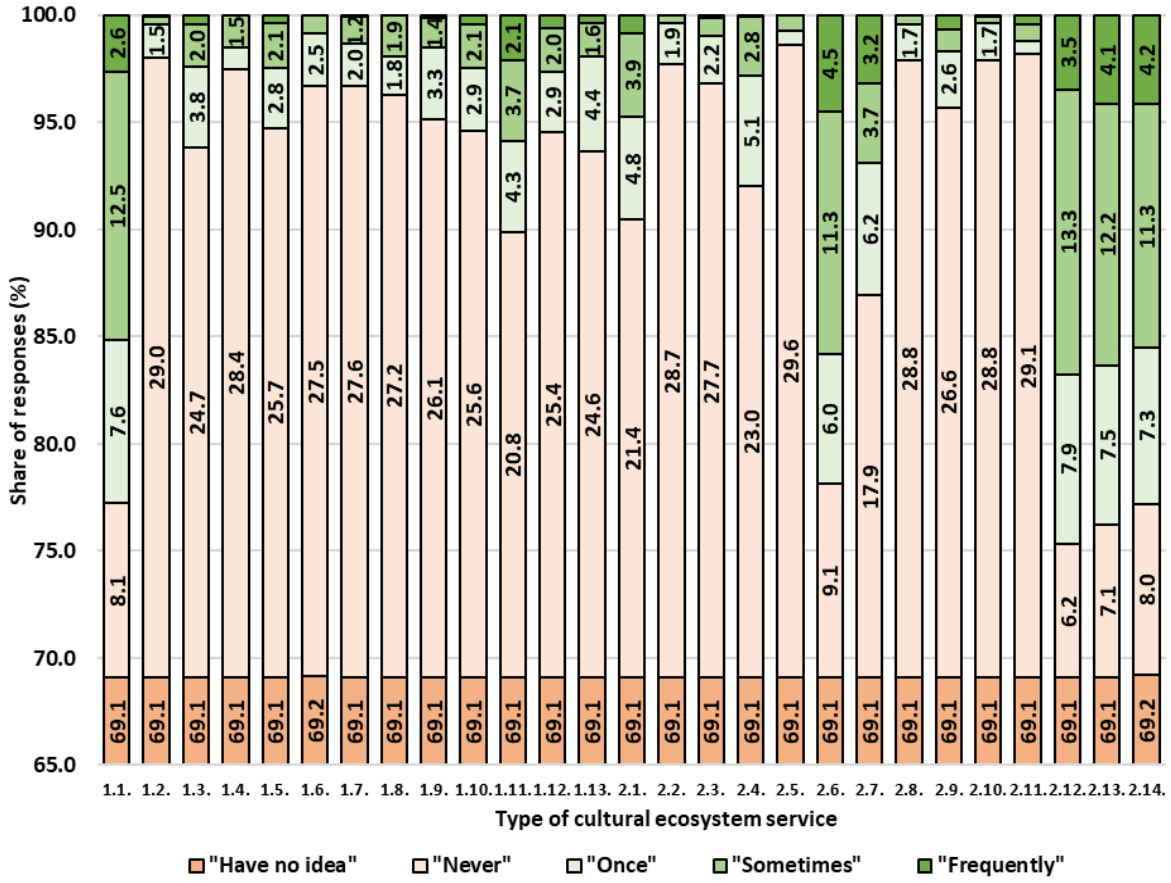


Figure 5. *Share of ratings on tyeps of cultural ecosystem services*

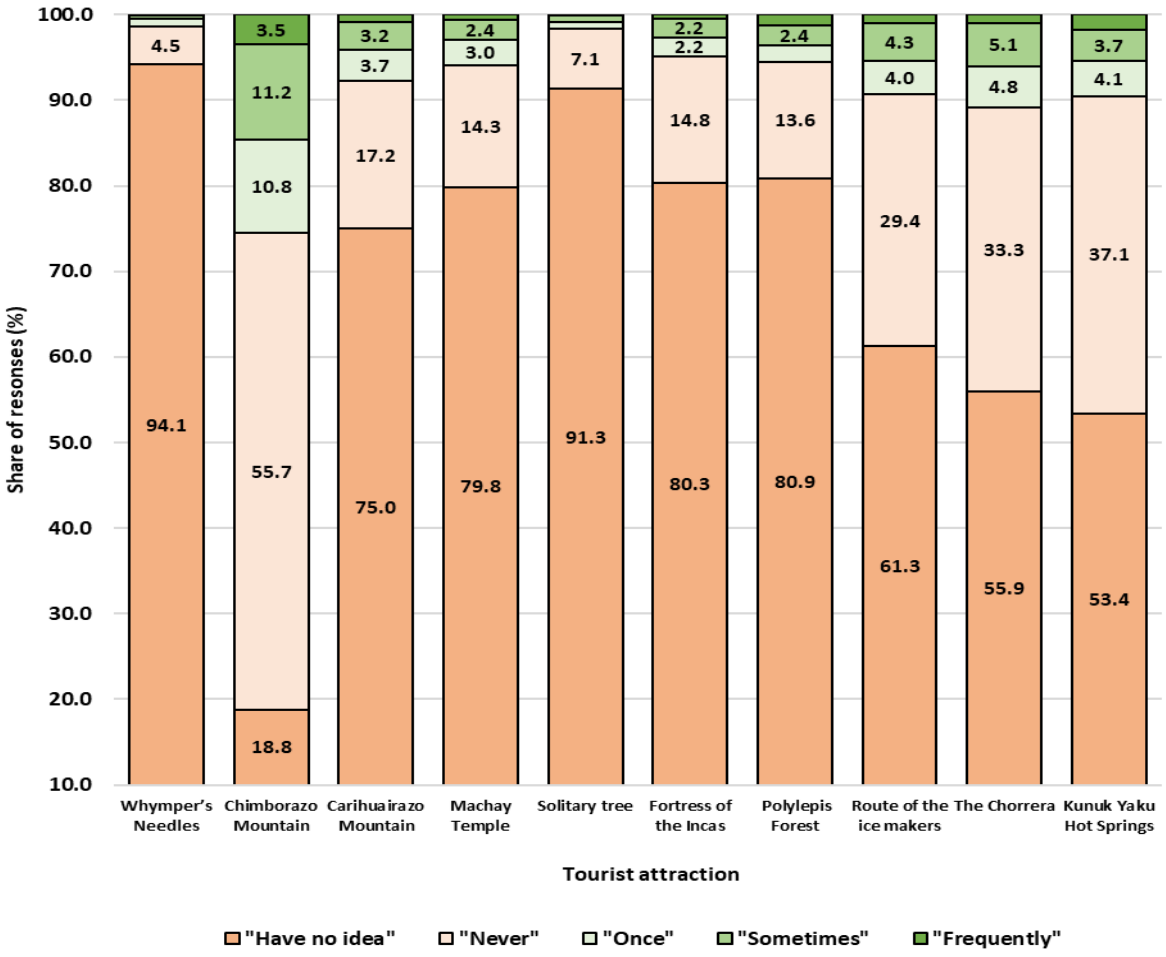


Figure 6. *Share of ratings on tourist attractions*

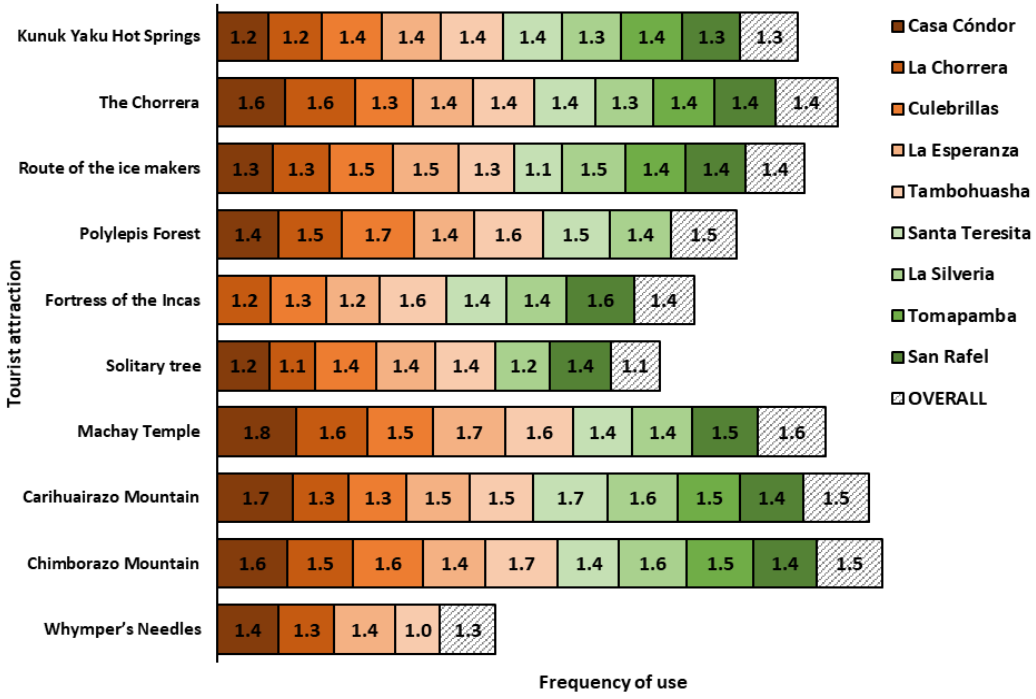


Figure 7. *Aggregated frequency of use on tourist attractions and communities*

A community-level breakdown of the aggregated frequency of use and frequented tourist attractions is shown in **Figure 7.** Distribution of ratings needs to be interpreted with caution. For instance, an overall value of 1.1 could be interpreted somewhere between "never" and "once" but probably it stands more for "never" at the community level. In comparison, a value of 1.6 stands for ratings placed between "once" and "sometimes", indicating rather the latest rating at community level.

The body of knowledge on ecosystem services assessment is very large but there is a general consent that information on ecosystem services is still lacking (*e.g.* Eigenbrod et al., 2009; MEE, 2014). This situation is hindering the attempt to scale the results, and probably distorts the image of full range of ***ES*** in a given area (*i.e.* Eastwood et al., 2016). In particular, data on cultural ecosystem services (***CES***) is scarce while the assessments should take in consideration the local culture and believes. While the protected areas are assumed to provide more cultural ecosystem services compared to managed land (Eastwood et al., 2016), in some regions there is a tendency to prefer provisioning services (He et al., 2018). In other regions the locals place similar values on both, provisioning ***ES*** and ***CES*** (Garrido et al., 2017), while in other regions ***CES*** such as the recreation may be underrepresented (Anderson et al., 2009; Eigenbrod et al., 2009). In relation to the above-mentioned, the data showed that communities located near ***CNR*** are using and are aware of the potential of local cultural ecosystem services. However, proximity to a given landscape seems to affect the preferences in use, which is readily a known social behavior (*e.g.* He et al., 2018).

4.3.3. Use of cultural ecosystem services by the local communities in the *Polylepis* Relict Forest

Figure 8 shows the aggregated responses of the local inhabitants specific to the ***Polylepis Relict Forest*** as a hotspot. ***CES*** used more than once, which were rated with grades such as "sometimes" and "frequently" would seem to present very low values in relation to the sample size. In this group, 5 types of ***CES*** were the most appreciated (used) for the ***Polylepis Relict Forest***: observation of flora and fauna (1.1. - 11.5%), hiking (2.6. - 13.8%), rest and relaxation (2.12. - 11.5%), entertainment (2.13. - 10.1%) and landscaping (2.14. - 9.8%).

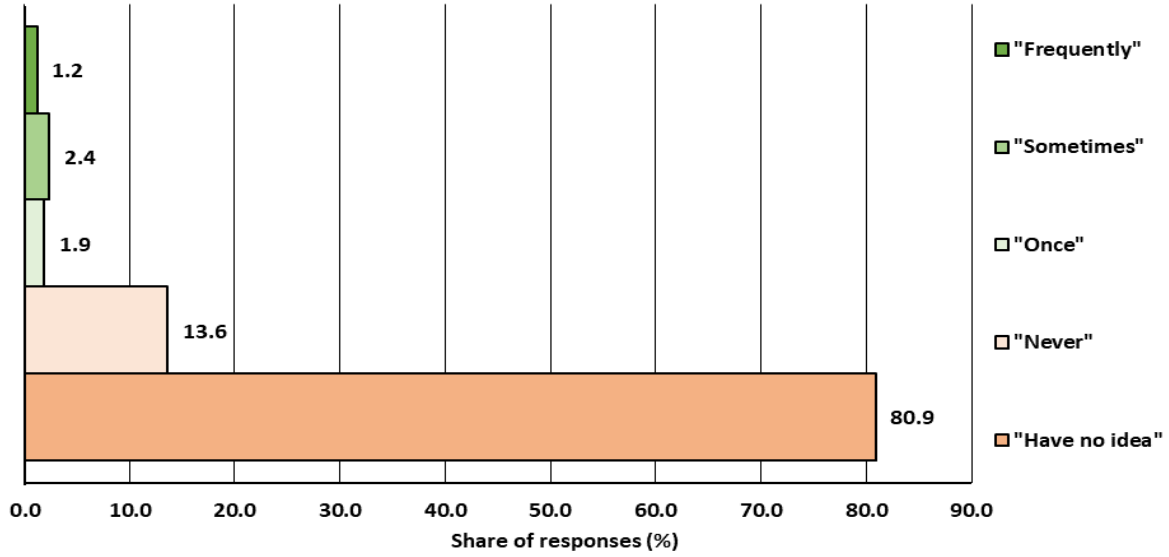


Figure 8. *Aggregated share of ratings in relation to the Polylepis Relict Forest*

Almost 81% of the respondents gave ratings of "0", which means that they had no idea about the cultural services that this forest may provide, while only 13.6% of them knew the place and its ***CES***, but had not used them. In general, local inhabitants associate the presence of the forest with feelings of peace, stillness and joy (Castillo et al., 2005). Even when there is information on how

resources are used, little has been explored about the behavior of different social actors when they are disputed or in conflict with the appropriation and use of ***ES*** (O'Brien and Leichenko, 2003).

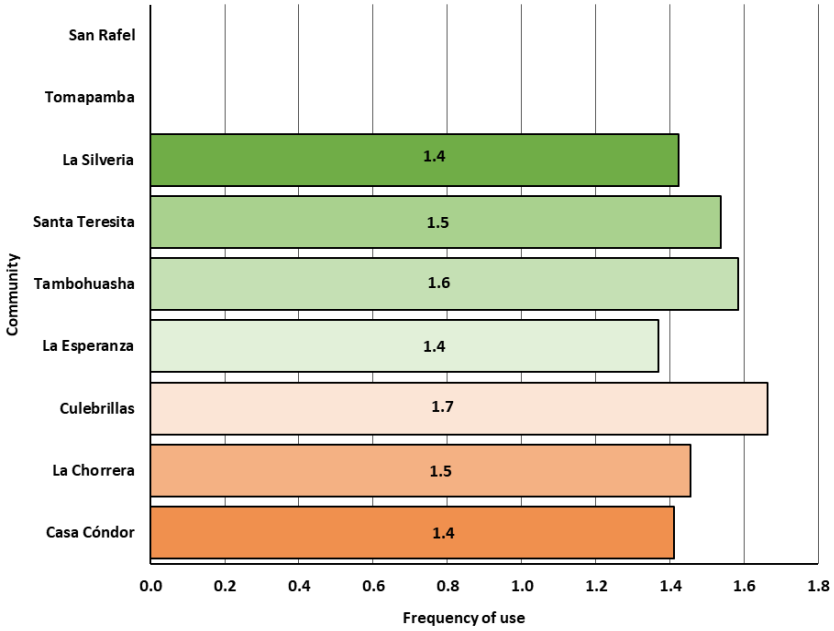


Figure 9. *Aggregated frequency of use on communities in relation to the Polylepis Relict Forest*

The aggregated frequency of use by communities in relation to the ***Polylepis Relict Forest*** has showed some variability, as specific to some communities, but finally, the general trend was the same: 1.1. - Observation of flora and fauna = 0.60, 2.6. - Hiking = 0.68, 2.12. - Rest, relaxation = 0.60, 2.13. - Entertainment = 0.59, 2.14. - Landscaping = 0.55. Therefore, 7 of the 9 communities taken into study use the ***CES*** specific to the ***Polylepis Relict Forest***, with average values characterizing the frequency of use in between 1.4 and 1.7 (**Figure 9**), values that stand for ratings in between "never" and "once". This fact can be associated to that the locals do not have much interest in visiting the ***Polylepis Relict Forest*** as it only provides to them, in the majority of the cases, just recreational services. The only activity benefiting probably from the ***Polylepis Relict Forest*** is tourist activity related to guidance for nationals and foreigners. On the other hand, ***CES*** are found in natural areas as a category of services whose benefits may be tangible or non-tangible, a quality that arises from the contribution of ecosystems to experiences that are pleasant or beneficial (Chan et al., 2011).

