UNIVERSITÄT BAYREUTH

Social valuation of ecosystem services provided by the Mariño watershed, Apurimac, Peru

M.Sc Thesis

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Declaration of originality

Hereby, I declare that this Master thesis was written by me and that I did not use any other sources and means than specified. This Master thesis was not submitted at any other university for acquiring an academic degree.

19.7.19, Bayreuth 

Date , location, signature

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I dedicate this research work to my beloved country, Peru.

TABLE OF CONTENTS

LISTS OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ANFOR	Andean Forest Program (Program by the HELVETAS Swiss Inter-Cooperation)
ES	Ecosystem Services
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
LDC	Least Developed Countries
m.a.s.l.	meters above sea level
MMR	mixed methods research
NCP	Nature's contribution to people
NMV	Non-monetary valuation
PES	Payment for ecosystem services
SES	Socio-Ecological System
SVI	Social Value Index
TEEB	The Economics of Ecosystems and Biodiversity
WSM	Weighted Sum Model

Terms interchangeably used in the study

- Social value, intangible value, non-use value, relational value, non-monetary value.
- Economic value, tangible value, use-value, instrumental value, monetary value.
- Interviewees, locals, rural residents, community residents
- Quechua-speaker, Quechua people
- Valuation exercise, ranking exercise
- Social valuation, social value assessment, alternative valuation, non-monetary valuation
- Social Value Index, Social Value Score
- Social predilection, social preference, relative importance, subjective importance

ABSTRACT

Economic assessments of ecosystem services (ES) have traditionally monetized environmental contributions to human-well being, neglecting however, multiple, incommensurable and intangible values people ascribe to nature.

The Mariño river watershed located in Apurimac, Peru, is a complex socio-ecological system and study site, where relict Andean ecosystems provide ES vital to upstream rural and downstream urban users. Current anthropogenic ecosystem degradation and climate change effects have awoken local interest for ES conservation strategies in the watershed. Strategies have prioritized environmental concerns of urban residents over rural residents. The latter ones, located in the upper watershed, play a key role in the management of relict ecosystems and are highly dependent on their maintenance, given their subsistence livelihoods.

The monetary poverty in the rural communities and the need to make their environmental values and concerns visible to urban-based decision-making configure an ideal context to perform a non-monetary *social valuation of ES*. The aim of this study is to identify the most important ES and threats according to rural residents, using novel survey methods for the Quechua-speaking context. Elicited social values (relative importance) show *water provision, water cycle regulation* and *intergenerational value of nature* are the most important ES according to 65 %, 31 % and 24 % of interviewees, respectively. *Bush fires* moreover receive the highest social concern, according to 31 % of the participants. Reported limitations of methodological instruments when surveying Quechua-speakers expose the constant epistemological clash it implies to articulate Andean views about nature with valuation tools rooted in Western ES science.

This *exploratory-descriptive* social valuation study provides first insights into transdisciplinary ES research in the Andean context as well as leverages local values in contexts of historical social marginalization. Future research shall venture into dialogue across western and Andean systems of knowledge.

Key words

Ecosystem services, non-monetary valuation, local knowledge systems, natural capital, participatory methods

1 INTRODUCTION

Ecosystem services (ES) or the benefits people derive from nature are a concept traditionally used in assessments to value nature's goods and services to humanity. Valuing nature has become in recent decades an important endeavour to raise civil society awareness and political interest towards the anthropogenic impact on the natural capital.

ES assessments popularized since the Millennium Ecosystem Assessment 2005 have been largely influenced by economic thinking and have sought to monetize ecosystem's contributions to human well-being. Monetary valuations have accomplished to make clear that the choice of *"the environment versus the economy"* is a false dichotomy, given the major contribution that the natural capital provides to human economy (**COSTANZA ET AL., 2014**). Although monetary value is useful to policy makers in assessing the quantitative worth of ES, it has, however, failed at articulating non-monetary, multiple or intangible values of nature's contributions to society, such as intrinsic, ecological, social and cultural values that people ascribe to nature.

Conceptualization and methodology of monetary approaches to ES face further critical challenges when scaled down to socio-cultural contexts outside the Western and scientific worldviews. For instance, monetary approaches fail when applied to poverty and illiteracy contexts in developing countries, where inhabitants, little familiar with the concept of money, are unable to express worth of surrounding ecosystems in monetary terms. Here, alternative measures of value are required. Moreover, societies holding traditional ecological knowledge are a challenge to monetary approaches, as local environmental or spiritual values cannot be translated to financial terms.

Constraints to monetary approaches are not the only ones being widely recognised in the academia. Epistemological constraints of the existing ES frameworks are also recognised, as these have been traditionally conceptualized rooted in scientific Western worldviews, what makes them inapplicable to other worldviews and places. Specially in certain contexts, where groups of people hold local or indigenous customs and systems of knowledge, science-based ecosystem management has been demonstrated to not be taken up by them (**ZAGAROLA ET AL., 2014**). Authors recognise the need to develop transdisciplinary, multivariable and participatory tools for natural resources management that *leaves no one behind* (**MARTÍN-LOPEZ ET AL. 2012; PAUDYAL ET AL. 2018; RAYMOND ET AL. 2009; ZAGAROLA ET AL., 2014; VERGARA 2017**).

To overcome mentioned challenges, emerging scientific efforts, promote *non-monetary valuation (NMV)* of the natural capital as a way to articulate multiple values that people hold towards nature in participatory

manner. NMV is a preference-based technique that explores how humans interact with nature and that assesses the worth of ES in non-financial terms employing qualitative and quantitative research methods (**KELEMEN ET AL., 2016**). NMV seeks integral valuation of nature and recognises the existence and importance of local ecological knowledge, that tackles system complexity and understands nature in holistic and ecocentric manners (**DIAZ ET AL. 2016**). In this way, participatory NMV becomes an adequate technique to achieve transdisciplinarity across Western and local knowledge.

Contextualized in the Peruvian Central Andes, in the Apurimac department, the present study takes place in the Mariño river watershed. This is a socio-ecosystem challenged by the anthropogenic degradation of the natural capital and intensified climate change effects in its fragile highland ecosystems. In this watershed, special attention has been given to water conservation, mostly for the benefit of the downstream urban users in the city of Abancay. Meanwhile, rural subsistence farmers in the uplands, who directly manage and benefit from relict Andean ecosystems, still play a secondary role in regional governance processes of the threatened and vital Andean commons. This lack of political attention to rural social values may derive into rural social discomfort with environmental policies created from the City, as rural residents may feel these are not representative for their local interests and concerns.

In the interest of making environmental values of rural residents visible to local decision-making, a social valuation method of ES is chosen.

The Mariño watershed offers a novel valuation context that enables the use of NMV methods given that study communities are peasant and community-based societies living in material poverty, with little capital flow or little familiarized with the concept of money. Given this, money measures can very limited articulate plural values and social preferences towards nature (**KELEMEN ET AL., 2016**). Moreover, previous studies in rural Apurimac indicate existence of local awareness and value systems towards nature, where environmental values are deeply interwoven with community values (**HUASASQUICHE AND KOMETTER, 2017**). It is furthermore observed that in the Mariño watershed, local decision-making processes are affected by knowledge gaps, as decision makers do not know environmental values and concerns of rural residents. Moreover, there is to date no comprehensive social valuation study of ES in the Peruvian Andean region and international ES frameworks have poorly explored ES in relationship to Andean systems of knowledge (**APGAR ET AL., 2009**). On a global scale, most ES valuation literature, either monetary or non-monetary, has been geographically biased, focused in developed countries and neglected least developed countries like Peru **(CHRISTIE ET AL., 2012**).

Embedded in an adequate valuation context, this study explores the non-monetary values or *relative importance* ascribed to ES, derived from nature, and threats affecting nature, according to the opinions of

rural residents in the watershed. The study's *central questions* are to identify which of the ES types (typologies from **IPBES** and **MA 2005** frameworks) and environmental threats are the four most important, and why. Assumed is that elicited social priorities are rooted in local systems of values and empirical knowledge, which allow rural residents, despite educational marginalization, to recognise a wide spectrum of benefits derived from nature and threats affecting it.

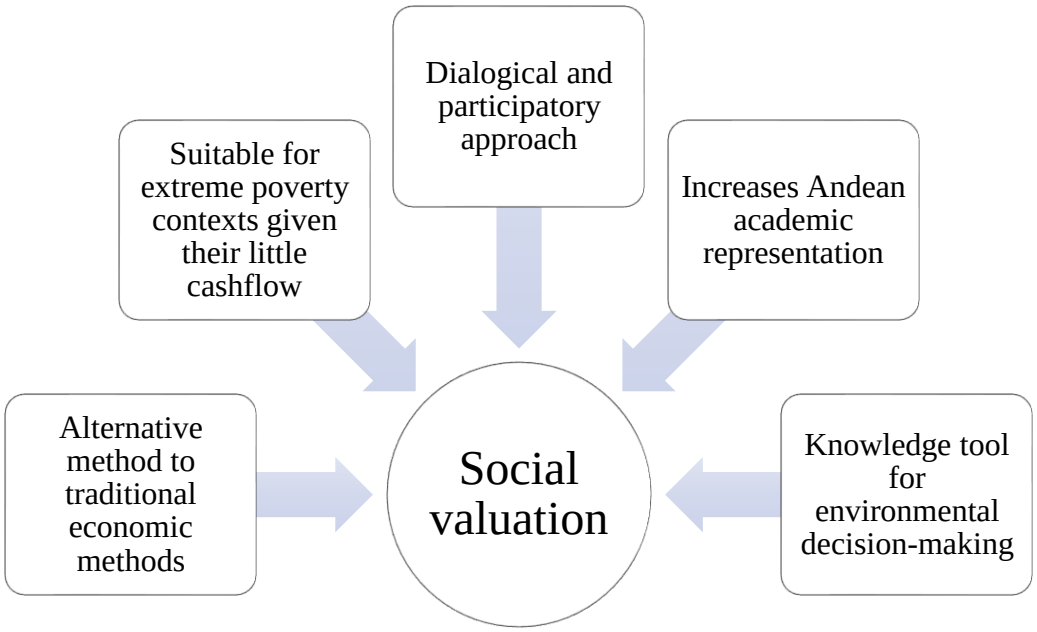


Figure 1 Schematization of the Reasons for a Social Valuation Study in the Mariño watershed.

To capture social values ascribed to nature and reasons behind them from multiple perspectives, a *mixed methods research* (MMR) is applied. The novelty of MMR for the Andean region and for the social valuation research field lies in combining quantitative and qualitative data sources and analysis methods. Only one known previous social valuation study of ES in rural Lima, Peru has applied mixed methods (**CALERO VALDEZ, 2018)**.

A specific type of MMR sensu Hammersley 1996 **(**cited in **BRYMAN 2012)** called triangulation is chosen. Through *methodological triangulation* sensu Denzin 2000 (cited in **BENAVIDES AND GÓMEZ 2005**) different data sources (e.g. observations, numerical ranking data, participant comments, theories) and analysis methods are employed to deepen understanding of social preferences around ES and threats in question. The usefulness of the triangulation approach in this research consists of its ability to *explore complexity*, specially in a Quechua socio-cultural context where social values are shaped by underlying social and environmental phenomena.

Specifically, quantitative data was gathered through a set of *mixed survey methods* to elicit social values. Survey methods were mixed because they encompassed different types of data collection techniques,

ranging from qualitative visual tools, such as photo-elicitation, to participatory ranking exercises and categorical questionnaires. Mixed survey methods were *participatory* as their purpose was to overcome potential illiteracy and linguistic (Quechua) boundaries in the sampled population. Only a versatile set of mixed survey methods allowed participants to value ES in intuitive, sensorial, visual and engaging manner.

Quantitative ranking data was analyzed using descriptive statistics and ordination. Statistical findings were interpreted under the light of field observations and collected participants comments and reactions.

Overall, the methodological triangulation is a novel approach in the study of socio-environmental phenomena in the Andes, limited reported in the general ES valuation literature.

Surveys elicit social values around an array of pre-selected ES types to be valued, which encompass ES previously underassessed in monetary valuation studies, like soil formation and pollination services, thus expanding the multiple values ascribed to ES which are difficult to monetize.

By making visible social preferences around a wide array of ES, current policy focus on hydric ES conservation (e.g. provision of water, regulation of water cycle, sediment retention) can be shifted towards non-hydric ES and threats in the watershed that are socially relevant. Findings can furthermore, inform whether people's values are aligned to conservation of relict ecosystems or not. Social values can serve as knowledge tool for value-based and culturally relevant management of the Andean commons.

Regionally, the study seeks to increase academic representation of the conservation challenges in deepest Peruvian Andes, where most natural capital key for water, food and climate security receive no legal protection and is exposed to unregulated natural resource exploitation (**COOPERACCION ET AL., 2018**).

Overall, the novelty of this research design and methodologies can be replicated and rescaled to mountain contexts that face similar anthropic and natural changes and seek sustainable ways to manage their biological and cultural landscapes.

2 RESEARCH QUESTIONS

Research Problem

On the one hand, most ES valuation studies have been of monetary nature thus leaving social values of ES greatly underassessed. There is to date no comprehensive social value assessment of ES in the Mariño watershed, that would encompass a wide array of ES types and that would elicit social values from rural stakeholders. Previous valuation studies in the watershed have assessed either only monetary value of hydric services (**CONDORI QUISPE, 2016**), the different social value dimensions of cultural ES (**VALDIVIA DIAZ, 2017**) or social values of ES, however, only according to urban expert opinion (**LOCATELLI AND GALMEZ, 2015**).

Furthermore, I observe, that ES valuation studies have often adopted *mono-research methodologies* and have focused on either only qualitative or quantitative methods. The so-called *mixed methods research (MMR)*, which seeks to combine and contrast more than one research method in the study of social phenomena, has been only limited applied in valuation studies. Despite the limited application of MMR in valuation studies, there is however growing recognition of MMR potential to provide understanding free of epistemological and ontological constraints (**BRYMAN 2012**, p. 649).

On the other hand, most social valuation studies of ES have included ranking exercises in written questionnaires format. These methods may be not applicable for *illiterate* and *non-scientific* rural audiences. Adequacy of alternative and participatory survey methods, like photo-elicitation, in the research field of ES valuation remains greatly underutilised.

In summary, the central research problem is that it is unknown which is the social value ascribed to ES and threats in the Mariño watershed, according to the opinion of rural *non-expert* residents. To address this, a mixed research methodology and visual survey tools are *novel* and *flexible* approaches utilised to explore social values in an underassessed modern Quechua socio-cultural context.

Research Questions

This study poses the research question: w*hich are the four ES and threats in the Mariño watershed receiving the highest social value, according to the social preferences of rural residents in the study communities?*

The specific research questions are: *which is (i) the provisioning ES, (ii) the regulating ES, (iii) the cultural ES, and the (iv) environmental threat with the highest social value according to rural interviewees?*

Research Hypothesis

The study has an *ex post* hypothesis, which is a qualitative, data-based open statement. An ex post hypothesis "*seeks to reveal possible relationships by observing an existing condition and searching for plausible contributing factors*" (**KERLINGER & RINT, 1986**). Through an inductive logic, specific observations, e.g. informal talks, participant observations, field notes, quotes and surveys, were explored to answer the research questions. Surveys used a quantitative approach not *ex ante*.

The research variables or *units of analysis* are social values of relative importance ascribed to (i) ten provisioning services; (ii) eleven regulating services; (iii) eight cultural services; and (iv) to eleven environmental threats. Each category was assessed separately. The specific types are listed in Methods: Data Collection. To capture social values, data collection instruments such as semi-structured surveys, standardized questionnaires with closed, preference and qualitative visual questions, were used. The sampling is quantitative and probabilistic.

An overview of the entire research design is compiled in Appendix: Table 28.

Research Design

The present study has an *exploratory-descriptive* design, also called mixed methods research (MMR).

The use of the *exploratory approach* is justified by the low amount of previous work on the topic of social valuation, executed in a social (modern rural Quechuas) and natural (high-Andean) context. Specifically, the study is *exploratory* because of three reasons:

First, the study has an inductive logic, which explores social values ascribed to nature and the underlying social factors explaining them. The inductive logic, as opposed to the deductive one, moves from specific observations to tentative hypothesis and broader generalizations. *Secondly*, the study operationalizes the ES conceptual framework in a novel cultural context, i.e. modern rural Quechuas. The ES framework is chosen, given that there is current policy focus on ES payment schemes in the Mariño watershed to tackle water insecurity. *Thirdly*, the study employs novel survey methods, e.g. qualitative visual tools, whose methodological performance is unknown for the Andean rural setting. Mixed survey methods were selected prior to field entry as data collection instruments, because it was known to me that local people have high levels of illiteracy and material poverty, hence a *non-fixed* methodological design fitted the local circumstances better. Mixed survey methods allowed for dialogical knowledge exchange and provided *soft data* about the local social world as well.

The study is moreover *descriptive* because of its deductive logic, which allows to generalize the knowledge and theoretical assumptions to other populations (**VARA 2012**). The study collects relevant information and

social values regarding multiple phenomena, namely 40 ES and environmental threats. Research is quantitative, as elicited social values are quantifiable and analyzed statistically to create social value rankings.

Through the *exploratory-descriptive* study design, multiple perspectives have been collected about a complex dataset of Quechua social values ascribed to ES in the Mariño region. A mixed research design and mixed survey methods made a dialogical research between scientific and Andean thinking possible. Study findings become a baseline for future transdisciplinary ES research work in the watershed and potential knowledge tool for decision makers interested in watershed management that is socially inclusive and culturally relevant.

The Broader Research Project

It is important to highlight that the present thesis work is only a part of a broader research project that I developed and executed on the ground with the support of the HELVETAS Swiss-Intercooperation and its regional Andean Forest Program (ANFOR Program). The three phases of the broader research project are detailed in Appendix: Table 29.

In summary, the research project was conceptualized remotely from Germany, based on profound literature screening and without having ever been to Apurimac before. On the field site, the research project underwent three phases: *Firsty*, expert knowledge about ES interventions in the Mariño watershed was collected. *Secondly*, in-depth interviews with rural residents were conducted to gain a broader understanding of the Mariño socio-ecosystem. *Thirdly*, a social valuation of ES was conducted through semi-structured surveys. The present thesis focuses ***only*** on the findings of the social valuation phase. Data collected from the first two project phases will be subject of future investigations.

The research project had an adaptive design which allowed familiarization with the Andean study and first contact with local people; pre-testing; field observations and learnings about social norms and customs; and improvement of survey tools and simplification of technical language required for the social valuation phase.

3 THEORETICAL BACKGROUND

For the development of this research, theoretical and international ES frameworks were used, as ES research based on local knowledge is still at its early stages and only few social valuation studies for the Quechua-speaking Andean region exist to date.

Key concepts and terms referred to in this study are compiled in Appendix: Glossary.Table 27

3.1 THE SOCIO-ECOLOGICAL SYSTEM (SES)

The present study understands the rural study communities and natural surroundings in the Mariño watershed as a *socio-ecosystem* (SES) where humans have co-created knowledge and values around Andean ecosystems in the watershed, through traditional landscape use. Socio-ecosystems or social-ecological systems (SES) are complex and constantly adapting systems consisting of biophysical and social units. SES are in other words the nature-culture fusion, where humans shape the landscape and landscapes shape human interactions (**OSTROM, 2009**).

In the following, the natural and social components of the Mariño socio-ecosystem are detailed, these are the ES Conceptual Frameworks used for the study and the Local Cultural Setting, respectively.

3.1.1 Ecosystem Services (ES)

Ecosystem Services (ES) are the benefits people obtain from ecosystems (**MA, 2005**), which make human life possible. Their annual worth is estimated to be 125 trillion USD (**COSTANZA ET AL., 2014**).

ES are typically grouped in four categories (**MA 2005)**, namely (i) *provisioning services* or material benefits obtained from ecosystems, e.g. food, fiber; (ii) *regulating services* or benefits obtained from the regulation of ecosystem services, e.g. air purification; (iii) *cultural services* or nonmaterial benefits people obtain from ecosystems through spiritual enrichment, education, recreation and aesthetic experiences (cultural services are tightly bound to human values and behavior, institutions and social, economic, and political organization patterns); and (iv) *supporting services*, services necessary to produce all other ES, they impact people indirectly or over a very long time, e.g. water cycling and soil formation. These categories were used for the present study, with the exception that regulating and supporting categories were merged.

ES frameworks have been widely used as tool for climate change adaptation and natural resource management (**CHAN ET AL., 2012; OTEROS-ROZAS ET AL., 2014**; **PAUDYAL ET AL., 2018**). ES frameworks reflect people maintaining a dynamic interaction with ecosystems, a relationship in which any

human action causing direct or indirect damage to ES will in turn threaten human well-being and its basic material constituents for a good life, security and social relations.

ES are one of the components of the *natural capital*, a term derived from the economic notion of capital that encompasses the stock of natural objects and functions between these objects, that can produce a sustainable flow of goods and services (ecosystem services) to sustain the human life and economy (**NAHUELHUAL ET AL., 2016)**. Essentially by valuing ecosystem services, one partially values the natural capital (Figure 2). In this way, ES become a tool to identify, value and mainstream the multiple functions provided by ecosystems to human well-being, to call for civil society awareness and understanding of the critical role nature plays in societal well-being.

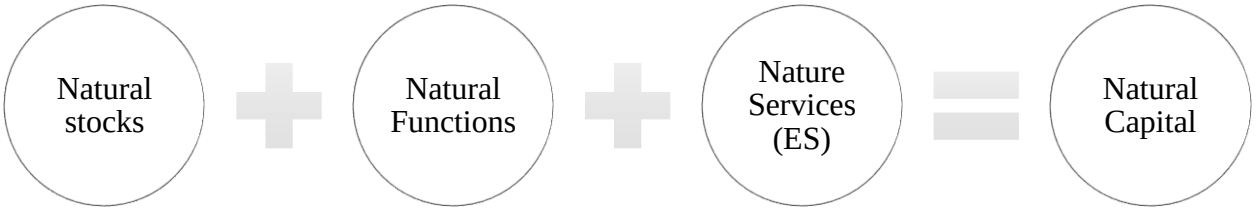


Figure 2 The logic of the Natural Capital

3.1.2 The Different ES Frameworks

Three international ES Frameworks have approached typologies and valuation methodologies of ES differently. The IPBES and MA frameworks are *essentials* for this study, as the selection of ES for the surveys was based on their ES typologies.

First, the Millennium Ecosystem Assessment 2005 (MA) popularized the ES term and established the ES conceptual framework, thus making ecosystem degradation, resulting from economic growth in the second half of the 20th century, visible. Later in 2009 the Economics of Ecosystems and Biodiversity (TEEB) mainstreamed the economic and monetary value of biodiversity and ES into policy making. More recently since 2012, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), an UN-authority, has sought to mainstream ES into decision-making. Peru is IPBES founding member since 2012. IPBES's innovation lies in recognising the existence of non-Western knowledge systems gravitating around native notions of nature protection, as well as recognising holistic, spiritual and future benefits derived from nature.

Although this study is based on the international ES conceptual frameworks, it is worth highlighting that some alternative ES frameworks, which are based on local knowledge systems and on their ability to handle system complexity and trade-offs, have been proposed.

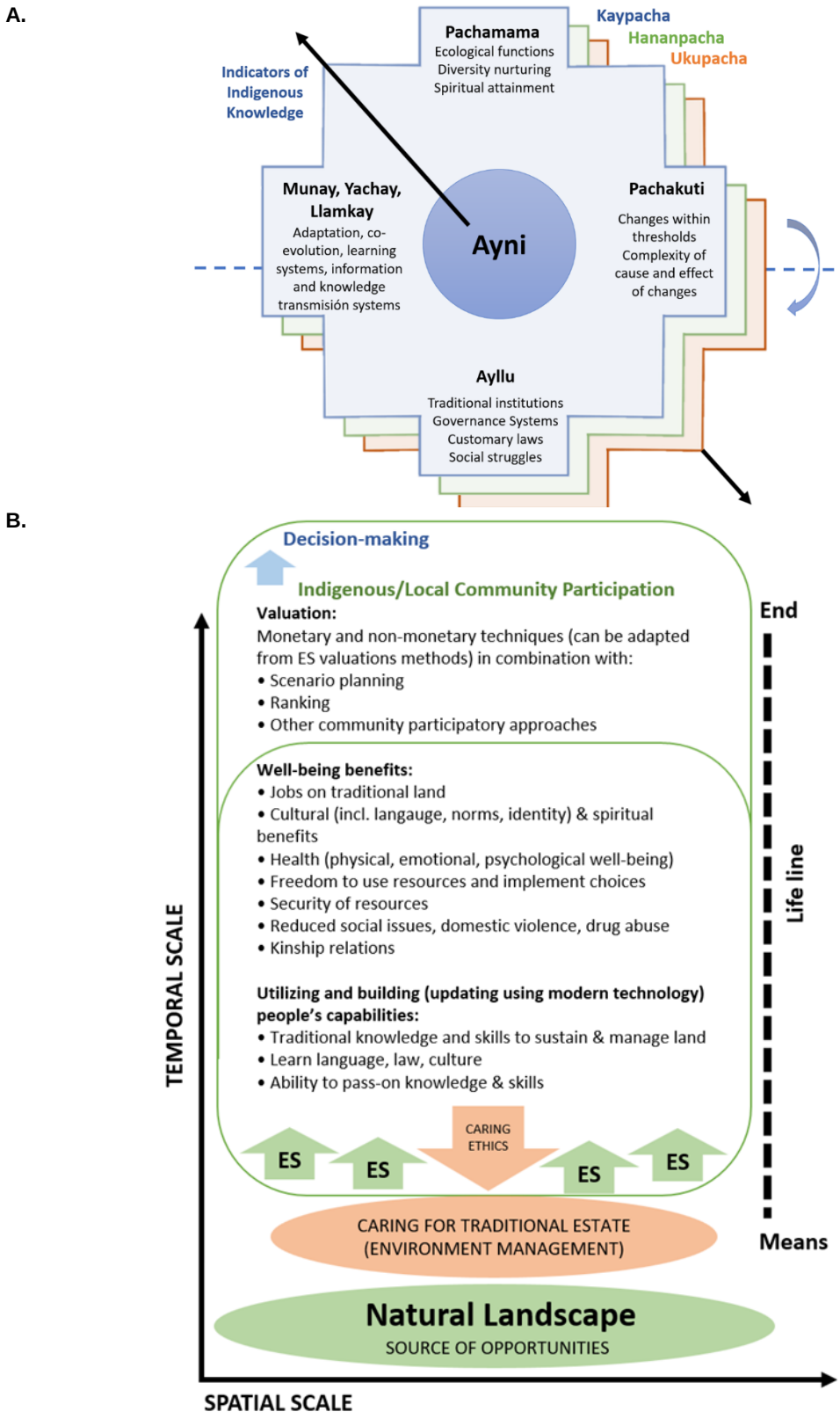


Figure 3 Alternative indigenous ES frameworks

(**A**) The Vilcanota ES Conceptual Framework uses the Chakana cross, sacred to Quechua people, and illustrates systemic Andean thinking, adapted from **Apgar et al., 2009**. (**B**) An indigenous-specific ES framework, accounting for people as spiritual beings and their connections with land, adapted from **Sangha et al., 2018**.

For instance, **SANGHA ET AL. 2018,** suggested a bottom-up ES framework that mainstreams indigenous and local ethics for the public benefit (Figure 3). Authors proposed this framework arguing that MA and IPBES frameworks were created applying Western knowledge systems which do not contemplate the role of local people's relationships with nature. These relationships are of vital importance to local communities. Moreover, **APGAR ET AL., 2009** challenged the linear and deterministic MA framework and proposed an ES framework rooted in the Andean Quechua cosmology, which tackles complexity (e.g. climate change) and seeks to facilitate dialogue across Western and local knowledge systems (Figure 3).

3.1.3 Local Societies, Values and Knowledge

In order to understand the cultural setting of the rural study communities, I shall define (i) what local values are, as these are the study units of analysis; (ii) what the Andean worldviews are, given that these influence the thinking of the surveyed Andean people; and (iii) who the modern Quechuas are, given that interviewees were mostly Quechua-speakers.

First, the rural interviewees in the Mariño watershed are assumed to be holders of local values and local knowledge. Local and indigenous knowledge refers to the understandings, skills and philosophies developed by societies with long histories of interaction with nature. These are millennia-old, specific to place, are well assimilated into people's lifestyles (**SANGHA ET AL. 2018)** and inform local and indigenous people about fundamental aspects of day-to-day life. Local knowledge is also part of a cultural complex, that encompasses language, systems of classification, resource uses, social and spiritual interactions (**UNESCO, 2017** pp. 8). For these reasons, local knowledge systems are holistic as they connect people and nature, and include a wide range of social well-being values **(APGAR ET AL., 2009).**

Nowadays it is widely accepted that indigenous knowledge is a powerful resource complementary to Western knowledge (**ALTIERI, 1996**). Local and indigenous knowledge are part of the world's cultural diversity and contribute to the achievement of Sustainable Development Goals for 2030 and the Paris Agreement (**ZAGAROLA ET AL., 2014**), given their tight links with long-term sustainability.

Secondly, the Peruvian Andes have been ancestral places of knowledge co-production and human-nature interaction. The Andean knowledge is knowledge related to beliefs, myths, rituals and nature, practiced by the Andean population, e.g. the Quechua, Aymara and other peoples. This knowledge is linked to a holistic worldview, where the local *pacha* (the living landscape), the *runas* (humans), the *sallqa* (nature) and *apus* (deities) are all are part of a whole (Figure 4). The Andean worldview is agrocentric and gravitates around ancestral principles of *Ayni* or reciprocity, not limited to being compensated, reciprocity refers as well to the exchange of energy between humans and nature. Further principles are *Ayllu* or collectivity of visible and non-visible living beings; *nurturance*, or treatment and respect of all entities as equivalent beings; and

sustainability, or balance and harmony intrinsic to this millenary worldview (**PILGRIM AND PRETTY, 2010**). Andean worldviews and values do not separate culture and nature. Andean knowledge is not static, adapts and changes over time, thus providing co-creation opportunities with modern science.

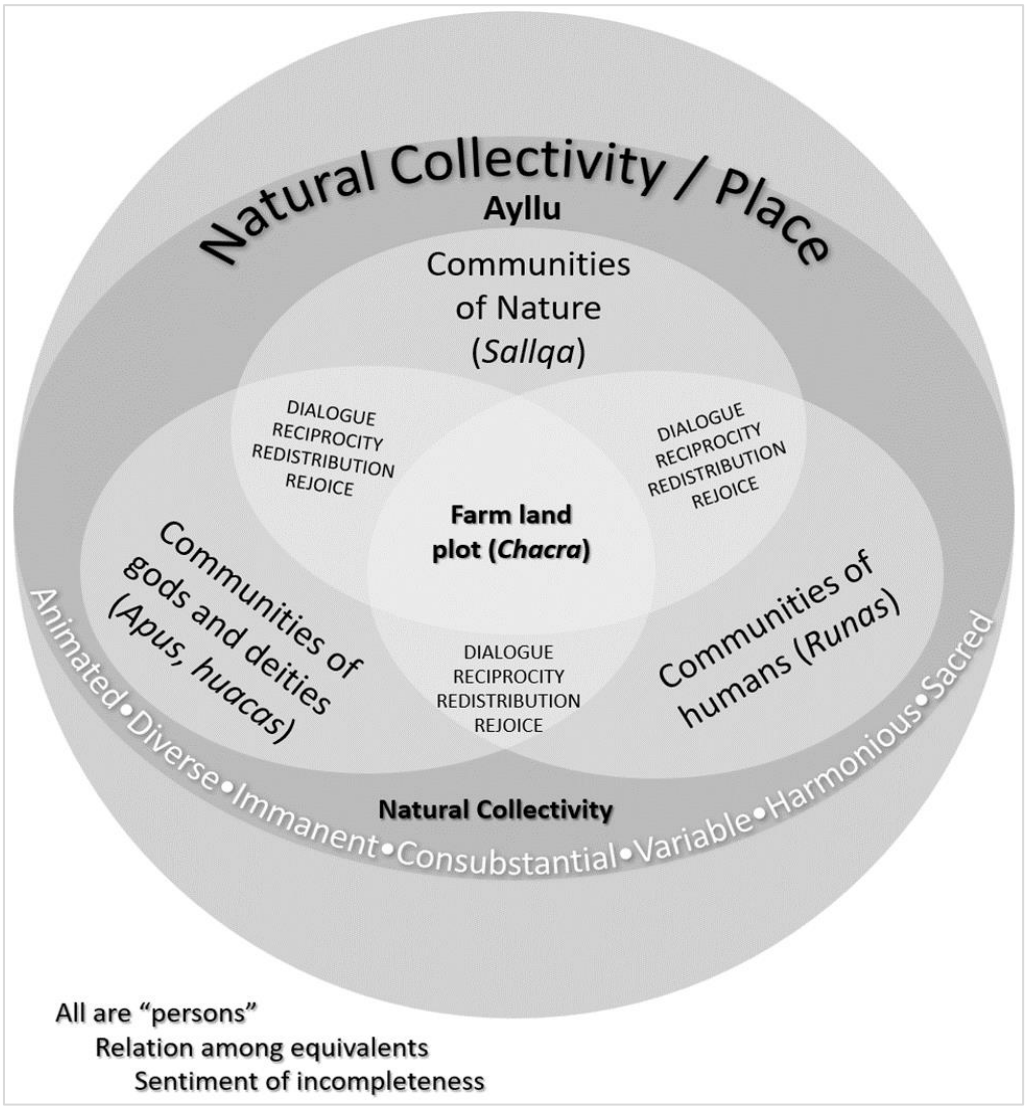


Figure 4 Graphic Illustration of the Andean Worldview. Source: **Pilgrim & Pretty 2010**.

Thirdly, the Quechua language is the language of the Andes. Quechua is an indigenous non-written language of South America. In Peru, Quechua is the co-official language to Spanish and Aymara (stated in the **PERUVIAN CONSTITUTION 1993**, Article N° 48). In Peru, 3.5 million people are Quechua-speakers. This language has different regional dialects, in Apurimac the dialect Quechua II C is spoken.

Quechua language and its people have suffered historical, cultural and social persecution and linguistic marginalization since colonial times, causing a serious linguistic shame in their speakers nowadays. The linguistic shame inhibits the oral and traditional transfer of Andean knowledge and values. Recent policies

of the Peruvian State seek to promote bilingual education and general services in public institutions in Peru. Systemic efforts to mainstream Quechua cultural vindication are needed (**SERVINDI, 2014).**

Fourthly, Andean knowledge is practiced and conserved today by modern and aboriginal Quechuas. On the one hand, *modern Quechua people* live in cities, homesteads and communities. They have been heavily influenced by modern culture, modern state policies and Christianity. As a result of this, Quechua customs may be partially or fully practiced as a mixed Andean culture in day-to-day life. Regarding the present study, study subjects are understood as modern Quechuas.

On the other hand, *pure or aboriginal Quechua* are peoples that still practice centuries-old traditions, religions and symbolisms in the Andean highland villages. They usually live in clay and brick houses with straw roofs and wear traditional clothing. Pure Quechuas in Peru are found only in very remote communities like the Q'eros people in Cusco, Peru, the last Incan community.