4.3.4. Social and demographic characteristics of tourists

The full description of the socio-demographich characteristics of tourist samples is given in the extended version of the thesis. Females had a higher share în the sample (N=131, 52%) compared to males (N=119, 48%). More than half of the respondents (N=156, 62%) were aged less than or equal to 30 years, followed by those who were aged between 31 - 40 years old (N=53, 21%). Most of the respondents declared that they had completed the bachelor level (72%). 19% of respondents declared that they have completed the secondary education. Completion of higher education levels was almost absent in the sampled population with only 4.4% of the respondents indicating that they are following or have finalized the third and fourth level studies. Finally, there were no tourists that declared no education. Based on the collected data, the occupations of respondents seem to be strongly associated to the studying sector (33%), followed by work activities in the public (25%) and private sector (24%). The rest of 17.4% was shared between different kind of occupations such as being a freelancer, unemployed or retired.

4.3.5. Use of cultural ecosystem services by the tourists

Most of the answers (N=85 - 99.9%) associated to different ***CES*** were rated by "0", which means that the respondents had no idea about the presence of such ***CES*** in ***CNR***. Even so, ***CES*** such as the observation of flora and fauna (1.1. - 1.8%), aesthetic values (1.11. - 1.6%), hiking (2.6. - 2%), photography (2.7. - 2.6%), rest and relaxation (2.12. - 1.8%), entertainment (2.13. - 2.5%) and landscaping (2.14. - 3%) were the highest rated among the frequent use, while the rest were rated as unused and used only once, in small proportions.

The tourists had no knowledge on many of the tourist hotspots present in the area of ***CNR***. In particular, the foreigners exhibited this kind of behavior for many of the analyzed hotspots. Some knowledge and use were associated to tourist attractions such as the Chimborazo Mountain, Carihuairazo Mountain, Machay Temple and La Chorrera. From these, the Chimborazo Mountain was the highest rated to be used for ***CES*** at sample level (4.1%) and also the most known tourist attraction, but, at the same time, the use of ***CES*** in this area was more associated with the national tourists (almost 5% used this location frequently).

This outcome could be associated to the high scenic beauty of Chimborazo Mountain, as well as to the tourist promotion of this attraction (MEE, 2014), which generates a great interest to visit it by tourists. However, the rest of tourist attractions have been rated only by 0.1% - 0.8% as being used frequently, a fact that could be the effect of the lack of tourism promotion and, in some cases, the poor access conditions to these attractions. In this regard, it is necessary to understand how the relationships between tourist attractions and their access facilities are shaped by the visitors so that to enable actions development in favor of a high level of satisfaction, considering that a satisfied tourist tends to return to the destination and tells his positive experiences to friends and family (Pavlić et al., 2011; Murphy et al., 2000).

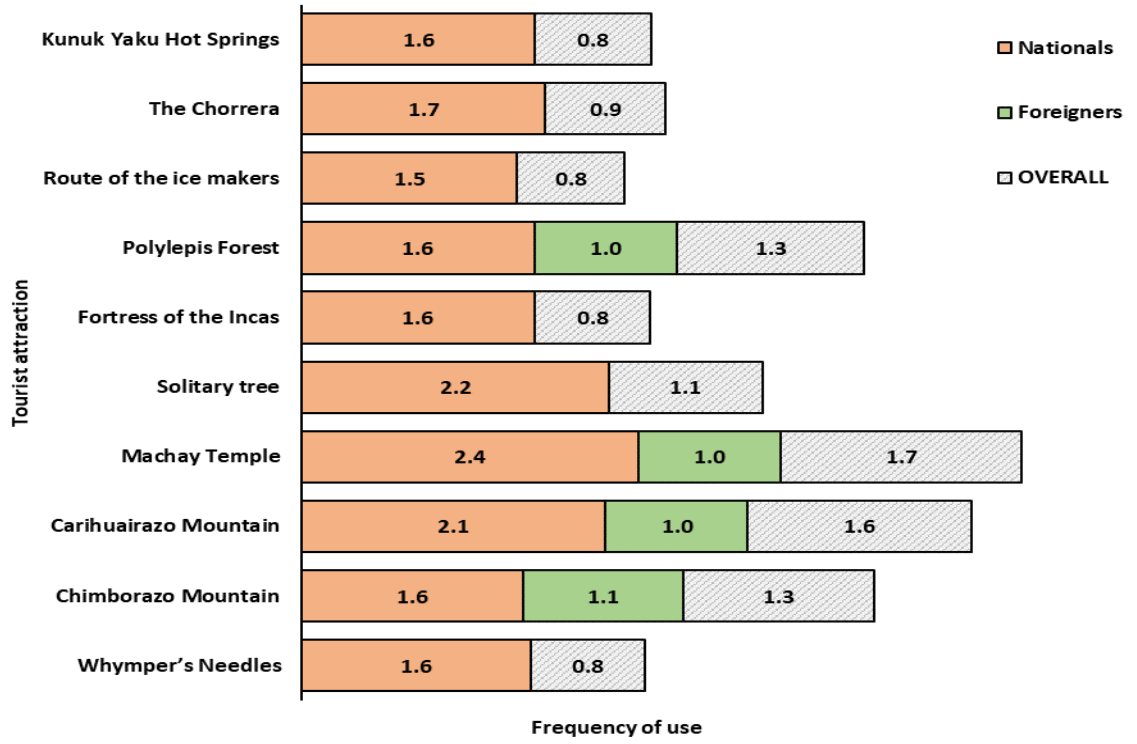


Figure 10. *Aggregated frequency of use on tourist attractions and tourist groups*

There was some variability in and between the groups of tourists as well as at the aggregated level in relation to the types of ***CES***, indicating an aggregated frequency of use for the ***CES*** as follows: 1.7. - Environmental education = 1.53, 1.8. - Environmental interpretation = 1.42, 2.10. - Climbing = 1.46,

2.13. - Entertainment = 1.41 and 2.14. - Landscaping = 1.41. National tourists, on the other hand, have indicated higher frequencies of use compared to the foreign tourists. This behavior may be the effect of proximity. **Figure 10** shows the aggregate distribution of ratings per tourist attractions. In relation to this, the most frequented ones were the Machay Temple (1.7), Carihuairazo Mountain (1.6), Chimborazo Mountain (1.3), and the ***Polylepis relict forest*** (1.3). Nevertheless, these figures are those characterizing the aggregated datasets and there was an evident difference between national and foreign tourists. In this direction, the national tourists visited, in average, at least once, each of the attractions taken into study. The types of ***CES*** and their frequency of use by the tourists as found in this work are supported by the results of other studies. For instance, ***PA*** are considered to be an ideal place to develop recreational activities, where tourists enjoy such ***ES*** (Olmos et al., 2015) most frequently. In addition, there is also a notable increase in the tourist-recreational activities in ***PA*** due to the scenic beauty that is present in such spaces (NCPNA, 2011).

4.3.6. Frequency of use by the tourists in the *Polylepis* Relict Forest

For the ***Polylepis Relict Forest*** 6 types of ***CES*** were the highest rated, in relation to their frequency of use: observation of flora and fauna (1.1. - 1.6%), hiking (2.6. - 1.6%), photography (2.7. - 3.2%), rest and relaxation (2.12. - 2.4%), entertainment (2.13. - 2.8%) and landscaping (2.14. - 3.6%). However, the frequency of using ***CES*** in the forest has shown that 98.7% of respondents have no idea on the specific ***CES*** or they have never used them (1.3%). This was the case of foreign tourists. Instead, only 1% of national tourists reported to have made frequent use of these services while the foreigners responded that they have not used them even once. At the tourist sample level, close to 95% of the respondents declared that they have no idea of the indicated ***CES***, 3% have never been used them, 1.8% have been used them at least once and close to 1% declared that they have been used them frequently. Probably this fact was related to the limited knowledge on the forest and ***CES*** that the ***Polylepis Relict Forest*** provides. However, the *Polylepis* forests represent one of the most threatened ecosystems worldwide and, at the same, time they play a significant role in high Andean ecology, being a habitat for many species as well as a substantial source of cultural ecosystem services for tourists and local communities (Kessler, 2006).

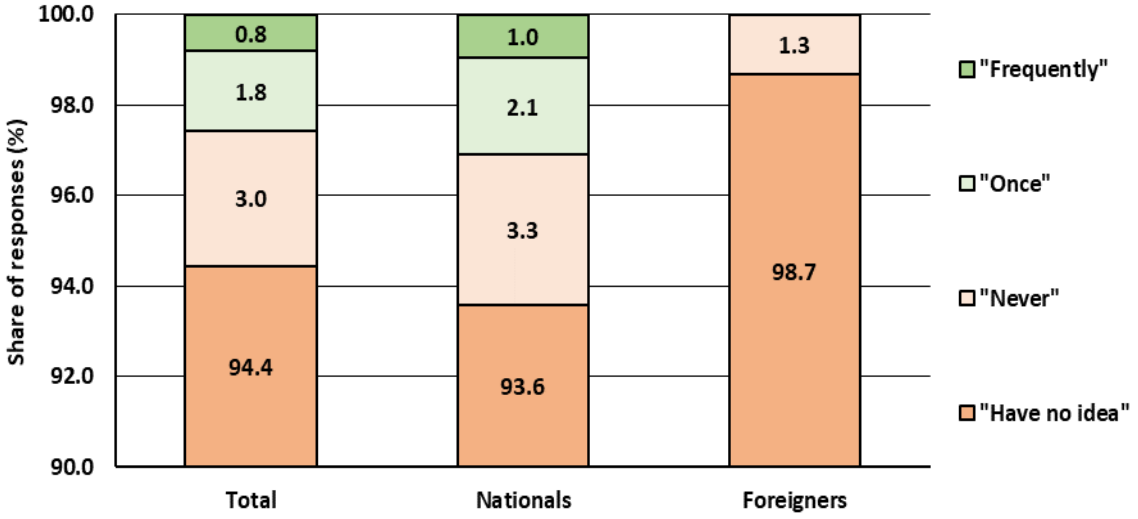


Figure 11. *Share of ratings on the Polylepis Relict Forest*

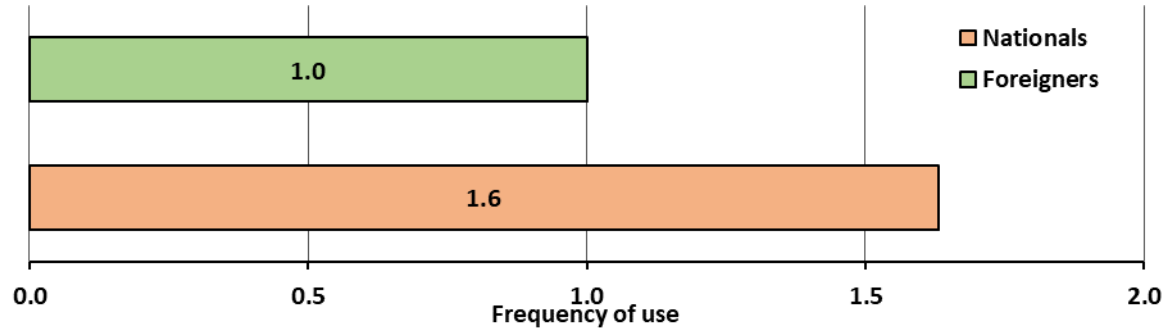


Figure 12. *Aggregated frequency of use by tourists in the Polylepis Relict Forest*

The nature-based tourism has been defined to refer to those activities that people do while on holiday with focus on the engagement with nature (Silvennoinen and Tyrväinen, 2001), a fact that involves travelling to and passing locations close to ***PA***, forests, lakes etc. and undertaking activities compatible with the local natural quality (Fredman and Tyrväinen, 2010). The ***Polylepis Relict Forest*** is one of the tourist attractions of ***CNR.*** **Figures 11** and **12** show the aggregated frequency of use per ***CES*** and tourist groups in the ***Polylepis Relict Forest***. The highest frequencies of use in relation to the ***CES*** potentially provided by the forest were: 1.1. - Observation of flora and fauna = 0.17, 2.6. - Hiking = 0.16, 2.7. - Photography = 0.17, 2.12. - Rest, relaxation = 0.16, 2.13. - Entertainment = 0.15, 2.14. - Landscaping = 0.16. The results also show that the national tourists (1.6) were those who indicated a higher frequency of use of ***CES*** compared to foreign tourists (1.0). Lately, the national parks are considered to be among the drivers of economic growth sustained by the development of nature-based tourism (Fredman and Tyrväinen, 2010). According to this work, it appears that frequency of use may be the result of social context and experience with the landscape which was different among the two samples of tourists. It also appears that the ***Polylepis Relict Forest*** is not a tourist attraction that is frequently used by the tourists coming in the area.

4.3.7. Comparison between the frequency of use as specific to local communities and tourists

According to Kianicka et al. (2006), there are fundamental differences which shape the understanding of the landscape in the view of locals and tourists, as for locals, the landscape has mainly social and existential values while for the tourists, it may have individual values.

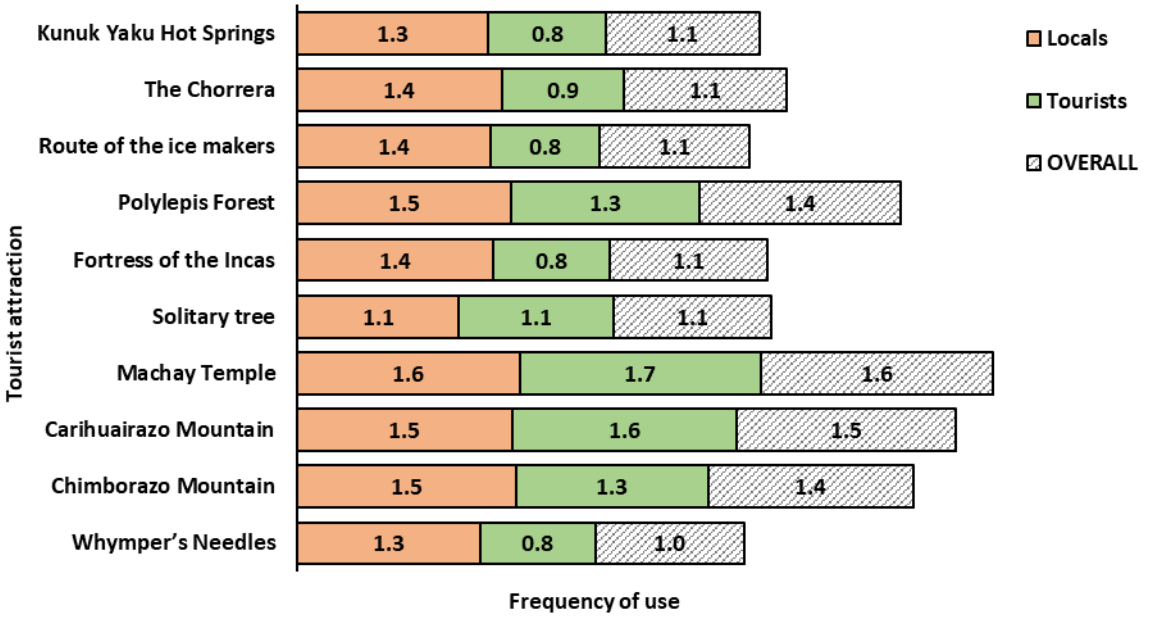


Figure 13. *Comparison of the aggregated frequency of use between locals and tourists on tourist attractions*

In this regard, **Figure 13** shows a comparison between the frequency of ***CES*** use by locals and tourists. For locals, the most frequented tourist attractions were the Machay Temple (1.6), Chimborazo Mountain (1.5), Carihuairazo Mountain (1.5), and ***Polylepis Relict Forest*** (1.5). In the case of the tourist they were the Machay Temple (1.7), Carihuairazo Mountain (1.6), Chimborazo Mountain (1.3) and ***Polylepis Relict Forest*** (1.3). As the tourists are characterized by having a different social and existential background compared to locals, they also hold an "outsider's" view an may perceive and value landscapes in a different way (Stremlow, 1998). Therefore, there are needed extensive efforts to understand the tourist demand and to align the supply of local landscape to it. This also addresses the locals' willingness to share their community with incomers, as they prefer the economic development of their place of living while the tourists prefer the conservation (Kianicka et al., 2006).