3.2 THE CHALLENGE OF VALUING ES

Valuation of natural resources follows a diversity of purposes, being the main one to mainstream the contribution ecosystems make to human well-being, here well-being is traditionally measured as economic growth.

Some valuation methods explore the monetary value of natural resources using market or pseudo-market prices to estimate socio-economic benefits of ecosystems to human-wellbeing (**FOLKERSEN, 2018**). Other methods explore the socio-cultural worth individuals assign to natural resources. These estimations can raise awareness among policy-makers. In developing countries, monetary valuations reveal ways to protect ecosystems and decrease poverty levels. In brief: (i) Valuation methods assume that natural capital and ES have a value (**SHERROUSE ET AL. 2011)**; and (ii) Valuation is made to better understand the implications of our actions and take decisions for us and for nature's long-term well-being.

There are three methodologies available for the valuation of ES. The first one is *monetary valuation* which elicits public preferences in monetary terms, such as willingness to pay, willingness to accept and travel cost methods (i.e. revealed preference and stated preference methods). The resulting Economic Value of an ES encompasses use and non-use value dimensions (**DEFRA, 2007**).

The second method one is *biophysical valuation* which is the biophysical assessment of the contributions provided by landscape entities (land, rivers, forests), for example, nitrogen budget calculations for a watershed.

The third methodology is the *non-monetary valuation*, an approach mostly applied in ecosystem planning and management that examines importance, needs, demands or preferences in units other than money and requires qualitative and quantitative understanding of people's preferences. This method uses deliberative and participatory methods, for example, qualitative semi-structured surveys and group deliberative discussions (**KELEMEN ET AL., 2016**). In general, non-monetary valuation methods make multiple values around nature visible in conservation and environmental management (**RAYMOND ET AL., 2009, MARTÍN-LÓPEZ ET AL., 2012, NAHUELHUAL ET AL., 2016**) and employ different tools to collect and quantify multiple values ascribed to nature (see Figure 5). A type of non-monetary valuation is the *social valuation method.*

3.2.1 Shortcomings of the Monetary Valuation

On the one hand, the **MA 2005**, heavily rooted in economic theory and terminology, mainstreamed the focus on monetary values of ES to understand monetary costs and benefits of certain human actions on the environment (**BENIS EGOH ET AL., 2012)**. The monetary valuation of ecosystems has traditionally assessed the contribution of ecosystems to economic growth. Its advantage has been to use money as common and understandable language to mainstream ES to policy-makers. The argument was: *it is impossible to manage what cannot be valued, and ES without public value go degraded* (**La NOTTE ET AL., 2012**). Economic valuation questions what the market price and the economic benefit is. Hereby it was possible to understand what changes in economic consumption patterns would lead to the loss of environmental benefits.

On the other hand, there are important limitations to the economic methods. First, monetary approaches do not inform about underlying constituents of social well-being nor public values (**PAUDYAL ET AL., 2018**). Secondly, economic valuation methods such as stated preference methods have predominantly assessed ES with instrumental value, leaving aside ES with intrinsic or relational value. Moreover, economic valuation fails at integrating cultural and nonmaterial benefits of ecosystems in ES research and decision-making (**ZAGAROLA ET AL., 2014)**.

Similarly, not only economic, but also biophysical values are often used to define high priority hotspots in conservation planning and environmental management, thus rarely considering community values (**RAYMOND ET AL., 2009**). Finally, the monetary valuation has been proven inadequate in least developed countries and in rural, indigenous or low-income communities. These groups often have little cash flow or are not familiar with the concept of money.

All in all, the economic approach has dominated ES research and policy to address market failures and include ecosystems' monetary worth into economic models. Although economic approaches are important, they are only a subset of many possible valuation methods. For these reasons it becomes crucial to consider

the different ways in which people perceive and relate to ecosystems when making environmental decisions, since social well-being is not derived solely from economic valuation.

The complex societal challenges, like climate change, urge science to advance towards more holistic and integrated approaches to understand and value nature. The social valuation is one of them as it accounts for multivariable complexity of the socio-ecosystems. ES research must go beyond money and complement it with methods from social sciences to capture the value pluralism and inform decision-makers.

3.2.2 Suitability of the Social Valuation Method

The social valuation method employs non-monetary metrics to capture social values, perceptions and preferences around ES. Social values depict human-nature relationship (**NAHUELHUAL ET AL., 2016)** and account for the fact that people value things beyond financial terms, in spiritual, recreational or cultural terms. Social valuation helps identify priority ES, informs decision-making for livelihood improvement, poverty reduction and environmental conservation in developing countries (**PAUDYAL ET AL., 2018**). It has been promoted as a strategy for sustainable development and can guide value-based management, which prioritises ES or even community values at risk.

Social values are in general the perceived qualities from nature that provide benefits to human well-being. Different studies use different social value typologies. The **IPBES GUIDE ON MULTIPLE VALUE** is the most recent academic effort to compile this value pluralism (see **Current State of Research**).

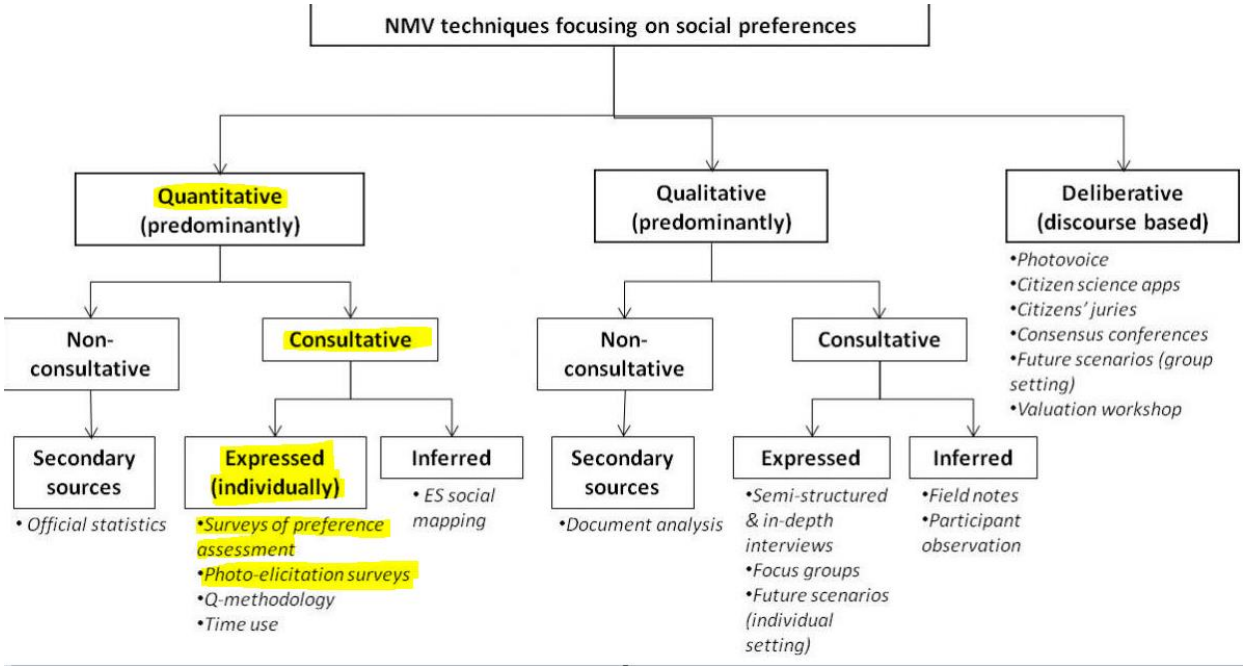


Figure 5 An overview of Non-monetary valuation (NMV) methods.
Methods used in this study highlighted in yellow. Adapted from **KELEMEN ET AL., 2016**

Justifying the Suitability of the Social Valuation Method

Social valuation emerges as a tool and new paradigm that overcomes Western academic bias in the assessment of nature's worth, rescues local perceptions and makes decision-making more *people-friendly*. The following key arguments highlight the suitability of the social valuation method for the selected study area.

Firstly, *social valuation overcomes materialistic bias.* Economic and biophysical studies assessing the value of ES have insufficiently explored the category of supporting services, also called life sustaining services, mostly non-tangible (**MA 2005**; **IPBES 2016**; **BENIS EGOH ET AL., 2012**). The resulting value assessments neglecting inmaterial supporting services portray an incomplete picture of reality. This is especially critical in contexts of subsistence livelihoods, which are highly dependent upon life-sustaining ecological services (**ZAGAROLA ET AL., 2014**). It is through qualitative and social science research methods employed by social valuation that importance ascribed to intangible environmental benefits is captured.

Secondly, *social valuation overcomes the Western bias in ES research.* **ZAGAROLA ET AL, 2014** states that research that uses western scientific ES frameworks has been called to be rooted in scientific and technical knowledge, as well as in political and economic priorities, that have forced foreign worldviews on indigenous community members, excluded their local voices and failed to support local social well-being. This has led to failure of conservation policies. For these reasons, **RAYMOND ET AL., 2009** highlights the need for science that identifies and empowers local priorities, values and knowledge. Only so, the socio-ecological system can become robust and trust into decision-making can be built. For this endeavour, the social valuation method becomes suitable, as it combines qualitative and quantitative methods that explore the personal, political and societal background processes whereby environmental values are experienced, used, sensed and represented (**NAHUELHUAL ET L., 2016**).

Thirdly, *social valuation is especially convenient for valuation studies in developing countries*, in landscapes shaped by long-term community activities (**PAUDYAL ET AL., 2018**) and in low-income contexts, where market economies are non-existent and ecosystem management may be better guided by socio-cultural value systems.

Moreover, *social valuation is a tool to support bottom-up policy-making* and a tool for justice and transparency, as it allows people to communicate and to be heard by their authorities voted into power. It is important to empower communities to talk about their values and priorities, as well as increase interest of policy-makers to involve and consult communities (**MARINE CONSERVATION SOCIETY, 2014).** Understanding community values through participatory and deliberative social valuation methods allows decision-making to be culturally-relevant.

Finally, *social valuation seeks collective well-being*. If the purpose of public policy is to maximize public benefit, then public policy design must consider the economic and non-economic constituents of public well-being (**NAHUELHUAL ET L., 2016)**. Shifting attention to social values, beyond the monetary worth of nature, can help policy-makers think about the world in wider forms.

3.3 CURRENT STATE OF RESEARCH

The state of the art of the social valuation research encompasses previous Value Frameworks and previous valuation studies from global to local scale.

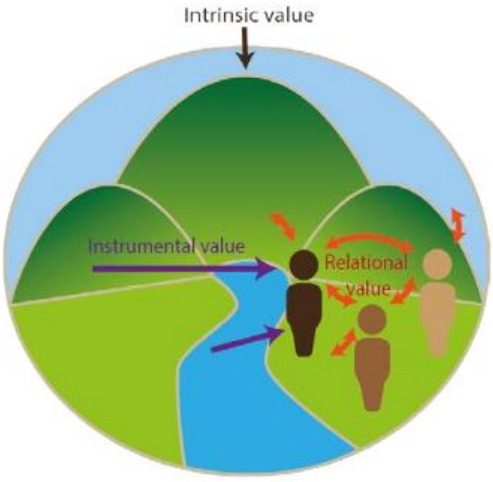


Figure 6 IPBES value dimensions. Source: **Diaz et al 2016**

Conceptually, the *IPBES guide on multiple values* (**DÍAZ ET AL., 2016, GONZÁLEZ-JIMÉNEZ ET AL., 2018**) compiles the diverse value typologies by defining four types of values (values as moral principles, subjective importance, preferences or measure) and three value dimensions. These are the instrumental (nature is a means to achieve an end, for instance human well-being), relational (human-nature relationships) and intrinsic dimension (non-anthropogenic) (Figure 6). Table 1 compiles the synonymy of the value terminology used in the literature. IPBES acknowledges that values are conceptualized differently by different systems of knowledge, i.e. values in western science are conceptualized differently than values in experience-based or traditional forms of knowledge. Moreover, it highlights that although unifying different knowledge systems is an epistemological challenge, it brings fruitful exchange to inform policy design increase its own acceptance and legitimacy.

Table 1 Synonymy of the 'value' terminology.

The three Value dimensions	IPBES grouping	Economic grouping
Intrinsic	Non-Anthropocentric values	Non-use values, non-instrumental, intangible values
Relational	Anthropocentric values	
Instrumental (incl. biophysical)		Use-values, tangible, instrumental values

Empirically, great part of general valuation studies of ecosystem services has been carried out in the Global North, few studies being carried out in the Global South and data-poor regions (see Figure 7). Although much of the research on the subject of social valuation of ES has a Western bias, Western-approaches nevertheless help us understand the social value that humans attribute to nature's services.

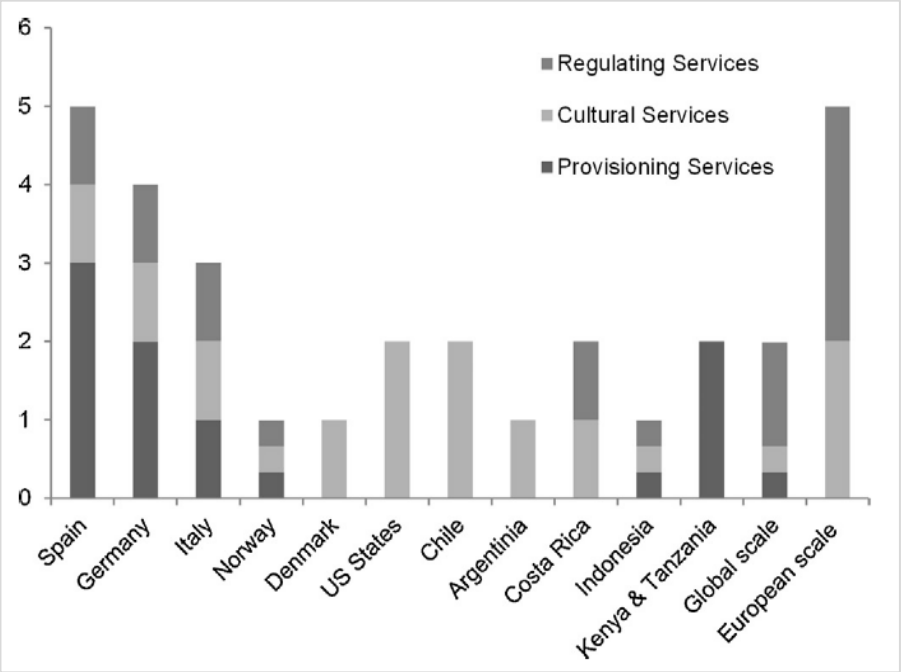


Figure 7 Geographical bias in ecosystem services valuation studies.

The Andean region is underrepresented. Picture shows Number of studies which have mapped ES demand by ES category type, source: **Wolff et al., 2015.**

Table 2 Overview of reviewed ES valuation studies.

REGION	COUNTRY	STUDY TYPE	AUTHORS	STUDY LOCATION	ES FRAMEWORK	SURVEY METHOD	SAMPLE POPULATION	#ES
GLOBAL	Spain	SV	Martín-Lopez et al. 2012	Mixed	Western (MA)	Questionnaire	Diverse residents	13
	Nepal	SV	Paudyal et al. 2018	Phewa mountain watershed	Western (TEEB)	Ranking exercise	Rural communities and experts	23
	Australia	SV	Raymond et al. 2009	Murray-Darling Basin	Western (MA)	Participatory mapping	Community and experts	31
REGIONAL	Chile, Argentina	SV	Zagarola 2014	Southern Patagonia	Western (MA)	Ranking exercise	Urban residents and specialists	32
	Ecuador	SV	Vergara 2017	El Padmi Amazon watershed	Western (MA)	Questionnaire	Rural residents	11
	Colombia	SA	Arias-Arévalo et al., 2017	Andean watershed	Western (IPBES)	Mixed methods	Urban and rural residents	None
	Peru	SA	Codato 2015	Andean-Amazon watershed	Western (MA)	Questionnaire	Rural residents	None
	Peru	SV	Calero Valdez 2018	Montane Forests	Western (MA)	Mixed methods	Rural residents	29
	Peru	E	Saylor et al 2017	Andean community	None	Ethnographic	Indigenous residents	None
	Peru	MV	Landolt 2018	Kosñipata Andean community	Western (MA)	Contingent economic valuation	Rural residents	11
	Peru	E	Huasasquiche & Kometter 2017	Andean community	None	Ethnographic	Rural residents	None
	Peru	SA	Valdivia et al. 2016	Mariño watershed	Western (MA)	Questionnaire	Urban and rural residents	None
	Peru	SV	Locatelli & Galmez 2015	Mariño watershed	Western (MA)	Ranking exercises	Urban experts	19

Note: (SV) Social valuation of ES, (SA) assessment of social value dimensions, (MV) monetary valuation of ES, (E) Ethnographic study

Review of studies at international as well as regional scale show social valuation studies are still in the early stage: thematic and geographical coverage is not continuous, and rather spotted. Key previous findings discussed below expose the state of the art (see overview Table 2).

Social valuation studies at international scale

The participatory nature of social valuation became evident with studies like by **Raymond et al., 2009** who highlight social values shall be taken into consideration by policy-makers. By combining GIS-techniques with natural capital social valuation, authors identified socially prioritized natural stocks, ES and threats in Southern Australian watershed, to guide local decisions.

Moreover, a social valuation study by **Martín-Lopez 2012** found out that the rural-urban landscape gradient drives social preferences. Urban and rural residents across Spain held different ES perceptions explained mainly by local knowledge held by rural residents and formal education received by urban residents.

Recently, **Paudyal et al. 2018** provided a conceptual framework for social valuation of ES in data poor region. Authors used the TEEB framework to elicit social values around ES provided by a watershed in Nepal. Perceptions from different stakeholder groups were collected (communities, traders and experts). Findings show that social valuation methods can assess any ES, as well as identify ES synergies and guide landscape management.

Social valuation studies at regional scale

An early social valuation study in South America, executed by **ZAGAROLA ET AL., 2014** in Southern Patagonian region highlighted the need for science-public dialogue in the environmental management. Authors assessed how urban residents and specialists socially valued ES and threats. Authors found that most urban residents were lacking basic ecological knowledge about natural resources.

VERGARA 2017 furthermore, used the social valuation method to make local systems of values visible. Her study explored the social value ascribed to ES following the MA framework in an Amazon watershed in Ecuador. Content analysis reported that rural residents possess high local knowledge about local drivers of environmental degradation, as well as high understanding of the ES concepts thanks to the local knowledge.

Moreover, **ARIAS-ARÉVALO ET AL., 2017** highlighted that value pluralism can guide decision-making and reduce environmental conflicts. Authors explored the association between the IPBES value dimensions, environmental motivations and socioeconomic factors of rural and urban Andean interviewees in a Colombian watershed. Qualitative discourse analysis showed that respondents attribute plural values to watershed ecosystems, being the most frequent relational value dimension.

Finally, **RUIZ AND BELLO, 2014** carried out a meta-analysis of economic valuation studies in the Colombian Andes. Although only economic studies were reviewed, authors exposed the lack of scientific ES research in the region as economic studies had high variability and little spatial representativity. Authors highlight that grey literature on ES in Colombia is a reason why the topic is not disseminated at scientific level.

Valuation studies in Peru

In Peru there are few social valuation studies run to date. Most ES valuation studies in Peru have applied economic methods, mainly motivated ever since the PES scheme Law 2014 came out.

CODATO 2015 explored seven dimensions of social values ascribed to an Andean-Amazon watershed in Peru, according to the opinion of rural and urban interviewees. Surveys explored how familiar they were with the ES concept and results showed differences in their ranked importance of seven dimensions of social values.

CALERO VALDEZ 2018 performed a social valuation of ES in montane clouded forests in rural Lima, Peru and identified three ES most prioritized by rural residents. Mixed methodologies encompassing unstructured observations, interviews, participatory social mapping and ranking surveys elicited social preferences. The study sought to inform ecotourism viability projects for the conservation of local relict montane forests.

An ethnographic study by **SAYLOR ET AL. 2017** highlighted the vast potential that local ecological knowledge has to improve sustainability strategies. Authors evidence how interwoven life, land, culture and spirituality are in the Andean worldviews of rural Quechua and Aymara communities in Peru. They highlight the necessity of bottom-up ES research to revive ethno-ecological knowledge, see Figure 8.

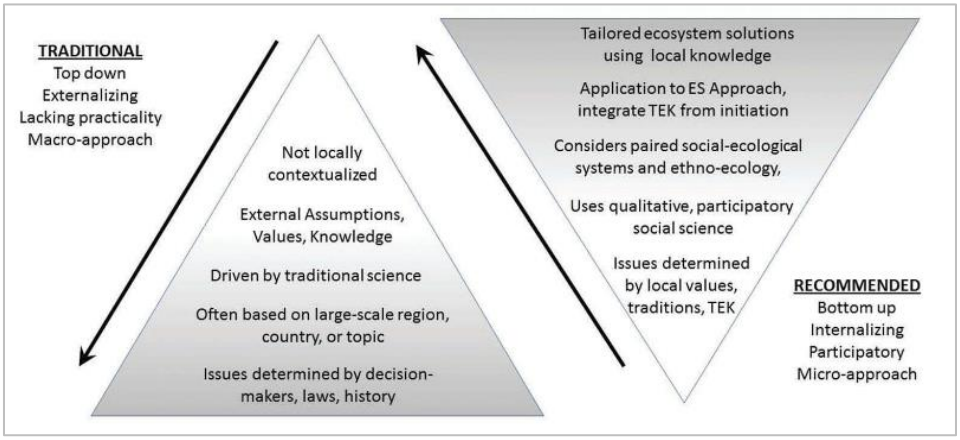


Figure 8 Current versus. recommended ES approaches. Source: **Saylor et al. 2017**

Valuation studies in Apurimac

In the context of rural Apurimac, **LANDOLT 2018** estimated the monetary worth of Andean forests and its annual economic benefit to the Kiuñalla rural community around 165 000 USD. This figure is the result of a contingent valuation of only few provisioning ES. Although the figure translates the potential cost of the natural capital loss under human pressure, the author acknowledges that the real cost lies much higher if intangible and indirect benefits would also be monetized, such as pollination services and soil fertility.

In social terms, the ethnographic study by **HUASASQUICHE & KOMETTER 2017** highlights the necessity to revitalize local Andean knowledge, empower women in their role as cultural and intergenerational transmitters, and future steps to implement community-led forest conservation. Surveyed were communities in the Saywite-Choquequirao-Ampay corridor. Authors evidence the existence of local knowledge which traditionally allocates use-values to native flora and fauna. Authors expose also the wide spread rural perception of changes in the local climate.

In the context of the Mariño watershed, **LOCATELLI AND GALMEZ 2015** ran a workshop on social valuation where only technical experts participated, thus excluding rural representatives from the watershed communities. In total, 40 ES were ranked using the MA framework; prioritized drivers of change in the landscape and spatial ES hotspots were identified.

VALDIVIA M. ET AL. 2016, moreover, explored different types of social values ascribed to Andean landscapes by rural, urban residents and tourists in the Mariño watershed. The study suggests that rural communities in the Mariño despite lying outside the Ampay National Sanctuary, are perceived by locals and visitors as hotspots of spirituality, scenic beauty and recreational services. This opens the question whether rural community residents think the same about their lands.

3.4 BACKGROUND CONTEXT

Regional Context

At the regional level, the study is contextualized in Apurimac, one of Peru's 24 departments. Apurimac is the 5th less dense populated department and has the third-lowest Human Development Index (Peruvian national average = 0.5058, Apurimac average = 0.3444, **UNDP 2012**). This index is a statistic composite of life expectancy, education, and per capita income indicators.

Table 3 Key facts about Apurimac

General facts	Location	South-Eastern Central Andes, Peru
	Surface	20 896 km²
	Capital	Abancay (City)
	Population	405 759 (1.25 % of total national population)
	Population by residence area	34.9 % lives in urban areas 65.1 % lives in rural areas (**PRODERN 2016**)
	Administrative provinces	7
	Administrative districts	80
	Foundation date	28 April 1873
Economic facts	Human Development Index	0.3444 (Rank 22 / 24 in Peru)
	Extreme poverty (%)	39.7 % (national average 13.7 %)
	Main economic activities	Agricultural production (employs 49 % of economically active population), Services, Commerce, Mining
	Contribution to national GDP	0.49 %
Environment	Average temperature	16°C
	Altitudinal range	1000 – 5700 m.a.s.l (**Webb et al., 2012,** pp. 45)
	Average altitude	2900 m.a.s.l.
	Main land cover types	Andean forests and shrublands, plantations, cropland, pasture lands, water bodies, urban settlements
	Land cover (%)	44.3 % grasslands, 25.38 % forests and urban settlements, 16.14 % arid lands, 14.48 % shrubland
	Biodiversity	80 plant species, 34 animal species, among other endangered species (*)
Culture	Quechua identity	84.1 % of population perceives itself with Quechua (people) origins
	Quechua language	71.5 % of population learnt Quechua during childhood
	Illiteracy rates	28 % of the Quechua-speakers and 1.4 % of the Spanish-speakers are illiterate in Apurimac
	Illiteracy rates	21.6 % of Apurimac's population is illiterate (national average: 5.9 %)
Note: Apurimac's etymology: Quechua term 'Apu Rimaq': *the god that speaks.* (*) there is no biodiversity inventory to date for Apurimac (**PRODERN 2016).**		

In *economic* terms, Apurimac contributes to 0.49 % of the national Gross Domestic Product. Its main economic activities are agriculture and livestock breeding (employs 49 % of the economically active population), services and commerce. Specially the agricultural sector is affected by poor road network and poor technological advancement.

Apurimac is part of the *Southern Peruvian Mining Corridor,* which concentrates 50 % of the mining mega-investment in Peru for iron and copper extraction valued 30 000 Million USD. This Corridor also concentrates most socio-environmental conflicts in Peru (34.7 %), conflicts which result from threats to public health, water pollution, violation of community agreements by extractive companies, strikes for labor rights and legal issues. A critical figure is that 49.1 % of Apurimac's surface is currently concessioned to mining activities (**COOPERACCION ET AL., 2018**).

In *social* and *cultural* terms, Apurimac is affected by poverty and institutional failure, short life expectancy, high malnutrition rates, child mortality and environmental pollution due to mine dumps. This region has a high proportion of Quechua-speakers and illiteracy rates. According to ethnic self-identification in the last census, most of the population in Apurimac perceived themselves as *Quechua* (84.1 %), compared to the

national average of 22.3 %, and 71.5 % declared having learned Quechua during childhood (**INEI 2017**). Illiteracy rate in Apurimac is 21.6 % and in the province of Abancay, where the Mariño watershed is located, illiteracy rate is 13.4 %. Being raised in Quechua-speaking environments is tightly linked to less educational and economic opportunities in Apurimac (**INEI 2007)**. Illiteracy in Apurimac affects 28 % of the people who learnt Quechua during childhood, whereas it only affects 1.4 % of the Spanish-speakers. Illiteracy affects more the rural than the urban sector.

In *ecological and geographic* terms, Apurimac is located in the Eastern slope of the Andes and has one of the most accidented topographies in Peru. Altitudes range from 1050 to 5700 m.a.s.l. (**WEBB ET AL., 2012**, pp 45). Apurimac's accidented topography hosts the Apurimac Canyon, the deepest in the world (4691 m depth) and the Ampay National Sanctuary, Apurimac's only protected area.

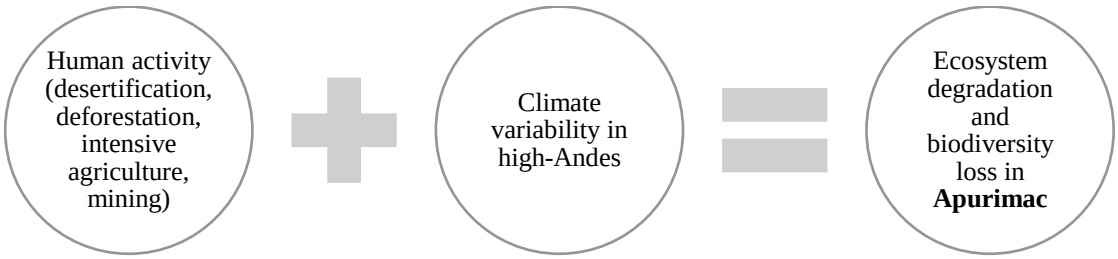


Figure 9 The climate and anthropogenic vulnerability in Apurimac.

Apurimac's rugged topography hosts great diversity of microclimates and ecological floors; however, it also makes Apurimac vulnerable to climate change and intensified human activities. It is expected that climate change will impact Apurimac with water shortage, biodiversity loss, extreme events and thus threaten its agriculture-based economy (**PACC PERU, 2014**).

Climate change adds to the anthropogenic ecological vulnerability in Apurimac (Figure 9). Using the agricultural rural production as example, the transition from communal to individual land governance is observed in Apurimac, and this implies that land use of Andean hill sides intensifies, land rotation and rest practices get lost. Intensified land use increases the climate risks in high mountain agricultural parcels (**ERFCC APURÍMAC, 2012**). Furthermore, there is a weakening of social structures in peasant communities and knowledge produced over centuries for the adaptation to the climatic variability of the Andean ecosystems will be lost in part. Without strengthening of good community environmental governance, social vulnerability will increase under climate change (**ERFCC APURÍMAC, 2012**, pp 75).

Poorly informed decisions risk Andean ecological resilience and aggravate human poverty. Policy design often results in decisions detrimental to Apurimac's biocultural capital and human well-being. Moreover,

the study area of the Mariño watershed undergoes rapid changes in landscapes and conservation conflicts emerge, thus causing loss of ecosystems, sources of ES.

Regarding biodiversity, there is no study to date about Apurimac's biodiversity abundance or distribution. Apurimac's Regional Government **(PRODERN 2016)** only highlights presence of endangered native flora and fauna in the department.

National Context

At a national scale, Peru, whose territory is differentiated in coastal, Andean and Amazon region, faces challenges to reduce poverty and protect its natural and cultural heritage, especially vulnerable to climate change and human decisions.

Peru is one of the most megadiverse countries in the world (according to diversity of species) and has 27 of the 32 climate zones of the world, influenced by the presence of the Andes and the Humboldt current. This biological wealth, shaped by rugged terrain, is especially affected by climate change: *Peru is the third most vulnerable country to climate change in the world* (**ADGER ET AL., 2004**). In the last 30 years, Peru has lost 39 % of its glaciers' surface, which in turn make 71 % of the world's tropical glaciers. Although Peru causes 0.01 % of global Greenhouse Gas Emissions (138 million tons of CO2), 40 % of these emissions come from the changes in land use and deforestation of primary forests (**MINAM, 2013**). Climate change impacts in Peru range from water scarcity, glacial melt, food insecurity, infrastructure damage and risks to human health (malnutrition) projected as early as 2030. This is detrimental to agriculture, the national traditional economic activity. Vulnerability of Peru to climate change is shown by 67 % of disasters caused by climatic phenomena.

It is crucial to highlight that climate change in Peru only aggravates pre-existing institutional failures of the Peruvian State such as absent social and environmental safeguards, absent investment in science and technology, centralist policies and systematic abandonment of the rural sector. Moreover, extractive economic policies lead to the overexploitation of Peru's natural heritage, as well as social displacement and marginalisation, causing altogether cultural erosion of highly specialized local systems of knowledge. Adaptation to climate change in Peru thereby demands institutional changes of social, political and economic structures in the pursuit of sustainable and inclusive development (**HEIKKINEN, 2017**).

To address systemic challenges, Peru started environmental legal stewardship efforts. Since 1997 sustainable use of biodiversity and its research is promoted (Conservation and sustainable use of biodiversity **Law Nr. 26839**). Since 2014 Payment for Ecosystem Services **Law Nr. 30215** promotes raising payments from ES users for long-term conservation of ecosystems. Since 2017 the intangibility of upper watersheds, as water storage sources, has been declared (Hydric Resources **Law Nr. 30640**), thus

limiting extractive activities in intangible watersheds and promoting territorial ordering and hydric inventories. Most recently, the Climate Change **Law Nr. 30754** in 2018 promotes climate stewardship.

Global Context

The topics addressed in this investigation are relevant to global sustainability efforts. For instance, the climate vulnerability in the Peruvian Andes is linked to the *Paris Agreement* and global urgency to keep the global average temperature increase limited to 1.5°C above pre-industrial levels. In total, 195 countries have subscribed, and Peru is a signed member.

Furthermore, the core of this valuation study is to make multiple values of nature visible to decision-makers, given the high rates of ecosystem degradation in the study area. These conservation challenges align with the general concern by the *Convention on Biological Diversity (CBD)* and its Aichi Biodiversity Targets by 2020, which seek the sustainable use of biological diversity and equitable share of its derived genetic benefits. Peru is one of the 196 nations having subscribed. Recent restoration initiatives in the Mariño watershed also align with international forest restoration challenges, such as the *Bonn International Challenge*, which aims at restoring 20 million hectares by 2020 in Latin America, and to which Peru committed in 2014 (**CIFOR 2017**).

It is important to highlight, that the interest of valuing the natural capital responds to the ultimate goal of achieving human well-being. This overarching goal is well represented by the 17 *Sustainable Development Goals* (SDGs), set by United Nations in 2015, which cover global sustainable human development goals to be reached by 2030, such as no poverty (Goal Nr. 1), clean water (Nr. 6), climate action (Nr. 13) to protected life on land (Nr. 15). Peru is one of the 193 signing members.

Overall, there are important sustainability efforts that seek to increase momentum for sustainable decision-making in neglected but vital hotspots of life on the planet and to which Peru has committed. This global context validates the general importance of undertaking research for sustainable development in the Peruvian Andes, a region with limited access to data and academic representation.

4 METHODS AND STUDY AREA

4.1 RESEARCH METHODOLOGY

Mixed Methods Research (MMR)

The present study uses an MMR approach called *methodological triangulation* (Webb et al 1966 cited in **Bryman 2012**). This approach uses more than one data collection and analysis method to analyze and better understand a socio-environmental phenomenon, in the Mariño context that is the social valuation of ES and threats. Mixed methods allowed for collection and triangulation of diverse data sources to answer research objectives. The general research flow is detailed in Figure 10.

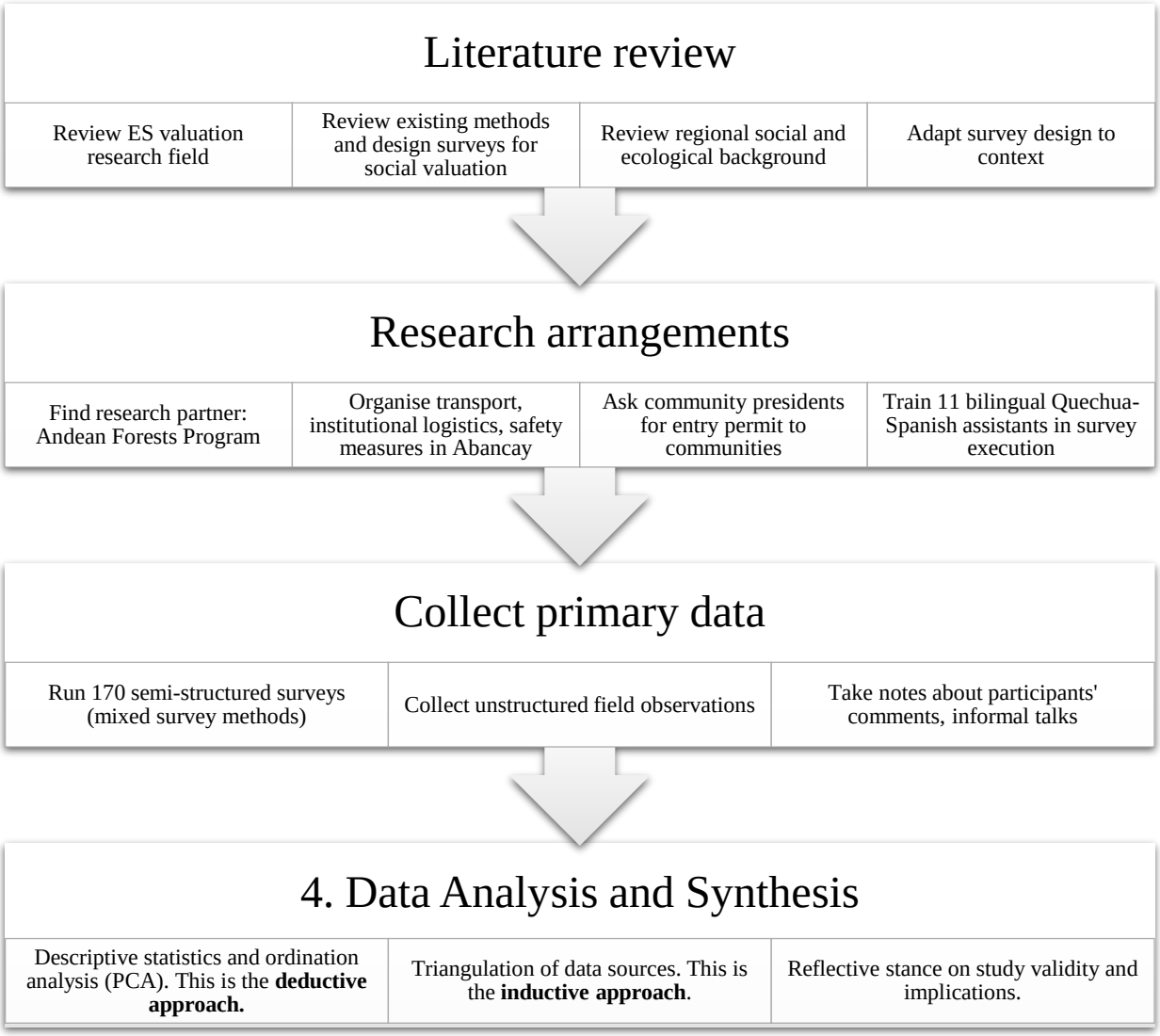


Figure 10 Flowchart of Research Steps

The study collected *quantitative data* in the form of numerical rankings through semi-structured surveys. The study collected also *qualitative data* in the form of unstructured participant observation, informal talks with rural residents, field notes and quotes from interviewees.

A *deductive logic* is used to interpret the quantitative data and statistical analysis, supported in the review of secondary sources. Moreover, an *inductive logic* is used to describe the logic of local people and social reality behind the social value rankings. Both logics are combined for the Discussion.

Value Assumptions in this Study

The study focus on social values is justified in the *values-beliefs-norm theory* (Figure 11). According to this theory of environmental behaviour, values are one of the key drivers of environmental behaviour (**KENTER 2015**). By understanding social values ascribed to nature, we understand environmental behaviour of rural residents in the Mariño uplands. Findings may set foundation for regional value-based policy-making that targets local social priorities and concerns more effectively, e.g. as a multi-criteria decision support tool **(GONZÁLEZ-JIMÉNEZ ET AL., 2018)**.

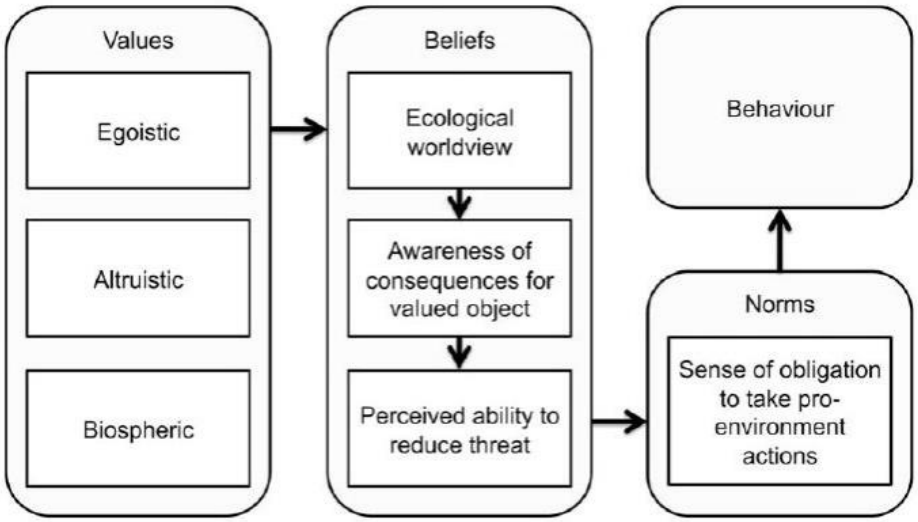
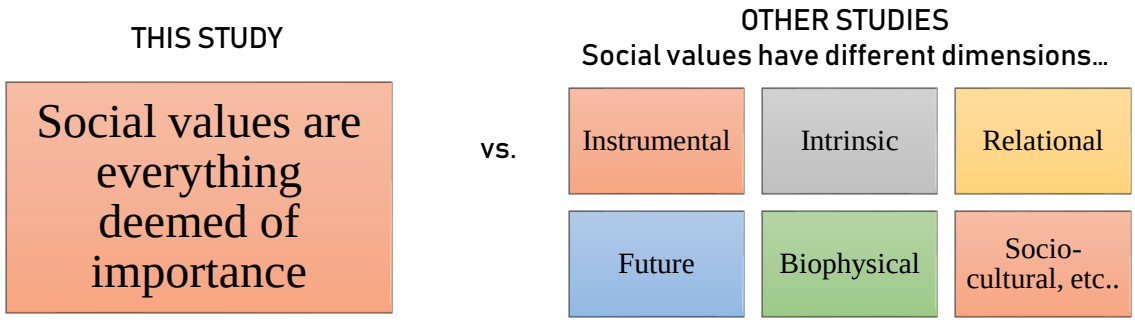


Figure 11 The Values-Beliefs-Norm Theory of environmental behaviour. Source: **Kenter et al., 2015**.

Furthermore, social values are defined as "*everything being deemed of importance*", based on the social value definition by **ZAGAROLA ET AL. 2014**. This allows me to capture the various value dimensions that might exist for an individual, such as instrumental, economic, cultural, social, and intrinsic value, without imposing the use of any particular type. This simpler approach contrasts to more complex social value typologies used in previous studies by **SHERROUSE ET AL., 2011, PAUDYAL ET AL. 2018, VALDIVIA 2017, NAHUELHUAL ET AL., 2016**, schematized in Table 4.

Social preferences will depend on perceptions and knowledge people have about the entity to be valued (e.g. a certain ES), as well as on the relative contribution of this ES to individual and community well-being.

Table 4 Social Value definition in this study



Valuers or value-holders are defined as rural residents in the uplands of the Mariño watershed who are users of ES. Rural residents are known to live near Andean native ecosystems, practice traditional subsistence livelihoods, live in partial or complete material poverty conditions and have incomplete or no formal education. Previous studies in rural Apurimac expose the existence of Quechua social institutions, practices and customs (**KOMETTER 2018; HUASASQUICHE AND KOMETTER, 2017**).

It is plausible to state that rural residents ascribe social values to environmental goods and services, according to previous social valuation studies of cultural ES and compilation of local medicinal plant knowledge (see **VALDIVIA 2017, LOCATELLI ET AL 2016** and **VALLET ET AL. 2016)**. Furthermore, values are those that local groups attach to land-based livelihood strategies and are associated to the local groups' relationships with the landscape, comprising cultural identity, stewardship and knowledge about the land. For these reasons, locals shall be able to value nature's benefits, sensu **GONZÁLEZ-JIMÉNEZ ET AL., 2018.**

Regarding the geographical study specifications, the study subjects were three rural communities named *Atumpata, Llañucancha, and Micaela Bastidas*, located in the upper part (2500 to 4000 m.a.s.l) of the Mariño watershed. Further communities located upstream or downstream of the Mariño watershed, that is the middle and lower watershed part below 2500 m.a.s.l, were not surveyed. The sampling targeted any rural household member willing to participate in the study, no selection is made based on gender or family role (e.g. role as *head of family*).

4.2 STUDY AREA: THE MARIÑO SOCIO-ECOSYSTEM

The Mariño Watershed

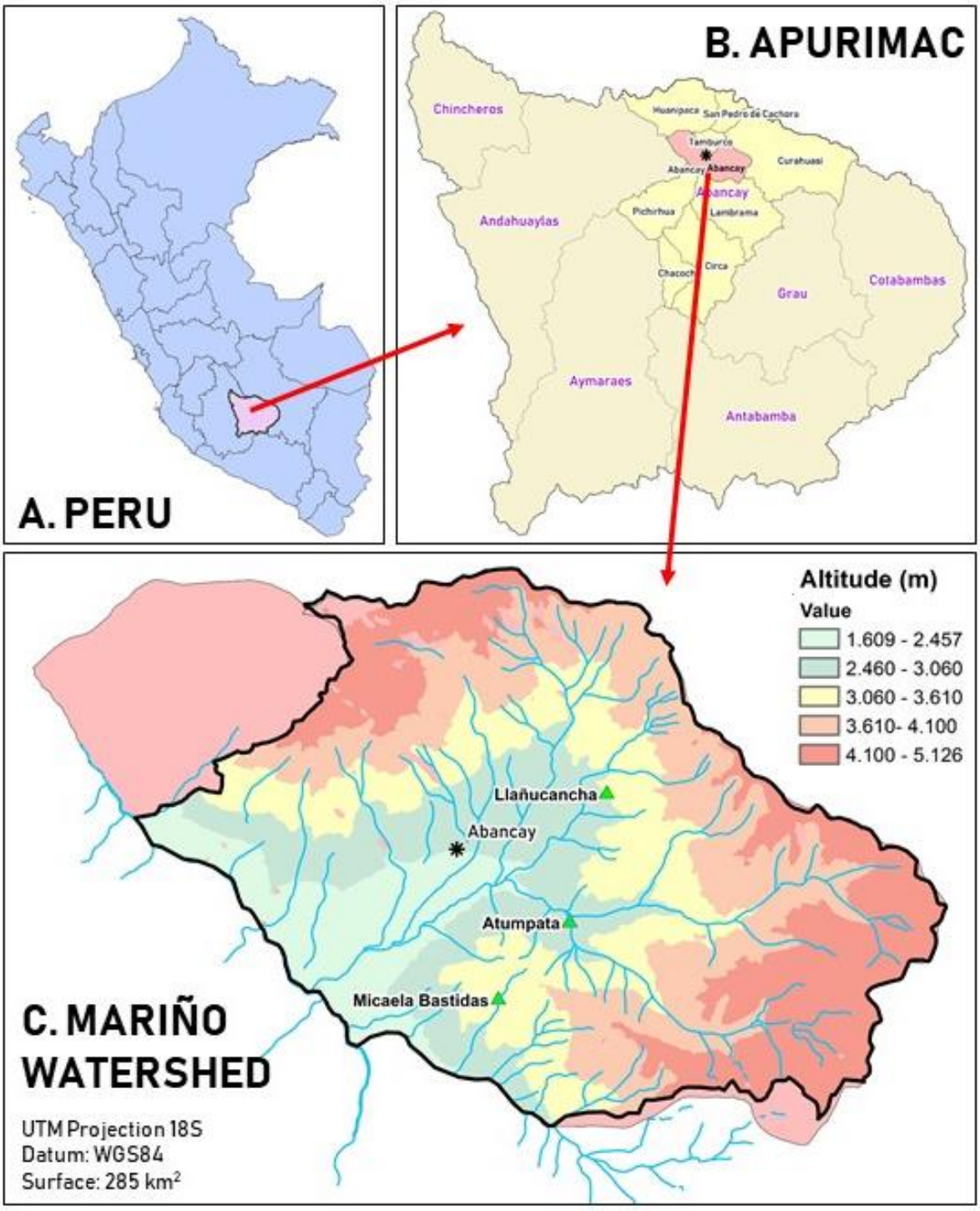


Figure 12 Location of the Mariño watershed.
(A) Peru and its 24 departments, (B) Apurimac department and its 07 provinces in purple text, and the Abancay province and its 09 districts in black text, (C) the Mariño watershed.

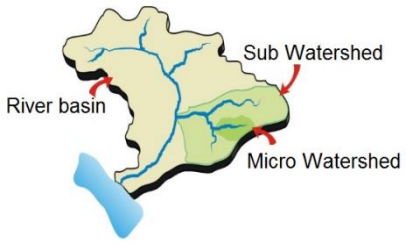
The present study takes place in the micro-watershed of the Mariño river, near the City of Abancay, Capital of the Apurimac Department in Peru. The watershed covers 80 % of the *Abancay district* and 20 % of the *Tamburco district*, both located in the Abancay province (see Figure 12). This micro-watershed is a complex socio-ecological, mountain and high-Andean system that provides ecosystem services and goods to upstream rural users in the communities of Micaela Bastidas, Atumpata and Llañucancha, as well as to downstream urban beneficiaries in the city of Abancay (2377 m.a.s.l).

The Mariño watershed was chosen as the study area given that it is one of the Andean Forest (ANFOR) Program's key intervention areas in Apurimac, and the research takes place within the ANFOR program. ANFOR carries out applied research in the Peruvian Andean forest seeking its restoration and rehabilitation to mitigate climate change.

General Watershed Characteristics

Hydrologically, the Mariño watershed is the unit of area that covers all the land that contributes runoff to the Mariño river, the common outlet. This micro-watershed belongs to the Pachachaca sub-watershed. Table 5 compiles morphological characteristics of the watershed. The Mariño micro-watershed has an upper part, mountainous areas limited by water dividers; the middle part where the waters are collected from the highlands; and the lower basin, where the river flows into larger rivers.

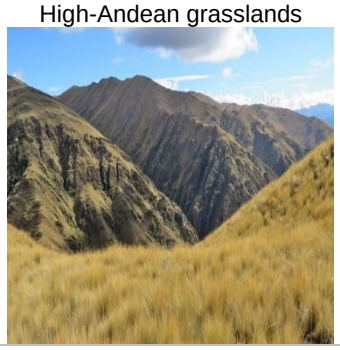
Table 5 The Mariño micro-watershed: Morphological characteristics

Watershed type	Micro-watershed, schematization: 
Area	285 km^2
Perimeter	87.4 km
Altitudinal range	1618 m.a.s.l. (Pachachaca river) to 5178 m.a.s.l. (Ampay glacier)
Relief	High-mountain watershed with outstanding natural features (lakes, rivers, forests).
Climate	• Average annual temperature: 16.7°C, temperate climate • Annual total precipitation: 685 mm • Rainy season (October – March), rainiest month is March • Dry season (April – September), driest month is June

Note: Picture from **CONDORI QUISPE, 2016**. Climate data from climate-data.org

Ecologically, there are four native Andean ecosystems present in the study communities relevant for the social valuation listed in Table 6. The traditional Andean agricultural and production unit called *chacra* is also considered as source of ES.

Table 6 The Ecosystems present in the Study Communities.

Ecosystem	Definition
Andean forests 	Andean forests can be of mid (3000 - 3800 m.a.s.l.) to high (3500 - 4900 m.a.s.l.) altitude. They occur in semi-arid environment and cover **0.25 %** of the national territory. **Mid-Andean** forests have a fragmented distribution, mostly located on inaccessible mountain slopes, dominant species of the genus *Escallonia* (0.17 % of the territory). **High-Andean** relict forest are highly fragmented and poorly accessible, dominated by genus *Polylepis* (*Queñua*) and *Escallonia* (0.08 % of the territory). Both forests are present in the Mariño watershed.
High-Andean grasslands 	Grasslands occur in sub-humid environments in the high plateaus and bottoms of glacial valleys of the Andes mountain range (3800 - 4800 m.a.s.l.). Consists of herbs in the form of grass and shrubs (15cm - 120cm high). They cover **14.16 %** of the national territory.
High-Andean wetlands (*bofedales*) 	Bofedales occur in super-humid environments in the high Andean region of southern Peru, starting at 3800 m.a.s.l.. They feed on water from melting glaciers, upwelling of groundwater (called *puquial*) and local rain. They cover a total **0.42 %** of the national territory.
Managed production systems (*chacra*) 	These are areas where the traditional agricultural and breeding activity is carried out in slopes of valleys up to the limit of the high-Andean grasslands (3000 - 3800 m.a.s.l.). They cover **4.57 %**of the national territory.
Note: Vegetation cover types descriptions sensu **MINAM, 2015.**	

The **importance** of the Mariño watershed relies *first*, in its high climate vulnerability. Glaciers in the Ampay National Sanctuary, located within the watershed, suffer a serious setback of glacier surface. High-altitude water reserves and wetlands suffer decrease in the volume of water. Increasingly frequent and intense warm spells and shifts in precipitation patterns are the most evident effects of climate change in the Mariño (and Andean) region (**SCHOOLMEESTER ET AL., 2018**). *Secondly*, the watershed is important as it is greatly affected by anthropogenic water insecurity: rural communities in the upper part of the watershed subsist on native ecosystems and use them in uncontrolled ways whereas urban population in the lower part of the watershed cause further deterioration of the Mariño river morphology and riparian zones through pollution and habitat conversion. *Thirdly*, the Mariño region is an important hotspot of native Andean flora and fauna species, like the relict tree *Polylepis sp.* one of the ten most threatened endemic tree species of Peru **(SERFOR, 2016**). Anthropic pressure on biodiversity hotspots outside the Ampay sanctuary drives its loss. *Finally*, Mariño watershed is marked by strong social contrasts: 20 % of the population in the city of Abancay and surroundings live in extreme monetary poverty and 55 % of the total population in the city of Abancay speaks Quechua (**INEI 2007).** Overall, tight links between poverty, social exclusion, low formal education levels and practice of Quechua language and customs are observed.

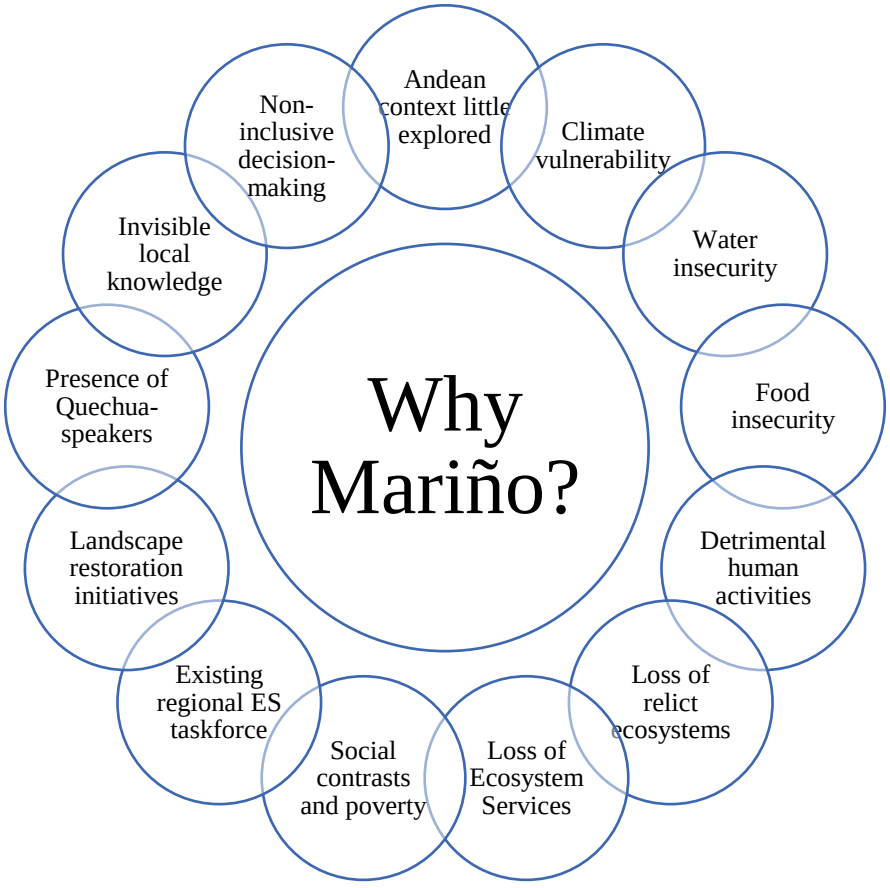


Figure 13 Why Mariño? Specific reasons for a social valuation in the Mariño region.

The **conservation status** in the Mariño watershed is increasingly drawing attention from local decision-makers. On the one hand, the Sanitation and Sewerage Service Providing Company in Abancay (EPS EMUSAP Abancay) and the National Superintendence of Sanitation Services (SUNASS Abancay) have implemented a payment scheme for use of water ecosystem services in the Mariño watershed since January 2018. Funds raised from 12 300 water users in Abancay city tackle water shortage in the upper watershed. The Mariño watershed becomes in this way one of the only three watersheds with an already implemented payment scheme. Parallel to this, the Mariño region has seen growing regional interest towards ES valuation studies in the watershed e.g. by **LANDOLT 2018, LOCATELLI AND GALMEZ 2015**.

Interest to record time series and meteorological data for research purposes to warn about water scarcity exists ever since a hydrogeological monitoring project started in the Rontoccocha lake in 2015 (4000 m.a.s.l.), the first of its kind in the region. This high-altitude water reservoir, located in the Atumpata community, feeds tributaries of the Mariño river.

Decision-makers in Mariño have also shown interest towards revaluing ancestral water management practices. Water harvesting programs using artisanal *qochas* (dams) have been implemented in upstream grasslands. These activities have empowered rural land-owners towards community-based climate resilience and ecosystem restoration (**KOMETTER, 2018)**. These and other initiatives supported by International Cooperation Agencies (Swiss, Spanish, German, Belgian), local NGOs, Peruvian national and regional Government's programs and communities seek altogether to strengthen environmental awareness, poverty alleviation and ecosystem restoration with native species in the watershed.

The Study Communities

The upstream rural communities of Llañucancha, Atumpata and Micaela Bastidas (hereafter *study communities*) were selected because the ANFOR Program had been working directly with them for the last years with mutual understanding and field entry point. In the Mariño watershed there is a total of ten rural communities (**LOCATELLI AND GALMEZ, 2015** pp 17).

LOCATELLI AND GALMEZ, 2015 describe the suitability of the selected three study communities as they are ecologically representative for the upstream Mariño watershed (2500 m.a.s.l. to 4200 m.a.s.l.). Specifically, they have (i) abundant genetic resources, in the upstream part of the watershed; and (ii) high quality and abundance of water, as communities' location overlaps with Andean ecosystems harvesting water. Moreover, the communities host the Rontoccocha-hydrological route, an important ecotourism pilot project by the local municipality.

The studied communities, like all rural communities in Apurimac, are spaces for self-government and within them the families use the land under communal property in an organized way (**PRODERN 2016,** pp. 27). These rural communities are often deficient in basic services, with a low level of education and high poverty rates. The surrounding natural environment has rugged topographies and steep slopes.

Access to the study communities, from Lima, capital of Peru, is possible by air up to Cusco and then by land up to Abancay. It is convenient to stay in the city of Abancay for the duration of the investigation, and from there travel in pick-up trucks for up to 1.5h one-way to reach each of the rural communities.

Table 7 The Study Communities.

CRITERIA	COMMUNITY		
	ATUMPATA	LLAÑUCANCHA	MICAELA BASTIDAS
Coordinates (UTM)	18S 732350 E 8489926.2 N	18S 733594.9 E 8494183.4 N	18S 730010 E 8487380 N
Area (km^2)	4.9 km^2	2.7 km^2	19.0 km^2
Air distance from Abancay city	7.0 km	6.3 km	9.0 km
Sectors	Upper Atumpata, Lower Atumpata	Upper Llañucancha, Lower Llañucancha	Wiraccochapata, Rosaspata, Tancarpata, Upper Quisapata, Lower Quisapata
Average Altitude (m.a.s.l)	3000	3193	3189
Total population > 18 years < 18 years Female : male	**180** 120 60 80 : 100	**400** 360 40 200 : 200	**1000** 600 400 600 : 400
Average Annual Temperature	15.3 °C ± 3°C	12.5 °C ± 3.4 °C	12.0 °C ± 3.4 °C
Average Annual Precipitation	758 mm	869 mm	858 mm

Note: Population data estimated by Community Presidents, high resolution census data not freely available. Climate data from **climate-data.org**

4.3 DATA COLLECTION

Surveys were chosen as the methodological instrument for data collection as "*their research objective is to find information about a given social group in the form of either measurable results or qualitative results"* (**PEREZ 2011**). Semi-structured surveys were designed to encompass a set of mixed survey methods taken from previous social valuation studies by **FONTAINE ET AL., 2013; VALDIVIA DIAZ, 2017; PAUDYAL ET AL., 2018; OPENNESS PROJECT, 2016** and **ZAGAROLA ET AL., 2014.**

Foci of social valuation

Foci of valuation were a selected set of ES and threats, that exclusively exist and occur in the study communities, and to which social values were ascribed. Rural residents thus prioritized *place-specific ES.*

The selection of the valuation foci was based on bibliographic review of ES frameworks (**IPBES 2017**, **MA 2005**); literature informing about ES and threats relevant for the Mariño or mountain context

(**PAUDYAL ET AL., 2018, ZAGAROLA ET AL., 2014, CAST AT AL., 2008, RAYMOND ET AL., 2009, LANDOLT 2017, LOCATELLI AND GALMEZ 2015, VERGARA 2017**); and field observations during previous research project phases in the region. Papers for ES selection compiled in Appendix: Table 34.

Table 8 The 29 ecosystem services selected for the social valuation

CATEGORY	ID	ECOSYSTEM SERVICES	DEFINITION
PROVISIONING	P1	Water for consumption	Surface and groundwater quantity supply for direct use like drinking or indirect use like irrigation, cattle, transport, domestic use.
	P2	Food from managed systems	Food for human consumption from managed systems (agriculture, livestock, fisheries).
	P3	Food from natural systems	Wild foods for human consumption from natural systems: wild fruits, bush meat, mushrooms, honey
	P4	Medicinal resources	Supply of medicinal plant and animal resources
	P5	Biomass energy sources (firewood)	Biomass for energy production (firewood, straw, animal dung)
	P6	Materials, fiber and ornaments	Building materials, such as wood and straw. Wool, leather, bones, fertilizers (manure), ornamental plants, seeds.
	P7	Fodder for animal consumption	Food for animal consumption
	P8	Geological resources	Supply of metals and non metals.
	P9	Natural shadow	Natural shadow from trees
	P10	Renewable energies	Abiotic renewables (geothermal, sun, hydropower) energy sources
REGULATING	R1	Regulation of soil, water and air quality	Biological storage and filtration of pollutants in air, land and water. Filtration of particles and pathogens.
	R2	Regulation of freshwater quantity	Regulation of how much water is stored, how much water leaves and how much water enters the system
	R3	Extreme events regulation	Erosion and landslide control by vegetation.
	R4	Soil formation and fertility	Geochemical soil conditions, includes nutrient storage and cycling, soil fertility and formation
	R5	Local climate regulation	Maintenance of local climate patterns
	R6	Carbon sequestration and storage	Carbon storage and sequestration through many processes (PS, microbial activity, C capture)
	R7	Pollination and seed dispersal	Pollination by bees and other insects; seed dispersal by insects, birds and other animals
	R8	Control of pest and diseases	Reduction in disease incidence, risk for human populations. Reduction in animal and plant disease incidence, risk for managed and natural ecosystems
	R9	Habitat services	Watershed as nursery place for endemisms
	R10	Genetic resources, breeding	Genetic information used for plant and animal breeding and biotechnology.
	R11	Primary production through PS	Oxygen production
CULTURAL	C1	Scenic beauty and inspiration	Watershed offers aesthetic enjoyment (all senses), scenic beauty based on close contact with nature, and inspiration for art and design
	C2	Recreation and ecotourism	Watershed offers physical and psychological beneficial opportunties for healing, recreation, leisure, tourism, entertainment
	C3	Spiritual and religious values	Watershed living beings and landscapes and as the basis for spiritual and religious narratives, rituals and celebrations
	C4	Intrinsic value	Existence values, enjoyment and satisfaction provided by knowing that a particular landscape, habitat or species exists in the waterhsed
	C5	Value for future generations	Continued existence of wateshed for future benefits for future generations (discoveries, unanticipated uses of organisms that exist), ethical perspective or belief
	C6	Cultural identity	Cultural diversity and heritage values, sense of place. Watershed living beings and landscapes providing you a sense of place and cultural belonging
	C7	Source of knowledge	Watershed living beings and landscapes offer opportunties for the development of cognitive skills, knowledge, formal and informal education
	C8	Sense of place	Place where you feel you and your social boundings rooted, connected to

By selecting proper valuation foci, I *controlled* for (i) scientific validity to the social valuation exercise, by selecting only ES types used by previous scientific studies; (ii) identification of ES valuation gaps and include underassessed ES in the literature; (iii) identification of ES outside ES policies and payment schemes in the Mariño region.

In total, **29 Ecosystem Services** were selected for the social valuation and were grouped in the three **MA 2005** categories (see Table 8). Categories were: (i) *provisioning ES* or tangible marketable products; (ii) *regulating ES* or benefits obtained from the regulation of ecosystem processes and necessary to produce all other ES (regulating and supporting ES are merged here); and (iii) *cultural ES* or nonmaterial benefits people obtain from ecosystems. Previous social valuation studies have used in average 20 ES (see Table 2). The selected ES cover a wide span of instrumental to non-instrumental value dimensions.

Similarly, **11 threats** were selected after review of local studies, see Table 9. Threats are defined as potentially damaging physical events that can cause human death, material damage, environmental degradation and interruption of social and economic activity that exist and are perceived in the three study communities. This definition has been used before in **ERFCC APURÍMAC, 2012**. Threats can be of human (e.g. deforestation) or natural (e.g. hailstorms) origin.

Anthropogenic or natural threats existing in the Mariño watershed but not in the study communities, like deglaciation of the Ampay glacier **(LOCATELLI AND GALMEZ, 2015**, pp11), are not considered in this study. Other threats of economic, institutional or social character remain outside the scope of this study.

Table 9 The 11 threats selected for the social valuation

ID	THREAT	DEFINITION
T1	Droughts and desertification	Climate-change effect: lack of precipitation. Shortage of rain, water scarcity, dry fields.
T2	Floods	Climate-change effect: excess of precipitation. Mudflows (huaucos) created by intense rains.
T3	Landslides and soil erosion	Anthropogenic. The soil is eroded, no vegetation layer, unstable soil.
T4	Bush fires	Anthropogenic, threat not endemic to the Andes. Seasonal, uncontrolled or accidental induced fires to expand the agricultural front threaten native forests, flora and fauna, and cropland.
T5	Logging	Anthropogenic. Forest logging for firewood or timber.
T6	Overgrazing and overtrampling	Anthropogenic. Livestock overgrazing and overtrampling (animal weight causes mechanical damage on soil), there is lack of territorial ordering and fencing.
T7	Extreme heat	Climate-change effect: extreme hot temperatures. Warm spells (*veranillos* in Spanish).
T8	Solid waste pollution	Anthropogenic. Garbage lies open-air, is not collected, lack of municipal waste collection and treatment.
T9	Urbanization	Anthropogenic. The populated city of Abancay is expanding threatening agricultural parcels, wild areas.
T10	Hailstorms and frost	Climate-change effect: extreme cold temperatures. Frosts and hail events cause damage to crops and houses.
T11	Agrochemicals	Anthropogenic. Fumigation and an excessive use of agrochemicals, poison local biodiversity and soil.

Survey design

Surveys were designed encompassing an array of qualitative visual and questionnaire methods summarized in Table 10.

Selected mixed survey methods were preference methods widely used in social valuations to articulate people's needs in non-monetary ways (**FELIPE-LUCIA ET AL., 2015**). Selected survey methods had the purpose of (i) identifying priority ES and threats on a participatory basis; (ii) eliciting social values in non-monetary units, specially of ES traditionally difficult to quantify like cultural and regulating service (**DE GROOT ET AL., 2016**); (iii) creating understanding and use intuitive methods for all types of audiences (ranging from illiterate to university students, young to elder participants); and (iv) stimulating ecological thinking in locals.

Table 10 Description of Survey Methods applied

METHOD	DEFINITION	CONCEPTUAL STRENGTHS	STRENGTHS ON THE FIELD
ECOSYSTEM SERVICES CARD GAME	• Captures sociocultural values related to ES combining photo-elicitation and ranking exercise.	• Explores and understands human perceptions on ES. • Ideal for small spatial scales (communities).	• Practical and light weight format (cards) for changing weather conditions and long hikes to households.
PHOTO-ELICITATION	• Visual qualitative tool to identify social perceptions of ES	• Visual stimuli can be commonly understood • Participants reflect on what ES mean to them	• Intuitive (for elderly, illiterate) • Practical (short time, changing weather field conditions) • Photos in cards of local landscapes exclusively.
RANKING EXERCISES	• Simple preference method where respondent chooses preferred item over others.	• Quantitative ranking built following subjective importance (evaluation criterion). • Results can be compared across individuals. • Identifies priority ES and threats	---
SOCIODEMOGRAPHIC QUESTIONNAIRE	• Closed and multiple-choice questions on 17 socio-economic variables	---	• Quick, easy to understand

Selected survey methods had to have also a quick application and low-costs. As the study area was unknown to me, methods chosen had to be flexible, intuitive and practical to be implemented in diverse survey settings (precarious settings, harsh weather conditions, little farmer's time availability).

It is important to highlight that semi-structured surveys benefited from field learning inputs in pre-testing phases (phases overview in Appendix: Table 29). First contact with residents and local partner CEDES NGO allowed me to rephrase technical terms into popular wording (see Appendix: ES Description in Popular Language**)**.

Survey procedure

The social valuation followed an *individual survey* format consisting of a card game and a sociodemographic questionnaire. Each survey had a duration of 30 to 45 minutes and required one researcher for each interviewee. Table 11 provides an overview of the specific field work dates in which surveys were carried out for each study community. Participants signed the List of Participation.

Table 11 Field Survey Dates. Month: November 2018.

Monday	Tuesday	Wednesday	Thursday	Friday
12 **Micaela Bastidas** Surveys start: 6:00am Surveys finish: 6:00pm	13 **Micaela Bastidas** Surveys start: 6:00am Surveys finish: 6:00pm	14 **Micaela Bastidas** Surveys start: 6:00am Surveys finish: 6:00pm	15 **Llañucancha** Surveys start: 6:00am Surveys finish: 6:00pm	16 **Llañucancha** Surveys start: 6:00am Surveys finish: 6:00pm
19 **Llañucancha** Surveys start: 6:00am Surveys finish: 6:00pm	20 **Atumpata** Surveys start: 6:00am Surveys finish: 6:00pm	21 **Atumpata** Surveys start: 6:00am Surveys finish: 6:00pm	22	23
Note: Schedule and travel logistics coordinated with Partner NGO CEDES beforehand. Trained research assistants joined throughout the survey process.				