4.4. Perception on the capacity to provide cultural ecosystem services

4.4.1. Perception of local communities

The data characterizing the aggregated perception on the capacity to provide ***CES*** was characterized by a high variability which was probably related to the communities' proximity to certain tourist attractions, the frequency of use characteristic to different types of ***ES*** and the general believes of locals in relation to their residence landscapes (**Figure 14**). One good example on how the proximity and frequency of use probably affected the perceived capacity to provide ***CES*** is that of "La Chorrera" respondents that rated very high "The Chorrera" tourist attraction in this regard (**Figure 14a**). Excepting the community of "La Esperanza", which is located at the farthest distance from Chimborazo Mountain, it seems that the latter was also consistently perceived as having a medium-high to very high capacity to provide recreation, inspiration, education and science services but not spiritual experiences (**Figure 14a-d**), which were attributed to the closest Whymper's Needles by two communities.

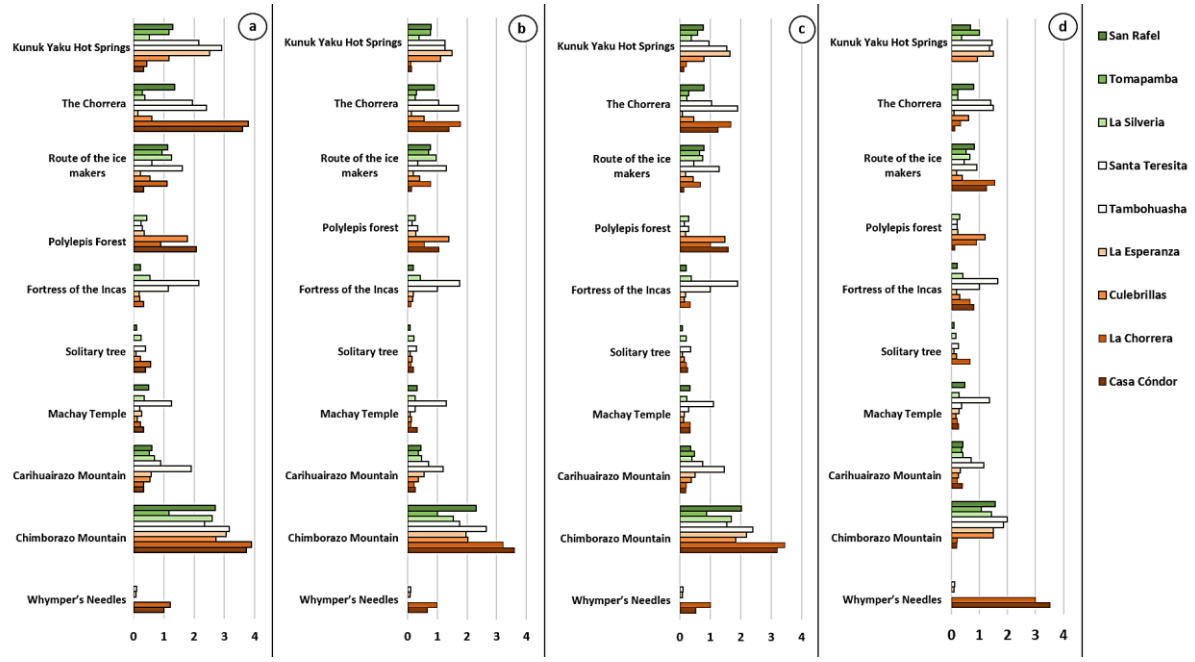


Figure 14. *Aggregated perceived capacity to provide cultural ecosystem services on categories of services. Legend: a) recreational, b) inspiration, c) education and study, d) spiritual experience, 0 means "NA", 1 means "Lowest capacity", 4 means "Highest capacity"*

At the study level, Chimborazo Mountain was perceived to have the greatest capacity to provide cultural services (**Figure 15**). Another key behavior of the communities taken into study was their value placement on iconic landscapes and their dominant features. As an example, many of the locals still believe that Chimborazo Mountain is a God, and many of the locals still use to give

offerings for the mountain in the tourist attraction known as the Machay Temple. Therefore, it was not surprising to find that respondents of local communities placed most of the value on the Chimborazo Mountain. In fact, people, including those from completely different regions and cultures, still tend to place value on rather mythical or religious connotated values of the landscapes (Irvine and Herret, 2018).

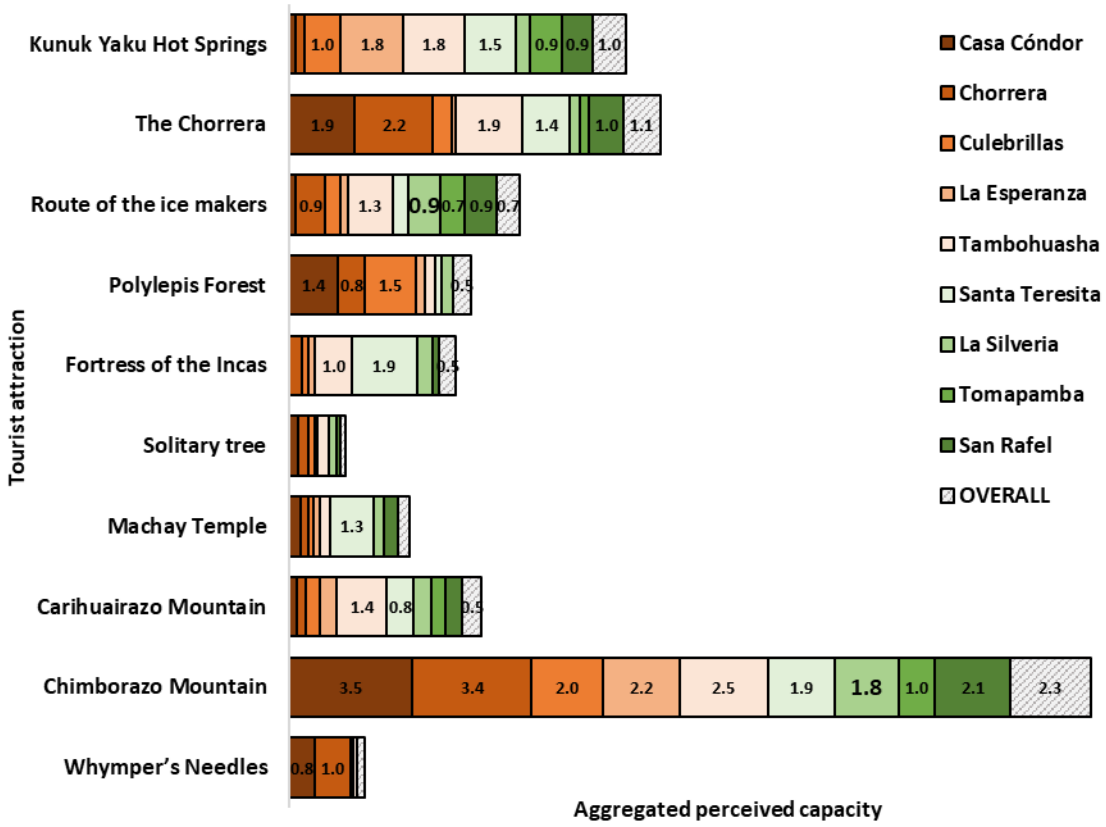


Figure 15. *Perceived capacity to provide cultural ecosystem services on tourist attractions and local communities*

This fact is probably related to this landscape which is unique in the country because it is the highest mountain in Ecuador. Also, it is unique in the world as it stands for the highest point from the center of the Earth and, it is for sure the most visited tourist place in the Chimborazo Province (GINPSE, 2016).

4.4.2. Factors affecting the perception of local communities on the capacity to provide cultural ecosystem services

The analysis of the factors that may affect the perception on the capacity to provide ***CES*** was carried out for all of the tourist attractions taken into study. A full description and interpretation are given in the extended version of the thesis.

The significant socio-demographic factors affecting the perception on the capacity to provide recreational, inspiration for creative work, education and science ***ES*** were found to be, in general, the gender, occupation, age and level of education. In general, male respondents tended to rate higher the capacity to provide recreational, inspiration for creative work, education and science services compared to women. The respondents working in tourism business valued, in general, more the potential of tourist attractions to provide recreational services. In regards to the age, respondents coming from the group of 52-63 years tended to place more value on the capacity of tourist attractions to provide recreation and education and science services. In what concerns the level of education, respondents who have primary incomplete studies tended to rate higher the

capacity to provide education and science services. Therefore, male respondents those working in the tourism in the area, as well as those belonging to the last age groups and those having primary education completed or noncompleted were those who evaluated the capacity to provide as being the highest in regards to ***CES***. In the following, some examples are discussed in relation to the factors affecting the perception on the capacity to provide ***CES***.

For instance, the perceived capacity to provide ***CES*** in the case of Whymper's Needles was affected by gender, occupation, age and level of education (**Table 5**). Nevertheless, the ratings were rather low, being close to 0, meaning that many of the respondents felt that they were not qualified to judge this aspect.

Table 5. *Factors affecting the perceived capacity to provide cultural ecosystem services on tourist attractions: Whymper's Needles*

Tourist attraction	Category of service	Feature	Item	Perceived capacity	Parametric test	Confidence level
Whymper's Needles	Recreation	Gender	Male	0.2*	t	α=0.05
			Female	0.04		
		Occupation	Agriculture and livestock	0.1	ANOVA	α=0.05
			Commerce	0.0		
			Tourism	0.5*		
			Construction	0.0		
			Other	0.02		
	Inspiration for creative work	Gender	Male	0.1*	t	α=0.05
			Female	0.04		
	Education and science	Gender	Male	0.1*	t	α=0.05
			Female	0.03		
		Age	18-28	0.03	ANOVA	α=0.05
			29-40	0.04		
			41-51	0.03		
			52-63	0.2*		
			64-75	0.09		
		Level of education	Without education	0.01	ANOVA	α=0.05
			Primary incomplete	0.2*		
			Primary complete	0.1		
			Secondary incomplete	0.05		
			Secondary complete	0.02		
			Bachelor incomplete	0.00		
			Bachelor complete	0.00		

Note: * denotes significant differences compared to each other values in a group

In the case of Chimborazo Mountain (**Table 6**), the significant socio-demographic factors affecting the perception to provide recreational ***ES*** were found to be the gender, occupation and level of income. Male respondents tended to rate higher the capacity to provide recreational services compared to women. The respondents working in tourism and other undeclared economic sectors tended to place more value on the capacity to provide recreational services. In fact, those working in tourism rated the capacity to provide recreational services as being close to very high. In what concerns the level of income, the first category, having a less income, tended to better rate the capacity to provide recreational services. Therefore, male respondents those working in tourism and those having the lowest income in the area attributed the highest potentials for recreational services to the Chimborazo Mountain. Worth mentioning that in this case, only for the recreational services were found differences related to some factors as well as the fact that for Chimborazo Mountain the ratings on the perceived capacity to provide ***CES*** were the highest.

In the case of ***Polylepis Relict Forest***, the ratings on its capacity to provide ***CES*** were low, showing that respondents were not believing that this tourist attraction has a high capacity to provide ***CES*** (**Table 7**). The only significant socio-demographic factor affecting the perception to provide ***CES*** was

the gender and this was true only in the case of recreational ecosystem services. In this respect, male respondents tended to rate higher the capacity to provide recreational services compared to women.

Table 6. *Factors affecting the perceived capacity to provide cultural ecosystem services on tourist attractions: Chimborazo Mountain*

Tourist attraction	Category of service	Feature	Item	Perceived capacity	Parametric test	Confidence level
Chimborazo Mountain	Recreation	Gender	Male	2.9*	t	α=0.05
			Female	2.5		
		Occupation	Agriculture and livestock	2.3	ANOVA	α=0.05
			Commerce	2.5		
			Tourism	3.8*		
			Construction	2.0		
			Other	3.1		
		Level of income	386-708 $	2.8*		
			709-1030 $	2.3		
			1031-1353 $	2.0		
			Not Declared	2.3		

Note: * denotes significant differences compared to each other values in a group

Table 7. *Factors affecting the perceived capacity to provide cultural ecosystem services on tourist attractions: Polylepis Relict Forest*

Tourist attraction	Category of service	Feature	Item	Perceived capacity	Parametric test	Confidence level
Polylepis Relict Forest	Recreation	Gender	Male	0.6*	t	α=0.05
			Female	0.3		

Note: * denotes significant differences compared to each other values in a group

There is many research on the relationship between gender and value placed on the forests and, compared to the results of other studies, the test outcome came as a surprise. It has been shown, for instance, that female tourists perceive more positively highly natural forests, while an important share of males appreciated more managed forests (Pastorella et al., 2016). This is also a conclusion found by Tarrant and Cordell (2002) who have shown that in Southern United States, females placed themselves among non-utilitarian group compare to male respondents. The only similarity found for the results of this work compared to others was that in relation to recreational values which are more appreciated by males. In Ontario (Canada), for instance, it was found that women placed more emphasis on the spiritual and environmental values of forests, whereas men appreciated more the recreational values (Kumar and Kant, 2007). These differences are connected to the different perception as an effect of gender in relation to forests, shaping different mind constructs, also related to the place of origin and diversity in culture.

4.4.3. Perception on the capacity of *Polylepis* Relict Forest to provide cultural ecosystem services in the view of local communities

The aggregated perceived capacity to provide ***CES*** on categories of services in respect to the analyzed communities and in relation to the ***Polylepis Relict Forest*** indicated a high variability in results (**Figure 16**). As shown, the communities perceiving a greater capacity to provide ***CES*** in these categories were Casa Condor, Chorrera and Culebrillas, that indicated, in average, a capacity to provide between low and medium (0.6 - 2.1) in the 4 categories. Most probably, this fact is associated to the proximity of these communities to the ***Polylepis Relict Forest*** and their variability in terms of frequency of use. On the other hand, Tomapamba and San Rafael communities presented null qualifications in the different categories of ***CES***, a fact that was probably associated to

the lack of knowledge of the ***CES*** provided by the ***Polylepis Relict Forest*** and the location of the communities in relation to this tourist attraction.