In total, 173 individual workshops were conducted in total with the assistance of 11 trained research assistants. Assistants were bilingual university students and professionals in Spanish and Quechua, with experience in conducting surveys in rural areas in Peru. The survey guide (see Appendix: Survey Guide**)** was developed to train assistants and to control for the correct information transfer during the individual workshops. Due to data incompleteness, three surveys were discarded, 170 was the final sample size.

Surveys were applied face-to-face to one single rural interviewee and by one single bilingual interviewer (research assistant fluent in Quechua and Spanish) or by the researcher and her Quechua translator. Encounter with rural residents was made by visiting them in their homes or farms in person or by random encounter with them on pathways. Survey procedure required a quiet environment, sitting participants and flat surface to present laminated pictures.

Figure 14 Field impressions during survey execution: interviewees familiarize with and build social value rankings.

Needed survey materials (see Appendix: Survey materials) were: (1) Answer sheets containing tables to record valuation rankings; (2) 29 ES cards and 11 threats laminated cards with allusive pictures in the front and text description in the back; (3) a cloth with the printed numerical ranking; (4) certificate of

participation for interviewee; (5) small donation item for participant; (6) smartphone with installed GPS App called Osmand version 3.2.2 (OpenStreetMap database). If research assistant had not installed Osmand, households were re-visited to be georeferenced.

The *survey procedure* started by introducing the study goal, how the community may benefit from the knowledge generated through the social valuation and by mentioning the president's permission to carry out the study in the community. Interviewer proceeded to establish rapport with participant, introduce the Card Game (and discard unknown services cards) and run the ranking exercise per category (example: provisioning services only) using elicitation questions to awake reflection in participants. Interviewer then recorded rank order of cards (taking numeric Card ID Codes) per category on answer sheets. Interviewer ran the sociodemographic questionnaire and requested participants to voluntarily confirm participation by signing List of participants. At the end, interviewee would receive certificate of participation and donation item as reward.

Sample Size

Sample size or the number of surveys to run was calculated based on population size estimations made by the communal presidents, as census data was not freely available. The final sample size or total number of surveys was 170 (adjusted sample size). Sample size was determined by study area characteristics, for example, walking distances to households and safety on the field. The sample size has a confidence level 95 % and a sampling error of 7 %.

Atumpata was the most sampled community, given the good connectivity of households to roads. For Llañucancha and Micaela Bastidas, final sample size was lower than the calculated one, given that many houses were found empty during field survey dates. In those cases, missed residents most likely alternated residence place between Abancay city and the community.

Table 12 Sample size calculation

A. Population data

Community	Total population (>14 years old)
Atumpata	120
Llañucancha	360
Micaela Bastidas	600
Total (N)	1080

B. Criteria for sample calculation

Criteria	Value
Sample size	170
Confidence level	95 %
Z	1.96
Error	0.07
N	1080
P = Q = 0.5	

C. Sample distribution

Community	Sample per community	Adjusted sample (*)
Atumpata	19	44
Llañucancha	56	42
Micaela Bastidas	95	84
Sampled total (N)	170	170

(*) According to personal refusal to participate, incompatibility of schedules. Otherwise, willingness to participate.

4.4 DATA ANALYSIS

The overall tenor of the data analysis is that through *triangulation* of quantitative and qualitative methods, confidence in findings shall be reinforced and compared, see Figure 15. Comparison of the study findings to previous mixed methods studies in the region is limited, given the poor number of social assessments of ES using mixed research methods in the Andes.

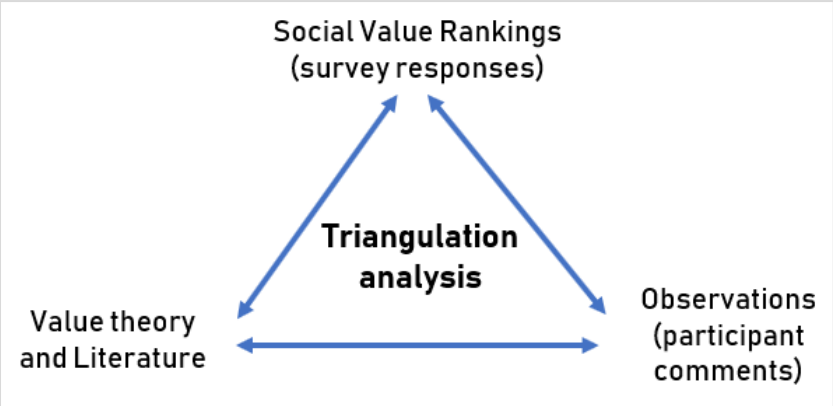


Figure 15 The methodological triangulation approach in this study.

Quantitative analysis

All surveys were systematized in a data editing program (MS Excel 2010), where numeric ES ranking data and sociodemographic questionnaires were converted to numeric codes to run statistical frequency analysis. Georeferenced surveyed households were mapped using ArcMAP 10.6.1.

To answer the specific research objectives and identify the four most prioritized ES and threats, absolute frequencies were modelled using the *weighted sum model* which yielded Social Value Rankings without overlaps, contrary to the overlaps in rank orders observed in **Figures 16 – 19.**

The *weighted sum model* (WSM) is an analytical solution from decision theory which assigns relative weights to a set of alternatives. The WSM is the most known and simplest *multi-criteria decision analysis* method to evaluate several alternatives in terms of a number of decision criteria (**TRIANTAPHYLLOU, 2000).** Analytical solutions to identify priority ES in social valuations have been used by **FONTAINE ET AL., 2013.**

The WSM was applied to numerical data, that is the absolute frequency values (note: applying WSM to the relative frequency values yields same social index-rankings). Moreover, the WSM used an inverse linear weighting method, i.e. for the 10 provisioning ES, the 1st rank position gets 10 points, up to the 10th position which gets 1 point. In this way, the weighting scheme follows a maximization principle, where the 1st rank position gets the highest WSM score.

Using MS Excel 2016 and the SUMPRODUCT formula**,** WSM scores were calculated for all categories of ES and threats (see Appendix: Data). The resulting WSM or **Social Value Index (SVI)** is the modelled social value (rank position) that rural interviewees assign in average to an ES, or in the case of environmental threats, SVI denotes social concern.

Moreover, a **principal component analysis** (PCA) was run to reduce the multidimensionality of the dataset while preserving as much information as possible. The XLSTAT 2019.2.3 Software (free trial) was used in MS Excel 2016. ES and threats were the variables, and individual survey ranking were the observations.

PCA required data cleaning: Regarding the *variables*, four of the most unknown ES, e.g. unknown by more than 10 % of the sampled population, were excluded. These ES types are listed in Table 15 and were Mineral resources and Renewable energies (provisioning); Carbon Sequestration (regulating); and Spirituality (cultural). Remaining were 25 ES, to which weights were assigned following the inversed linear WSM model. Regarding *observations* (e.g. individual surveys), four surveys were excluded given ranking incompleteness and PCA sensitivity. Final number of observations for PCA was 166.

Qualitative analysis

Unstructured field observations, without an observation schedule, aimed at capturing as much detail and insights as possible about the local environmental behaviour and participant comments to develop a narrative account of local behaviour and values. These observations done over a short period of time enriched the *inductive* interpretation of the data and Social Value Index rankings.

Triangulation of primary (observations and survey questionnaires) and secondary sources aimed at finding plausible and reliable contextual explanations to the quantified social preferences.

5 RESULTS

A total of 170 surveys were executed in the watershed; Per community these were 44 in Atumpata, 42 in Llañucancha and 84 in Micaela Bastidas, see Figure 16.

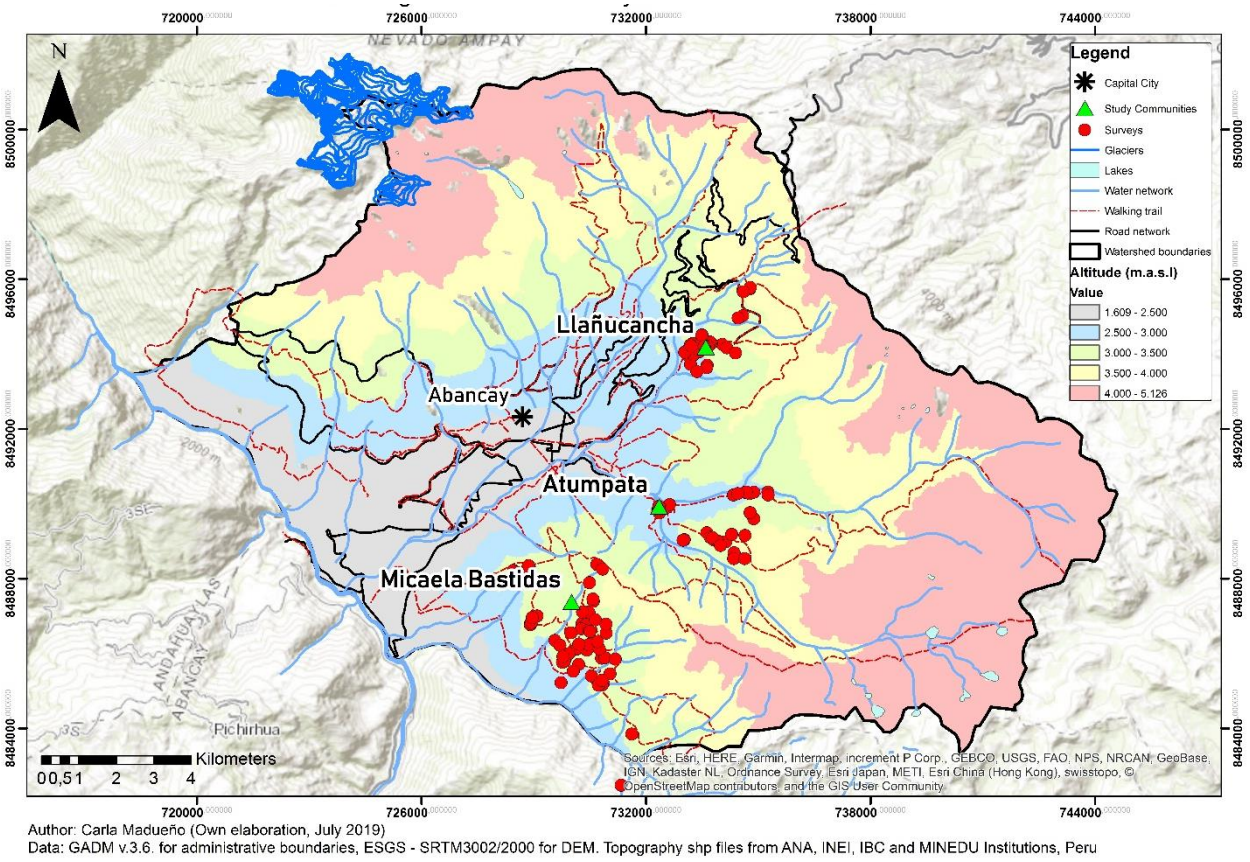


Figure 16 The 170 surveys in the Mariño watershed, Apurimac, Peru in red dots.

5.1 SOCIODEMOGRAPHIC CHARACTERISTICS OF THE SAMPLED POPULATION

Frequency analysis of the fourteen collected social variables are reported in Table 13. Regarding *gender*, 51.2 % of the interviewees were women and 48.8 % were men. The *age* of the sampled population ranged between 14 to 84 years, with an average age of 47.2 years. Most interviewees (82.9 %) indicated having no *community role*, 15.9 % (percentage sum) indicated having a communal leadership role.

The *average monthly income* of respondents was 257.4 soles (for comparison, 1 USD = 3.3 soles) and the most frequent monthly income was 50 soles.

Table 13 Socio-demographic characteristics of the sampled population

Variables		Rural communities	
		(n=170)	%
Gender	Female	87	51,2 %
	Male	83	48,8 %
Age (year)	14.0 – 22.8	16	10 %
	22.8 – 31.5	18	11 %
	31.5 – 40.3	30	18 %
	40.3 – 49.0	23	14 %
	49.0 – 57.8	25	15 %
	57.8 – 66.5	29	17 %
	66.5 – 75.3	15	9 %
	75.3 – 84.0	12	7 %
	Blank	2	1,2 %
Community role	Committee of…	4	2,4 %
	Board of …	6	3,5 %
	President	4	2,4 %
	Other role	13	7,6 %
	No role	141	82,9 %
	Blank	2	1,2 %
Average monthly income (Peruvian soles)	0 – 1	20	13 %
	1 – 176 [a]	87	54 %
	176 – 338.5 [b]	31	19 %
	338.5 – 620 [c]	11	7 %
	620 – 930 [d]	2	1 %
	930 – 1141 [e]	1	1 %
	1141 – 5500	8	5 %
	Blank	10	5.9 %
Occupation	Subsistence agriculture only	77	45,3 %
	Subsistence cattle-raiser only	1	0,6 %
	Subsistence agriculture and cattle raiser	55	32,4 %
	Trader, seller	14	8,2 %
	Domestic worker (housewife)	6	3,5 %
	Construction worker (bricklayer, miner)	1	0,6 %
	Student	12	7,1 %
	Other	2	1,2 %
	Blank	2	1,2 %
Education	Illiterate	36	21,2 %
	Primary school complete	27	15,9 %
	Primary school incomplete	51	30,0 %
	Secondary school complete	24	14,1 %
	Secondary school incomplete	26	15,3 %
	Superior technical	2	1,2 %
	Superior university	3	1,8 %
	Blank	1	0,6 %
Languages spoken	Only Quechua	38	22,4 %
	Only Spanish	3	1,8 %
	Quechua and Spanish	129	75,9 %
Mother tongue	Only Quechua	139	81,8 %
	Only Spanish	9	5,3 %
	Quechua and Spanish	22	12,9 %

Note:
(a) 176 is the extreme poverty line for Peru since 2016. http://webapp.inei.gob.pe:8080/sirtod-series/
(b) 338.5 is the poverty line for Peru since 2017 http://webapp.inei.gob.pe:8080/sirtod-series/
(c) 620 soles is average monthly income derived from work for Apurimac. INEI 2012 Technical Report
(d) 930 soles is minimum monthly wage for Peru since April 2018. INEI 2012 Technical Report
(e) 1141 soles is average monthly income from work: national average, sensu INEI 2012

From the total sample, 86 % of interviewees earned less than 338.5 soles, which means they were below the national poverty line; and 67 % of interviewees lived in extreme monetary poverty, earning less than 176 soles (national threshold value for extreme poverty), and 13 % from the total sample had no monthly income. Only 7 % of interviewees earned above the national minimum wage (930 soles or 282 USD). All poverty lines sensu **INEI 2017**. Observed on the field were interviewees living in houses of noble material (straw, adobe and clays).

Regarding *main occupation*, 45.3 % of interviewees practiced only subsistence agriculture and 32.4 % practiced both subsistence agriculture and cattle-raising. Only 7 % were currently students at school or university.

In terms of *educational level*, 21.2 % of interviewees was illiterate, only 15.9 % of the population finished primary and only 13.5 % completed secondary education. Only 5 people (3 %) out of 170 respondents pursued higher education.

Assessed was as well the ratio of Quechua-speakers: regarding *mother tongue* or first learnt language during childhood, 81.8 % of respondents indicated to have Quechua as their first language. In terms of *languages spoken*, 75.9 % were bilingual, i.e. fluent in Spanish and Quechua.

Table 14 Spatial characteristics of the sampled population

Variables		Rural communities	
		(n=170)	%
Main place of residence	Community of Micaela Bastidas	74	43,5 %
	Community of Llañucancha	38	22,4 %
	Community of Atumpata	39	22,9 %
	City of Abancay	2	1,2 %
	City of Abancay and community	17	10,0 %
Time living in main residence place	Always, my whole life	140	82,4 %
	For some years	29	17,1 %
	Blank	1	0,6 %
Have you ever lived in a city?	Yes, I have lived / am living in a city	78	45,9 %
	No, never	92	54.1 %
Frequency of visits to Abancay city	Daily	24	14,1 %
	Weekly	96	56,5 %
	Monthly	37	21,8 %
	Annually	9	5,3 %
	Never	0	0,0 %
	Blank	4	2,4 %
Frequency of visits to other communities in the watershed	Daily	2	1,2 %
	Weekly	11	6,5 %
	Monthly	23	13,5 %
	Annually	27	15,9 %
	Never	106	62,4 %
	Blank	1	0,6 %
Frequency of visits to water bodies in the Mariño region	Daily	21	12,4 %
	Weekly	38	22,4 %
	Monthly	54	31,8 %
	Annually	37	21,8 %
	Never	20	11,8 %

Moreover, Table 14 reports assessed variables regarding spatial behaviour, which were included in the surveys to better understand the interviewees' spatial knowledge of the Mariño region.

Regarding the interviewees' *main place of residence*, 88.8 % of the respondents declared their communities were their main residence places. 82.4 % of the community members had always lived in their own communities. Furthermore, more than half of the interviewees (54.1 %) indicated to have never lived in a city yet.

Most rural residents *visit Abancay city* once per week (56.5 %). This is self-evident given that most of the interviewees are rural farmers who would sell their harvest products at popular fairs or markets during weekends in the City of Abancay. Farmers sell their products at the *Las Americas* market on Sundays.

Rural residents rarely *visit other rural communities* in the Mariño region: On the one hand 62.4 % never visit other study communities, that is, a resident of Atumpata community would never visit the Llañucancha nor Micaela Bastidas communities. On the other hand, 37.1 % (summed percentages) would annually visit other rural communities. In fact, rural residents often commented to visit other communities for community work (*faenas)*. Collective construction of artisanal dams or *qochas* in the high-altitude wetlands evidence remnants of Andean community work systems still practiced up to date (*ayni, minka*).

Regarding frequency of visits to local water bodies, 66.5 % (percentage sum) of respondents maintain *contact with water bodies* (e.g. springs or "*puquiales*", rivers and lakes) in their own communities, or in the Mariño area at least once per month.

5.2 FREQUENCY ANALYSIS

Frequency analysis was run for the four ecosystem services and threats categories. It provided *absolute frequencies*, e.g. the number of people that ranked a certain ES at a certain rank position, and *relative frequencies*. The stacked bar plots (Figure 17 to Figure 20) display relative frequencies. The last rank positions (8^{th} – 10^{th}) do not reach 100 % on the X-axis because certain ES cards unknown to the interviewee were removed prior to starting the valuation exercise, and thus rankings ended already at *earlier* positions.

Overall, the relative frequencies (expressed in %) are plotted in the X-axis, the rank positions are plotted in the Y-axis. Regarding the **provisioning services,** Figure 17 shows the first row dominated by the service *Water for consumption*. **65 %** of the interviewees rank water 1^{st} . After this marked social predilection, rank order of other provisioning services is rather not distinctive.

Regarding **regulating services,** Figure 18 shows that *Regulation of the water cycle* is ranked 1st by nearly one third of the sampled population. After this marked social predilection, rank order of remaining regulating services is rather unclear.

Regarding **cultural services,** Figure 19 shows that *Intergenerational value of nature* dominates the 1st rank position according to the opinion of **23 %** of the sample. Order of ES in following rank positions is rather not distinctive.

Regarding **threats,** Figure 20 shows that **31 %** of the participants ranks *bush fires* 1st as the most pressing concern. Order of threats in following rank positions is rather not distinctive, except for *urbanization* which is clearly ranked as subject with the least concern by **28 %** of rural interviewees.

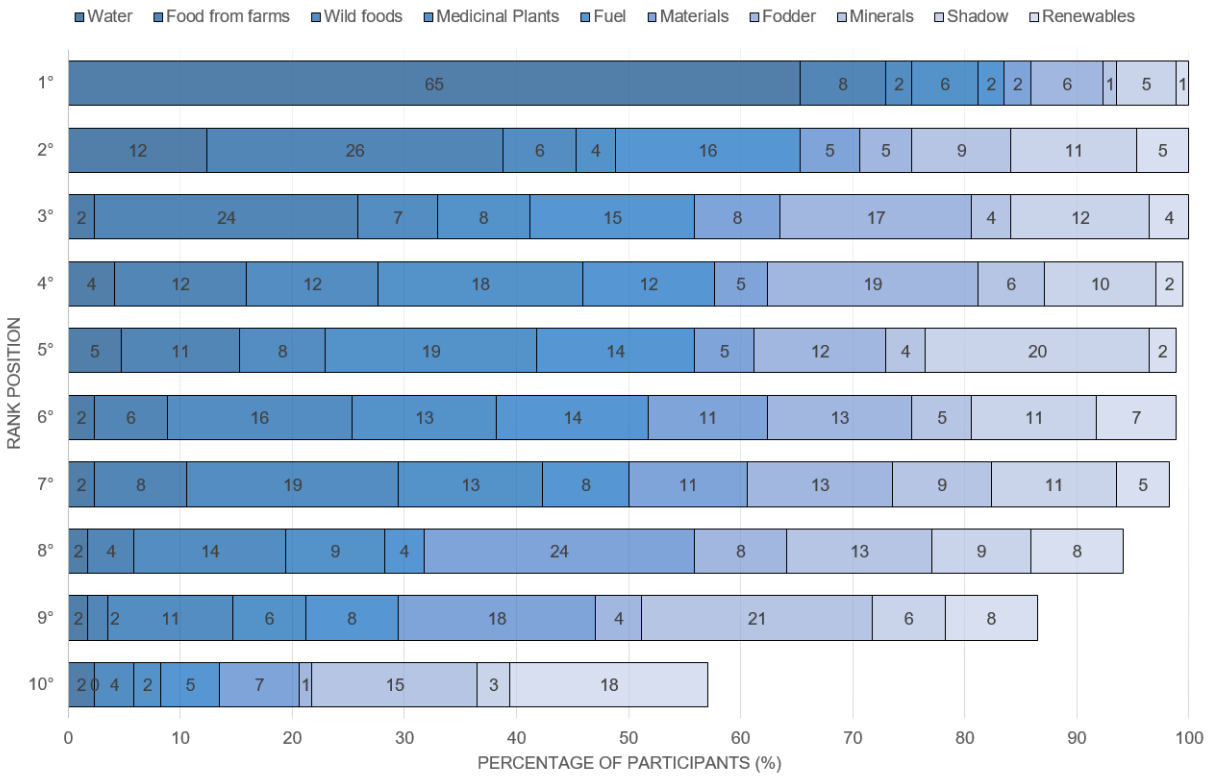


Figure 17 Relative frequencies for provisioning services (n=170).

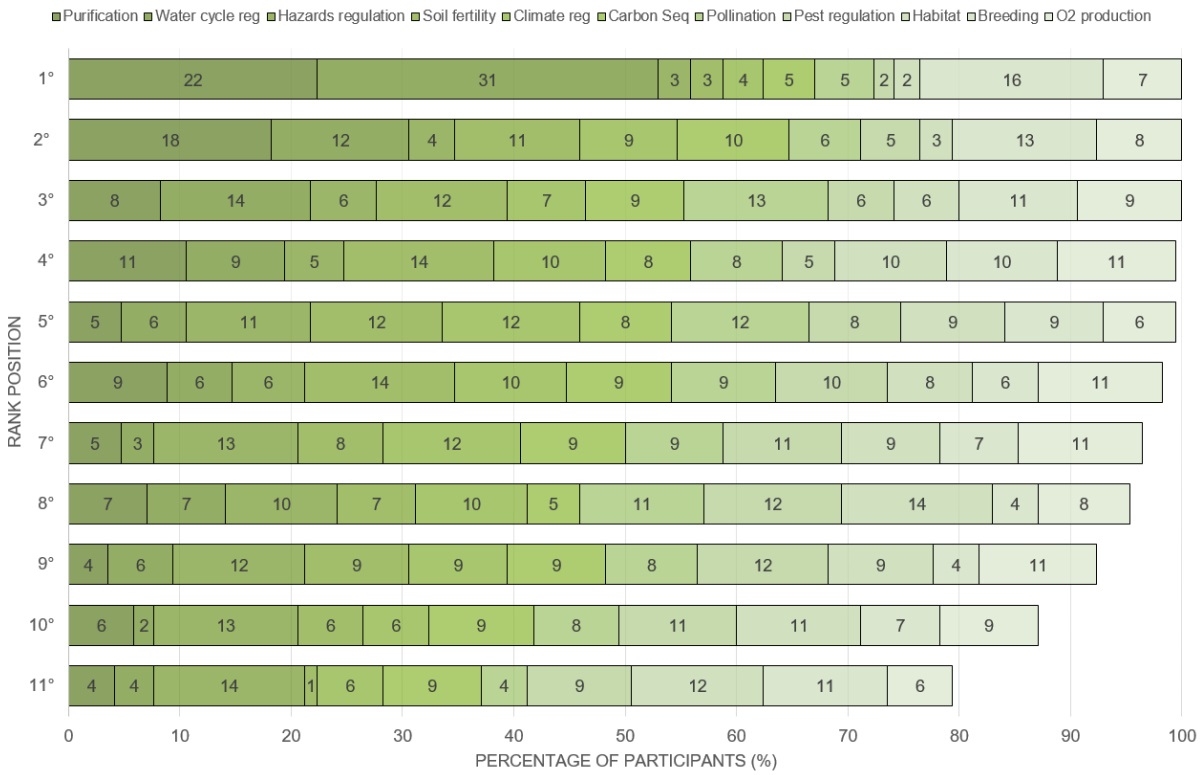


Figure 18 Relative frequencies for regulating services (n=170).

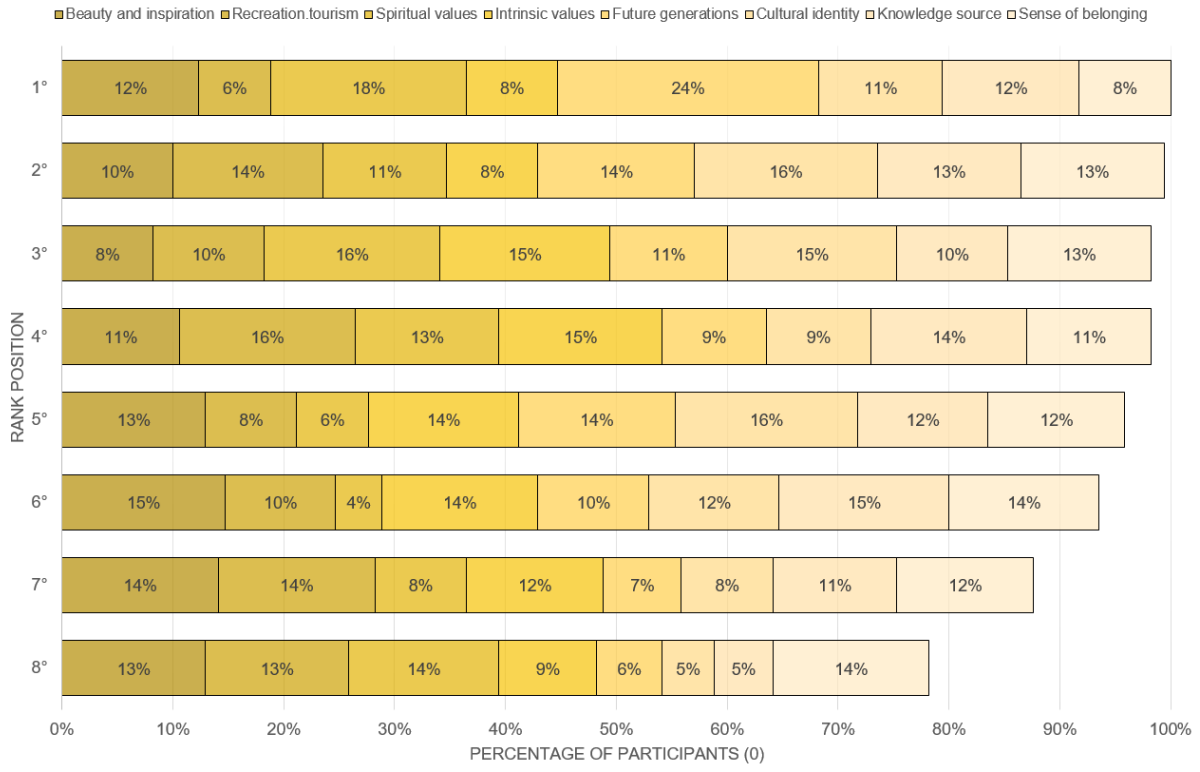


Figure 19 Relative frequencies for cultural services (n=170).

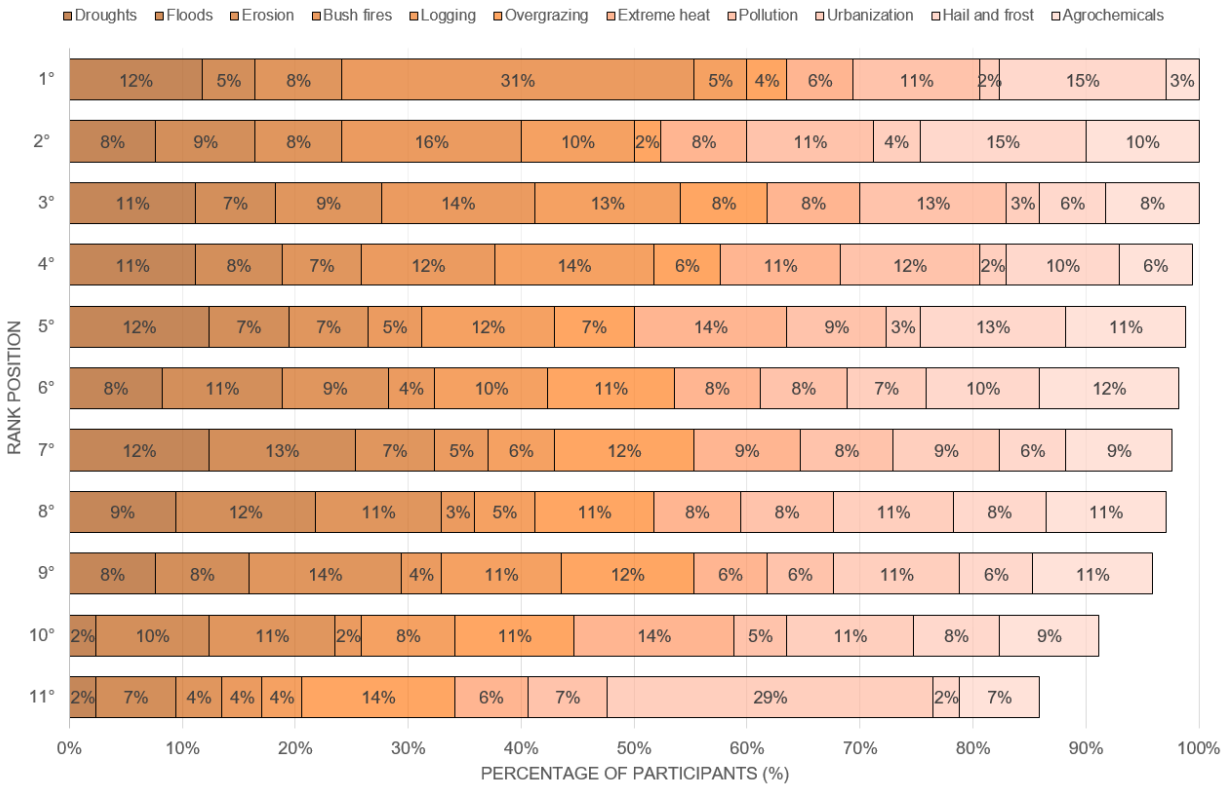


Figure 20 Relative frequencies for environmental threats (n=170).

Limitations of the Frequency Analysis

Taking the example of Figure 17, apart from the service *Water for consumption*, ranked in 1st place by 65.29 % of interviewees, further rank positions cannot be clearly interpreted as the social preference around the following services barely differentiates from each other. This pattern is observed for all the frequency analysis barplots for the four categories of ES and threats.

The problem observed is a *decision problem*, this means, a social value ranking cannot be deducted from the frequency analysis nor priority ES can be easily identified, given the almost similar relative frequencies.

5.3 THE SOCIAL VALUE INDEX (SVI)

The SVI calculated for all surveyed ES and threats are displayed below, where X-axis shows the SVI scores, and ES or threat names are listed in the Y-axis.

On the one hand, all SVI rankings suggest that the rural interviewees value *water provision*, *water cycle regulation* and *intergenerational value of nature* as the most important services they perceive from the Mariño watershed. On the other hand, *bush fires*, a anthropogenic threat, receive the highest social concern.

SVI for provisioning ES (Figure 21) peaks with *water for consumption*, followed by *food from farms*. *Fodder*, *fuel* (firewood for domestic use), *tree shadow* and *medicinal plants* obtain moderate SVI values. Mineral resources such as clays and black earth, as well as renewable energies such as solar energy are the services with the least social value.

The category of provisioning ES shows the strongest differential in SVI scores between the most and least preferred service (difference was 70% of provisioning SVI score).

SVI for regulating ES (Figure 22) peaks with *Water cycle regulation* as the most valued service, followed by *Purification of soil, air and water, breeding of good quality species* and *soil fertility*, which also receive high social preference. Moreover, pest regulation, oxygen production, climate regulation and carbon sequestration are scored with moderate value. Habitat services for endemic species are ranked second-last and Pollination & seed dispersal obtain the overall lowest social value.

Differential in SVI overall was 43% of regulating SVI score.

SVI for cultural ES (Figure 24) peaks with *Value for Future Generations*. Following this, *cultural identity, spiritual values, knowledge source* and *intrinsic values* share a similar SVI, the decrease of importance is subtle. *Aesthetic enjoyment & inspiration*, together with *recreation & tourism services* are the least socially valued ES.

Remarkably, the category of cultural ES shows the smallest SVI differential (differential was 22% of cultural SVI score)

SVI for environmental threats (Figure 24) peaks with *bush fires*, which obtain the highest social concern. This is the second highest peak in SVI units, after importance of *water for consumption*. Following rank positions are H*ail & Frost*, P*ollution* and *Droughts*. *Overgrazing & over-trampling* are ranked second last, and *urbanization* as a threat receives the least social concern.

Differential in SVI between maximum and minimum value was 58% of the threat SVI score.

Once the prioritized ES and threats in the Mariño watershed are identified, it is fundamental to contrast these findings with bibliographic sources and field observations. In this way a holistic understanding of the research findings can be reached.