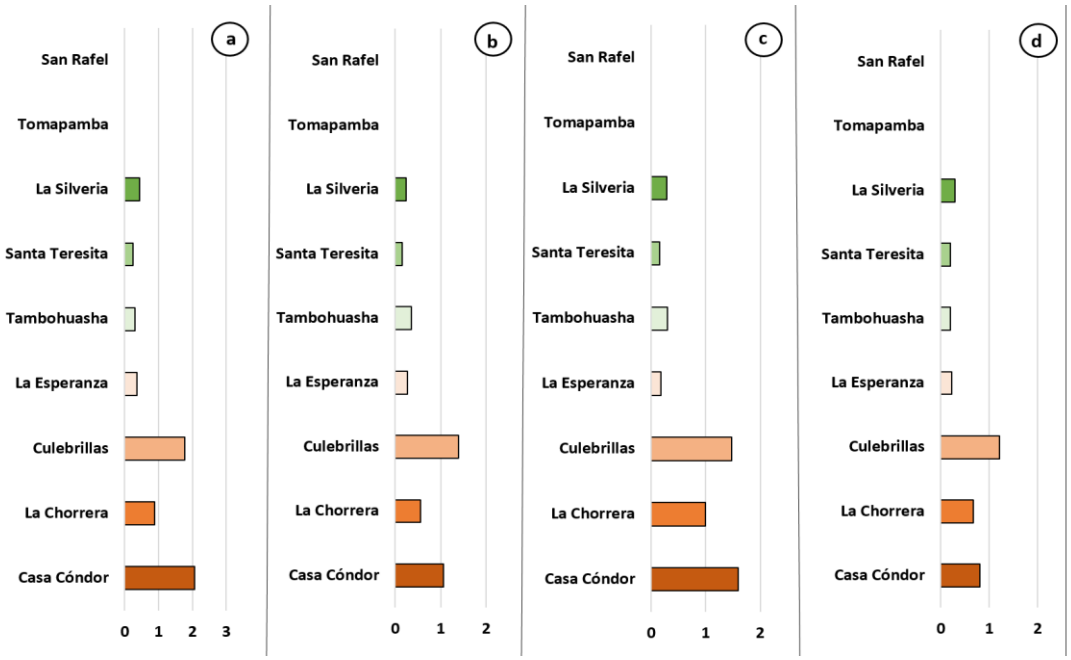


Figure 16. *Aggregated perceived capacity to provide cultural ecosystem services by the Polylepis Relict Forest on categories of services and communities. Legend: a) recreational, b) inspiration, c) education and study, d) spiritual experience. Legend: 0 means "NA", 1 means "Lowest capacity" and 4 means "Highest capacity"*

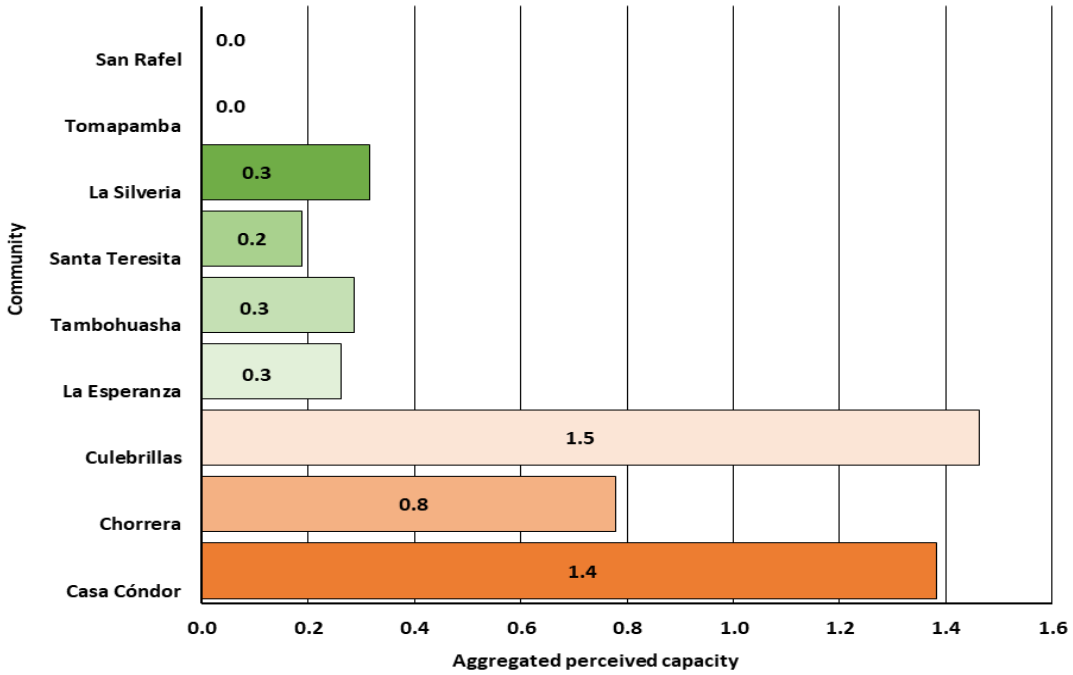


Figure 17. *Perceived capacity to provide cultural ecosystem services by the Polylepis Relict Forest*

Figure 17 gives the average values on the perception of local communities in relation to the capacity of the ***Polylepis Relict Forest*** to provide ***CES*** based on the 4 described categories. The communities of Culebrillas (1.5), Casa Condor (1.4) and Chorrera (0.8) gave the highest ratings when evaluating the capacity to provide ***CES*** by this tourist attraction; however, the average values were low indicating rather a small perceived capacity to provide ***CES***. Still, 7 of the 9 analyzed communities have rated this tourist attraction.

4.4.4. Perception of tourists

The results of the aggregated perceived capacity to provide ***CES*** on categories of services - a) recreational, b) inspiration, c) education and study, d) spiritual experience - between tourists and attractions are given in **Figure 18**. Perception on capacity to provide ***CES*** was focused on the Chimborazo Mountain, a tourist attraction evaluated to have a medium to very high capacity (2.6 - 3.8) to provide the 4 categories of ***CES*.** This fact can be attributed to the knowledge that tourists may have of this attraction for being an iconic mountain probably known worldwide. The rest of tourist attractions have been evaluated to have rather low capacities to provide ***CES*** (0 - 0.60).

Figure 19 shows the averaged values on the perception of tourists in relation to the capacity of the attractions to provide ***CES*** irrespective of the four categories taken into study. As shown, Chimborazo Mountain was perceived to have the greatest capacity to provide ***CES*** when considering all the tourist data set - 3.4 - a value that could be interpreted as a high capacity. At this scale of data analysis, the differences between the foreign and local tourists were small (3.3 and 3.4 respectively).

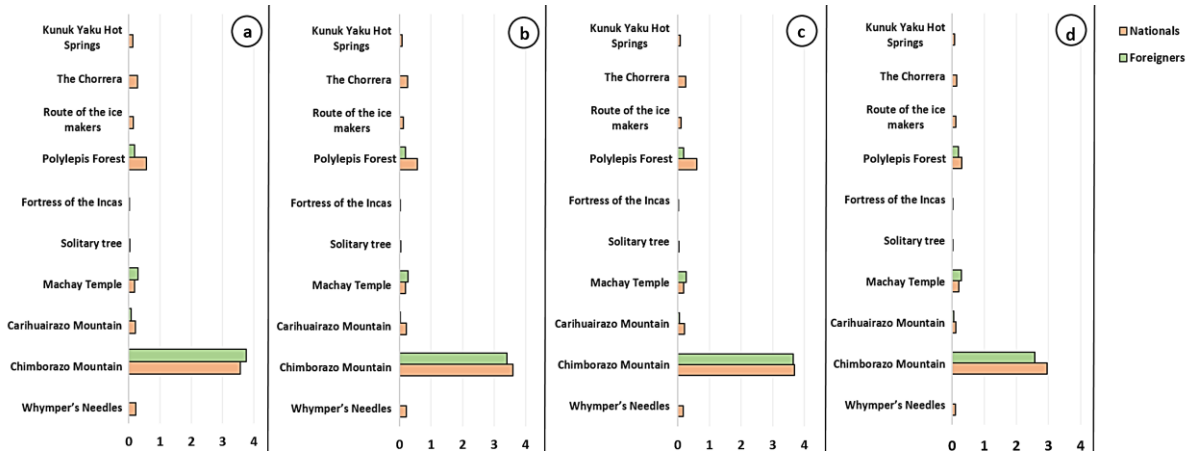


Figure 18. *Aggregated perceived capacity to provide cultural ecosystem services on categories of services. Legend: a) recreational, b) inspiration, c) education and study, d) spiritual experience. Legend: 0 means "NA", 1 means "Lowest capacity" and 4 means "Highest capacity"*

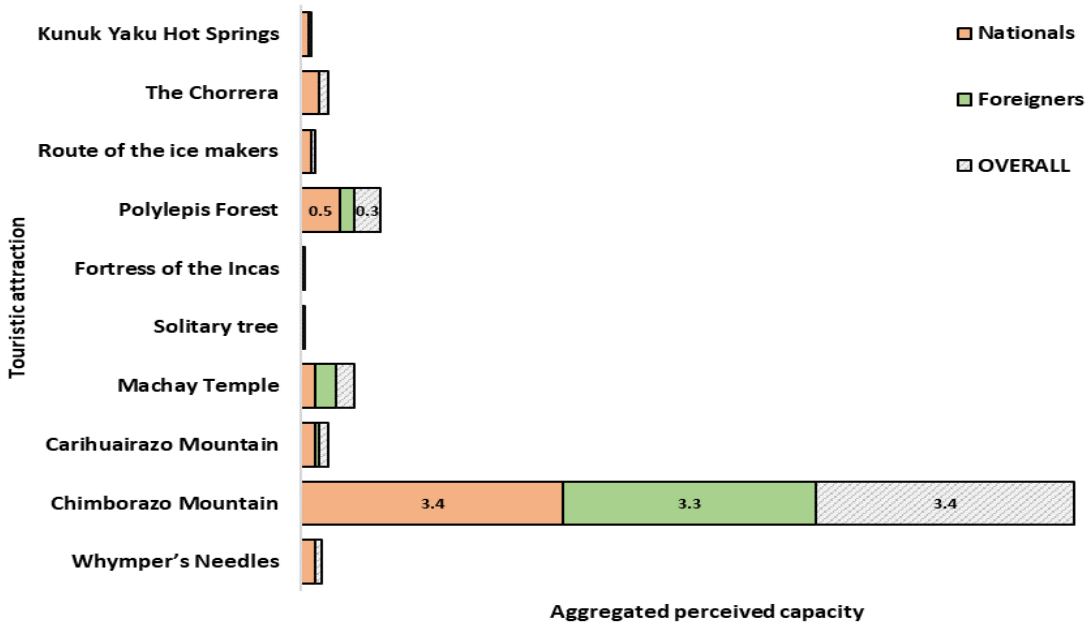


Figure 19. *Perceived capacity to provide cultural ecosystem services on tourist attractions*

Explanations for this outcome in relation to the Chimborazo Mountain may rest in the fact that this tourist attraction is well known and advertised at both, national and international level. Many tourists define this attraction as being ideal to connect with nature and as the perfect place for the recreation of travelers and climbers. As a reference, Plieninger et al. (2013) have shown, in their study, that (potential) incomers hold the ability to identify spots of particular aesthetic meaning, social customs, or even educational values.

4.4.5. Factors affecting the perception of tourists on the capacity to provide cultural services

The analysis on the factors that may affect the perception on the capacity to provide ***CES*** by the attractions was carried out, for each one, and for each category of service. At the tourist attraction sample level, the significant socio-demographic factors affecting the perception on the capacity of tourist attraction to provide ***CES*** in the four categories (recreational, inspiration for creative work and education and science) were found to be the gender, age, occupation and level of education. Nevertheless, the number of factors affecting the perceived capacity differed between the tourist attractions and the category of ***CES*** taken into study. The full range of factors and their meaning is given in the extended version of the thesis while here were reatained only those found to be significant for the Chimborazo Mountain and ***Polylepis Relict Forest***.

Table 8. *Factors affecting the perceived capacity to provide cultural ecosystem services on tourist attractions: Chimborazo Mountain*

Tourist attraction	Category of service	Feature	Item	Perceived capacity	Parametric test	Confidence level
Chimborazo Mountain	Recreation	Occupation	Unemployed	3.9	ANOVA	α=0.05
			Retired	4.0*		
			Student	3.4		
			Freelancer	3.7		
			Private	3.7		
			Public	3.6		
	Inspiration for creative work	Age	≤ 30	3.6*	ANOVA	α=0.05
			31 – 40	3.6*		
			41 – 50	2.9		
			51 – 60	3.3		
			> 60	3.4		
	Education and science	Gender	Male	3.5	t	α=0.05
			Female	3.8*		
		Level of education	Without education	-	ANOVA	α=0.05
			Primary	4.0*		
			Secondary	3.6		
			Technician	4.0*		
			Technologist	3.3		
			Bachelor	3.7		
			Master	4.0*		
			Doctorate	2.0		
	Spiritual experiences	Gender	Male	2.6	t	α=0.05
			Female	3.1		

Note: * denotes significant differences compared to each other values in a group

The best ratings were specific to the Chimborazo Mountain (**Table 8**). In this case, recreation services were best rated by retired people and the occupation was a significant factor affecting the perception on the capacity to provide recreation services. People under 40 years old placed more value on the capacity of the Chimborazo Mountain to provide inspiration for creative work and age was a significant modifying factor, while the analysis of the education and science category revealed that both gender and level of education were significant factors affecting the perception on the

capacity of Chimborazo Mountain to provide this category of service. Spiritual experiences were rated higher by the women in regards to the Chimborazo Mountain capacity to provide them. In fact, only the gender was found to act as a modifying factor in this case.

Table 9. *Factors affecting the perceived capacity to provide cultural ecosystem services on tourist attractions: Polylepis Relict Forest*

Tourist attraction	Category of service	Feature	Item	Perceived capacity	Parametric test	Confidence level
Polylepis Relict Forest	Recreation	Gender	Male	0.7*	t	α=0.05
			Female	0.3		
	Inspiration for creative work	Gender	Male	0.7*	t	α=0.05
			Female	0.4		
		Age	≤ 30	0.7*	ANOVA	α=0.05
			31 – 40	0.3		
			41 – 50	0		
			51 – 60	0.3		
			> 60	0		
	Education and science	Gender	Male	0.7*	t	α=0.05
			Female	0.4		

Note: * denotes significant differences compared to each other values in a group

In contrast, the capacity of the ***Polylepis Relict Forest*** to provide ***CES*** in the four categories was rated lower, but still, it was the second tourist attraction that received a good rating (**Table 9**). In this regard, capacity of ***Polylepis Relict Forest*** to provide recreation services was affected by the gender, capacity to provide inspiration for creative work was affected by the gender and age with males and those under 30 placing more value on this capacity, while the perceived capacity to provide education and science services was affected by the gender only, with males placing more value on this aspect.

4.4.6. Perception on the *Polylepis* Relict Forest to provide cultural ecosystem services in the view of tourists

The results presented in **Figure 20** indicate a low perceived capacity on the ***Polylepis Relict Forest*** to provide ***CES*** on categories. At the tourist sample level, the results show average values that were similar for three categories: recreation, inspiration for creative works and education and study, with values of 0.5.