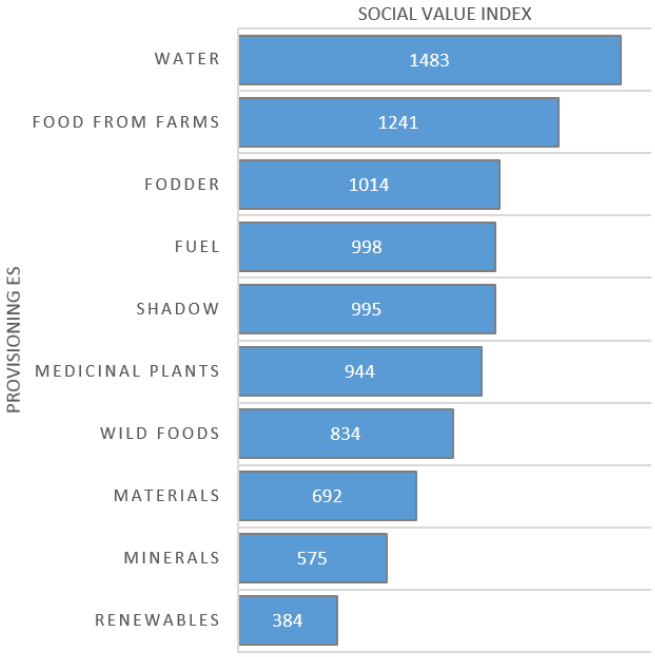


Figure 21 SVI for Provisioning ES.

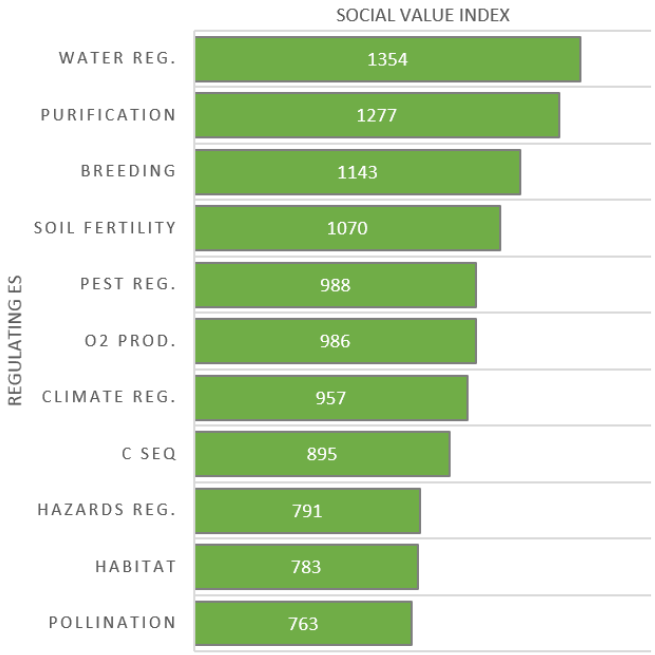


Figure 22 SVI for Regulating ES.

Figure 23 SVI for Cultural ES

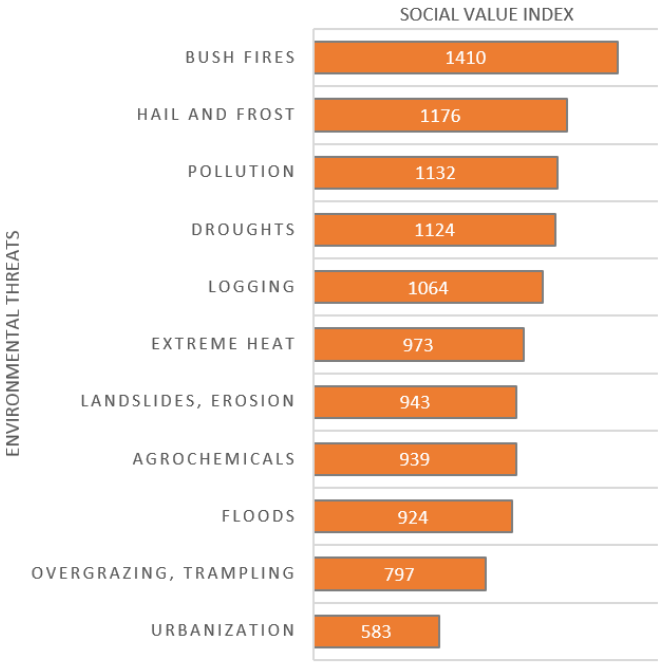


Figure 24 SVI for environmental Threats

SVI across Categories

A further broader look is taken to compare all the SVI minimum and maximum peaks reached by each category, namely by the regulating, provisioning and cultural services, and threats. The boxplot in Figure 25 illustrates the range of SVI values covered by the four surveyed categories: threats, regulating and provisioning services cover a broader range of SVI values, while SVI values for cultural services oscillate very little only. See further discussion in Cross-category comparison.

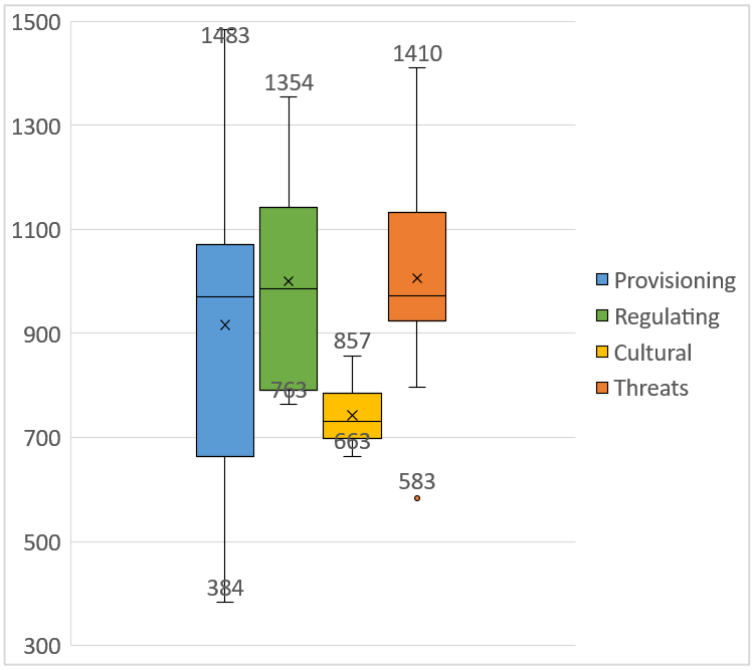


Figure 25 Comparison of Social Value Index value range across categories.

5.4 The Excluded Services

Before starting the ranking exercise, each interviewee could exclude unknown cards of ES or threats. Table 15 frequency of exclusion of ES or threat car; excluded cards were understood as *unknown* service. For provisioning services, *Renewables Energies* was the most excluded card (by 40 % of population), followed by *Mineral resources* (excluded by 14 % of population). For regulating services, *Carbon sequestration* was most excluded card (by 10 % of the population), followed by *Pest regulation* (excluded by 8 % of population). The cultural service of *spiritual values* was the most excluded one (by 10 % of population). The *Urbanization* card was the most excluded threat (by 8 % of the sampled population).

Table 15 Excluded cards from valuation exercise

ID code	Provisioning ES		Regulating ES		Cultural ES		Threats	
	f	%	f	%	f	%	f	%
1	1	1 %	3	2 %	7	4 %	6	4 %
2	0	0 %	3	2 %	15	9 %	6	4 %
3	2	1 %	5	3 %	17	10 %	8	5 %
4	3	2 %	7	4 %	8	5 %	3	2 %
5	4	2 %	9	5 %	9	5 %	5	3 %
6	8	5 %	17	10 %	11	6 %	6	4 %
7	3	2 %	9	5 %	12	7 %	4	2 %
8	24	14 %	16	9 %	4	2 %	3	2 %
9	1	1 %	12	7 %	--	--	13	8 %
10	68	40 %	3	2 %	--	--	2	1 %
11	--	--	5	3 %	--	--	5	3 %
Note: Absolute (f) and relative frequencies (%). ID Codes in Table 8.								

5.5 MULTIVARIATE ORDINATION ANALYSIS (PCA)

Cleaned and reduced dataset with 25 ES, 11 threat variables and 166 observations were tested for normality. *Shapiro-Wilk test* reported p-values < 0.0001 for all variables, meaning all followed non-normal distributions, which was expected as variables were categorical items (ranking answers) and not continuous variables.

PCA analysis was run for each category of ES and threats, results are sown in Table 16 and Table 17. Explained variance threshold for the first two principal components was set to 30 %. Scree plots of the two principal components show overall a low percentage of explained variability.

Visual interpretation of the PCA plots suggests clusters of variables. Coincidences of the visual clustering with social value SVI rankings are discussed in next **chapter**.

Table 16 PCA Analysis of Provisioning (n=8) and Regulating (n=10) Services.

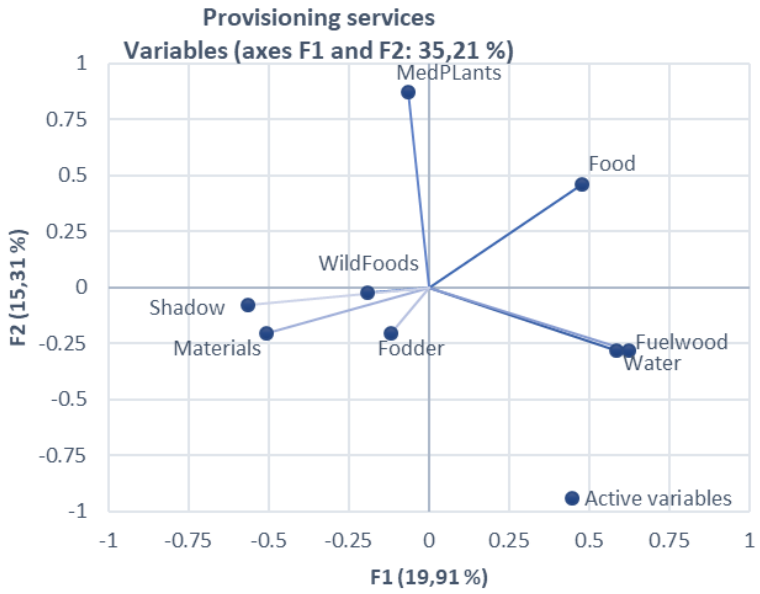
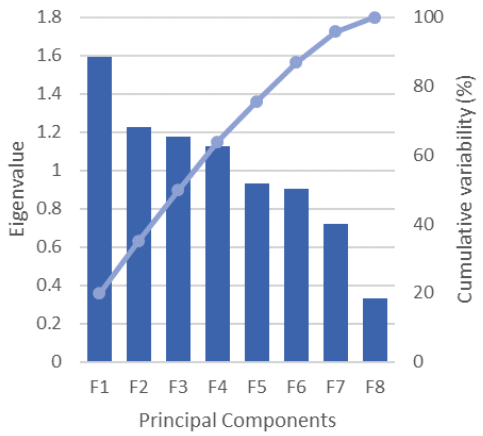
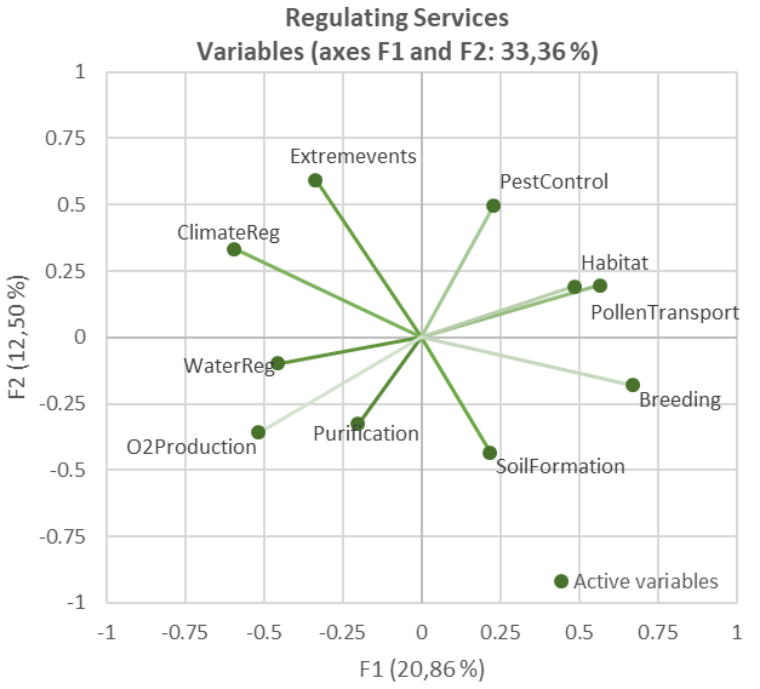
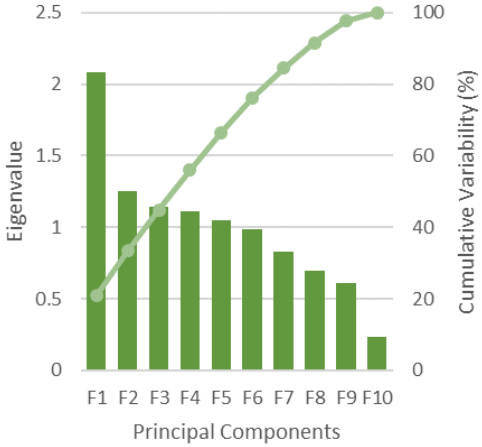
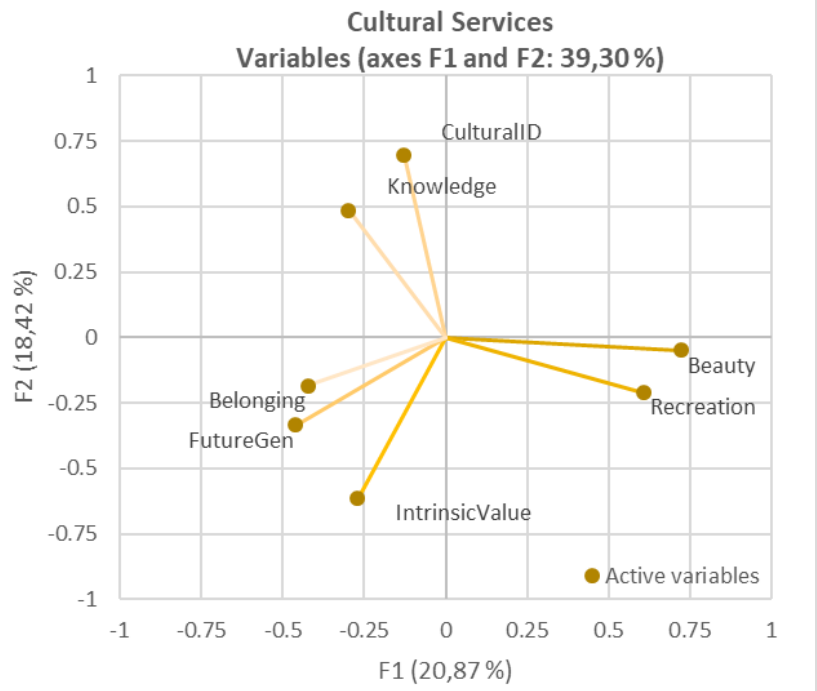
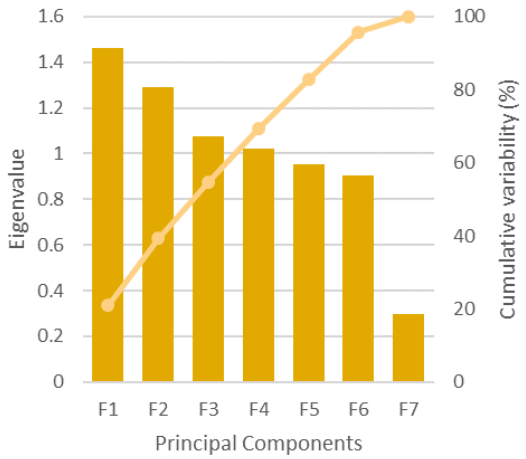
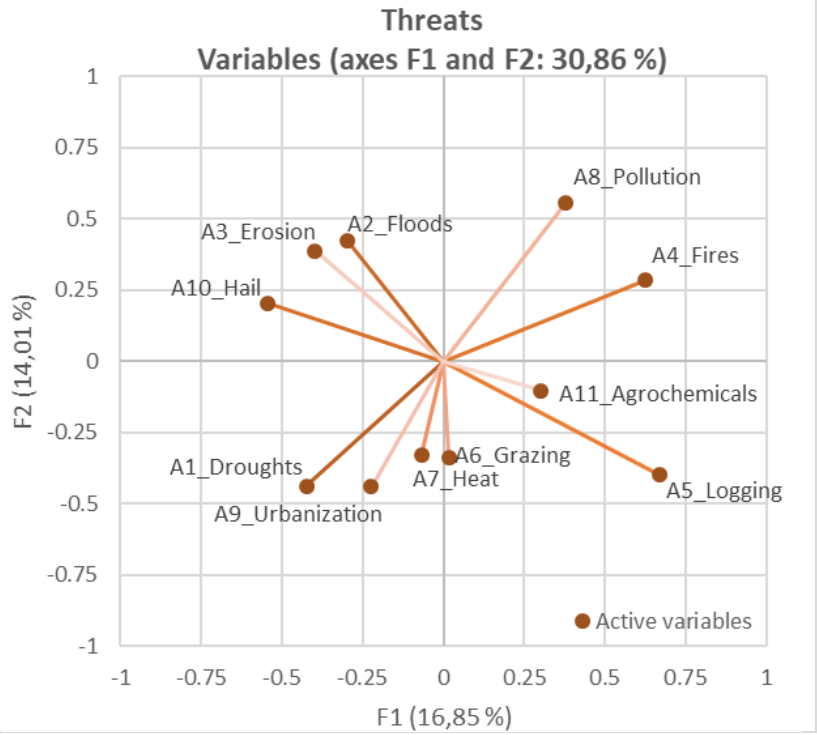
PCA plots	Scree plots
A 	**B** 
C 	**D** 

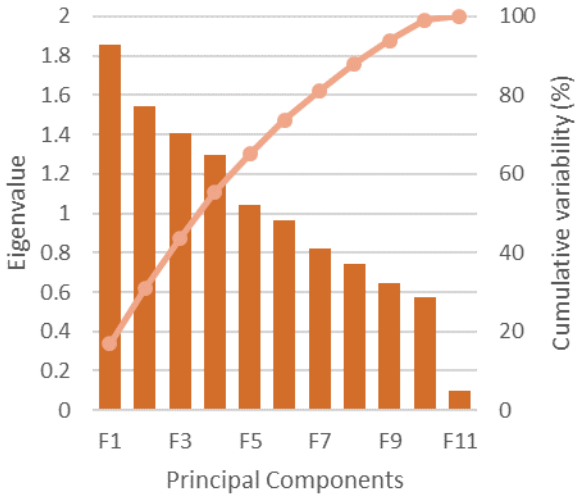
Table 17 PCA Analysis of Cultural Services (n=7) and Threats (n=11).

PCA plots	Scree plots
A	**B**
C	**D**









6 DISCUSSION

The aim of this *mixed methods study* was to integrate qualitative and quantitative primary and secondary data sources to provide a deeper and better understanding of the socially prioritized ES and threats. More specifically, quantitative semi-structured surveys and qualitative unstructured field observations were conducted in the study communities. Analysis of 170 semi-structured surveys and development of the Social Value Index revealed the existence of three socially prioritized ES provided by the native ecosystems in the Mariño watershed, and the existence of one socially prioritized threat (see Figure 26). These findings answered the four specific research objectives.

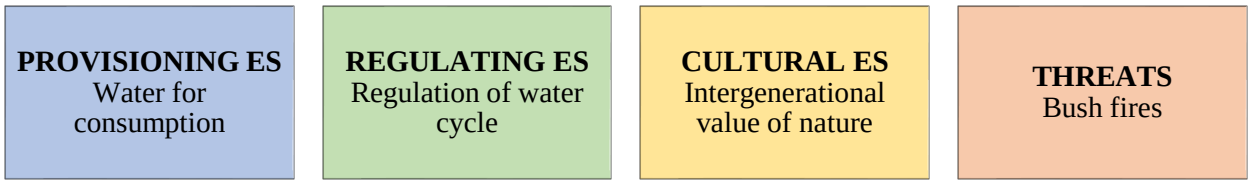


Figure 26 The four social priorities.

Micro-ethnographic field observations over a span of 6 weeks, e.g. observations of local lifestyles, land uses, beliefs, customs, concerns and habits, provided valuable insights for the interpretation of the Social Value Rankings, and thus *justified* the mixed methods nature of the research. Field observations of reactions and opinions by rural participants about visual survey tools and questions asked provided additional insights on the epistemological and methodological implications of the study applied to a peasant community holder of Andean worldviews and Quechua cultural customs.

The discussion of the present exploratory-descriptive study focuses on: (i) the identified four social priorities, their justification and interpretation through triangulation; (ii) the study's epistemological implications in the Andean cultural setting; (iii) the research validity (internal and external), discussed under a *reflexive stance*; followed by (iv) research recommendations and conclusions.

6.1 SOCIODEMOGRAPHIC ANALYSIS

Collected social variables help understand the social, economic and cultural context behind the social valuation exercise. Overall there is little blank data reported (for few social variables blank data makes up to 2 %).

Sociodemographic results show the sampled population was rural people, engaged in small-scale activities (households) with little use of capital. Overall high illiteracy rates, high monetary poverty and practice of

peasant's livelihoods are observed, as well as spatial isolation of rural communities and limited contact to urban spaces.

Among the findings, it is observed that sampling of the population was unbiased. Surveys equally sampled genders by interviewing female (51 %) and male (49 %) in similar proportions. Most interviewees (77 %) were older than 30 years. Observed on the field was that young people in studying or working age leave the communities and head to the City of Abancay for better education and working opportunities.

Nearly 16 % of interviewees occupied a communal leadership role, this means 1 every 6 interviewees was a communal authority or leader active e.g. in local committees (natural resources or water and irrigation committees) or local boards (mothers' club "*club de madres*"). A sampling that includes a wide array of social preferences by local residents and authorities is key for the participatory approach of this study.

Regarding monthly income, 67 % of interviewees lived in extreme monetary poverty (below national extreme poverty line sensu **INEI 2017**). Regarding occupation, 77 % practiced subsistence livelihoods (agriculture and livestock breeding). These socio-economic figures strongly validate the conceptual reasons to use a non-monetary ES valuation method in low-income contexts.

Overall the prevalence of the Quechua language was demonstrated. It is extremely valuable for this study to observe that 76 % of interviewees were bilingual and 82 % had learnt Quechua as their first language during childhood. The important role that Quechua may have had in shaping their mindsets and systems of values is a field worth exploring, given that Quechua as a non-written language is tightly linked to Andean worldviews (**PILGRIM AND PRETTY, 2010**) and thus plays a strong role in traditional oral knowledge transmission in the Andes. For purposes of this study, the high proportion of surveyed Quechua-speakers is understood as a *high ethnicity component* in the social perceptions collected.

Chronic illiteracy is furthermore observed, as high illiteracy rates are reported for 21.2 % of the sample, in contrast to the 5.9 % national average. The observed absent or incomplete formal education can be explained by the local practice of subsistence livelihoods with culturally-rooted Quechua customs.

Questionnaires addressed also the environmental behaviour of residents regarding water. The water element was reported in two sociodemographic variables: first, 37 % of interviewees mentioned they attend inter-community annual gatherings for collective work, for instance, artisanal dam-construction. Secondly, 67 % of interviewees said to maintain monthly contact with water bodies. A social role of water can be induced from the opinions collected, a role especially relevant for the water scarcity context in the Andes.

Finally, a valuable insight into how locals behave in space was gained: 89 % of participants declare their respective communities as their main place of residence and 82 % of participants had lived in their

communities their entire lives. Understanding local spatial cognition is a fundamental aspect of human behaviour (**DEVLIN 2001**), given that a resident that knows more about his or her surroundings comes in contact with ecosystems, its services and threats to it, more often. Answers suggest locals maintain a strong linkage to the land and landscapes. How this spatial cognition may correlate to the value ascribed to environmental assets lies, however, outside the scope of the study.

6.2 SOCIAL VALUATION

Social values ascribed to ES inform us about which ES are perceived as present in the study communities, which ES are known, and which ES are ascribed the highest social value. Key discussion criteria addressed in the following sections are listed in Table 18. Future studies will further explore rank order of the 36 remaining variables, as well as multivariate interrelationships among these.

Table 18 Social Priorities and discussion criteria.

CATEGORY	Provisioning ES	Regulating ES	Cultural ES	Threats
STUDY OBJECTIVES	Identify provisioning ES with highest social value	Identify regulating ES with highest social value	Identify cultural ES with highest social value	Identify threat with highest social concern
PRIORITY SERVICES	Water for consumption	Water cycle regulation	Intergenerational value	Bush fires
DISCUSSION CRITERIA	Use values of water		Policy-making relevance	Fire causes
	Non-use values of water		Theoretical relevance	Fire consequences

6.2.1 Water as Supreme Element

Water for consumption, irrigation and livestock was the most important provisioning ES according to the perception of 65 % of the sampled population and SVI ranking. No other provisioning ES nor service in the other categories of regulation, culture or threats received a social preference as high as water.

The saliency in the recognition of hydric ES is consistent with previous valuation studies in rural Apurimac (**LANDOLT 2017**) and in the Mariño watershed (**LOCATELLI AND GALMEZ 2015**). Global studies also report water for consumption as the top most socially valued provisioning ES (**VERGARA, 2017; SAYLOR ET AL 2017; DE GROOT ET AL., 2016, PAUDYAL ET AL 2018; RAYMOND ET AL 2009; CAST ET AL 2008; ZAGAROLA ET AL., 2014**; **OCHOA CARDONA ET AL., 2017; CALERO VALDEZ 2018)**.

Furthermore, *regulation of water cycle* was the most important regulating ES according to 30 % of the sampled population and SVI ranking. Previous social value rankings ranked regulation of water cycle also first (**VERGARA, 2017; CAST ET AL 2008; RAYMOND ET AL., 2009)**. Other studies report *regulation of water cycle* in third (**ZAGAROLA ET AL., 2014**) and in fifth place (**PAUDYAL ET AL 2018).**

The water motif dominates two of the three surveyed categories of ES (provision and regulation). The social predilection can be explained by a combination of several factors: subsistence livelihoods, water scarcity, NGO awareness campaigns and Andean cultural values around this element, among others.

Use-values of water

A key argument explaining the water predilection are the use-values ascribed to water in subsistence economies. Use of water resources and services are tightly linked to socio-economic characteristics of the sampled population. On the one hand: the observed main economic activity of the sample interviewed is subsistence agriculture and livestock breeding (practiced by **77.7 %** of participants). Their subsistence livelihoods are based on the supply of water in good quantity and quality; this direct dependency on water services explains its prioritization.

On the other hand, only **6 %** of the surveyed participants had monthly income higher than the national minimum wage. From the remaining 94 %, 67 % live in extreme monetary poverty. Their irregular incomes are highly dependent on climatic conditions and generous harvests. These factors make rural interviewees realize the extractive and economic nature of water, food and fodder in much easier ways, as these material services alleviate their daily nutritional and economic needs (**PAUDYAL ET AL 2018**).

Water scarcity context

Moreover, the water scarcity in the Mariño watershed also explains the social preference for water.

Naturally, endemic Andean ecosystems such as the relict Andean forests, high-altitude wetlands and grasslands present in the Mariño region are biotic pumps that provide fresh water. Observed on the field was that they act as delicate water collection structures or "*water sponges*". Grasslands have fine leaves that retain fog above the 4000 m.a.s.l. close to the soil surface. The resulting super humid and high-altitude environments are called Andean wetlands *bofedales* and lakes (Figure 27). Through run-off processes, water springs in the uplands develop into streams which flow down the hillsides and valleys as tributary rivers and that flow into the Mariño river around the 2500 m.a.s.l. In this way, the Mariño river, upland tributaries and water-harvesting Andean ecosystems are key elements for rural and urban water security.

According to ground evidence, climate and anthropic change threaten water availability in the Mariño hydric network (**CONDESAN, 2014; PACC PERÚ, 2014**). Efforts by international NGOs and local Government in the Mariño have risen environmental awareness in the upland communities since 2014, as well as promoted rescue of traditional Andean water engineering and harvesting practices, like artisanal dam building (Figure 28). Artisanal small-scale dam constructions are done by the communities themselves on annual meetings called *faenas*. In this way, dams retain water in high-altitude lakes or temporary ponds, avoiding running off or drying off under the increasing heat.

Figure 27 The Rontoccocha lake (4000 m.a.s.l.) is one of Abancay's six water catchment points.

Figure 28 Communal small-scale dam construction in the Mariño watershed. *Source: Ruderson Rivera*

Also, communities are self-organising in committees to fence and thus protect delicate sponge-like *bofedales* and grasslands from mechanical damage by introduced livestock (any species different than Andean camelids). Moreover, study communities in their communal statutes ration water consumption per

farm and household. This is an increasing trend in the Andes: local farmers are becoming aware and organizing themselves to tackle climate change (**HUASASQUICHE AND KOMETTER, 2017**).

All these communal efforts are practiced in the Atumpata, Llañucancha and Micaela Bastidas study communities. Since early 2018, NGOs and local and regional Government implemented PES schemes which tax urban water users in Abancay; funds are invested back in the upland areas, where water authorities collaborate with local people to secure water under a changing climate.

All in all, the rural social predilection for water suggests residents in the uplands of the watershed are aware of the changing Andean landscapes under human pressure; of the decision-making and conservation activities undertaken in their own communities; and of downstream urban concern around water.

Non-use values of water

Social predilection for water in Andean mountain communities is justified not only by instrumental values of water but may in fact be justified by mystical values, ancestral worshiping practices and religious customs related to water and mountain deities. Sensu **REINHARD 1985** pp. 307 "*the connection between mountains, clouds and rain was obvious in ancient times (…) the significance of such beliefs is that mountains and meteorological phenomena are intimately linked in the minds of the people in many areas of the Andes".* The same author writes then in page 308 *"worship of mountains for water has also been reported in recent times for several areas in Peru (…) In southern Peru ritual offerings were made for a stable water supply".* Most study participants had the remote communities as their main residence place (88 %), most of them were Quechua-speakers (81 %) and had none or incomplete formal education (66 %). These social characteristics are understood as they are potential holders of informal and ancestral Andean spiritual values.

Collective water management can furthermore play a role in the cultural identity and legacy. Subsistence lifestyles are closely tied to water availability and management, both with technical and social implications (**SAYLOR ET AL 2017**).

Through the contrast of the social value ranking with field observations and theories, the social predilection around water becomes credible and is justified in the context described above, thus validating the findings and method.

6.2.2 Intergenerational Value of Nature

Value for future generations was the most important cultural service according to 23 % of interviewees and SVI rankings. This finding shows similarities with **LOCATELLI AND GALMEZ 2015** where *future value* is ranked second in the sub-group of ES considered highly threatened and yet highly beneficial.

First, I highlight the fact that, *intergenerational value of nature* is a non-typical ES, as it has not been listed in the MA 2005 nor TEEB 2009 frameworks before and is often excluded from social assessments (as observed in **VERGARA 2017, PAUDYAL ET AL. 2018, LANDOLT2017**). The methodological difficulty to measure, appropriately elicit and report values around this intangible ES may explain its weak assessment.

Secondly, *intergenerational value* receives recent attention at the science-policy level. IPBES includes *intergenerational value* in the definition of the 18th Nature Contribution to people (NCP) called "*Maintenance of options*". NCP 18 is defined as the non-material contribution from nature to people and calls practitioners to consider future values in decision-making (**DÍAZ ET AL., 2016** pp14).

Thirdly, eliciting intergenerational concerns in Andean rural people can help identify sets of personal or collective principles of cultural intergenerational awareness, despite economic marginalisation and limited access to formal education. This may suggest the existence of Andean values that acknowledge temporal dimensions of nature.

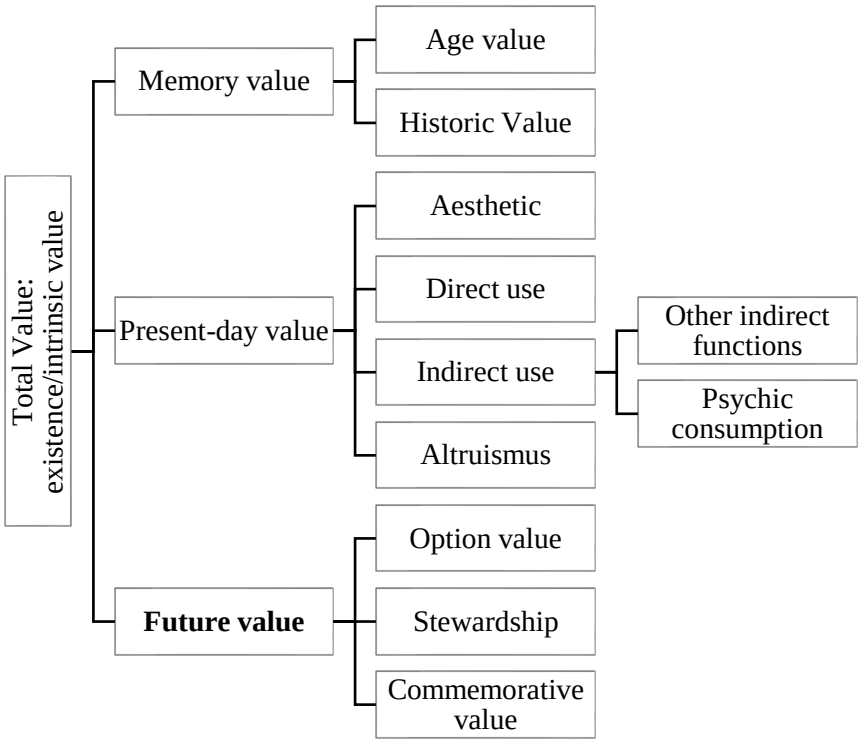


Figure 29 Value concepts and the temporal aspect. Source: **PAŘIL AND TÓTHOVÁ, 2015**

Referring to the *theory of value* (**PAŘIL AND TÓTHOVÁ, 2015**, Figure 29), I observe that previous valuation studies have been challenged to assess this ES and disentangle the dimension of *future value* from the *present-day* and the *historic value* of nature. It is true that these three temporal aspects conform the *total*

existence value of nature, but it is an epistemological challenge to independently elicit temporal aspects of values in interviewees not familiar with these categorizations.

Weaknesses are observed in social valuation studies by **ZAGAROLA 2014**, **CAST 2008** and **RAYMOND2009** where the terms *intrinsic value, bequest value, legacy, social historic identity* and *future value* are used interchangeably and greatly overlapping in their temporal dimensions, sometimes meaning *present day* value and other times meaning *historic* or even *future* value. Said confusion is however not observed in the studied population. In fact, rural people very clearly prioritize the future aspect or *intergenerational value* of nature. This can suggest that in the Andean worldview, intergenerational environmental consciousness is culturally rooted, specially through the Quechua language. The majority (82 %) of interviewees learnt Quechua as first language and this, as a non-written language, inherently perpetuates oral transmission of the Andean knowledge and tradition (**PILGRIM AND PRETTY, 2010**).

The *intergenerational concern towards nature* becomes credible and valid. It aligns with previous studies that suggest the existence of the Andean temporal understanding of sustainability issues (**SAYLOR 2017**).

6.2.3 The Social Concern around Fire

Bush fires are the threat with highest social concern, according to the SVI index and to **31 %** of the respondents (relative frequencies). **HUASASQUICHE AND KOMETTER, 2017** report high social concern around bush fires and decrease of forest cover in rural Apurimac. Similarly, **OCHOA CARDONA ET AL., 2017** reports bush fires as a local practice in rural Colombia linked to agricultural and cattle raising practices and perceived by communities as the most pressing environmental threat.

Bush fires are a pressing issue for the entire South-American Andes. Cause of fire occurrence in South America, and more specifically in Peru are humans (98 %), followed by unknown causes (1.5 %) and natural causes (0.5 %). Annual economic losses derived from bush fires only in the Peruvian Andes is estimated at 12.4 million USD. Apurimac is a critical national wildfire hotspot (Figure 30).It is estimated for Apurimac that the totality of bush fires is caused by human negligence. Between 1995 and 2014, 249 fire events affected 26 078 hectares of Apurimac's natural capital. Within Apurimac, the provinces most affected by fires are first Cotabambas and then Abancay with 32.9 % and 32 % respectively of surface burnt between 1995 and 2014 (**GORE APURIMAC, 2017)**.

Bush fires are intentional or planned fires that target in first instance native grasslands, followed by wetlands and native forests. These ecosystems are cleared in 60% of the cases for ranching and in 30% for farming purposes (**GORE APURIMAC, 2017** pp5). Direct consequences are loss of ecosystems regulating water and climate, and biodiversity loss.

In the Mariño watershed, rural residents experience extreme poverty, malnutrition and subsist with traditional farming dependent on natural resources from forests **(HUASASQUICHE AND KOMETTER, 2017).** At the same time, urban consumers from Abancay City demand crop products from the upland valleys. The resulting local response is an unsustainable measure to alleviate rural poverty and satisfy urban demand by expanding the agricultural front at the expense of relict Andean ecosystems.

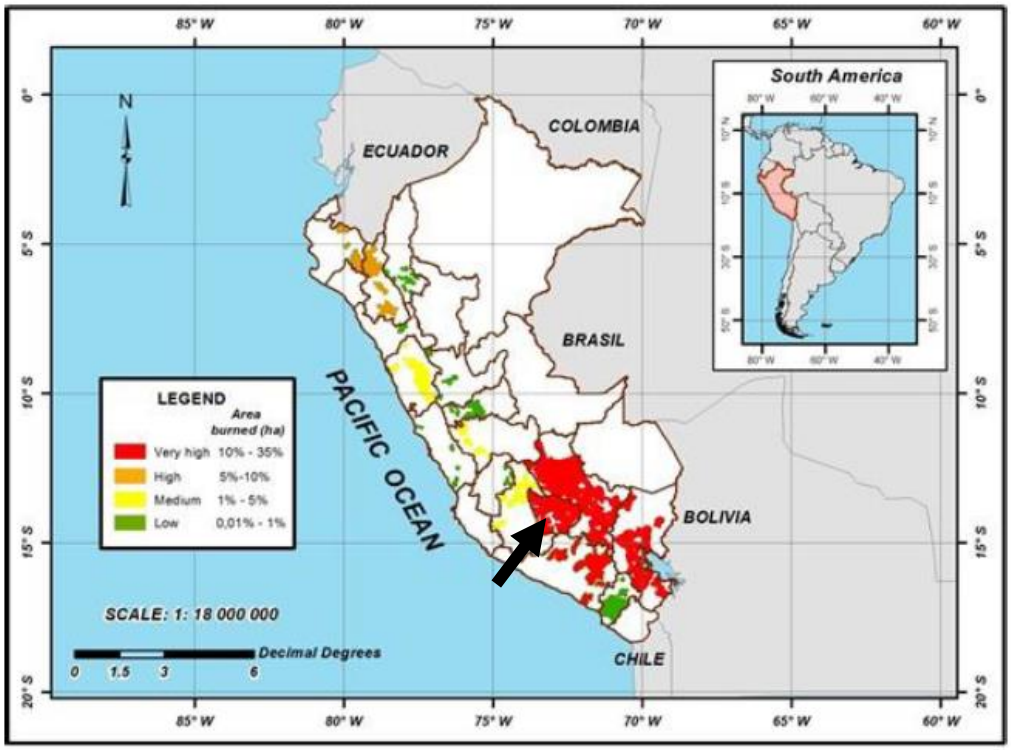


Figure 30 Fire danger map for the Peru, administrative division in 24 departments. Source: **Manta and et. al., 2018**. Black arrow points at Apurimac.

Bush fires are also caused accidentally. A recent fire burnt 10 ha in the Micaela Bastidas study community in just one day **(COEN, 2019)**. Interviewees mentioned during surveys fires were caused by children playing with matchsticks in the uplands, by incautious or jealous farmers starting uncontrolled fires, or during community gatherings and alcohol consumption. Strangely, interviewees would rather blame someone else for starting fire, than admitting self-starting it.

Moreover, bush fires can also be a symptom of loss of ancestral practices of controlled burning. If these practices are gone, itinerant agriculture with slash and burning of the Andean pastures and forest occurs (**HERVE 1994).** Also, the local belief that *fire will call the rain in times of drought* was recorded on the field. **CIFOR 2017** reports for Peruvian Andean forests that these are seen as rainforests for harvesting purposes of timber or firewood; and where restoration still plays a limited role.

Although fire management in Apurimac has recently become target for conservation and restoration efforts (**ARCE BACA, 2018**), government organizations must still prioritize strategies to reduce and adapt to bush fires. For instance, capacity building can enable subsistence farmers to replace detrimental land use practices and recover ancestral and ecological use of the land.

The risk of not tackling this issue is that burnt ecosystems aggravate effects of climate change in the Andes, increasing climate and hydrological risk (**Manta and et. al., 2018**). Overall, the high social concern about bush fires is plausible, based on field observations and regional fire danger statistics, thus validating the findings.

6.2.4 Further Trends

Further trends of the SVI rankings are briefly discussed, to expose complexity of the dataset.

Overview of Provisioning Services

Table 19 Thematic overview over provisioning ES.

SOCIAL VALUE	RANK	ES	EXPLANATION
HIGH	1	Water	(+) Water predilection,
	2	Food from farms	(+) Subsistence farming
	3	Fodder	(-) Fodder and overgrazing and logging for firewood threaten water security
	4	Fuel (firewood)	
INTERMEDIATE	5	Shadow by trees	(+) Local perception of microclimates
	6	Medicinal plants	(+) Local use and knowledge of plants (-) Why is relevance moderate although health care infrastructure is limited?
	7	Wild foods	--
LOW	8	Materials, fiber	--
	9	Mineral resources	(+) Common rejection to mining activities (-) Black earth not relevant for farmers
	10	Renewable energies	(-) Underutilised geographical potential
Note: (+) if logic or not (-) to my perspective.			

Water (1st rank), *food from farming systems* (2nd rank) and *fodder* (3rd rank) make the top 3 most valued provisioning ES. This triad of ES was also prioritized for local benefits in **PAUDYAL ET AL 2018**.

Firewood as fuel occupies the 4th place. The use of firewood for cooking is very common in Peruvian rural homes: 78.1 % of rural households use firewood for cooking according to national survey (**MEF, 2009**). The dependence on firewood is a habit in rural households that threatens Andean forest and shrubland with logging and resource over-extraction.

Medicinal plants (6th rank), *wild food*s (7th rank), *materials, ornamental plants and fiber* (8th rank) obtained moderate social value in SVI rankings, this in contrast to **LOCATELLI & GALMEZ 2015** where experts reported these ES as *non-relevant at all* for the Mariño watershed.

Regarding *medicinal plants* (6th rank) and looking at the broader context of poor infrastructural and transport connectivity in rural Apurimac and high costs of the health care institutions, one could argue that rural interviewees would highly value medicinal plants as their only curative resources (**AMÉLINE VALLET ET AL., 2016**). Locals, however, assign moderate to low importance to these medicinal resources. Medicinal resources, in comparison to other provisioning services, are not needed on daily basis. This suggests interviewees in the social valuation involved several value dimensions to judge importance of an ES (instrumental values and frequency of use, for instance). Another argument is that market proximity and transculturation in the rural Andes promotes abandonment of traditional medicines (**ARGUMEDO AND PIMBERT, 2005**).

Overview of Regulating Services

Table 20 Thematic overview over regulating ES.

SOCIAL VALUE	RANK	ES	EXPLANATION
HIGH	1	Water regulation	(+) Water predilection (+) Subsistence agriculture and cattle raising
	2	Purification water soil air	
	3	Breeding and genetic resources	
	4	Soil fertility	
INTERMEDIATE	5	Pest regulation	
	6	Oxygen production	--
	7	Climate regulation	(+) Climate local perception
	8	Carbon sequestration	
LOW	9	Hazards regulation	(-) Locals don't know ecosystem regulate extreme events, linked to ecosystem degrading activities
	10	Habitat services	(+)Low value due to existing human-wildlife conflicts and habitat degrading activities (-) Unrecognised biodiversity-hotspot role of Mariño
	11	Pollination and seed dispersal	(-)Farmers don't know pollination, explains fertilizers use
Note: (+) if logic or not (-) to my perspective.			

The most valued pair of regulating services was *water cycle regulation* (ranked 1st) and *purification of air, soil and water* (ranked 2nd). Looking beyond water, **MARTIN-LOPEZ 2012** reports air purification as the most valued regulating service for 45 % of social valuation participants in Spain. Water purification is important, and has also been reported by **RAYMOND2009, CAST2008 AND VERGARA 2017** in second place, whereas **ZAGAROLA2014** reports it in first place.

Following this, rural interviewees rank *breeding* as 3rd, *soil fertility* as 4th and *pest regulation* as 5th most important services. This preference suggests strong social values being ascribed by Andean subsistence farmers (77.7 % of sample) to regulating services critical for agriculture. The role of *ancestral breeding practices* is briefly reviewed in Appendix: Data.

The reported findings inform the Andean peasant's perception of regulatory services, which are in turn critical for subsistence and agricultural livelihoods. Peru uses only 3.2 % of its area for crops, and the agriculture existing in the Andes is mostly for subsistence (**SEVILLA, 2008**). Understanding the perceptions that Andean farmers have about the environment can be extrapolated to other study areas in the Andes.

It can be induced that water regulation and services vital for agriculture (e.g. soil quality, soil fertility, genetic resources) are more valued if they bring direct benefits to the farmers' well-being and *chacra* productivity. Other regulating services related to climate like *climate regulation* (7th) and *carbon sequestration* (8th) are moderately valued: farmers are possibly aware of the climate's role but rather as an indirect benefit for their crops.

Finally, *habitat* (10th) and *pollination services* (11th) are ascribed the lowest social values. These are potentially perceived to bring no direct benefits to farmers. The low values ascribed to habitat services for biodiversity are briefly commented in Appendix: Data.

Overall, I observe that the most important regulating ES gravitate around the agricultural activity, which is one of the traditional human activities in the Andes and very climate-prone.

Overview of all Cultural Services

Table 21 Thematic overview over cultural ES.

SOCIAL VALUE	RANK	ES	EXPLANATION
HIGH	1	Intergenerational value	(+) Andean worldview and customs, still present (but not enacted).
	2	Cultural identity	
	3	Spiritual values	
INTERMEDIATE	4	Knowledge source	--
	5	Intrinsic values	(-) Contradicts current detrimental land use practices
	6	Sense of belonging	(+) Sense of pride for community
LOW	7	Scenic beauty and inspiration	(-) Unrecognised Mariño's eco-touristic potential, low cultural empowerment in rural areas
	8	Recreation and tourism	
Note: (+) if logic or not (-) to my perspective.			

Table 21 shows *intergenerational value* (1st) , *cultural* identity (2nd) and *spiritual values* (3rd) predominating in the cultural ranking. These three ES are most likely being ascribed relational values, values resulting from the human-nature interaction and influenced by remnants of traditional Andean worldviews. It lies

outside the scope of this study to report whether local people practice or not Andean spirituality. Although studied communities are rural, not self-identified as *indigenous*, Andean culture is still a subject of concern and value.

On the one hand, field observations suggest that the Mariño region experiences erosion of Andean spiritual and cultural practices. Traditional spiritual Andean value-holders maintain a profound respect for Mother Earth (Pachamama) and reverence for the power and fragility of the Mountains (Apus). Andean spiritual practices are for example ritual payments to the Earth to insure personal safety, crop yield or rain. Mountain worship has been called the *keystone of Andean culture* and continues to play an important role in the beliefs and ritual practices of Andean peoples which date back to pre-Inca times (**REINHARD 1985).**

Sociodemographic variables reported in this study like most interviewees being bilingual (75.9 %), having Quechua as first language (81.8 %), and having always lived in the community (82.4 %), suggest interviewees live relatively isolated lifestyles, away from the urban and modern Abancay. One could argue they still preserve ancestral Andean worldviews.

Field observations, however strongly suggest that interviewees practice rather remnants of Quechua cultural expressions, gone lost over time. Participants' intention while valuing was to me rather about expressing a concern about the cultural loss. Interviewees would comment about the *spiritual values* card pointing out these practices were important and sacred for their ancestors but that "*nobody or just few practices them in the communities nowadays*" (common statement). Factors like historical indoctrination by Church in the Andes shall also be considered.

On the other hand, *scenic beauty* (7^{th}) and *recreation* (8^{th}) were poorly ranked by locals. Previous social value assessment by **LOCATELLI AND GALMEZ, 2015** collected expert opinion about recreational hotspots in the Mariño watershed, who pointed out that exactly the three study communities were areas with ecotourism potential. **VALDIVIA ET AL., 2016** collected opinion from rural residents in the Mariño region who highly value scenic beauty and identity values of landscape features. Collected opinions by rural residents in this study is contrary to previous findings.

Overall, social values ascribed to cultural services by rural residents shall make decision-makers aware of the current cultural erosion. Policy-makers must revitalize and promote understanding of traditional knowledge which is the basis for adaptive management of highly complex Andean ecosystems.

Overview of all Threats

Table 22 Thematic overview over threats. (+) if logic or not (-) to my perspective.

SOCIAL CONCERN	RANK	THREAT	EXPLANATION
HIGH	1	Bush fires	(+) It is an illegal and harmful activity in the watershed (-)Locals burn forest themselves
	2	Hail and frost	(+) Climate change effects on agriculture (-)Intensification of land use concentrates frost risks
	3	Pollution	(+) Lack of waste(water) treatment
	4	Droughts	(+) Climate change and agriculture
INTERMEDIATE	5	Logging	(+) Forest loss, firewood scarcity
	6	Extreme heat	(+) Climate change and agriculture
	7	Landslides, soil erosion	--
	8	Agrochemicals	(-)Chemical damage to soil, agricultural vulnerability
LOW	9	Floods	--
	10	Overgrazing, overtrampling	(-)Lack of territorial ordering, water insecurity
	11	Urbanization	(+) City expansion not perceived from further rural settlements
Note: (+) if logic or not (-) to my perspective.			

All threats are linked to multiple ES and may affect them in various degrees. Finding the effect intensity and directionality of each threat on a certain ES remains outside the scope of the study.

Hail and frost events are the threat with the second-highest social concern. Frost and hailstorm events have increased in the Andes in last decades. Hailstorms cause severe mechanical damage to crop and precarious infrastructure, rural households become nutritionally and financially more vulnerable. Hail and frost signals also how spatial land use concentration concentrates frost risks in one single parcel (**HERVÉ 1994**).

Solid waste pollution is the third most severe threat for the communities: lack of municipal waste collection and wastewater treatment in the Mariño explains the social concern. Livestock grazing in water springs leaves fecal coliforms, thus affecting water quality downstream (**CONDESAN, 2014**).

Droughts and desertification are ranked fourth: subsistence farmers report water shortage and shifts in rainfall patterns over the last years (*personal observation*s, **PACC Perú, 2014**). Drought are driven by unsustainable land use practices and severity of climate change. Apurimac is the Peruvian province with the highest percentage of territory affected by desertification and droughts in Peru (**GUAITA ET AL., 2007**). Collected social concerns expose the rural vulnerability to drought.

Further threats receive intermediate social concern like *logging, extreme heat, soil erosion and agrochemicals.* Farmers seem not to worry about the overuse of fertilizers, most likely, they may not be aware of chemical damage to soil properties.

Finally, local opinion does not consider *overgrazing and over-trampling* as threats. This weak social concern signals unsustainable human behaviour and cultural loss of ancestral farming practices in the high-

Andes. Collective territorial ordering, crop rotation and crop systems using long duration periods made over centuries human subsistence possible in the hostile Andes with harsh climate conditions. Market pressure and short-sighted solutions for poverty alleviation promote intensive land use, excluding crop rotation and long fallow periods. Spatial concentration of land use is unsustainable for the Andean medium (**HERVÉ 1994)**. Livestock breeding around the Rontoccocha lake in Atumpata continues to happen despite fencing efforts, this depletes natural grasslands, pollutes water streams and threatens local water security.

6.2.5 Cross-category comparison

Looking across categories, some observations are made. First, *Provisioning and regulating services* are the categories which get the most attention. Boxplot (Figure 25) revealed higher SVI scores for provisioning and regulating services than for cultural ES. One could argue local people value provisioning and regulating services more, given their direct material dependency and subsistence economy context (**PAUDYAL ET AL., 2018**). Moreover, local people may not call these services *provisioning and regulating* but may understand them as *producing and maintaining forces* for social benefit.

Contrary to **DE GROOT ET AL., 2016**; **PAUDYAL ET AL., 2018; VERGARA 2017** and **MARTÍN-LÓPEZ ET AL., 2012**, a bias towards provisioning services was not observed in the rural preferences, nor did people value regulating services less for living in the rural areas or for supposedly obtaining from them only *indirect* benefits. It is true that regulating services do not provide *material tangible* benefits, but they do provide *direct services* such as regulation of available water quantity and quality, essential for subsistence livelihoods.

Secondly, *Cultural services* got the least attention. Social valuation methods are typically used to value cultural ES given its suitability to address personal beliefs and values (**PAUDYAL ET AL., 2018).** Based only on the SVI scores, I observe that cultural services get smaller SVI scores than other categories (Figure 25), what suggest underestimation of cultural services. Local people may have perceived cultural services as intangible and indirect benefits, or in general these were undervalued given the cultural erosion in the Andes. The surveyed rural communities are located very close to the expanding City of Abancay. Cultural erosion is shown through personal comments by participants, who exposed the ethnic and cultural marginalization experienced as Quechua-speakers. These and other observations are compiled in Appendix: Field Observations.

6.2.6 Interpreting the Ordination Analysis

PCA analysis was run to display in more detail the complexity of the data set and get more insights about people's preferences and linkages across variables.

The low percentage of explained variability, in average 34.68 %, suggests the PCA analysis did not capture in the two principal components most information of the data. Previous social valuation studies report first components explaining 76 % (**MARTÍN-LÓPEZ ET AL., 2012**) or 57 % (**OTEROS-ROZAS ET AL., 2014**) of the variance.

Nevertheless, the PCA multivariate ordination analysis is an attempt to deepen understanding of the complex dataset, by looking at it from different sides (e.g. variable clustering, correlations, ambivalences). In the following, visual interpretation of the PCA plots is discussed and compared with the SVI rank orders (*ranks order in brackets*).

PCA analysis of **Provisioning services** in Table 16.A, show *water supply* (1st) clustered with *fuelwood* (5th); and *shadow* (5th) clustered with *materials* (8th). I observe mismatches between the visual clusters and the SVI rank orders (in brackets), the low explained variance by the PCA may explain this incongruence. Regarding importance or length of eigenvector, *water supply* (1st), *food* (2nd) , *fuelwood* and *medicinal plants* (6th) were similarly valued. Regarding trade-offs, people who valued *water supply* the most, valued *materials* and *natural shadow* the least, which is plausible given their opposite ranking in SVI.

PCA analysis of **Regulating services** clusters *Habitat services* (10th) with *Pollen transport* (11th). This grouping coincides with the SVI ranking, where both ES were the lowest valued. Regarding trade-offs, people who valued *Breeding* (3rd), did not value *Climate regulation* (7th) nor *Extreme events regulation* (9th). These trade-offs in social preferences coincide with SVI rankings. Regarding importance of other regulating services, their eigenvector lengths were equally long. I interpret this as people likely valuing regulating services more on a random basis. An explaining argument is that regulating services are rooted in very technical knowledge, what may difficult understanding by a *non-scientist* audience. I can also argue language, education level and culture played barriers in translating technical concepts like regulating ES.

Cultural services report the highest explained variance by the principal components (39.30 %) in Table 17.A. Clear clusters are observed: (i) *intergenerational value, intrinsic value* and *sense of belonging*; (ii) *beauty* and *recreation*; (iii) *cultural identity* and *knowledge source*. Clustering of beauty and recreation coincides with the SVI ranking, as both were ranked last. Regarding importance, all 7 cultural ES show long eigenvectors, meaning all were perceived as important by people. Regarding trade-offs: those who value *future generations* (1st), do not value *beauty* (7th). This ambivalence coincides with the SVI ranking.

For **threats**, the following clusters are observed: (i) *fires* and *pollution*; (ii) *Hail storms, floods* and *soil erosion*; (iii) *droughts* and *urbanization*. Clustering of (ii) suggests people associate increased intensity of precipitation events with increased run-off and soil erosion. Regarding least important threats, *heat, grazing* and *agrochemicals* are the least important threats for the people, what coincides with their last rank orders

in SVI rankings. All other threats receive high social value. Regarding trade-offs, people who are concerned about *hailstorms*, neglect severity of *logging*. This trade-off could be explained by looking at the local logic, as the decrease of forest coverage (logging), leaves more bare land exposed, hence the *hailstorms* are stronger perceived.

6.3 EPISTEMOLOGICAL IMPLICATIONS

The IPBES guide on multiple values recognizes the *epistemological challenge* to unify scientific paradigms and methodologies with experience-based and traditional forms of knowledge. I have experienced these challenges on the field and compile them in Table 23**.**

Table 23 Epistemological clash between western and Andean knowledge systems: field observations

CRITERIA		CHALLENGE	PARTICIPANT'S REACTIONS	ADDITIONAL JUSTIFICATIONS / MEASURES
1	Local systemic thinking	• Local people value nature's benefits all at the same time.	• Some locals can't rank ES in a numeric scale.	• Holistic Andean values systems are not linear, existence of incommensurable values.
2	Locals don't see the Human-Nature dualism	• Research uses the term *nature* as this is needed to elicit social values around ES provided by Nature or threats affecting nature. • The western term *nature* has no direct translation to Quechua, Pachamama is closest in meaning, however with strong spiritual and religious connotations.	• Local people were not familiar with the term "nature" (*naturaleza* in Spanish) • Alternatively, I referred during surveys to forests, lakes and grasslands as sources of ES.	• Rural people have their own idea of nature different to peer-reviewed concepts. (also observed by **Nahuelhual et al., 2016**) • Indigenous peoples do not see themselves as outside the realm of nature, but as part of nature (**UN Permanent Forum on Indigenous Issues, 2009** pp 52). • South American Andes use rather the term Mother Earth *Pachamama* as systems of life (**Díaz et al., 2016** pp. 20).
3	Locals don't see the rational-spiritual dualism	• I cannot account for the degree of spirituality during ranking exercise.	--	• Spiritual Andean practices present to some extent in the study communities.
4	Different knowledge, different terms	• Participants did not understand technical terms, • Hard to describe technical ES with local examples.	--	• Surveys were rephrased in popular language, with the advice by local translators and NGO partner.

The uncertainty whether rural interviewees understood the valuation task to rank in lineal order was a **core challenge** throughout the entire study. During surveys many did not conform to the linear ranking and would insist on *"everything (all ES) being important, everything, at the same time"*.

Throughout the work I adapted concepts to popular language and Quechua. Key comments are made about the observed clash of western and Andean thinking.

Local Andean Knowledge

Aware of the differences in knowledge systems before field stay, I designed a controlled methodology ranging from standardized survey questions to translations to Quechua to avoid confusions. However, on the field, when participants would express their own sets of values and understandings: who was I to invalidate their equally valid ways of knowing? The concrete epistemological differences are compiled in Table 23.

I highlight the role of *local ecological knowledge* during the valuation exercise: (i) Local people recognised a broad range of services and threats, and (ii) only few ES were unknown to them.

Embodied Knowledge

Embodied knowledge consists of the routines, habits and information our bodies enact without conscious thought. Interviewees may have never consciously reflected about their inner environmental values nor had them being elicited before. Embodied knowledge of rural interviewees may explain difficulties with the ranking exercise.

Figure 31 The challenge of linear rankings for female interviewee from Llañucancha.

For instance, while surveying participants about cultural ES, they would deny obtaining inspiration from the natural landscape, thus suggesting that the ES *Scenic beauty and Inspiration* would not be relevant. However, on the field I saw that after a half-day of work on the cropland, agricultural laborers would play the Andean quena (flute) during their break, to liven up. At that moment the view down the valley was colorful and sunny, and they were playing music. I could assume the landscape had a role in inspiring artistic expressions and music. Field assistants, native to Apurimac, mentioned playing music with traditional instruments is an ancient tradition, yet rarely practiced in Mariño communities. This anecdote suggests the likely gap between embodied knowledge and reported values on rankings

The Western-thinking Bias

Although the IPBES Framework on Multiple Values provides an objective approach to understand the multiple values around nature, field observations show interviewees would not value nature in such

reductionist ways. This suggests weaknesses of the scientific reductionist approach of *"knowing best about less"* which cannot properly capture holistic values around nature ascribed by local people (**UNESCO 2017 pp.41).** Furthermore, the IPBES framework proposes ES valuation methodologies that have been validated using only western scientific methods: So how should these methods be applied in non-western contexts? In fact, many participants did not feel comfortable with linear ranking of ES.

Overall, the study design was tempted to quantify local knowledge and make it visible. This endeavour may however fall in the *inconvenient approach* of using science to validate indigenous and local knowledge, as this presupposes that local knowledge should be validated using western scientific criteria. I acknowledge the methodological bias of the study and therefore recommend future studies should seek interdisciplinary knowledge co-production (**UNESCO 2017,** pp 48; **Apgar et al., 2009**).

6.4 METHODOLOGICAL IMPLICATIONS

Table 24 Participants' reaction to the survey methods, compiled field observations.

SURVEY METHOD	PARTICIPANTS' REACTIONS		CONCLUSIONS ABOUT METHOD
	POSITIVE	NEGATIVE	
ECOSYSTEM SERVICES CARD GAME	• Participants actively interacted with the cards	--	• Simple and practical tool • Allows illiterate people to *touch the concepts* • Hidden tool for raising awareness (locals feel empowered about their communities' natural beauty awakening research interest)
PHOTO-ELICITATION	• Participants liked pictures • Some requested keeping the learning material • Participants knew very well were photos were taken (strong spatial knowledge)	• Pictures deviate attention from exercise (comments, anecdotes, stories evoked) • Participants rank according to picture beauty	• Helps breaking the ice between foreigner researcher and local (comment, jokes) • *Pictures say more than 1000 words* pictures also raise awareness • Good intercultural skills needed to allow for good humor and focused work in Quechua language.
RANKING EXERCISES	--	• Participants can't rank ES following a linear scale, there is need to rank ES simultaneously • Confusion in participant, participant feels pressure to provide the "right answer"	• For some, the linear scale of values does not match their holistic thinking

Participatory and ludic *mixed survey methods* engaged interviewees not familiar with the social valuation method nor with the ES framework. Phrasing of technical language into popular language prior to survey execution clearly eased participants understanding of the ES and threat cards subject to value. 29 different ES were actively recognised and valued by rural interviewees, few ES remained unknown (see Table 15). The value elicitation was an exhaustive process, which reported high social values specially for threats,

regulating and provisioning services, in contrast to previous studies which tend to exclude regulating and cultural ES from value assessments (**Benis Egoh et al., 2012)**. Here, it is important to consider that reported values may be also a result of previous education interventions in the area (NGO campaigns and other researchers).

Methods awoke interest of participants, who expressed their experience-based knowledge and made valuation process a *tool for mutual learning* as well (see compiled observations in Table 24). During surveys, as interviewees reflected on values, I learned from their local worldviews. The card game substantially helped communication, through *local figures* names of services were usually understood instinctively, research became in this sense dialogical.

6.5 STUDY VALIDITY

Criteria sensu LeCompte and Goetz 1982 cited in **BRYMAN 2012** to assess the quality of research are discussed below.

6.5.1 Internal Validity

Achievements

The study valued, quantified and prioritised ES, and threats to them. In this way, the study made local values visible using an interdisciplinary approach. Methodological instruments were validated with a total of 170 surveys conducted with a low sampling error of 7 % and a confidence level of 95 % (see sample size calculation in Table 12).

In addition to this, the sampling covered the views of all community demographics thus gaining reliable understanding of the Mariño socio-ecological system without no sampling bias. For example: one communal authority was interviewed for every five community residents and sampling was free of gender-bias.

Even though my field stay in the Mariño watershed was relatively short (6 weeks), collected unstructured observations on social and environmental behavior of participants enriched data interpretation and helped create value narratives.

Overall, the internal validity of the study is supported by the match between my field observations and the theoretical arguments explored in the discussion.

Limitations

Regarding the *conceptual limitations*, the social valuation assessed only the social demand side of ES (e.g preference, importance, usefulness, level of use, desirability) not its supply side (**OPENNESS PROJECT 2016; WOLFF ET AL., 2015**). By assessing the demand side only, e.g. the amount of service required or desired by society, each interviewee is assumed to be only a user of ES. The second side of interviewee as producer of ES for downstream populations remained outside the study assumptions.

Moreover, only the individual values ascribed to ES were assessed and not the collective values. Individual values provide a clearer but not entire picture about the local systems of values. Also, Andean participants expressed often their discomfort to rank ES in a linear way. Obtained Social Value Rankings shall be understood as an approximation to local values. It is important to highlight, that Quechua-based research methods that allow the rural interviewee to be in control of the knowledge transfer can be explored in future ES assessment studies (**ARGUMEDO AND PIMBERT, 2005**).

Although I define value as a general subjective importance, I do not exclude the existence of other mystical dimensions of Andean social values. From the elicited social values, a finer typology of social values cannot be deducted. Participants may have ranked one single ES based on multiple social value dimensions (intrinsic, cultural, life-sustaining, etc.). Overall, results are discussed considering only the socio-ecological scope. Relevant political and institutional scopes remain outside the study design.

Also, I acknowledge that the SVI ranking is only a first linear approach to model the social preference, multivariate statistics or multi-criteria analysis in future studies can provide deeper insights.

Regarding the *practical limitations* of the survey methods, these are listed in Table 25, following examination criteria by **BRYMAN 2012;** as well as ways I ameliorated limitations them in situ. I acknowledge that 29 selected ES is an exhaustive list for rural participants inexperienced in value assessments. Moreover, accuracy of numeric findings may have been influenced by the lack of reflective processes in local people mainly due to their knowledge of experience-based nature.

Table 25 Survey research limitations of the social valuation**.**

PRACTICAL LIMITATIONS		WAYS I AMELIORATED THEM IN SITU
1. Problem of meaning	• It was required to translate concepts into popular wording • Not all concepts could be translated (e.g. carbon sequestration). • Explaining too much (hand gestures and adjectives) may have influenced the valuation exercise.	• Get Quechua-speaking research assistants • Discard unknown ES at the beginning of exercise, don't force understanding. • Use local examples and expressions (compiled in previous study phase).
2. Problem of memory or exhaustion	• Potentially exhausting mental ranking and visual ordering of 40 cards .	• Elicit social values per category, this allows participant to concentrate in one category of services • If attention drops, present cards again and refresh memory only for the ES category in question • Remind participant surveys were **voluntary**, invite to stop if desired.
3. Reactive effect	• The participant knows he or she is participating in a study and this confounds the researcher's data. • Yea-saying and nay-saying: participants place ES cards in unjustified order.	• Remind participants to rank cards in the order they believed right, not to please interviewer.
4. Power relationships	Interviewer characteristics • Researcher is foreign, this can hinder a horizontal exchange of ideas, as well as honest replies by participants • I am not familiar with communities' social norms nor Quechua language.	Build trust with locals: • Get the research assistants (i) native to Apurimac, (ii) familiar with rural lifestyle (iii) fluent Quechua-speakers. • Get local field guides for each community: they introduced me to the rural interviewees.
	Hierarchy effect	Undo power hierarchies: • Use encouraging phrases*: "Your opinion is valuable to me"; "I want to learn from you"; "There is no right or wrong answer"* (locals feel their opinions matter)
	Lack of social rapport	Achieve rapport • Friendliness and familiarity are key to create a collaborative knowledge exchange in the Quechua culture (learnt from previous project phases). • Small talk, greetings in Quechua, food sharing break the ice.
5. Interviewer variability	• Interviewer variability in the asking of questions is a source of error if two or more interviewers are involved	• Fully trained research assistants (three half-day training sessions held prior to surveys) • Use Survey Guide
6. Valuation is a personal process	• participants understood the valuation tasks in internal, emotional processes ways that escape researcher's control Figure 32	• control definitions and guide the valuation exercise

A further practical limitation of the social valuation is to only capture the expressed values, but not to explore the personal motives and principles behind (see Figure 32), which remain outside the research scope and often outside the researcher's control.

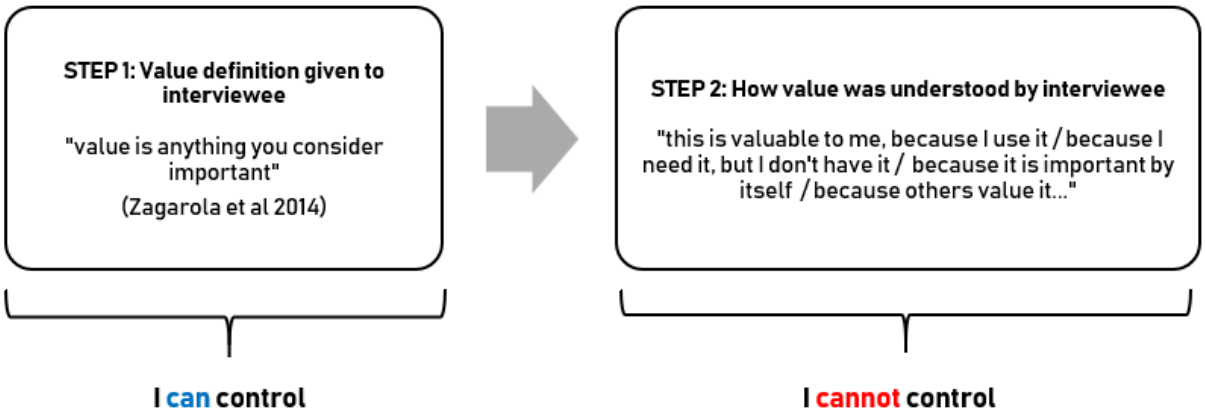


Figure 32 Valuation as a personal process beyond researcher's control

6.5.2 External Validity (Study Impact)

Study findings can impact society in different ways. First, the identification of the ES and threats with the highest social value makes ecosystem conservation opportunities and challenges visible in the Mariño region. Here, the study gives visibility to social preferences, that would have been otherwise difficult to capture in economic terms. Non-mainstream ES were assessed, this can complement previous and future valuation studies in the Mariño region and the draw attention to priority non-hydric ES beyond the focus of current water PES schemes.

Moreover, methods can be scaled to other mountain or rural contexts. Data analysis through the Social Value Index can be a simple analytical tool for study cross-comparison.

It is important to note that the choice of a valuation method was a *political choice***,** as certain methods would be more sensitive than others to elicit certain underlying worldviews and types of values **(GONZÁLEZ-JIMÉNEZ ET AL., 2018**). The political choice made in this study was to make local values visible, these were interpreted in a careful *reflection process* about the employed methods, the question asked, and the local context.