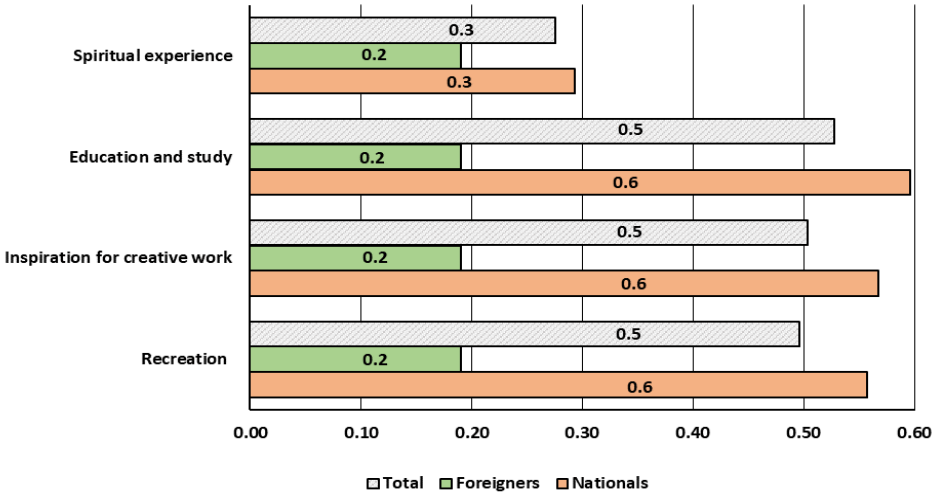


Figure 20. *Aggregated perceived capacity on the Polylepis Relict Forest to provide cultural ecosystem services, on categories of services. Legend: a) recreational, b) inspiration, c) education and study, d) spiritual experience*

Definitely these are low values, probably associated with the few visitors who know the forest where they probably have carried out some activities such as walking, photography, meditation and in very few cases research activities. Therefore, tourists may have some references and knowledge about the forest but still, they placed low values on its capacity to provide ***CES***. In this regard, worth mentioning the results and statements of Zoderer et al. (2016), who indicate that the experience with landscape has an important role; in this regard, tourists who visit a place more than once are likely to highly appreciate the landscape as they are seeing more opportunity to develop leisure activities compared to people having none or only little experience. Another thing that could be inferred from data is that the national tourists rated higher the ***Polylepis Relict Forest*** in regards to its capacity to provide ***CES*** in the four analyzed categories.

4.4.7. Comparison between the local communities and tourists in terms of ratings on the perceived capacity of tourist attractions to provide cultural ecosystem services

A rough comparison between the aggregated averaged ratings given by the local communities and tourists on their perception on the capacity of tourist attractions to provide ***CES*** is given in **Table 10**. As shown, the Chimborazo Mountain stands out in terms of value placed on its capacity to provide ***CES***, which was rated to be medium to high.

Table 23. *Aggregated perceived capacity to provide cultural ecosystem services: a comparison between local communities and tourists*

Group	Tourist Attraction									
	Whymper's Needles	Chimborazo Mountain	Carihuairazo Mountain	Machay Temple	Solitary Tree	Fortress of the Incas	Polylepis Forest	Route of the Ice Markers	The Chorrera	Kunuk Yaku Hot Springs
Locals	0.2	2.3	0.5	0.3	0.2	0.5	0.5	0.7	1.1	1.0
Tourists	0.1	3.4	0.1	0.2	0.0	0.0	0.3	0.1	0.1	0.0
Overall	**0.2**	**2.8**	**0.3**	**0.3**	**0.1**	**0.2**	**0.4**	**0.4**	**0.6**	**0.5**

Locals placed less value on this tourist attraction compared to the tourists. Quite at the opposite side was the ***Polylepis Relict Forest*** which was rated by both groups to have rather a low capacity to provide ***CES***. Nevertheless, it stood out by being higher rated by both groups compared to the other tourist attractions, excluding the Chimborazo Mountain. Another thing that could be extracted from this comparison is that the tourists tended to place, in general, less value on the capacity of attractions to provide ***CES*** compared to the locals. Having these distributions in mind, as well as the fact that the ***ES*** and biological diversity have been treated as free and infinite resources (Goicochea, 2011), worth mentioning that the ***PA*** are currently created for many reasons such as to conserve iconic landscapes, to provide habitats, to contribute to the welfare of local communities and to generate income from tourism (Dudley and Stolton, 2010). It is important, therefore, to consider not only what locals believe, but also what visitors coming in the area think about a specific landscape as a common approach to improve the local economy, even more so, since the locals may have a limited ability to financially contribute to the improvement of local economic balance.

4.5. Evaluation of the potential support to preserve the conservation of the study area

4.5.1. Willingness to pay to support the conservation of Chimborazo Natural Reserve

Figure 21 shows the results on the ***WTP*** to support the conservation of the ***CNR*** as shares between the two potential responses - yes and no - aggregated for the two groups of tourists taken into study: nationals and foreigners. Roughly half of the respondents (49%) would be willing to allocate a share of their annual income to support the conservation of ***CNR***. Of this share, 38.5% are nationals and 10.6% are foreigners. Based on the responses to the specific items in the questionnaire, the average contribution was estimated at $172.4 per year, based on the average potential contributions of nationals ($160.4) and foreigners ($216.2) respectively (**Figure 22**). Differences

between the potential contributions were probably related to the differences in income and welfare between Ecuadorian and foreign tourists. Regarding the factors that enable the tourists' ***WTP,*** the socio-demographic characteristics are probably related with ***WTP*** responses (García-Llorente et al., 2011). Older tourists might constitute an important source of revenue for biodiversity conservation. Also, highly educated tourists are more likely to commit, because they might be more self-aware of the potential benefits of biodiversity conservation (Stem et al., 2003). Last but not least, tourists' financial self-sufficiency also has a significant impact on the amounts declared as ***WTP*** (Bhandari and Heshmati, 2010).

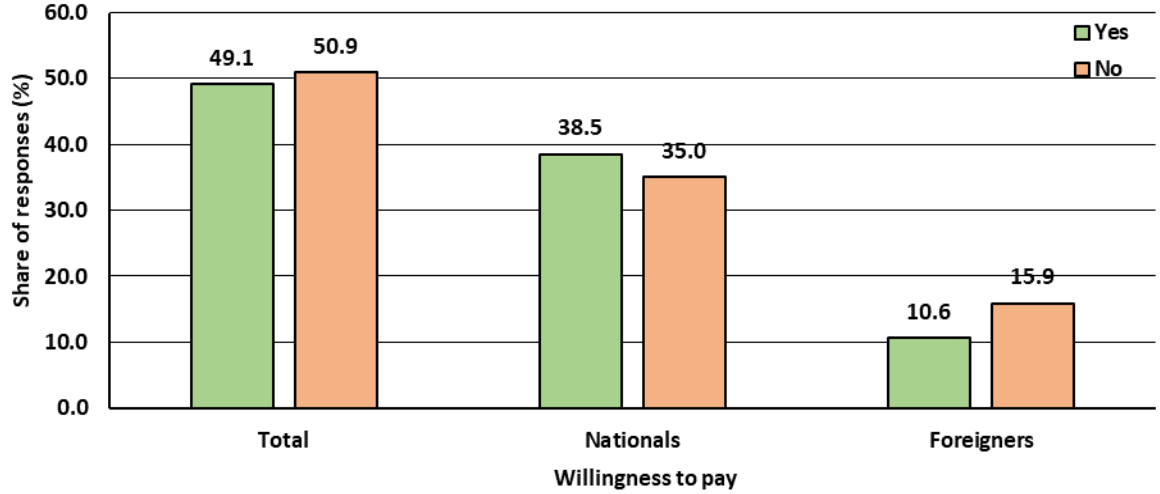


Figure 21. *Willingness to pay for the conservation of Chimborazo Natural Reserve*

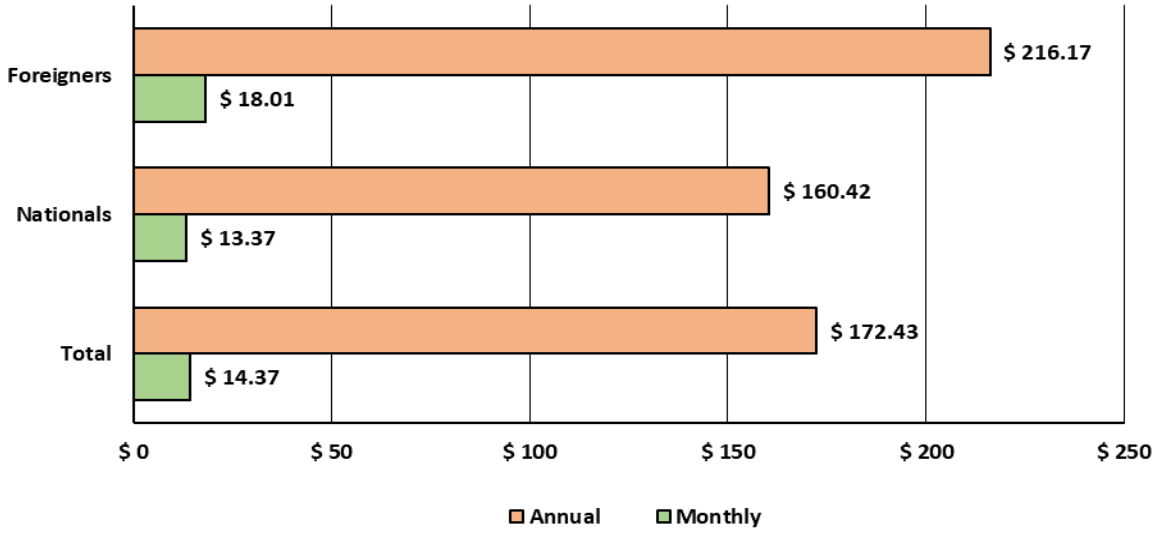


Figure 22. *Potential contributions as average values per year and per month, based on responses of foreign, national and total tourist sample*

At the opposite side, more than half (50.9%) of the interviewed persons have stated that they wouldn't commit themselves to allocate a part of their annual income to support the conservation of ***CNR***; of these, 35% were national tourists and 15.9% were foreigners (**Figure 22**). Worth mentioning here that the economic valuation of ***ES*** does not take into account their intrinsic value, therefore they acquire economic value only in the sense that they contribute to the well-being of humans (Salles, 2011). To this end, **Figure 23** is also showing some of the reasons for which part of the responses wouldn't contribute. Among the main reasons were those they don't have sufficient financial resources to participate (16.5%), they don't trust that their contribution will be wisely used

(7.9%), they are not interested in contributing (7.6%), they think that the support should be given by the State (14.1%), as well as other reasons (4.7%).

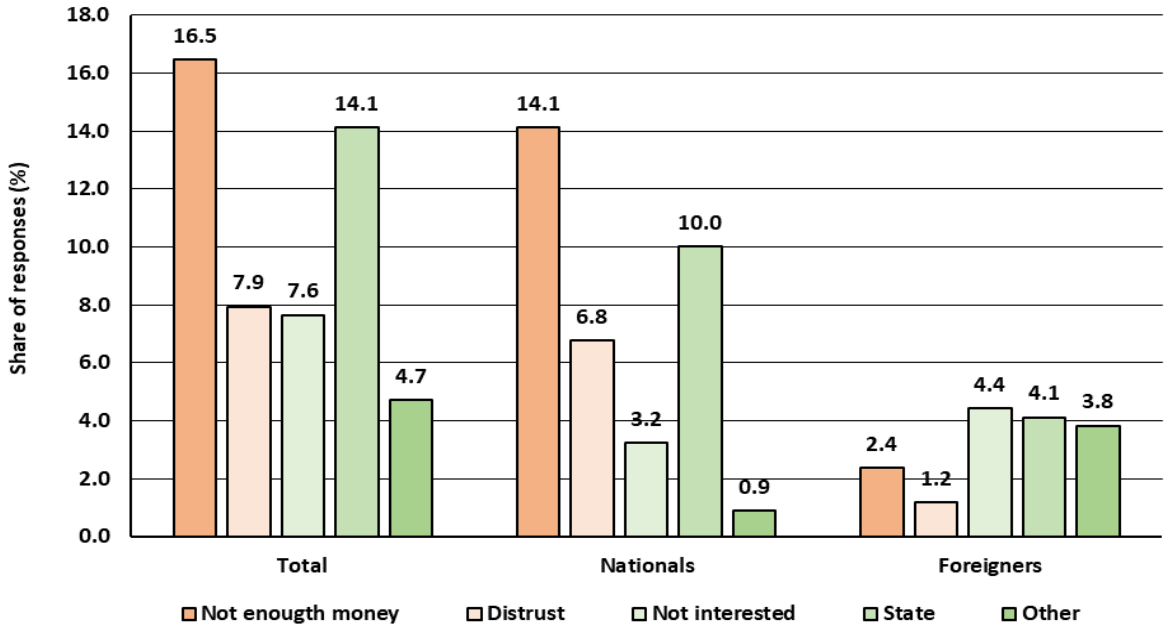


Figure 23. *Reasons provided by the respondents for not willing to pay for conservation*

The first reason may be related to the priorities that people made or make for their budget as well as the availability of money for additional expenses. Stands out, from this point of view, the situation of the national tourists for which the main reason was that of having not enough money, an issue that is difficult to address by any of potential actions that could be undertaken. Distrust and interest, on the other hand, may be addressed in the future by transparent processes and actions undertaken to co-interest people for giving their support. This is even more so important as it could be observed that it is difficult for given individuals to decide on a value they are willing to contribute for something that they do not understand or for which they do not have measurement parameters in the market, which would be in accordance with the criticism that is made to them (Tomio and Ullric, 2015).

Table 11. *Willingness to pay as rates per month and per year and the potential economic value*

Tourist group	Average *WTP* Monthly ($)	Average *WTP* Annualy ($)	Tourists > 18 years old in the *CNR* (2017)	Forecasted number of visitors willing to pay	Potential economic value per month ($)	Potential economic value per year ($)
Nationals	13.4	160.4	92,323	45,331	607,429.95	7,271,027.12
Foreigners	18.0	216.2	18,909	9,284	167,117.74	2,007,269.77
Total	**14.4**	**172.4**	**111,232**	**54,615**	**774,547.69**	**9,278,296.89**

Table 11 is showing the economic value per month and per year that tourists are placing on the conservation of ***CNR***. There are many studies dealing with ***WTP*** in the area of biodiversity and environment (*e.g.* Mathieu et al., 2003; Togridou et al., 2006; Ahmed et al., 2007; Bhandari and Heshmati, 2010; Surendran and Sekar, 2010). Most of them addressed the relation between the socio-economic context and ***WTP***. Some studies revealed connections between the social capital and ***WTP*** (Jones et al., 2009; Jones, 2010; Zhang et al., 2006; Polyzou et al., 2011). In the study of Kamri (2013), was found that there are differences between ***WTP*** declared by visitors as they may be national or foreign. As such, the international visitors were willing to pay RM16.14 which was more than double compared to local visitors - RM 7.38 (Kamri, 2013). In this study, however, the greatest

potential contribution could be that coming from the national tourists (13.4 $) even if the average willingness to pay was significantly lower compared to foreigners (18.0 $). This is due to the number of national tourists which was much greater compared to that of foreigners for the reference year of 2017.

4.5.2. Willingness to pay to support the conservation of *Polylepis* Relict Forest

This study brings evidence on the potential support that national and foreign tourists may give for the conservation of ***Polylepis Relict Forest***. **Figure 24** shows the share of the tourists responding that they know the ***Polylepis Relict Forest***. Almost 11% declared that they have knowledge on the forest. Of this value, 9.8% were nationals and 1.1% were foreigners. Therefore, one good strategy that could contribute to the sustainability of the ***Polylepis Relict Forest*** would be that of taking actions for its promotion since the numbers presented indicate a low knowledge about it. In addition, **Figure 25** is showing the ***WTP*** to support the conservation of the ***Polylepis Relict Forest*** based on the responses of tourists. 70% of the responders would be willing to allocate a part of their annual salary to support the conservation of this landscape feature. Of this percentage, 60% were nationals and 10% were foreigners. The average contribution was estimated at $90.9 per year, based on the values of $84 and $132 declared by nationals and foreigners respectively.

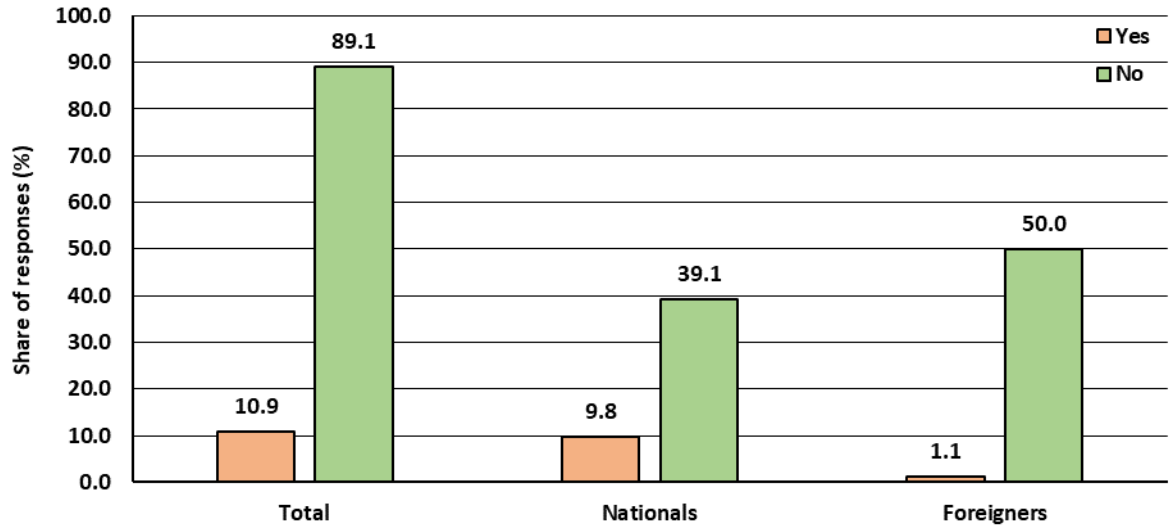


Figure 24. *Share of responders knowing the Polylepis Relict Forest*

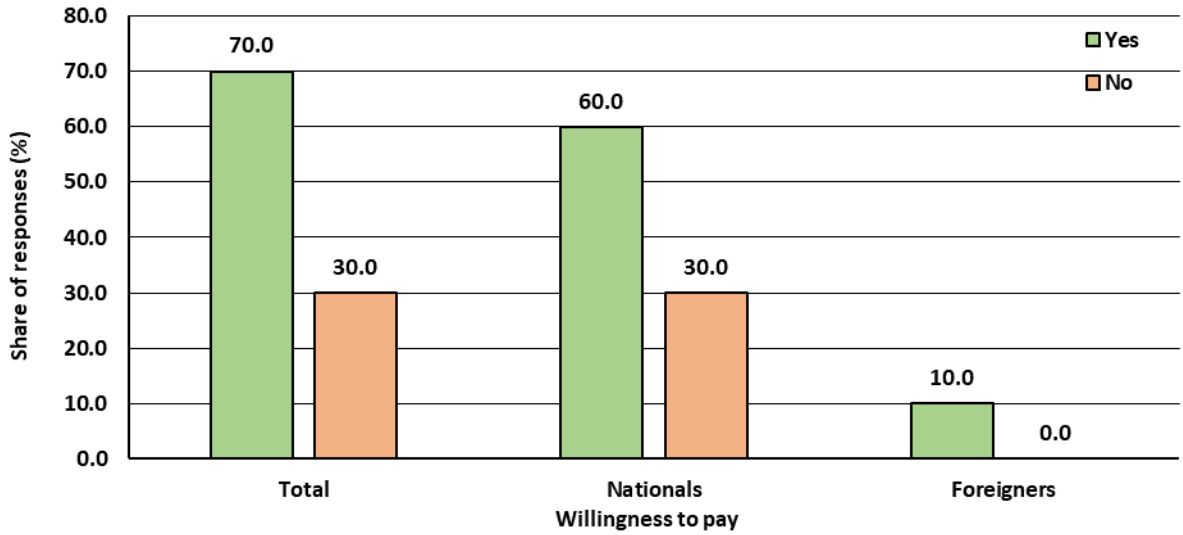


Figure 25. *Willingness to pay for the conservation of the Polylepis Relict Forest*

The rest of 30% of the responders, all of them being national tourists, wouldn't be willing to allocate money to support the conservation of the ***Polylepis Relict Forest*** (**Figure 25**). 10% of the total tourist sample, consisting only from national tourists stated that they don't have enough money to support the conservation of ***Polylepis Relict Forest*** while the rest (20% of the total sample, all of them nationals) think that the support should be given by the state of Ecuador.

Table 12. *Potential economic value per month and per year to support the conservation of Polylepis Relict Forest*

Tourist group	Average *WTP* Monthly ($)	Average *WTP* Annualy ($)	Tourists > 18 years old in the *CNR* (2017)	Forecasted number of visitors willing to pay	Potential economic value per month ($)	Potential economic value per year ($)
Nationals	7.0	84.0	11,012	1,200	8,402.16	100,825.87
Foreigners	11.0	132.0	1,224	134	1,474.00	17,688.00
Total	**7.6**	**90.9**	**12,236**	**1,334**	**9,876.16**	**118,513.87**

Note: * Tourists > 18 years old in the *CNR* that had knowledge on the *Polylepis Relict Forest*

Table 12 is showing the value per month and per year that tourists are placing on the conservation of ***Polylepis Relict Forest***. The greatest potential contribution could be that coming from the national tourists even if the average willingness to pay was significantly lower compared to foreigners. This is due to the number of national tourists which was much greater than that of foreigners for the reference year of 2017. On the other hand, ***WTP*** has often been described as only indicating the maximum payments that people would intend to pay (Kyle et al., 2002). In a study carried out in Georgia in 2009, on the overall, the results have shown that ***WTP*** depended on the income level and loyalty placed on given destination. In this case, the average ***WTP*** amounts were of $11.25 (mean) and $2.10 (median) respectively, resulting into a potential annual value estimated at $11.55 million based on the median ***WTP***, under the assumption that at least 50% of the visitors would pay this amount (Manjumdar et al., 2011). Such a behavior was also observed in this work where the visitors declared various amounts that they would intend to allocate for supporting the ***CNR*** and its features.

4.6. Perception and attitudes towards the main tourist attractions

4.6.1. Perception and attitudes towards the tourist attractions

Financing and paying for biodiversity conservation are among the greatest environmental challenges that humanity faces today (Luque and Venturini, 2006). The Chimborazo Mountain was the tourist attraction that received the highest rating share of those that felt qualified to judge (87.4%), followed by the ***Polylepis Relict Forest*** (23.8%) and by The Chorrera (22.1%). This fact was related, probably, to the fact that most of the respondents knowing these tourist attractions. On the other hand, the attractions that received the lowest share ratings in this regard, therefore the highest ones in relation to not feeling qualified to judge, were the Fortress of the Incas (84.4%), Route of the Ice Markers (83.8%) and the Solitary Tree (83.5%). This outcome was related to the fact that the majority of the tourists haven't visited these attractions before. Nevertheless, the tourists' commitment is affected by some socioeconomic features, perception towards conservation, and the characteristics of their visit (Bhandari and Heshmati, 2010). It is important, however, to mention that the ***Polylepis Relict Forest*** received the second higher share of ratings which may be the effect of its natural value and people attitudes, even if it is not one of the main tourist attractions of the area. Finding funds to manage tourism destinations has been already a big concern as there are required sufficient funds to manage tourist hotspots and to enhance their attractiveness (Bhandari and Heshmati, 2010). By finding other sources of financing such as those coming from tourist activities, the burden of landscape management could be also shared, contributing this way to sustainability.

Figure 26 shows the attractions that should receive funding for conservation according to the participants to this study. The way in which people value nature has become an important source of

information for landscape managers. As such, the later can use such information to identify more easily the needs for protection and the characteristics of target populations (Ban et al., 2013; Klain et al., 2014; Bennett et al., 2017; Loc et al., 2018) based also on tourists' expectations. The main tourist attractions indicated by the respondents that should receive the highest support for conservation (rated by 5) were the Chimborazo Mountain (56.2%) and the ***Polylepis Relict Forest*** (51.9%), followed by the Kunuk Yaku Hot Springs (38.5%), The Chorrera (37.5%), Carihuairazo Mountain (35.2%), Solitary tree (33.9%), Fortress of the Incas (32.1%), Machay Temple (31.7%), Route of the Ice markers (29.1%) and Whymper's Needles (27.4%).

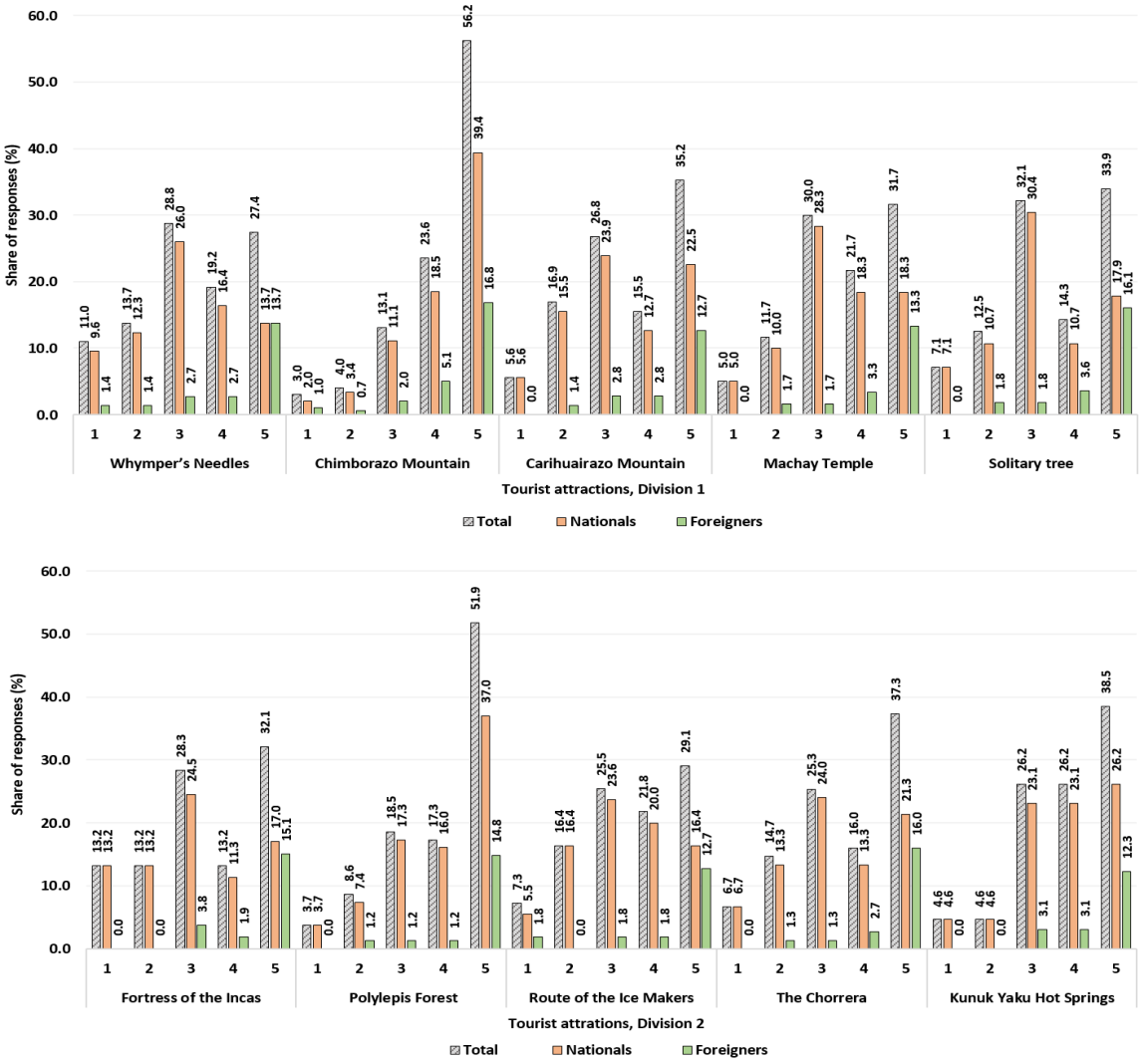
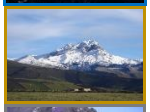
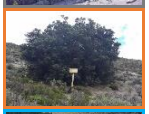
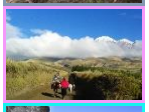


Figure 26. *Attractions that should receive funding for conservation on a scale from 1 to 5. Legend: 1 means "No support at all", 5 means "All the possible support".*

Another mechanism that could be used to enhance the quality of the landscape rests in a wise distribution of funds. For instance, in ***PA*** and in their proximity, local management may hold the right to receive a share from the visitor fees as a payback for preserving the landscape (Milder et al., 2010). Nevertheless, this is not the case of the communities located in the ***CNR***, excepting some cases in which the Environmental Ministry of Ecuador give them some activities or work as tourist guidance. Under the consideration that knowledge and understanding of factors which give positive attitudes towards ***PA*** and conservation is of great help (Karanth and Nepal, 2012) in actually getting support for such endeavors, **Table 13** shows the tourist attractions that should receive funding for conservation in the view of the respondents of this study. In this regard, attitudes might be said to be an enduring predisposition toward places, people and behaviors and also a predisposition to

various forms of behavior resulting from the evaluation of the perceived factual (Gu and Ryan, 2008).

Table 13. *Attractions that should receive funding for conservation and their rating in the view of tourists*

Picture	Name	Number and group of tourists who gave an answer*	Percentage and group of tourists who gave an answer (%)*	Low support (%)	Neutral support (%)	Hight support (%)	Percentage and group of tourists who gave a short answer (%)
	**Whymper's Needles**	T: 54	T: 21.6	5.6	6.0	10.0	6.0
		N: 42	N: 16.8	4.8	5.6	6.4	5.2
		F: 12	F: 4.8	0.4	0.8	3.6	0.8
	**Chimborazo Mountain**	T: 218	T: 87.2	6.0	11.6	**69.6**	34.0
		N: 162	N: 64.8	4.8	9.6	50.4	24.0
		F: 56	F: 22.4	1.6	1.6	19.2	10.0
	**Carihuairazo Mountain**	T: 52	T: 20.8	4.8	5.6	10.4	6.0
		N: 42	N: 16.8	4.4	5.2	7.2	5.6
		F: 10	F: 4.0	0.4	0.4	3.2	0.4
	**Machay Temple**	T: 44	T: 17.6	2.8	5.2	9.6	2.8
		N: 35	N: 14.0	2.8	4.8	6.4	2.4
		F: 9	F: 3.6	0.4	0.4	2.8	0.4
	**Solitary tree**	T: 41	T: 16.4	3.2	5.2	**8.0**	2.8
		N: 31	N: 12.4	2.8	4.8	4.8	2.4
		F: 10	F: 4.0	0.4	0.4	3.2	0.4
	**Fortress of the Incas**	T: 39	T: 15.6	4.0	4.4	**7.2**	1.6
		N: 31	N: 12.4	4.0	4.0	4.4	1.6
		F: 8	F: 3.2	0.0	0.4	2.8	0.0
	***Polylepis* Relict Forest**	T: 60	T: 24.0	2.8	4.8	**16.4**	7.2
		N: 49	N: 19.6	2.8	4.0	12.8	6.0
		F: 11	F: 4.4	0.4	0.4	3.6	1.2
	**Route of the Ice Markers**	T: 40	T: 16.0	4.0	4.0	**8.0**	2.4
		N: 33	N: 13.2	3.2	4.0	6.0	2.4
		F: 7	F: 2.8	0.4	0.4	2.0	0.0
	**The Chorrera**	T: 55	T: 22.0	4.8	5.6	11.6	5.6
		N: 43	N: 17.2	4.4	5.2	7.6	4.4
		F: 12	F: 4.8	0.4	0.4	4.0	1.2
	**Kunuk Yaku Hot Springs**	T: 48	T: 19.2	1.6	5.2	12.4	3.2
		N: 39	N: 15.6	1.6	4.4	9.6	3.2
		F: 9	F: 3.6	0.0	0.8	2.8	0.0

Note: * T: Total, N: Nationals, F: Foreigners

The main tourist attractions that the responders believe that should be supported for conservation were the Chimborazo Mountain (69.6%), followed by the ***Polylepis Relict Forest*** (16.4%), Solitary tree (8.0%), Route of the Ice Markers (8.0%) and Fortress of the Incas (7.2%), at the highest level. In general, people are willing to support the conservation of places that provide high scenic beauty and features of wellness. For instance, study of Walpole and Goodwin (2001), which was based on a questionnaire survey, has revealed the existence of positive attitudes towards tourism as well as a high intention (93.7%) to support conservation, under the recognition that tourism activity depends upon the existence of the protected area under question.