The bottom-up design overcomes socio-economic, geographical, epistemological and political barriers by eliciting perceptions from people that often enough remain outside policy making and research interest. Decision-makers can make use of these findings to maximize social acceptability of environmental initiatives, reduce social discomfort and protect relict Andean ecosystems. The contextualization of the study within the Andean Forest Program will help share its findings in the region.

6.6 RECOMMENDATIONS

Key practical recommendations are compiled based on stay in and access to the research area in Apurimac, as access to study communities is moderately difficult for a researcher coming from overseas. Future research steps are likewise listed to guide future works.

Logistic Recommendations

Regarding logistics, entry approval to communities or prior consent by the presidents of the three study communities was essential. Between October 9 and 12, 2018, I personally met with the community presidents and introduced them the study scope, presidents approved entry and requested to be informed about study results. Community interviewees demanded before starting the survey if I had their president's permission to do the study. The communities' presidents' approval was key to generate trust in locals.

Secondly, survey schedule had to rigorously adapt to the farmers' time availability and location. Communities' presidents informed me about the people's time schedules: in average farmers would leave their houses and head to their farms or take their cattle to upland pastures latest by 8am everyday and return home after 5pm. Daily departure by car from Abancay city was at 4:30am, arrival to community was at 06:00am, surveys were carried out until 5pm. A minimum daily walking distance of 4km had to be covered at altitudes 2800 to 3800 m.a.s.l. Households and croplands were shallowly distributed; group security considerations were taken.

Thirdly, previous studies of different kind had been carried out in the study communities which rewarded with money. Observed was little voluntary participation in the study area, so small donations (cleaning products, sugar) were provided and these encouraged participation in surveys.

Fourthly, accounting for security conditions on the field for the researcher and assistants was essential as daily field work was intense, and during the hikes to the households unleashed dogs and drunk men were sometimes spotted. Organising a local field guide for researcher and assistants is recommended. Travel security was also key: unpaved, single-lane and foggy ways marked the way to the Mariño uplands, so an experienced driver was arranged by local partner NGO CEDES.

Weather conditions shall be considered while planning research. Best time to do research in the Andean uplands is during dry season (August to November), the study was executed in November.

Finally, transport and access to the remote communities depended on financial resources availability (research grant). Car renting, personnel costs (experienced driver, research assistants, Quechua translators) and additional living costs in Abancay limited extended field stay duration.

Methodological Recommendations

The field experience shows that a social valuation study shall account for interdisciplinarity and dialogue across social and natural sciences. Including ethnographic and social science methods, especially when study populations have non-western mindsets and challenge current research methods, is key.

I recommend future social valuation studies to: (i) be multifactorial, include qualitative and quantitative data collection instruments; (ii) be inductive, accumulate as much descriptive detail as possible to recreate a more complex reality and socio-ecological setting; (iii) plan for longer field-commitment: this study is the result of 06-weeks long immersion in the Andean natural and cultural rural environment, longer field stays help stablish social rapport key to elicit inner values; and (iv) remain dialogic and flexible: use an adaptive study design and pilot phase, early contact with locals enrich methods, speaking their native language is not mandatory but eases most of the work.

6.7 Future Studies and Outlooks

Exploring ES and threats present in the Mariño watershed under the light of local values held by rural and Quechua-speaking study communities is a unique opportunity to stimulate intercultural and interdisciplinary thinking in the Andean region about the importance and vulnerability of ecological and cultural systems.

Study Outlooks

Key outlook for this study is therefore to disseminate, share and socialize results to increase visibility that the South American Andes can become a hotspot for transdisciplinary sustainability research that deals with Andean complexity, learns from it and engages with local knowledge-holders. Study findings can contribute to establish a quantitative baseline for evaluating whether environmental management is meeting local needs and expectations (**Zagarola et al., 2014**).

Social valuation methods can serve bidirectional purposes, as collection of public preferences can be used to promote local climate stewardship and to mainstream biocultural patrimony. Findings provide key insights into community values, which if adopted by local policy makers can boost cultural fit and public acceptance of environmental policies in the Mariño region.

Future Research Questions

Based on the extensive amount of data collected, future studies can run a multivariate analysis to find sociodemographic predictors of social values; a correlation analysis of social values ascribed to ES; and a spatial mapping of social preferences, as all households were georeferenced. Furthermore, social values can

be analyzed per community and be compared across. Regarding the social value index, a sensitivity test can be run to compare the SVI scores using non-linear conversion scales.

Based on this study's findings, the following unresolved questions emerge: (i) What is the state of Andean spiritual and cultural knowledge and values in the Mariño watershed? And how linked are these with environmental values? (ii) How would social preferences look like if this study was applied to urban residents in the city of Abancay? (iii) How far have social value assessments been incorporated in the policy design of rural areas in the Global South? Which are their success outlooks?

This research explores only a portion of the broad landscape of Andean knowledge. At a transdisciplinary level, future studies shall assess ES using the Andean ES conceptual framework proposed by **APGAR ET AL., 2009**, or execute a social valuation incorporating traditional Quechua research techniques, like prophesises, myths, traditional forecasting and back-casting techniques, visual and narrative techniques as noted by **ARGUMEDO AND PIMBERT, 2005**.

Conversations held with the many study participants greatly evidence the central role traditional land-use units, like the Andean farming system *chacra*, have for the production and use of many converging ES. Assessment of ES using the *chacra* as a spatial unit of ES flows remains an unexplored study subject.

7 CONCLUSIONS

Table 26 The social valuation study in a nutshell

Research Methodology	Study design	Exploratory-descriptive (mixed methods research)
	Data type	Quantitative
	Unit of Analysis	Social values (defned as everything deemed with importance)
	Value-holder	Rural community residents (older than 14 years).
	Valuation tools	photo-elicitation, card game, ranking exercises
	Scales of valuation	• Geographic (upper part of Mariño watershed) • Temporal (present day) • Social (modern Quechuas)
	Evaluation criterion	Ranking criterion
	Elicited information	Demand side of ES (dependencies)
Results	General results	Rural residents **ascribe** social values to nature. Rural residents understand a wide range of ES and threats. Rural residents possess local knowledge and value systems around nature.
	Answers to research questions	Identified were the **ES** with highest social values, by category: • (Provisioning) *Water for consumption, livestock and irrigation* • (Regulating) *Water cycle regulation* • (Cultural) *Intergenerational value of nature* Identified was the **threat** *bush fires* with highest social concern.

The present social valuation explorative-descriptive study in the Mariño watershed explored values and concerns of rural residents in the study communities of Atumpata, Llañucancha and Micaela Bastidas ascribed to 29 ecosystem services and 11 threats.

A total of 170 rural community residents were interviewed using semi-structured questionnaires. Mixed survey research methods as well as the development of the Social Value Index made it possible to identify that *water for consumption* (provisioning); *regulation of water cycle* (regulating) and *intergenerational value of nature* (cultural) were the three priority ecosystem services with the highest social value. The social predilection around water is explained by the instrumental value of this resource for subsistence activities, which occupy most of the sampled population (77.7 %); as well as by the non-instrumental, mystical and cultural values traditionally ascribed to the water element in the Andean cosmovision. Moreover, *bush fires* were reported as the environmental threat receiving the highest social concern: this anthropogenic threat mirrors the chronic fire danger across entire Apurimac triggered by detrimental land use practices and insufficient political and technical response. These findings answered the four **research questions**.

Additional analysis of the data set, such as the PCA ordination analysis, showed conflicts and coincidences when compared with the SVI rankings, thus exposing the complexity of the dataset. Further trends remain subject of future studies including multivariate statistics and ethnographic analysis of the underlying social world and local logic.

Overall, rural interviewees identified ES and threats without difficulties, despite their high illiteracy levels, social marginalisation and non-familiarity with the ES framework. This proves the existence of local

systems of knowledge and values of the rural Andean interviewees. Under triangulation of sociodemographic, environmental and cultural aspects, the observed social preferences were justified as plausible, thus validating the social valuation findings.

Moreover, the **sociodemographic analysis** of the sample showed most interviewees practiced small-scale subsistence livelihoods (77.7 %), were Quechua-speakers since childhood (81.2 %), were illiterate (21.2 %, four times higher than the national average) and were living in extreme monetary poverty conditions (67 %). The low-income context and the evident sociocultural and linguistic barriers afflicting the interviewees increase the relevance of this non-monetary study as it seeks to (i) leverage non-economic values of communities often left outside policy design and (ii) articulate intercultural, social and academic dialogue.

Furthermore, the **mixed research methodology** gave a comprehensive view on people's preferences regarding goods and benefits provided by the Mariño's ecosystems; as well as about threats to them. Although the study only gives a snapshot of public values ascribed to local ecosystems, it provides a vivid picture of people's values co-existing with highly threatened ecosystems and events causing ecosystem degradation. The study contributed with a methodological innovation, by having combined suitable mixed survey methods, e.g. photo-elicitation and ranking exercises, for the social valuation in the Andean context. Selected methods saved time and financial resources, were practical for Spanish to Quechua translations, were intuitively understood, specially by elderly and illiterates and engaged participants in ludic ways. I observed that the methods brought bidirectional benefits. It elicited values for the research purpose, but it also promoted environmental reflection in the interviewees. Taken as a whole, this study suggests that social perceptions about nature's worth are embedded in both local ecological and cultural contexts.

The achievements of the study are as important as its **limitations**. On the conceptual side, the entire research design shows the constant epistemological clash when trying to articulate Andean views about nature with tools rooted in western science and meant to be applied in western contexts.

The social valuation method as well as the general ES research are still fields in their early stages for the Andean context. Transdisciplinary research efforts play a bridging role in complex and historically marginalized social contexts where local systems of values and knowledge can be leveraged and thus local people’s voices, too. Future research steps shall venture into dialogue across systems of knowledge.

Throughout this research it has become evident that the Peruvian department of Apurimac has an incredibly high social and environmental potential to be rediscovered, rescued and promoted. A promising outlook for sustainable development in Apurimac is the promotion of ecotourism, touristic infrastructure and Quechua-based culture of nature conservation. Altogether, these can become Apurimac’s best allies to face a changing climate.

I conclude that the social valuation of the Andean natural capital is a promising tool and must be an important science-policy endeavour to catalyze the voice of rural communities and make it visible for regional and national decision makers. Despite all challenges Apurimac faces, this Peruvian department can become an emerging Andean hope towards a collaborative and sustainable transition in its deepest and often forgotten valleys. The Andean treasure of life and culture awaits academic and political interest at national and global scale.

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9 APPENDIX

9.1 GLOSSARY

Table 27 Glossary of terms used in the study.

CONCEPT	DEFINITION
Biodiversity	Genetic, functional and evolutionary variability of living beings (**Diaz et al 2016).** Changes in biodiversity can influence the supply of ecosystem services. Biodiversity, as with ecosystem services, must be protected and sustainably managed.
Chacra	(*Quechua* term) traditional Andean agricultural and production unit, farm.
Capital	Resources that make production of more resources possible.
Climate change	Statistically significant variation in the average state of the climate or in its variability, which persists for a long time (**IPCC 2001**)
Ecosystems	Dynamic complex of plant, animal and microorganism communities and the nonliving environment interacting as a functional unit (**MA 2005**). The Mariño watershed hosts managed and natural ecosystems.
Ecosystem services (ES)	Benefits that people obtain from ecosystems. Principle oriented to human well-being (**MA 2005)**
Global warming	Human exacerbated greenhouse and atmospheric heat retention effect due to industrial CO2 emissions.
Index	a term that is usually used interchangeably with scale to refer to a multiple-indicator measure in which the score a person gives for each component indicator is used to provide a composite score for that person (**Bryman 2012, pp. 715).**
Local knowledge	Understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings. For rural peoples, local knowledge informs decision-making about fundamental aspects of day-to-day life (**UNESCO, 2017).**
Nature	Continuum from nature as an autonomous functioning and evolving system to nature as domesticated species. Nature includes scientific concepts like ecosystems, biodiversity; and concepts from other knowledge systems, like Mother Earth and systems of life (**Diaz et al 2016).**

9.2 DATA

Study Design Matrix

Table 28 Matrix of Research Problems and Objectives

LEVEL	PROBLEM	QUESTION	OBJECTIVES	VARIABLES	INDICATORS	METHODOLOGY
GENERAL	It is unknown which ecosystem services in the Mariño watershed have the **highest social value** according to rural residents.	Which ecosystem services in the Mariño watershed have the **highest social value** according to rural residents?	Know the ecosystem services with the highest social value.	(see specific objectives below)		<u>Research type:</u> exploratory and descriptive, quantitative <u>Unit of analysis:</u> social values ascribed to 29 ecosystem services and 11 environmental threats.
SPECIFIC	It is unknown which provisioning service has the **highest** social value.	Which provisioning service has the **highest** social value?	Know the provisioning service with the highest social value.	Social value of provisioning services	1. Water 2. Food from farms 3. Wild foods 4. Medicinal plants 5. Fuel 6. Materials 7. Fodder 8. Minerals and clays 9. Tree natural shadow 10. Renewables	

	It is unknown which regulating service has the **highest** social value.	Which regulating service has the highest social value?	Know the regulating service with the highest social value.	Social value of regulating services	1. Air, water and soil purification 2. Water cycle regulation 3. Natural hazards regulation 4. Soil fertility and formation 5. Climate regulation 6. Carbon sequestration 7. Pollination and seed dispersal 8. Pest regulation 9. Habitat for biodiversity 10. Genetic resources and breeding 11. Oxygen production via photosynthesis	Study subjects: Residents of three rural communities (Atumpata, Llañucancha and Micaela Bastidas) in the Mariño watershed. Survey sample 170 interviewees Data collection instruments: Semi-structured surveys (closed, preference and ranking questions).
	It is unknown which cultural service has the **highest** social value.	Which cultural service has the highest social value?	Know the cultural service with the highest social value.	Social value of cultural services	1. Scenic beauty and inspiration 2.Recreation and tourism 3.Spiritual values 4.Existencevalues 5.Value for future generations 6.Cultural identity 7.Source of knowledge 8.Sense of belonging	
	It is unknown which environmental threat has the **highest** social value.	Which environmental threat has the highest social value?	Know the threat with the highest social value.	Social value of threats	1.Droughts 2.Floods 3.Landslides and soil erosion 4.Bush fires 5.Logging 6.Overgrazing and over-trampling 7.Extreme heat 8.Solid waste pollution 9.Urban growth 10.Hail and frost 11.Agrochemicals	

The Broader Research Project

Table 29 The three phases of the Broader Research Project.

PROJECT ELEMENT	PROJECT PHASE		
	1. Collect expert knowledge	**2. Socio-ecological understanding**	**3. Social valuation**
Purpose	**Purpose 1** Collect information from local stakeholders on Ecosystem Services interventions in the Mariño watershed.	**Purpose 2** Understand the Mariño socio-ecological system through local social perceptions and knowledge.	**Purpose 3** Understand the social value of ecosystem services
Results	**Result 1.** Information from different stakeholders on the development and implementation of the Payment for Ecosystem Services (PES) scheme in the Mariño watershed is compiled . **Result 2.1.** A list of ecosystems services perceived as present in the Mariño watershed are identified, according to the opinion of local authorities. **Result 2.2** A list of environmental threats perceived as present in the Mariño watershed are identified, according to the opinion of local authorities.	**Result 3**. Entry permit to study communities for research purposes is obtained from community presidents. **Result 4**. Social perceptions about benefits provided by four Andean ecosystems in the Mariño watershed and threats to them are elicited through surveys for rural residents.	**Result 5.** The social value of 29 ecosystem services and 11 environmental threats present in the Mariño watershed is elicited via surveys for rural residents.
Activities	**Activity 2.1** Eleven Interviews of up to 1h duration were conducted with local stakeholders. *Local stakeholders are: regional water authorities, regional NGO representatives, natural resources*	**Activity 3**. Request formal entry permit to community presidents or community board representatives for study purposes. **Activity 4.1** Training of 04 field research assistants to execute surveys in Spanish and Quechua	**Activity 5.1**: Training of 10 field research assistants to execute surveys in Spanish and Quechua language with appropriate survey material **Activity 5.2.** Execution of 170 individual workshops of up to 30

	technical experts; and the Atumpata, Micaela Bastidas and Llañucancha community presidents.	language with appropriate survey material. **Activity 4.2** Conduct 49 semi-structured surveys of up to 45 minutes duration to rural residents in the three study communities (age: 14 – 99). Sociodemographic data of participants is also collected.	minutes for ES valuation using semi-structured surveys (photo-elicitation, ranking exercises). Sociodemographic data of participants is also collected. **Activity 5.3.** Purchase and distribution of voluntary donations (300 kg of sugar in total) to reward rural interviewees for their participation in the study.
Materials	Survey materials, voice recorder.	Survey guide for field assistants, survey materials	Survey guide for field assistants, survey materials, donation for participant.
Timeframe	October 4 – October 21, 2018	October 22 – October 26, 2018	November 10 – November 24, 2018
Location	Different locations, City of Abancay, Apurimac, Peru	Atumpata, Micaela Bastidas and Llañucancha communities	Atumpata, Micaela Bastidas and Llañucancha communities

Note: The present thesis work **only** analyzes data collected in phase 3.

Frequency Analysis

Table 30 Frequency analysis of provisioning services (n=170, ES code in Table 8)

ES code	Provisioning Services Rank Order																			
	Place 1°		Place 2°		place 3°		place 4°		place 5°		place 6°		place 7°		place 8°		place 9°		place 10°	
	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%
P1	111	65.3%	21	12.4%	4	2.4%	7	4.1%	8	4.7%	4	2.4%	4	2.4%	3	1.8%	3	1.8%	4	2.4%
P2	13	7.6%	45	26.5%	40	23.5%	20	11.8%	18	10.6%	11	6.5%	14	8.2%	7	4.1%	3	1.8%	0	0.0%
P3	4	2.4%	11	6.5%	12	7.1%	20	11.8%	13	7.6%	28	16.5%	32	18.8%	23	13.5%	19	11.2%	6	3.5%
P4	10	5.9%	6	3.5%	14	8.2%	31	18.2%	32	18.8%	22	12.9%	22	12.9%	15	8.8%	11	6.5%	4	2.4%
P5	4	2.4%	28	16.5%	25	14.7%	20	11.8%	24	14.1%	23	13.5%	13	7.6%	6	3.5%	14	8.2%	9	5.3%
P6	4	2.4%	9	5.3%	13	7.6%	8	4.7%	9	5.3%	18	10.6%	18	10.6%	41	24.1%	30	17.6%	12	7.1%
P7	11	6.5%	8	4.7%	29	17.1%	32	18.8%	20	11.8%	22	12.9%	22	12.9%	14	8.2%	7	4.1%	2	1.2%
P8	2	1.2%	15	8.8%	6	3.5%	10	5.9%	6	3.5%	9	5.3%	15	8.8%	22	12.9%	35	20.6%	25	14.7%
P9	9	5.3%	19	11.2%	21	12.4%	17	10.0%	34	20.0%	19	11.2%	19	11.2%	15	8.8%	11	6.5%	5	2.9%
P10	2	1.2%	8	4.7%	6	3.5%	4	2.4%	4	2.4%	12	7.1%	8	4.7%	14	8.2%	14	8.2%	30	17.6%
Empty Rank	-	-	-	-	-	-	1	0.6%	2	1.2%	2	1.2%	3	1.8%	10	5.9%	23	13.5%	73	42.9%
Total (n= 170)	170	100.0%	170	100.0%	170	100.0%	170	100.0%	170	100%	170	100.0%	170	100.0%	170	100.0%	170	100.0%	170	100.0%

Table 31 Frequency analysis of regulating services (n=170, ES code in Table 8)

ES code	Regulating Services Rank Order																			
	Place 1°		place 2°		place 3°		place 4°		place 5°		place 6°		place 7°		place 8°		place 9°		place 10°		place 11°	
	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%
R1	38	22.4%	31	18.2%	14	8.2%	18	10.6%	8	4.7%	15	8.8%	8	4.7%	12	7.1%	6	3.5%	10	5.9%	7	4.1%
R2	52	30.6%	21	12.4%	23	13.5%	15	8.8%	10	5.9%	10	5.9%	5	2.9%	12	7.1%	10	5.9%	3	1.8%	6	3.5%
R3	5	2.9%	7	4.1%	10	5.9%	9	5.3%	19	11.2%	11	6.5%	22	12.9%	17	10.0%	20	11.8%	22	12.9%	23	13.5%
R4	5	2.9%	19	11.2%	20	11.8%	23	13.5%	20	11.8%	23	13.5%	13	7.6%	12	7.1%	16	9.4%	10	5.9%	2	1.2%
R5	6	3.5%	15	8.8%	12	7.1%	17	10.0%	21	12.4%	17	10.0%	21	12.4%	17	10.0%	15	8.8%	10	5.9%	10	5.9%
R6	8	4.7%	17	10.0%	15	8.8%	13	7.6%	14	8.2%	16	9.4%	16	9.4%	8	4.7%	15	8.8%	16	9.4%	15	8.8%
R7	9	5.3%	11	6.5%	22	12.9%	14	8.2%	21	12.4%	16	9.4%	15	8.8%	19	11.2%	14	8.2%	13	7.6%	7	4.1%
R8	3	1.8%	9	5.3%	10	5.9%	8	4.7%	14	8.2%	17	10.0%	18	10.6%	21	12.4%	20	11.8%	18	10.6%	16	9.4%
R9	4	2.4%	5	2.9%	10	5.9%	17	10.0%	16	9.4%	13	7.6%	15	8.8%	23	13.5%	16	9.4%	19	11.2%	20	11.8%
R10	28	16.5%	22	12.9%	18	10.6%	17	10.0%	15	8.8%	10	5.9%	12	7.1%	7	4.1%	7	4.1%	12	7.1%	19	11.2%
R11	12	7.1%	13	7.6%	16	9.4%	18	10.6%	11	6.5%	19	11.2%	19	11.2%	14	8.2%	18	10.6%	15	8.8%	10	5.9%
Empty Rank	-	-	-	-	-	-	1	0.6%	1	0.6%	3	1.8%	6	3.5%	8	4.7%	13	7.6%	22	12.9%	35	20.6%
Total (n= 170)	170	100.0%	170	100.0%	170	100.0%	170	100.0%	170	100%	170	100.0%	170	100.0%	170	100.0%	170	100.0%	170	100.0%	170	100.0%

Table 32 Frequency analysis of cultural services (n=170, ES code in Table 8)

ES code	Cultural Services Rank Order															
	Place 1°		place 2°		place 3°		place 4°		place 5°		place 6°		place 7°		place 8°	
	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%
C1	21	12.4%	17	10.0%	14	8.2%	18	10.6%	22	12.9%	25	14.7%	24	14.1%	22	12.9%
C2	11	6.5%	23	13.5%	17	10.0%	27	15.9%	14	8.2%	17	10.0%	24	14.1%	22	12.9%
C3	30	17.6%	19	11.2%	27	15.9%	22	12.9%	11	6.5%	7	4.1%	14	8.2%	23	13.5%
C4	14	8.2%	14	8.2%	26	15.3%	25	14.7%	23	13.5%	24	14.1%	21	12.4%	15	8.8%
C5	40	23.5%	24	14.1%	18	10.6%	16	9.4%	24	14.1%	17	10.0%	12	7.1%	10	5.9%
C6	19	11.2%	28	16.5%	26	15.3%	16	9.4%	28	16.5%	20	11.8%	14	8.2%	8	4.7%
C7	21	12.4%	22	12.9%	17	10.0%	24	14.1%	20	11.8%	26	15.3%	19	11.2%	9	5.3%
C8	14	8.2%	22	12.9%	22	12.9%	19	11.2%	21	12.4%	23	13.5%	21	12.4%	24	14.1%
Empty Rank	-	-	1	0.6%	3	1.8%	3	1.8%	7	4.1%	11	6.5%	21	12.4%	37	21.8%
Total (n= 170)	170	100.0%	170	100.0%	170	100.0%	170	100.0%	170	100%	170	100.0%	170	100.0%	170	100.0%

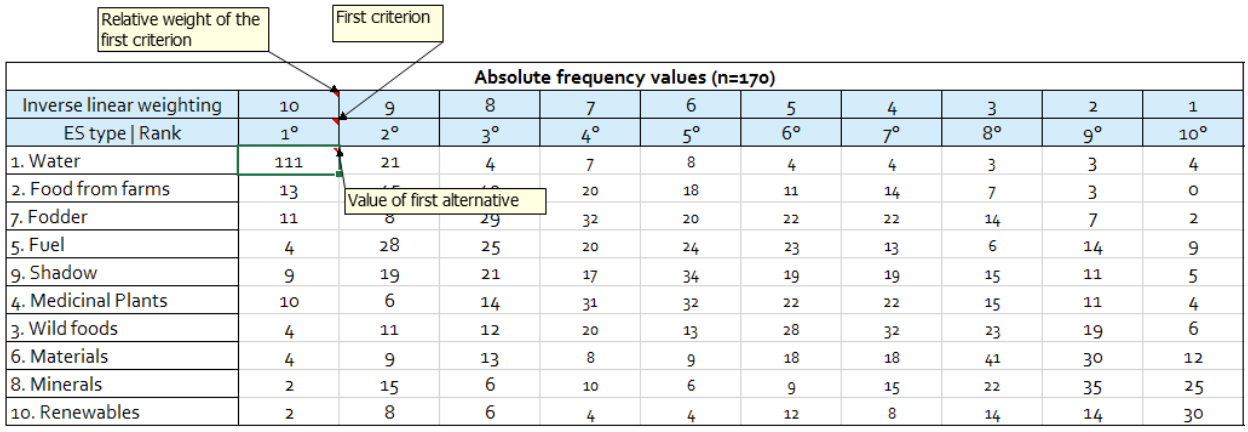
Table 33 Frequency analysis of threats (n=170, threat code in Table 9)

Threat Code	Threats Rank Order																					
	Place 1°		place 2°		place 3°		place 4°		place 5°		place 6°		place 7°		place 8°		place 9°		place 10°		place 11°	
	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%	Frec	%
T1	20	11.8%	13	7.6%	19	11.2%	19	11.2%	21	12.4%	14	8.2%	21	12.4%	16	9.4%	13	7.6%	4	2.4%	4	2.4%
T2	8	4.7%	15	8.8%	12	7.1%	13	7.6%	12	7.1%	18	10.6%	22	12.9%	21	12.4%	14	8.2%	17	10.0%	12	7.1%
T3	13	7.6%	13	7.6%	16	9.4%	12	7.1%	12	7.1%	16	9.4%	12	7.1%	19	11.2%	23	13.5%	19	11.2%	7	4.1%
T4	53	31.2%	27	15.9%	23	13.5%	20	11.8%	8	4.7%	7	4.1%	8	4.7%	5	2.9%	6	3.5%	4	2.4%	6	3.5%
T5	8	4.7%	17	10.0%	22	12.9%	24	14.1%	20	11.8%	17	10.0%	10	5.9%	9	5.3%	18	10.6%	14	8.2%	6	3.5%
T6	6	3.5%	4	2.4%	13	7.6%	10	5.9%	12	7.1%	19	11.2%	21	12.4%	18	10.6%	20	11.8%	18	10.6%	23	13.5%
T7	10	5.9%	13	7.6%	14	8.2%	18	10.6%	23	13.5%	13	7.6%	16	9.4%	13	7.6%	11	6.5%	24	14.1%	11	6.5%
T8	19	11.2%	19	11.2%	22	12.9%	21	12.4%	15	8.8%	13	7.6%	14	8.2%	14	8.2%	10	5.9%	8	4.7%	12	7.1%
T9	3	1.8%	7	4.1%	5	2.9%	4	2.4%	5	2.9%	12	7.1%	16	9.4%	18	10.6%	19	11.2%	19	11.2%	49	28.8%
T10	25	14.7%	25	14.7%	10	5.9%	17	10.0%	22	12.9%	17	10.0%	10	5.9%	14	8.2%	11	6.5%	13	7.6%	4	2.4%
T11	5	2.9%	17	10.0%	14	8.2%	11	6.5%	18	10.6%	21	12.4%	16	9.4%	18	10.6%	18	10.6%	15	8.8%	12	7.1%
Empty Rank	-	-	-	-	-	-	1	0.6%	2	1.2%	3	1.8%	4	2.4%	5	2.9%	7	4.1%	15	8.8%	24	14.1%
Total (n= 170)	170	100.0%	170	100.0%	170	100.0%	170	100.0%	170	100%	170	100.0%	170	100.0%	170	100.0%	170	100.0%	170	100.0%	170	100.0%

Social Value Index: Calculation steps

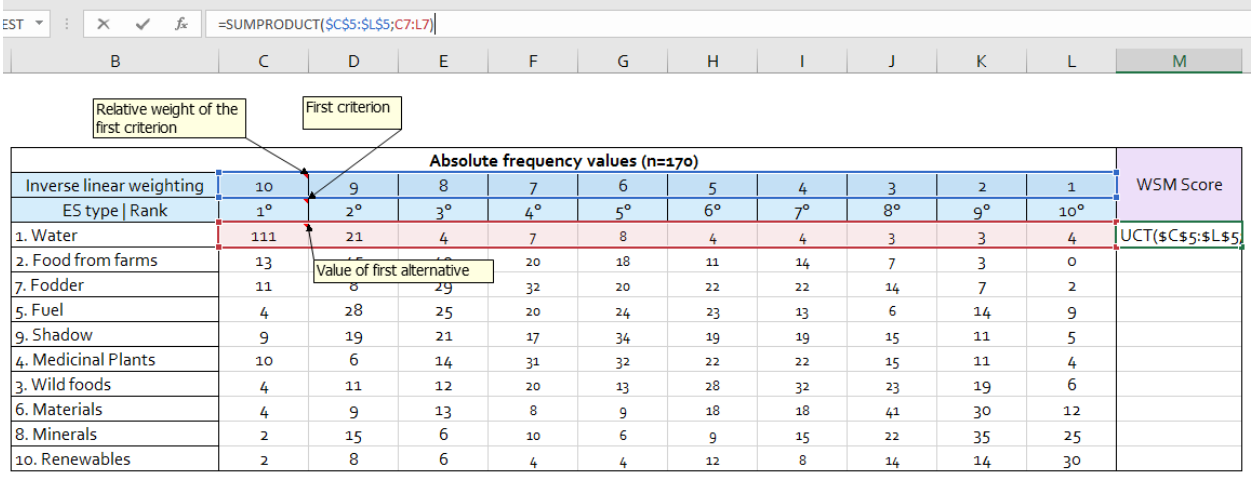
Using MS Excel 2016 and the SUMPRODUCT formula:

(1/3) Identify WSM components in the matrix of absolute frequency values.



	Absolute frequency values (n=170)									
Inverse linear weighting	10	9	8	7	6	5	4	3	2	1
ES type | Rank	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°
1. Water	111	21	4	7	8	4	4	3	3	4
2. Food from farms	13			20	18	11	14	7	3	0
7. Fodder	11	8	29	32	20	22	22	14	7	2
5. Fuel	4	28	25	20	24	23	13	6	14	9
9. Shadow	9	19	21	17	34	19	19	15	11	5
4. Medicinal Plants	10	6	14	31	32	22	22	15	11	4
3. Wild foods	4	11	12	20	13	28	32	23	19	6
6. Materials	4	9	13	8	9	18	18	41	30	12
8. Minerals	2	15	6	10	6	9	15	22	35	25
10. Renewables	2	8	6	4	4	12	8	14	14	30

(2/3) For the first row, i.e. for *water*, apply the SUMPRODUCT formula using the Inverse linear weighting.



(3/3) The WSM score is calculated for all 10 provisioning ES.

Relative weight of the first criterion

First criterion

Value of first alternative

Absolute frequency values (n=170)											WSM Score
Inverse linear weighting	10	9	8	7	6	5	4	3	2	1	
ES type | Rank	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	
1. Water	111	21	4	7	8	4	4	3	3	4	1483
2. Food from farms	13	[illegible]	[illegible]	20	18	11	14	7	3	0	1241
7. Fodder	11	8	29	32	20	22	22	14	7	2	1014
5. Fuel	4	28	25	20	24	23	13	6	14	9	998
9. Shadow	9	19	21	17	34	19	19	15	11	5	995
4. Medicinal Plants	10	6	14	31	32	22	22	15	11	4	944
3. Wild foods	4	11	12	20	13	28	32	23	19	6	834
6. Materials	4	9	13	8	9	18	18	41	30	12	692
8. Minerals	2	15	6	10	6	9	15	22	35	25	575
10. Renewables	2	8	6	4	4	12	8	14	14	30	384

Ecosystem Services Selection

Table 34 Bibliographic frequency of mention of the 29 selected ES. (n) number of studies reviewed.