4.6.2. Perception and attitudes towards the *Polylepis* Relict Forest

Figure 27 shows a breakdown on the view of tourists on the financial support that should be given for the conservation of ***Polylepis Relict Forest***. At the sample level (N=250), more than half of them stated that the conservation of the ***Polylepis Relict Forest*** should receive all the support needed. Of these, national tourists represented 37% and the foreigners about 15%. While such a distribution may mean that the ***Polylepis Relict Forest*** stands for one of the local landscape features that should be actively conserved, this outcome should be interpreted with caution since only about 11% of the interviewed tourists actually known the forest.

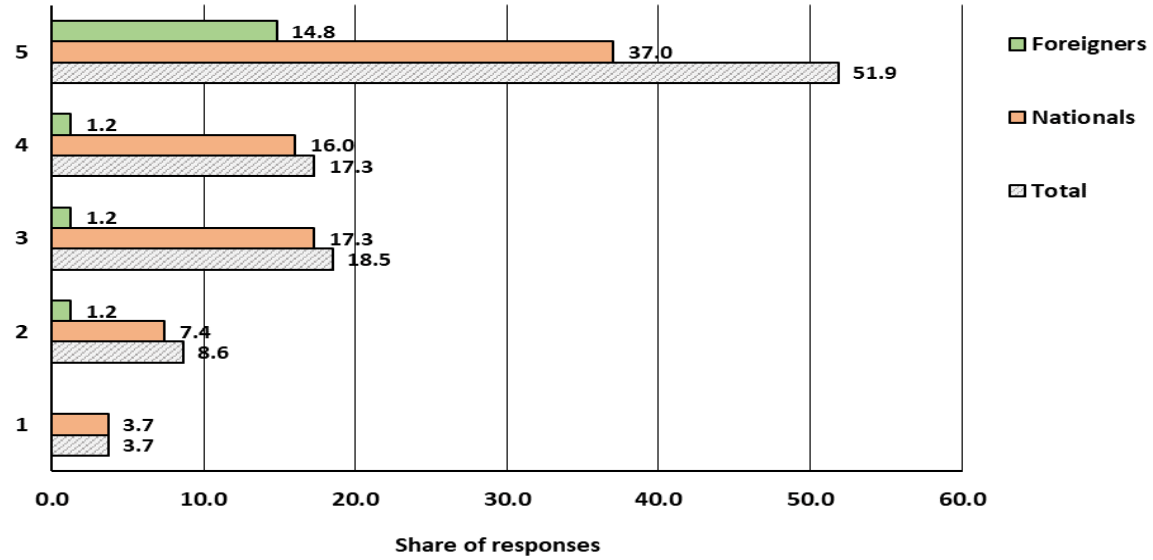


Figure 27. *Share of responses on the financial support for the conservation of Polylepis Relict Forest in the view of tourists. Legend: 1 - "No support at all", 5 - "All the possible support"*

On the other hand, conserving the Andean forests contributes to the improvement of local communities and their way of living (Garnett et al., 2007), while the management for conservation of natural resources needs all possible economic resources to enable a continuous provision of environmental services (Llampallas et al., 2019). At least form these points of view, the attitude of tourists was aligned to the existing knowledge. To what extent funds for conservation will be available from different sources is another thing. Even if many of the respondents believe that the ***Polylepis Relict Forest*** should receive all the possible support for conservation, their availability to pay for that was limited.

4.7. Discussion

The body of knowledge on ecosystem services assessment is very large but there is a general consent that information on ecosystem services is still lacking (*e.g.* Eigenbrod et al., 2009; MEE, 2014). While there is a good progress in the identification and assessment of ***CES***, a number of questions still remain open for investigation (Zoderer et al., 2016). This situation is hindering the attempt to scale the results, and probably distorts the image of full range of ***ES*** in given areas (*i.e.* Eastwood et al., 2016). In particular, data on cultural ecosystem services is scarce while the assessments should take into consideration the local culture and believes. That is, one cannot generalize the results provided by assessments in some areas to all the landscapes and cultures. While the protected areas are assumed to provide more cultural ecosystem services compared to managed land (Eastwood et al., 2016), in given regions there is a tendency to prefer provisioning services (He et al., 2018). In some regions the locals place similar values on both, provisioning and ***CES*** (Garrido et al., 2017), while in other regions ***CES*** such as recreation may be underrepresented (Anderson et al., 2009; Eigenbrod et al., 2009). In relation to these findings, this work showed that communities located near ***CNR*** think quite highly of cultural ecosystem services. However, proximity

to a given landscape seemed to affect both, preferences and perception on the capacity of landscapes to provide ***CES***, which is readily a known social behavior (He et al., 2018).

In addition, ecosystem services evaluation by integration of all the landscapes and ecosystems from a territory is important, as such an approach enables the placement of a correct value on each of the landscape/territory's features. Also, in tourist areas, is crucially important to account for all the stakeholders frequenting them, including here the administration representatives, local communities and incomers in the area. Using this kind of integrative research approach is one of the merits of this work in the general ecosystem services body of knowledge. That's because, the body of knowledge still lacks spatially-explicit studies and therefore, there is still room for improvement in knowledge about how landscapes, their features and the ecosystem properties may shape the people's perception, including the outcomes of ***ES*** valuation (López-Santiago et al., 2014, Scholte et al., 2015). Moreover, the problem of providing measures of ***CES*** in relation to specific ecosystems and regions still needs extensive research (Norton et al., 2012). Protected areas are described as places holding a higher capacity to deliver regulating and cultural services (García-Nieto et al., 2015); also, there is evidence in some areas, that humans actually prefer provisioning services, followed by regulating and cultural services (*e.g.* Hartter, 2010; Agbenyega et al., 2009). In relation to the above-mentioned, this work showed that tourists that arrived at ***CNR*** are using and aware of the potential of local cultural ecosystem services. Nevertheless, proximity is known to play an important role in the view that people make of landscape services (Fagerholm et al., 2012).

In the case of local communities of ***CNR***, perception on the landscapes' capacity to provide recreation services was affected by the gender, occupation and income level. Male respondents placed more value on the recreation services a fact that is probably related to the local family-related habits according to which females are assuming a strong role in housekeeping while males are undertaking jobs that are related to landscape use (Rodríguez et al., 2018). A greater perceived capacity given by those working in tourism, could be interpreted as one of the limitations of this study design. Nevertheless, the subsample containing the respondents working in tourism was very low (2% of the total number of respondents). Another key behavior of the communities taken into study was their value placement on iconic landscapes and their dominant features. As an example, many of the locals still believe that Chimborazo Mountain is a God, and many of the locals still use to give offerings for the mountain in the tourist attraction known as Machay Temple. Therefore, it was not surprising to find that respondents placed most of the value on the Chimborazo Mountain. In fact, people, including those from completely different regions and cultures, still tend to place value on rather mythical or religious connotated values of the landscapes (Irvine and Herret, 2018).

Perception on the landscapes' capacity to provide recreation services was affected by occupation, inspiration for creative work was affected by age, capacity to provide education and science services was affected by gender and level of education while the capacity to provide spiritual experiences was affected by gender. These findings are congruent with those coming from other studies. For instance, under a statistical approach, the individual respondents are known to perceive ***CES*** differently under the effect of certain social and demographic features. These include the culture, gender, age, living place, education, engagement in environmental issues, perception on the importance of ***CES***, and experience in relation to landscape (Zoderer et al., 2016). Female respondents placed more value on the education and science a fact that is probably the effect of women differing from men in seeing a higher cultural potential in ecosystems while men tend to see other potentials in forests (Affek and Kowalska, 2017). A greater perceived capacity of the local landscapes to provide recreation services was given by those respondents which were retired at the study time. However, the subsample containing the respondents from this category was very low (0.4% of the total number of respondents). Another key behavior of the tourists taken into study was their value placement on iconic landscapes and their dominant features. As an example, many of the national and foreign tourists still believe that Chimborazo Mountain is the highest point to the Sun measured from the center of the Earth. Therefore, tourist respondents placed most of the value on

the Chimborazo Mountain, for which they tend to value aesthetics and the recreation opportunities (*e.g.* Zoderer et al., 2016).

Another potential limitation of this work was that related to the practical impossibility to design the study to an extent able to clearly delimitate the perception of respondents in relation to particular spots compared to their encompassing landscapes. To balance the perceptual constructs of respondents, they were informed on the meaning of each evaluated feature prior to the response giving phase. To this end, the possibility to proactively inform and give advices on the interpretation of items is one of the advantages of door-to-door "in-person" surveys. In addition, the statistical design of this work tried to balance the shortcomings of using non-parametric statistical descriptors such as the median values which, in given cases, stand for the middle values of a data set, therefore they are characterized by a less powerful outcome when describing the data. The rationale behind this uncommon approach was given in the materials and methods section.

Andean forests are ecosystems considered to be crucial for conservation due to their fragility and importance in the generation of ***ES***. As a proposal for environmental economics, there are methods of economic valuation in the search for instruments that contribute to conservation based on total economic value, whether for direct, indirect, inheritance, option, existence and passive use (Heal et al., 2005; Costanza et al., 1997). Nevertheless, it should be noted that ecosystems have intrinsic values that cannot be captured in monetary amounts. However, the identification and assignment of value to the flow of ecosystem services is an efficient measure that allows quantifying their values in monetary units. Such outcomes are useful for decision makers to integrate conservation policies that quantify what the monetary losses from over-exploitation and bad management of ecosystems would be (Nunes and van den Bergh, 2001). As such, this work brings documented evidence about ***WTP*** for conservation the ***CNR*** and ***Polylepis Relict Forest.*** It also shows that tourists could commit themselves to pay 13.4 dollars (USD) and 7.6 dollars (USD) per month for ***CNR*** and ***Polylepis Relict Forest*** respectively. These results are comparable with those produced by other studies. For instance, study of Baral et al. (2008) has shown that people could be willing to pay in addition to entry fees. While the ***WTP*** has often been seen as a measure to indicate the maximum amount that people intend to contribute (Kyle et al., 2002), it is still a measure of intention and not of actual payment a reason for which a more active involvement could be expected from the state and from the local communities that may have roles in the sustainable management of Andean forests (Kómetter, 2015). Nevertheless, the social, political and economic contexts of local communities of ***CNR*** are different as they are involving themselves in the conservation, but they have no benefits for their involvement.

Polylepis Relict Forest, on the other hand, has been found to be also important for the tourists in respect to its conservation. For this fact, the government of Ecuador needs to design rules and incentives for its conservation and to involve communities as well, due to the cultural importance of the area which has the capacity to attract a large number of visitors. Involvement of local communities, and especially of those located in the rural Andean landscapes, that depend on the Andean forests for their survival, could be a good option, as they know and practice activities that are synergic with the conservation and the maintenance of forest functions (Salvatierra and Mogrovejo, 2017). Nevertheless, an administrative intervention is essential to guarantee the protection of these resources in the case the tourist attractions.

In terms of policy, and since the management of ***CNR*** provides a structured framework on the related scientific research, recreation, tourism and conservation of cultural and ethnic values (MEE, 2014), it is likely and probable that the enjoyment of ***CES*** will not be hindered by other human activities. Still, some measures such as a more adapted stewardship to increase the accessibility of the attractions for the tourists that could further support the conservation of the area, promotion and development of sustainable tourism with responsible practices by implementing the criteria and guidelines of the ***CNR*** management plan, could be taken to improve the situation in the area. In this direction, it has been found that users of recreational activities may bring significant contributions

towards a sustainable management of ***ES***, monitoring of ecosystems, as well as for raising awareness for sustainability (Conrad and Hilchey, 2011).

To conclude, the main merits of this study are related also to an exhaustive evaluation of many cultural ecosystem services, an approach that places this work among few attempts existing in the Latin America. The results may support many strategies related to the measures to be undertaken for improvement as they may serve as a background for such improvements.

CHAPTER 5. CONCLUSIONS, ORIGINAL CONTRIBUTIONS, RESEARCH ROADMAP AND DISSEMINATION OF RESULTS

5.1. Conclusions

In view of the proposed objectives, the following statements are briefly outlining the conclusions on the obtained results and their interpretation in a systematized approach, on subchapters. Thus, the following may be outlined:

i.) Regarding the frequency of cultural ecosystem services use in the Chimborazo Natural Reserve:

a.) 27 cultural ecosystems services were identified in the ***CNR***, which were also considered to be important for an appropriate local valuation and decision-making. While this extensive list of ***CES*** seemed to be appropriate for carrying on the field research, the results have indicated that many of the ***CES*** included were either not known or used by the respondents belonging to the two groups taken into study: local communities and tourists;

b.) Based on the reported results, the locals enjoy recreation services in most of the tourist attractions, with their opinions probably being influenced by the ancestral beliefs and their proximity to such places. In the case of national and foreign tourists, they also enjoy and value recreation services mainly in the Chimborazo Mountain, with their opinions being affected by their substantial knowledge of this tourist attraction compared to the rest. Besides documenting such trends, the results of this study may help generate proposals for improving the environmental management of ***CNR*** to increase the added value of tourist attractions;

c.) This study brings evidence on the locals' and tourists' use of the ***CES*** in the ***Polylepis Relict Forest*** of ***CNR***. The locals enjoy and value the recreational services, with their opinions being related to the only benefit obtained by the locals of the forest, which is the use of this site to provide tourist guiding service to domestic and foreign tourists. National tourists, on the other hand, have very little knowledge on the forest and almost all the foreign tourists had no such knowledge. While for the moment these trends may not help in the attempt to support the conservation of ***Polylepis Relict Forest***, the results may open new doors for designing appropriate touristic products that in turn may enable such attempts.

ii.) Regarding the perceptions on the capacity to provide cultural ecosystem services by tourist attractions of the Chimborazo Natural Reserve:

a.) This study brings evidence on the people view on the capacity of local landscapes and ecosystems to provide ***CES*** among the Andean communities and tourists frequenting the ***CNR***. The Chimborazo Mountain was perceived to be the place able to provide ***CES*** to the greatest extent by the local communities and the tourists of the ***CNR***, and dominated the results by the greatest perceived capacity to provide ***CES***, as evaluated by respondents. Besides documenting such trends, the results of this study may help in generating and implementing conservation strategies for the attractions of the ***CNR***, enabling this way an increment in their capacity to sustain and generate more ***CES***;

b.) Opinions and beliefs on the capacity of analyzed tourist attractions to provide ***CES*** were, on the other hand, influenced by personal mind constructs, knowledge on the places and, probably, proximity. Therefore, developing knowledge among locals and especially among tourist cohorts, may improve the outcomes in relation to other tourist attractions than the Chimborazo Mountain which, for the moment, is well known. For such an attempt, the results of this work may be of crucial importance as they are mapping preferences, frequency of use and, more importantly, the perceived capacity to provide ***CES*** which, in turn, may affect the people willingness to visit such places based on personal beliefs and opinions;

c.) Factors that have acted as modifiers of perception on the capacity to provide ***CES*** were heterogeneous in and between groups in relation to tourist attractions and groups of ***CES*** taken into study. Gender, occupation and level of income were factors that affected the perception on capacity to provide in the case of locals and occupation, age, gender, level of education in the case of tourists. While these are purely theoretical and based on the samples taken into study, they are also profiling the socio-demographic features of people, enabling knowledge on whom of these people could be approached by marketing products to enhance a better frequentation and contribution to the conservation of ***CNR***;

d.) This study also brings evidence on the perception on the capacity of ***Polylepis Relict Forest*** to provide ***CES***. Locals do not believe that the forest has a high capacity to provide ***CES***, excepting for those related to recreation; the opinions on the subject were probably influenced, even if the study design tried to avoid it, by other activities that are carried out in relation to the tourism in the area. In the view of national tourists, the ***Polylepis Relict Forest*** has very little capacity to provide ***CES***, and in the view of foreign tourists the capacity to provide ***CES*** was almost null, facts that are probably linked to the level of knowledge on the forest, as specific to the respondents. Besides documenting such trends, the results of this work may help in designing and implementing initiatives that aim to increase the recreational, cultural, and scientific value of the forest.

iii.) Regarding the willingness to pay for the conservation of Chimborazo Natural Reserve:

a.) This study brings evidence on the potential amounts as ***WTP*** of national and foreign tourists for the conservation of the ***CNR***. Tourists, in general, were committed to contribute financially for conservations of ***CNR*** but factors such as availability of funds, trust and transparency need to be addressed in the future to enhance a wider financial participation, even if potential for the time being. Foreign tourists were willing to contribute, on average, more than nationals, a fact that may be associated to their level of income. Nevertheless, the share that foreign tourists may bring for this attempt was estimated to be less than that which could be brought by nationals, a fact that is related to the numbers of visitors from the two groups. Documenting such trends, even if theoretical until the proof of amounts, may help direct further research on the topic as well as guiding the approaches to be undertaken in the future for an improvement of the economic balance of ***CNR***;

b.) This study brings evidence on the ***WTP*** of national and foreign tourists for the conservation of the ***Polylepis Relict Forest*** of the ***CNR***. Most of the tourists were not willing to provide a share of their income for the conservation of the forest, a fact which is, most probably, the effect of the lack of knowledge on the benefits provided by this forest. This situation brings new opportunities for improvement and indicates that urgent measures should be undertaken to properly promote the forest and its values among visitors at least by designing, in a first step, promotion materials showing meaningfully the functions and role it provides.

iv.) Regarding the evaluation of perceptions and attitudes towards the support that should be given for conservation of the Chimborazo Natural Reserve:

a.) This study brings evidence on the potential support of national and foreign tourists for the conservation of main touristic attractions in ***CNR.*** The tourists, in general, were committed to financially contribute in addition for the conservation of these attractions. Among the 10 selected tourist attractions, Chimborazo Mountain dominated the preferences related to the support for its conservation, as evaluated by respondents. Since this work documented the potential support for all of the tourist hotspots taken into study, the results are of a great importance in knowing what should be improved to raise additional support for other tourist attractions which were rated lower;

b.) This study also brings evidence on the support of national and foreign tourists for the conservation of ***Polylepis Relict Forest***. The tourists, in general, were found to be committed to contribute financially for the conservation of the forest, a result that came as a surprise given the low ratings received by this landscape feature in the use and perception evaluation exercises. From this point of view, it seems that people do not actually need to see something to commit themselves in supporting activities, a behavior that is somehow known at least from informal sources - people generally feel that it is their civil duty to protect forests.

5.2. Original contributions

This research complements the knowledge at the international level and also for the South American conditions and for Ecuador. This is due to a relatively small number of studies on the subject addressed. In particular, there are few scientific studies framed around the evaluation and valuation of ***CES*** in Ecuador and, typically, the area of study - Chimborazo Natural Reserve - lacks such studies. The results given herein allowed to identify, evaluate and theoretically valuate the ***CES*** flow of the Chimborazo Natural Reserve, through the frequency of use and the perception of the direct beneficiaries (local inhabitants and tourists) on the capacity of ***CNR*** to provide ***CES***. A particular attention was given to the ***Polylepis Relict Forest*** that is currently in a threatened condition in the research area.

The main personal contributions brought through the research underlying this work are the following:

i.) The analyzed ecosystems and tourist attractions, especially those where the Chimborazo Mountain is located, have a high degree of representativeness at the level of Ecuador and probably of the world, therefore, by addressing them and by bringing light on their value constitutes an important contribution;

ii.) The frequency of use by the locals and tourists in relation to the tourist attractions and their associated ***CES*** within the ***CNR*** has been studied for the first time at national and international level. In this regard, it was emphasized the role of iconic landscapes on the frequency of use of ***CES***, both, at the local communities as well as at the tourist cohorts' levels;

iii.)Dominance in knowledge and perceptions on the capacity to provide ***CES*** was found to be the same with regard to iconic landscapes. This stands for an important contribution because, on the one hand, it may characterize very well what types of landscapes will be frequented, as well as the support that could be attracted for their conservation and, on the other hand, it may support development of products targeting knowledge development on those landscape lacking tourists;

iv.)The study included daily field work for 3 months with all the communities surrounding the tourist attractions studied, which represents a high degree of importance and representativeness for the province of Chimborazo, and Ecuador in general;

v.) The research was also carried out by a careful verification and cross-validation of the field data, in particular the sociodemographic one, to be able to compare with the data recorded by the Chimborazo Department of Environment; this allowed to have a broader look at the profile of tourists entering the ***CNR***;

vi.)The research includes the first attempts to estimate a theoretical economic value of the ***CNR***, from the conservation point of view, in order to maintain a good state of ***CES*** provided by ***CNR***. Even if the amounts are purely potential at this point, they indicate a trend that could be developed in the future. By doing so, the results would help boosting the local economy;

vii.) The research also allowed, at a general level, identifying the tourist attractions of the ***CNR*** that are most valued by locals and tourists. As these reach an international cohort of visitors, the results are important to establish priorities and undertake actions;

viii.) As the centerpiece of this research was the ***Polylepis Relict Forest***, the approach designed to undertake the study was innovative in the sense that this feature was placed in the general landscape to be able to see what is its real value in terms of frequency of use, capacity to provide and financial support that could be raised to conserve it. In particular, this research proves that the locals use more the ***Polylepis Relict Forest*** than national tourists, while the national tourists are using it more than foreign tourists; this stands for an important contribution because, these results were compared with the data recorded by the Chimborazo Department of Environment, enabling a broader look at the profile of locals and tourists entering the forest. Furthermore, the study proved that gender, occupation and level of income were the factors that affected the perception on the capacity to provide ***CES*** in the case of locals while the gender, age, level of education and occupation were the perception modifying factors specific to the tourists, data that, along with the attitudes towards the forest, may help in establishing priorities and undertaking actions to conserve it.

5.3. Future research roadmap

The results of this study highlight that the ***CNR*** offers several ***CES*** that are particularly associated with recreation, inspiration for creative work, education, study and spiritual experience. Given the great diversity of ecosystems, tourist attractions and cultural ecosystem services that this Andean landscape holds, it would be useful to expand research in relation to the evaluation and assessment of the other types of ***ES*** of the ***CNR*** such as those of regulation and provision. Such an endeavor would help in meeting the demands of scientific information needed for decision-making on the importance of conserving these types of ecosystems. The methodology used in this work, and also some of the results, could be very useful for research aimed at determining the importance of payment for environmental services provided by ***CNR***. Once the economic value for supporting the conservation of the ***CNR*** was estimated, the next step would be to shape relevant products for knowledge enhancing of the landscape, followed by a science-supported payment scheme, that should enable the proper state of the goods and services of these Andean ecosystems. A practical and scientific importance would also be that related to the description of how the capacity of tourist attractions to provide ***CES*** influences decision-making by the conservation control agencies of these sites. This research could be quantified in economic terms and could be used to promote the attractions of the ***CNR*** by environmental education of communities and visitors, to generate sound actions to protect this type of resources for future generations.

5.4. Dissemination of results

5.4.1. Results produced within the frame of the PhD thesis

A. Papers published in BDI journals

1. **Castillo, D.D.**, Carrasco, J.C., Quevedo, L., Ricaurte, C., Gavilanes, A., Borz, S.A., 2017. Diversity, composition and structure of Andean high forest in Ecuador, South America. Bulletin of the Transilvania University of Brasov. Series II. Forestry, Wood Industry, Agricultural Food Engineering, 10 (2): 1-16.

2. **Castillo, D.D.**, Jara, C.A., Ricaurte, C.B., Vaca, B.E., Quevedo, L.A., 2018. Photosynthetic activity, canopy height model determined by UAV RGB and IR close-range remote-sensing in the high Andean *Polylepis* relict forest, Ecuador. Bulletin of the Transilvania University of Brasov. Series II. Forestry, Wood Industry, Agricultural Food Engineering, 11 (1): 1-16.

B. Papers published in journals indexed by Clarivate Analytics (former ISI Web of Science)

1. **Castillo, D.D.**, Gavilanes, A.V, Ricaurte, C.B., Chávez, C.R., Marcu, M.V., Borz, S.A., 2019. Perception and use of cultural ecosystem services among the Andean communities of Chimborazo

Reserve. Environmental Engineering and Management Journal, 18 (12): 2705-2718. **Journal classified in quartile 3 (Q3) by Web of Science.**

5.4.2. Results produced by participation in research teams external to the PhD thesis scope

A. Papers published in BDI journals

1. Salas, D.B., Gavilanes, A.V., Araús, A.B., **Castillo, D.D.**, Borz, S.A., 2017. Determination of ecological indexes to support the conservation of forest species in "Jacarón" natural forest. Revista Pădurilor, 132 (3): 3-12.

2. Gavilanes, A.V., **Castillo, D.D.**, Ricaurte, C.B., Marcu, M.V., 2019. Known and newly documented uses of 540 rainforest plant species in the Pastaza Region, Ecuador. Bulletin of the Transilvania University of Brasov. Series II. Forestry, Wood Industry, Agricultural Food Engineering, 12 (1): 35-42.

3. Gavilanes, A.V., **Castillo, D.D.**, Morocho, J.M., Marcu, M.V., Borz, S.A., 2019. Importance and use of ecosystem services provided by the Amazonian landscapes in Ecuador - evaluation and spatial scaling to a representative area. Bulletin of the Transilvania University of Brasov. Series II. Forestry, Wood Industry, Agricultural Food Engineering, 12 (61): 1-26.

B. Papers published in journals indexed by Clarivate Analytics (former ISI Web of Science)

1. Borz, S.A., Talagai, N., Cheţa, M., Gavilanes, A.V., **Castillo, D.D.**, 2018. Automating data collection in motor-manual time and motion studies implemented in a willow short rotation coppice. BioResources, 13 (2): 3236-3249. **Journal classified in quartile 1 (Q1).**

2. Borz, S.A., Talagai, N., Cheţa, M., Chiriloiu, D., Gavilanes, A.V., **Castillo, D.D.**, Marcu, M.V., 2019. Physical strain, exposure to noise and postural assessment in motor-manual felling of willow short rotation coppice: Results of a preliminary study. Croatian Journal of Forest Engineering, 40 (2): 377-388.

C. Papers presented at international conferences and symposiums

1. Talagai, N., Cheţa, M., Gavilanes, A., **Castillo, D.D**., Borz, S.A., 2019. Predicting time consumption of chipping tasks in a willow short rotation coppice from Global Positioning System and acceleration data. In: Proceedings of the Biennial International Symposium "Forest and Sustainable Development" 8th Edition, Brasov 25-27 October 2018, 1-12.

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Abstract

The research carried out in this doctoral thesis aimed to quantify the frequency of use and the perceived capacity to provide ***cultural ecosystem services*** (***CES***) of the ***Chimborazo Natural Reserve*** (***CNR***), Ecuador, in the view of visitors and local communities, with a special emphasis on the ***Polylepis Relict Forest*** (***PRF***) present in the area; based on these assessments, an additional attention was given to the evaluation of the willingness to pay for conservation of ***CES***. All these steps were carried out through a questionnaire survey. Based on the reported results, the locals enjoy recreation services in most of the tourist attractions. National and foreign tourists also enjoy and value recreation services mainly in the Chimborazo Mountain. Among the 10 selected tourist attractions, Chimborazo Mountain dominated the results by the greatest perceived capacity to provide ***CES***, as evaluated by respondents. Factors that have acted as modifiers of perception on the capacity to provide ***CES*** were heterogeneous both, in and between groups, in relation to tourist attractions and groups of ***CES*** taken into study. Gender, occupation and level of income were factors that affected the perception on capacity to provide in the case of locals while such factors were the occupation, age, gender and level of education in the case of tourists. Tourists, in general, are willing to contribute financially to the conservation of the ***CNR*** but factors such as the availability of funds, trust and transparency need to be addressed in the future to enhance a wider financial participation. Among the 10 selected tourist attractions, Chimborazo Mountain dominated the preferences related to the additional support for its conservation, being closely followed in preferences by the ***PRF***. These results place this research among the few ones existing in an important area of science; they could serve as a basis for quantification in economic terms and could be used to promote the attractions of the ***CNR*** by environmental education of communities and visitors, to generate sound actions able to protect this type of resources for future generations.

Scurt rezumat

Cercetările realizate în cadrul acestei teze de doctorat au vizat cuantificarea frecvenței de utilizare şi a percepției asupra capacității peisajului local al ***Rezervației Naturale Chimborazo*** (***CNR***), Ecuador de a furniza ***servicii ecosistemice culturale*** (***CES***) în viziunea turiştilor şi a comunităților locale, prin luarea în considerare, în mod particular, a ***Pădurii Relict de Polylepis*** (***PRP***), prezentă în zona aleasă pentru cercetare; pe baza evaluărilor realizate, o atenție deosebită a fost acordată evaluării angajării informale a respondenților în realizarea de plăţi voluntare pentru conservarea ***CES*** oferite de zona de studiu. Toți acești pași au fost implementați prin interviuri bazate pe chestionare. Pe baza rezultatelor obținute, s-a constatat că localnicii apreciază serviciile din categoria celor de recreare în marea majoritate a atracțiilor turistice din zonă. Turiştii naționali şi cei străini apreciază serviciile de recreare asociate cu Muntele Chimborazo. În cadrul celor 10 atracții turistice luate în studiu, Muntele Chimborazo a dominat în rezultatele obținute prin cea mai mare capacitate percepută de a furniza ***CES***. Factorii care au acționat drept modificatori ai percepției asupra capacității de a furniza ***CES*** au fost eterogeni, fiind relaționați cu atracțiile turistice şi cu categoriile de servicii ecosistemice culturale luate în studiu. Sexul, ocupația şi nivelul veniturilor au fost factorii care au influențat percepția asupra capacității de a furniza în cazul eșantionului reprezentând comunitățile locale, în timp ce factori precum ocupația, vârsta, sexul şi nivelul de educație au acționat ca modificatori ai percepției în cazul eșantioanelor de turişti. În general, turiştii s-au arătat interesați să contribuie din punct de vedere financiar pentru conservarea rezervației dar, factori precum disponibilitatea fondurilor, nivelul de încredere şi transparența trebuie să fie analizați în viitor pentru a favoriza o contribuție financiară mai amplă. Dintre cele 10 atracții turistice luate în studiu, Muntele Chimborazo a dominat preferințele relaţionate cu potențialul suport financiar adițional pentru conservare, fiind urmat îndeaproape, în preferințe, de ***PRF***. Rezultatele prezentate reprezintă primele încercări locale într-o importantă arie ştiinţifică; ele furnizează o bază de plecare pentru cuantificări economice şi ar putea fi utilizate în promovarea atracțiilor turistice ale ***CNR*** prin educarea comunităților locale şi a vizitatorilor, pentru a favoriza, în general, implementarea de acțiuni sustenabile pentru protejarea resurselor locale şi pentru conservarea lor pentru generațiile viitoare.