Provision	n	Authors	Regulation	n	Authors	Culture	n	Authors
1. Water	10	Benis Egoh et al., 2012; Abram et al., 2014; Paudyal et al., 2018; Cuni-Sanchez et al., 2016, Shoyama and Yamagata, 2016; Murphy et al., 2017; Landolt, 2018; Zagarola et al., 2014; Vergara, 2017; Raymond et al., 2009	**1. Air, water and soil purification**	9	Vergara2017. Cuni-Sanchez et al., 2016; Raymond et al., 2009, Cast et al., 2008, Shoyama 2013; Murphy 2017; Landolt2018, Paudyal et al., 2018; Zagarola et al., 2014	**1. Scenic beauty and inspiration**	9	Raymond et al., 2009, Cuni-Sanchez et al., 2016; Abram 2013, Landolt2018, Paudyal2018, Zagarola2014, Bagstad2016; Shoyama 2013, Murphy 2017
2. Food from farms	9	Benis Egoh et al., 2012; Paudyal et al., 2018; Cuni-Sanchez et al., 2016; Raymond et al., 2009; Cast et al., 2008; Landolt, 2018; Zagarola et al., 2014; Vergara, 2017; Locatelli and Galmez, 2015.	**2. Water cycle regulation**	6	Bagstad et al., 2017; Raymond et al., 2009), Cast et al., 2008; Landolt2018; Zagarola et al., 2014, Paudyal2018	**2.Recreation and tourism**	8	Benis Egoh et al., 2012, Landolt2018, (Raymond et al., 2009), (Cast et al., 2008), Paudyal et al., 2018), Zagarola et al., 2014, Shoyama 2013, Murphy 2017
3. Wild foods	3	Cuni-Sanchez et al., 2016; Landolt, 2018; Paudyal et al., 2018	**3. Natural hazards regulation**	7	Abram et al., 2014, Benis Egoh et al., 2012, (Raymond et al., 2009, Paudyal2018, Zagarola et al., 2014, Shoyama 2013, Murphy 2017	**3.Spiritual values**	7	Raymond et al., 2009, Landolt2018, Abram 2013, Paudyal2018, Zagarola et al., 2014, Vergara2017, Benis Egoh et al., 2012
4. Medicinal plants	8	Benis Egoh et al., 2012; Cuni-Sanchez et al., 2016; Landolt, 2018; Paudyal et al., 2018; Zagarola et al., 2014; Shoyama and Yamagata, 2016; Murphy et al., 2017; Raymond et al., 2009	**4. Soil fertility and formation**	9	Raymond et al., 2009, Vergara2017, Benis Egoh et al., 2012, Abram et al., 2014, Landolt2018, Shoyama 2013, Murphy 2017, Cuni-Sanchez et al., 2016; Zagarola et al., 2014	**4.Existence values**	3	Raymond et al., 2009, Cast et al., 2008, Zagarola et al., 2014
5. Fuel	5	Benis Egoh et al., 2012; Paudyal et al., 2018; Cuni-Sanchez et al., 2016; Landolt, 2018; Vergara, 2017.	**5. Climate regulation**	8	Shoyama 2013, Murphy 2017, Raymond et al., 2009, Landolt2018, Zagarola et al., 2014,Benis Egoh et al., 2012, Cuni Sanchez, Abram et al., 2014	**5.Value for future generations**	1	Locatelli and Galmez, 2015
6. Materials	12	(Materials and timber) Shoyama and Yamagata, 2016, Murphy et al., 2017, Paudyal et al., 2018, Landolt2018; Vergara 2017; Humphries and Cabrera Paredes, 2018; Locatelli and Galmez, 2015 (Ornamental resources) Benis Egoh et al., 2012, Raymond et al., 2009, Kometter 2018, Zagarola et al., 2014, Vergara 2017	**6. Carbon sequestration**	4	Shoyama2013, Paudyal et al., 2018, Bagstad et al., 2017, Landolt2018	**6.Cultural identity**	6	Benis Egoh et al., 2012, Raymond et al., 2009, Landolt2018, Abram 2013, Paudyal2018, Zagarola et al., 2014
7. Fodder	3	Cuni-Sanchez et al., 2016, Landolt2018, Paudyal et al., 2018	**7. Pollination and seed dispersal**	5	Benis Egoh et al., 2012, (Raymond et al., 2009), Landolt2018, Paudyal et al., 2018, Zagarola2014	**7.Source of knowledge**	4	Raymond et al., 2009, Cast et al., 2008, Paudyal2018, Zagarola et al., 2014
8. Minerals and clays	3	Raymond et al., 2009, Zagarola et al., 2014, Landolt2018	**8. Pest regulation**	1	Zagarola2014	**8.Sense of place**	3	Raymond et al., 2009, Cast et al 2008, Zagarola et al., 2014
9. Tree natural shadow	2	Cuni-Sanchez et al., 2016, Vergara2017	**9. Habitat for biodiversity**	7	Abram 2013, Landolt2018; Bagstad et al., 2017; Cuni-Sanchez et al., 2016; Paudyal et al., 2018, Benis Egoh et al., 2012, Vergara2017			
10. Renewables	1	Raymond et al., 2009	**10. Genetic resources and breeding**	3	Raymond et al., 2009, Landolt2018, Zagarola et al., 2014			
			11. Oxygen production via photosynthesis	4	Shoyama 2013, Murphy 2017, (Raymond et al., 2009), Zagarola et al., 2014			

9.3 FIELD OBSERVATIONS

Ancestral breeding practices

One the one hand, the Andean region, thanks its altitudinal gradient, is one of the main centers of origin of domestication of plants and animals in the world. The Andes are known for hosting a vast endemic genetic diversity that ancestors have utilized, domesticated and bred for centuries. Examples are camelid species and *superfood* plant species, like grains (quinoa, amaranth), potato and maize. Plant breeding has sought to improve yield, develop resistance and adapt to different agro-climatic conditions (**JACOBSEN, 2002**). Only in Peru 4400 native plant species have been reported with known uses, 1700 species are cultivated and 182 are cultivated at big-scale (**CASAS, 2016** pp.103).

On the other hand, domesticated species and genetic resources are highly concentrated in countries that experience State's disinterest, like in the Peruvian case. These factors hinder the research, revaluation of local knowledge and conservation of genetic resources (**ARGUMEDO AND PIMBERT, 2005**).

Interviewed farmers in the Mariño watershed explicitly acknowledge the importance of breeding and domesticating plant and animal species and rank it third in the regulating services scale. A recent study in the Mariño region by **Quispe Conde et al., 2018** evidenced the role and importance of local knowledge for the identification of 74 neglected and underutilised plant and algae species.

Moreover, farmers may not recognise themselves as holders of autochthonous knowledge (*personal field observation*), although their traditional farming practices, living collections and seed banks do in fact passively conserve rare domesticated and wild species from disappearing (**CASAS, 2016)**.

Undesired wildlife and human-wildlife conflicts

The three study communities are located in the Peruvian-Bolivian Biological Conservation Corridor *Vilcabamba-Amboró* (**Reaño, 2017**). This is a 30 million hectares large corridor located in the *Tropical Andes Hotspot*. Despite the conservation importance of the Mariño region, locals value habitat services second-last. One could argue that people do not derive direct benefits from wild and not utilized plant or animal species. Also, knowledge related to biodiversity may be linked to local knowledge availability which is currently eroded and marginalized (**VERGARA 2017)**. In either case, the stated social preference towards habitat services puts in evidence the critical absence of environmental awareness in rural interviewees and the existing human-wildlife conflicts in the Mariño uplands.

On the first aspect, it is urgent to mobilize knowledge and public awareness in watershed residents about the importance of their lands as last hotspots of Andean forests, in privileged neighborhood to the Ampay Sanctuary.

On the second aspect, I observed some cattle-raisers rejected the *habitat services* in the card game: seeing the *Andean puma* in the pictures evoked resentment. Shepherds kill Andean pumas, when these threaten the sheep. Sheep graze in the grasslands, which are the puma's natural habitat.

The little social importance attributed to habitat services evidences endemic land and resources mismanagement in the Mariño: overgrazing of native grasslands and hunting of Andean puma and deer, among others.

Intercultural clashes and linguistic marginalisation

To explain the low SVI values obtained for the cultural services (Figure 25), contextual factors must be taken into consideration. This study targets communities currently considered rural, but most likely in the coming years will be considered peri-urban due to the expanding city of Abancay. To prove this, the sector *Atumpata baja* (lower Atumpata), one of the two sectors that make up the community of Atumpata has already small shops and is connected to the city of Abancay with a public bus stop. Throughout the broader research project, I was able to collect comments from my participants, which reveal systematic cultural and linguistic alienation suffered in the Peruvian Andes and more seriously in rural areas. The gravity of this issue is that if a language is not recognised, nor is its culture recognised, hence the loss of cultural legacies.

"As children, it was forbidden to speak Quechua at school, which is why our parents did not teach it to us and we grew up speaking Spanish. But when we became older we realized that the community spoke in Quechua, we learned Quechua after Spanish, in this way we have felt accepted by the community. "

Woman, 34 years old, Llañucancha community

Field impressions like this suggest that the acculturation and transculturation of Andean cultural landscapes already occurs in the surveyed communities. The risk associated with the Andean-Western intercultural clash is that the Andean and Quechua worldviews misjudged and linguistically, ethnically and historically marginalized, decimate the Andean identity, holistic systems of knowledge and values. Further contextual factors like "*migratory processes, cultural miscegenation, discrimination and, above all, a state policy of assimilation based on the acculturation of the indigenous population have led to the progressive loss of the vernacular languages*" (**Valdivia et al., 2007** pp 635).

Weak cultural empowerment

The cultural loss in the Mariño watershed can also be understood as a symptom of a systemic disinterest and appreciation "for what is ours", a social wound very typical of the Peruvian imaginary. I illustrate this with an anecdote I had in more than one occasion during field surveys.

> When it was my turn to introduce to the interviewee the ES card of Scenic Beauty and Inspiration, and as part of the interview protocol (see appendix), I asked the respondent:
>
> *"Do you think the landscapes, forests and lakes in your community are beautiful? Do you feel happy and happy when you look at the landscape, the mountains and the mountain? "*
>
> Participants who perhaps trusted me enough to express themselves, told me that landscape beauty was something they did not find in their own communities, but was for example found in the Ampay Sanctuary or distant Salkantay glacier (located in Cusco, but whose peak is visible from the heights of their communities). Only a few participants would indicate that the Rontoccocha lacke in the community of Atumpata possessed scenic beauty.

I could observe that locals had attitudes denoting a lack of cultural self-esteem, pride or awareness of the local biocultural heritage. This may as well expose the systemic absence of cultural promotion and education in Apurimac. Hereby, I clarify that the rankings aim not to portray the Andean person as non-cultural or the cultural Andean legacy as non-existent. The South-American Andes are origin of human civilizations rich in history, science and traditions, which still remotely persist in deepest Peru (**Reinhard, 1985; Apgar et al., 2009; Argumedo and Pimbert, 2005; Huasasquiche and Kometter, 2017).** Social rankings aim to expose Mariño's urgent demand for cultural revival.

Survey language

Despite standardized definitions in popular language and translations to Quechua of the 29 ES and 11 threats utilized in surveys, misunderstandings took place. Here I list some field anecdotes, that show how despite controlled definitions, locals would sometimes understand concepts differently. Controlling for knowledge transmission was challenging, because they (1) they were illiterate or non-familiar with my own (scientific) thinking, (2) they were Quechua-speakers and were not entirely fluent in Spanish, (3) they lived in the Andes and had other sets of knowledge and values; (4) they had disinterest in the survey; (5) they had embodied knowledge and had never reflected about values before; etc.

Misunderstanding solar clean energies with the solar heat of father Inti (Andean deity): Although renewable energies (ID P10) was the most unknown provisioning ES, for the times it was understood some participants would relate the solar heat with the importance of the Andean god *Inti* (Quechua for *sun*) and openly stated: "*Of course, Father Inti (Sun) deserves to be at the top*". Locals could also have acknowledged solar heat's importance for crops. In those situations, it was difficult to tell participants not to think about the solar heat in a spiritual way, as telling them to suppress their religious understanding during the valuation exercise would have come across in the wrong way. I preferred not to limit nor influence their valuation process and stick to the standardized explanation of said ES at the backside of every single ES card. I let locals rank according to their own mindsets, although the uncertainty of whether internally they would or not think about *Father Inti*, remained.

Need for educational institutions confused with cultural ES "knowledge source": Based on observations, the cultural ES of knowledge systems was sometimes understood by locals as the need for education: more schools for children and learning centers for adults, rather than the cognitive and educational benefits derived from Nature. I was surveying a woman and while showing her the knowledge system ES card, she replied "*yes, we need schools here"*. Her reply left me thinking she had expressed a *need for knowledge* in the region, rather than the *existence of knowledge* in the region.

9.4 SURVEY MATERIALS

9.4.1 Survey Guide

Social valuation guide for research assistants

By: Carla Madueño Florian

Goal: Determine the social importance of ecosystem services and their threats in the Mariño watershed.
Methodological instruments: (1) social valuation workshop, (2) sociodemographic questionnaire
Materials: Ecosystem service cards, ranking on canvas, answer sheet, phone with GPS App, clear work surface

Guide purpose

This document has been developed to guide the semi-structured surveys to be carried out within the framework of the study "Social valuation of ecosystem services provided by the Mariño watershed to rural communities".

Guide features

The survey material is didactic, playful and participatory. The survey is suitable and understandable to any person and adapts to the local understanding of rural inhabitants, in some cases illiterate (not reading or writing) and Quechua-speakers (not fluent in Spanish).

Materials list

1. Guide (read only)
2. Answer sheet
3. Ecosystem services cards x 40
4. Pin to hold cards, plastic cover, ranking on canvas/cloth
5. Name tag for assistant
6. Ink, pen, pencil
7. Donation for interviewee

Rule for the interviewer: read the manual, avoid language that could influence the neutral assessment process. Avoid adjectives such as "the great endemic biodiversity", saying instead "the local diversity of living beings"

Section 1. Social valuation workshop

1. Introducing the project

Good morning my name is _____ and I am carrying out a study on behalf of the Andean Forests Program, with the support of the NGO CEDES throughout the months of October and November 2018. The goal of this study is to know the importance that you give to the benefits and goods that the land and nature here in your community to its people.

By participating in this interview, you can express what comes to mind and any thoughts on the benefits that nature gives you, as well as any concern regarding misuse of forests and grasslands. The information and opinions you provide is a great help for your local authorities, with your opinion the study may inform about taking better decisions. The information that you provide will be handled confidentially.

Could you support us in this interview, as far as you think convenient? (you may always abandon the process). If so, please sign the consent form (name and signature). This serves as records for this study.

I am very grateful for your help!

2. How much is nature worth in your community?

(Read to the interviewee)

- Step 1: Imagine the route of the Mariño river from its source in the upper part of the mountains, until it reaches the valley in Abancay and flows into the Pachachaca river. On its way, people living in the valley and on the hillsides receive many benefits, for example, products from the river, forests, pastures and grasslands.
- Step 2: Imagine all the benefits that nature gives to your community. Also think about the value or importance that each benefit has for you. The importance is not money, but the personal value that you put on it.
- Step 3: There are no wrong answers. Be honest and clear when valuing each benefit that nature gives you. If you do not know something, tell me please.

(Instructions for research assistant)

- In this game you will receive 10 cards with photos of goods or services that nature provides to your community.
- Is there a benefit you don't know? (Exclude card and write down card code)
- The goal of the game is to order these 10 cards according to its importance: from the most important service (above) to the least important service (below) on ranking canvas.

Elicitation questions: During the valuation process, induce reflection in participant:

- What environmental benefit is the most important to you?
- If you would have to compare environmental benefits, what order of importance would you give?
- How valuable is each environmental service for your community and for you?

Repeat process for (1) provisioning, (2) regulating, (3) cultural services.

3. What dangers does nature face in your community?

Here, I need your help to know what things put nature and yourself in danger, since you also depend on a healthy environment.

Instructions

- Receive 11 cards that represent threats to nature in your community.
- Rank the cards acording to the level of severity of each danger on the cloth ranking: first place is the most serious threat, second place for the second most serious and so on until you reach the threats of minor severity.

Elicitation questions

- What threat affects you the most in daily activities?
- If you would have to compare two threats, what order of severity would you give?
- How concerned are you about this threat? How dangerous is it to your environment?

Section 2. Fill sociodemographic questionnaire

Section3. Interviewee signs consent form provide donation

9.4.2 Survey Questionnaire

Assistant name: _____ | **Date**: ____ November 2018 | **Community**: Micaela Bastidas ☐ Llañucancha ☐ Atumpata ☐

I. Social valuation workshop

Level of importance (1st place = high value)			*Level of threat (1st place = serious threat)*
Nature gives us **(Provisioning services)**	Nature regulates **(Regulating services)**	Nature supports our culture **(Cultural services)**	They are dangers to nature **(Threats)**
☐ Interviewee knows all the cards ☐ Interviewee does not know: (write card code) _____	☐ Interviewee knows all the cards ☐ Interviewee does not know: (write card code)_____	☐ Interviewee knows all the cards ☐ Interviewee does not know: (write card code)_____	☐ Interviewee knows all the cards ☐ Interviewee does not know: (write card code)_____
1.	1.	1.	1.
2.	2.	2.	2.
3.	3.	3.	3.
4.	4.	4.	4.
5.	5.	5.	5.
6.	6.	6.	6.
7.	7.	7.	7.
8.	8.	8.	8.
9.	9.		9.
10	10		10
	11.		11.

Interviewer notes

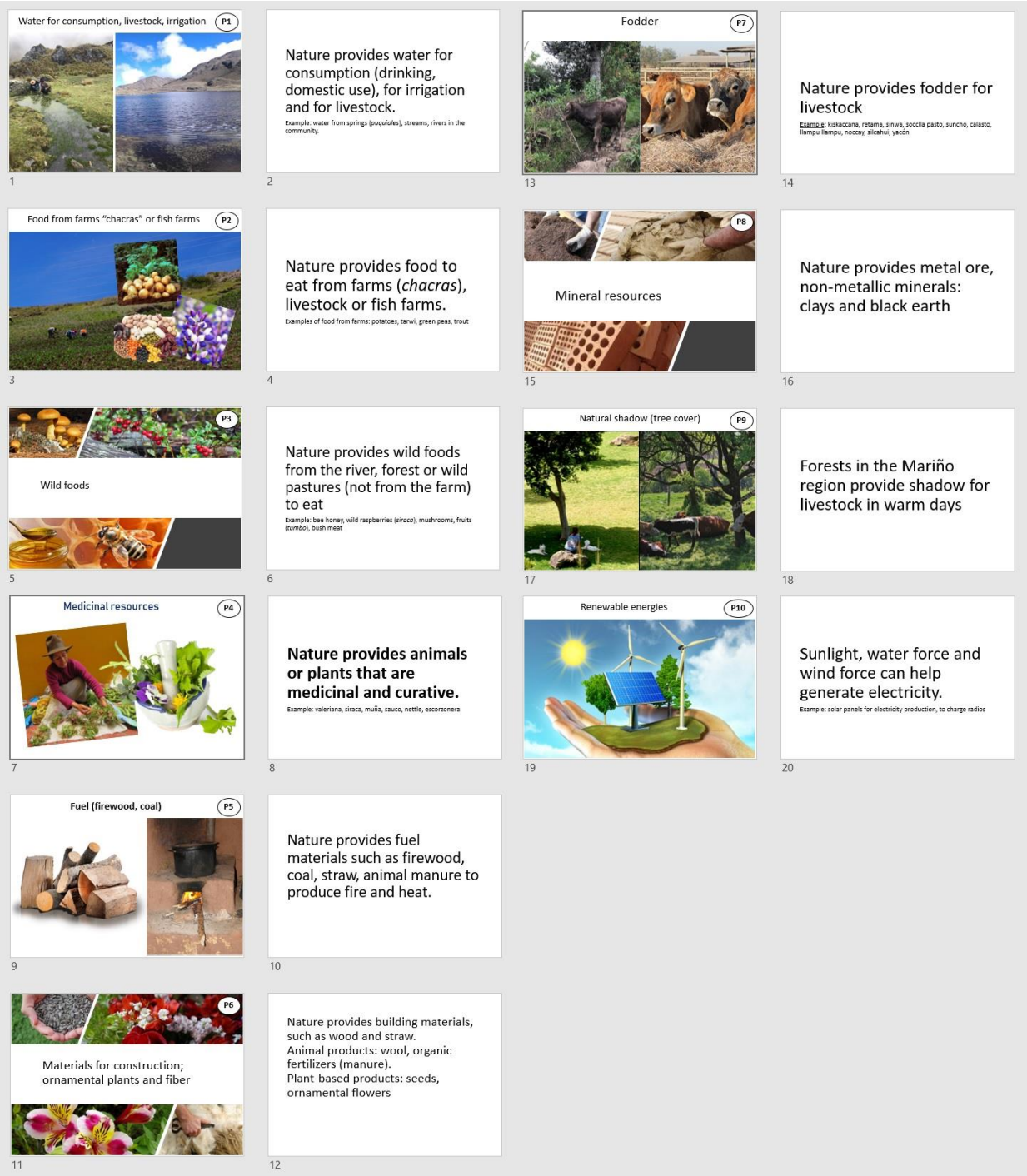
☐ The participant showed interest
☐ The participant did not show interest
Others (openness, understanding, attitude): _____
_____

1. Gender	☐ Woman ☐ Man
2. Age (years)	
3. Are you a registered community member?	☐ Yes (is registered) ☐ No (not registered)
4. What role do you have in the community?	☐ committee of ☐ group of _____ ☐ president ☐ others: _____ ☐ no charge
5. Marital status	☐ single ☐ cohabiter ☐ married ☐ widowed
6. Are you a parent? How many children do you have?	☐ Yes, total number of children: _____ ☐ No
7. Main occupation *(you can select more than one option)*	☐ Subsistence farmer, main crops: ☐ Subsistence cattle raiser, main livestock animals: ☐ Trader, seller ☐ Domestic worker (housewife) ☐ Construction worker (bricklayer, miner) ☐ Student ☐ Other: _____
8. ¿ What are your monthly income?	Approx. Monthly amount in S /. (Peruvian soles) _____
9. Education	☐ Primary complete ☐ Primary incomplete ☐ Secondary complete ☐ Secondary incomplete ☐ Higher technical ☐ Higher university ☐ Illiterate
10. Main residence place	☐ My primary residence is in the community of: Micaela Bastidas ☐ Llañucancha ☐ Atumpata ☐ ☐ My main residence is in the city of Abancay ☐ My main residence is in both, in the community of _____ and city of Abancay
11. Why do you live in your main residence? (brief reason)	
12. How long have you lived in your main residence?	☐ Always, all my life ☐ For some years, Write number of years:_____
13. Have you ever lived in the city?	☐ Yes (I live there now or I lived in the past) ☐ No, never.
14. Languages: What languages do you speak?	☐ Quechua only ☐ Spanish only ☐ Both Spanish and Quechua
15. What is your mother tongue?	☐ Quechua only ☐ Spanish only ☐ Both Spanish and Quechua
16. Do you visit the City of Abancay frequently?	Yes, daily ☐ Weekly ☐ Monthly ☐ Annually ☐ No, Never ☐
17. Do you visit other communities in the upper watershed, such as Micaela Bastidas, Llañucancha and Atumpata?	Yes, daily ☐ Weekly ☐ Monthly ☐ Annually ☐ No, Never ☐
18. Do you visit other communities such as Micaela Bastidas, Llañucancha and Atumpata?	Yes, daily ☐ Weekly ☐ Monthly ☐ Annually ☐ No, Never ☐

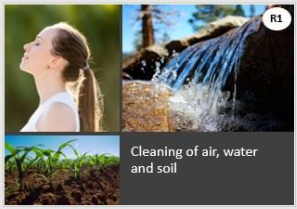
9.4.3 Card Game

ES picture and description printed on both sides of the card, card dimensions: 10cm x 8 cm.

Provisioning services Cards (x10)



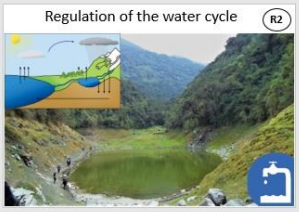
Regulating services cards (x 11)



1

Nature cleans and purifies: the air we breathe, the water we consume, the soil we work on, of contaminants that affect our health.

2



3

Nature regulates how much water is stored, how much water leaves and how much water enters the *qochas* (water springs)

4

5

When forests and pastures are healthy, it prevents and protects us from damage caused by natural disasters.

6

7

new soil is regularly created, it is kept fertile and rich in nutrients

8

9

The woods regulate the local climate (heat and rain) and protects us from sudden changes in temperature

10

11

Andean forests, grasslands and wetlands capture smoke from cars and coal burning

12

13

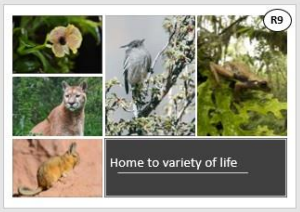
Bees visit flowers, carry pollen (yellow powder) from flower to flower, only so, flowers become fruit. Birds and animals transport seeds as they eat fruits and throw seeds to the ground, so the plants grow.

14

15

There are toads that eat plagues, thus protecting the farm and livestock from diseases.

16



17

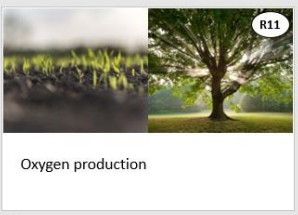
The woods are home and place of birth of living beings: wild animals and plants

18

19

Nature maintains the diversity of animal and plant species useful for breeding.

20

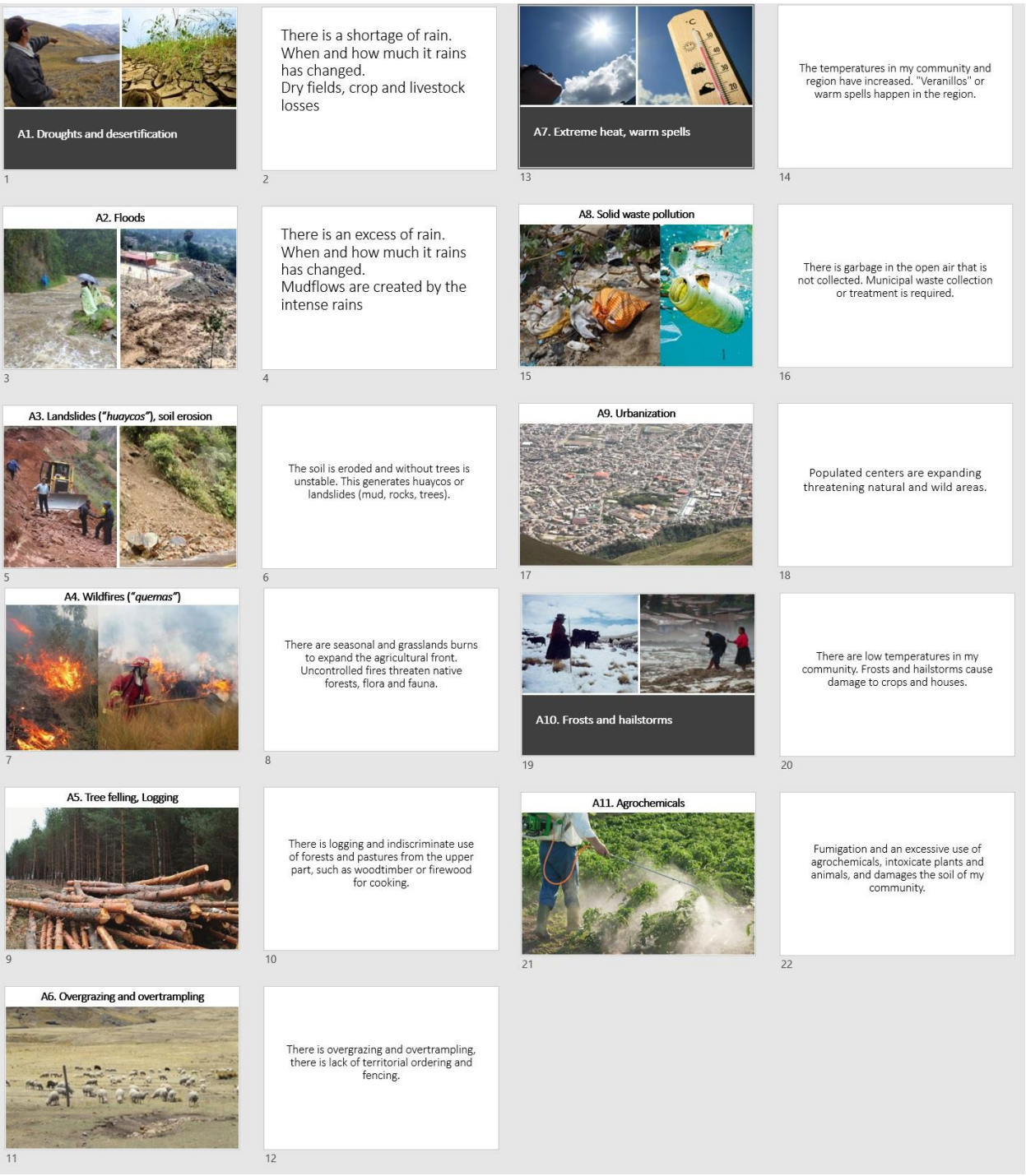


21

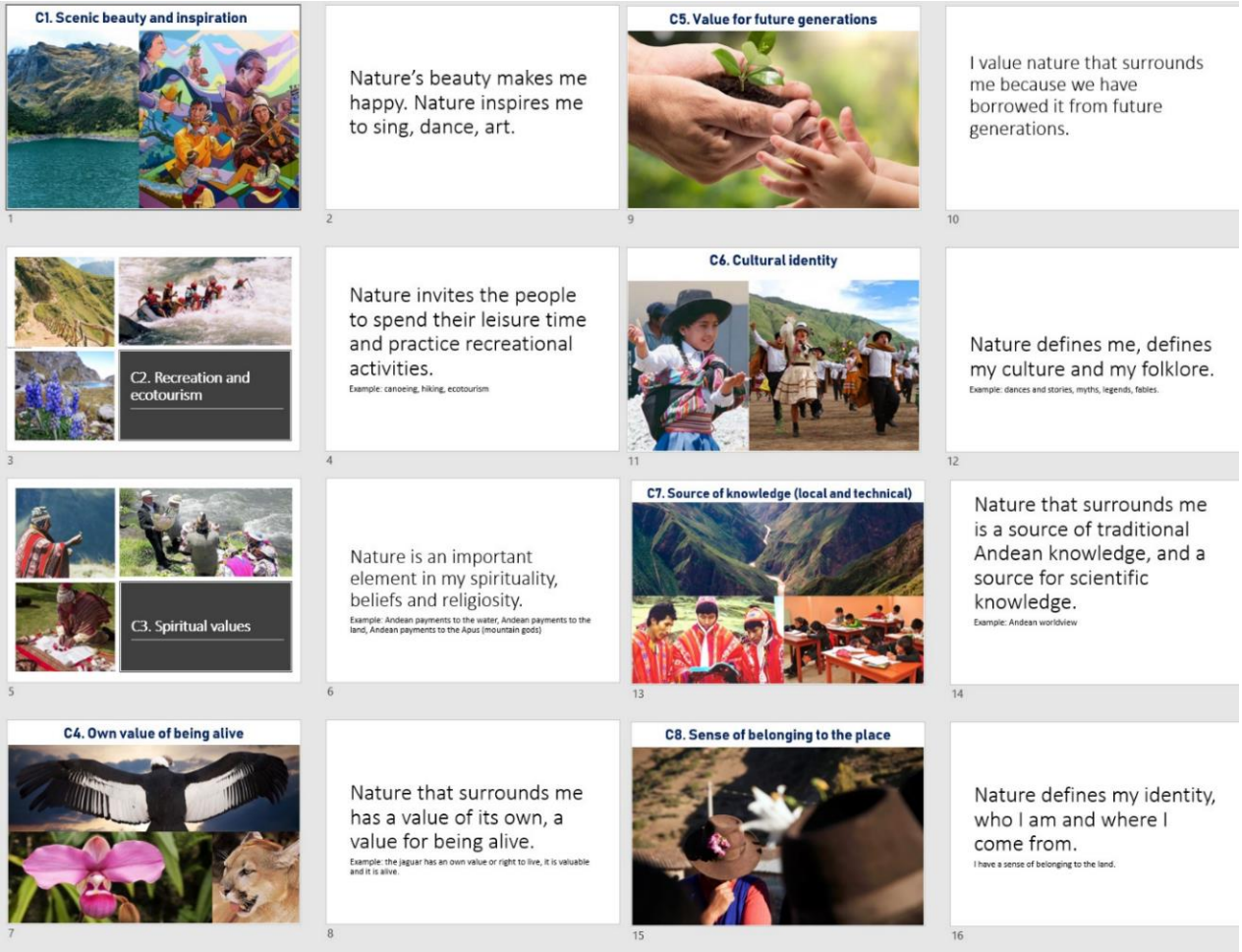
In the woods, the air is fresh. Trees and plants, these create more oxygen, new air

22

Threats cards (x11)



Cultural services cards (x8)



Valuation canvas (cloth)

Sketched ranking (demonstration purpose)

Provision	Regulation	Culture	Threats
1.	1.	1.	1.
2.	2.	2.	2.
3.	3.	3.	3.
4.	4.	4.	4.
5.	5.	5.	5.
6.	6.	6.	6.
7.	7.	7.	7.
8.	8.	8.	8.
9.	9.		9.
10.	10.		10.
	11.		11.

Ranking on cloth

9.4.4 ES Description in Popular Language

After introducing the ES card game to each participant, **pictures were described using a simple popular language.** Afterwards interviewee excluded unknown cards and ranked the known ones. ES ID codes in **Table 13**.

Provisioning Services

These are different benefits that nature, the forest, the pasture gives you:
P1: Water for consumption
P2: food from the farm or fish farms for consumption
P3: medicinal plants such as pinco pinco, eucalyptus
P4: firewood for cooking, or coal
P5: materials of all kinds, such as wood to build houses; wool from sheeps; flowers to sell in the market
P6: Fodder for livestock, like alfalfa
P7: mineral resources such as clays for building bricks or black earth
P9: natural shadow of trees
P10: the light coming from the sun, that generates electricity for the house, through solar panels

Regulating services
R1: nature has a value because it keeps the air, water and soil clean. We then drink clean water, breath pure air, have healthy soils for our crops.
R2: nature has a value because there are forests, water springs "*ojos de agua*" and grasslands act as water sponges that regulate the amount of water available
R3: nature has a value because it protects us from dangers. For example, if it has rained a lot and a landslide occurs on a hillside with trees, the trees will protect us and protect our homes from damages. So nature protects us from disasters, do you think this is important?
R4: nature has a value because it keeps the soil fertile, with earthworms so that the plants grow strong.
R5: Have you noticed that an empty hillside *"pampa"* without trees is cooler than in the bush? Vegetation regulates the climate; this is the value of nature to regulates the climate, do you consider this important?
R6: The black smoke resulting from fires disappear, sometimes trees help to clean the air.
R7: Have you seen little birds in your farm that come to take the fruits and seeds and disperse them over the land? There are also bees that go from flower to flower, they help flowers become fruits. Are these processes known to you and important to you?
R8: In your farm you will have seen toads that eat the pests and thus help to regulate the pests naturally, without the need to fumigate. Is this kind of animal or service important to you?
R9: You will have seen up in the pastures *tarucas* (deer), foxes, or lower down here parrots, they live here, forests and grasslands are their home. Also there are native trees such as *queuña*. Is it important for you that your community is home of these animals and plants?
R10: In your community, improved quality animals such as guinea pigs or improved plant crops are produced. Are these higher-quality resources important for you?
R11: When you visit Abancay, in the city there are few trees and often the air is not as good as here in the mountains. Trees help in giving us fresh air, is this important to you?

Cultural services
C1: look at the hills, the mountains, the mountain that surrounds you, the plants and animals. Does that look nice to you? We call that beauty of the landscape
This beauty makes us feel good, doesn't it? Do you feel good when you look at everything around you? We call that inspiration, we start singing, we get happy.
C2: when are you going to walk to the forest, to the pastures, do you relax? Do you get distracted? you have fun, don't you? The forests and grasslands have a value because they are a place for fun, to enjoy and visit.
C3: nature is a place where payment (spiritual Andean practice) to the land is traditionally practiced, also payment to the water or to animals. Nature is also a place where one feels at peace.
C4: Look around you, the plants, the animals, the birds that surround you. All of them are alive aren't they? By being alive they have a value, that right to live we call the value of being "alive", the value of existing. Do you consider nature have a value to exist?

C5: the forest and mountains that surround you, and the benefits you obtain, are not important only for you today, but also for your children tomorrow. What is the value of the forests, grasslands for the future? for those that come after we die?
C6: the landscape that surrounds you is part of your identity, of your customs, of what you do every day. Also the landscape that surrounds you has a value because it is part of the identity of your community. Perhaps there are traditions you celebrate, colors in your clothes, or songs. Do you consider the forests and grasslands inspire you cultural identity?
C7: nature is for many people like a first school, where one learns what plants are good and can eaten, and what are they for. We also learn these things from our grandparents who know many secrets of nature. The forest, the grasslands are then like a school and sources of knowledge, we also learn about nature in school. Do you think you have learnt many things from nature alone?
C8: have you lived your whole life here? (If yes) Well maybe you have a connection, a certain union with the Earth, with your community, you feel proud of your region.

Threats were not *translated* to popular wording, as they were very intuitive to understand.

9.4.5 Certificate of Participation for Interviewee

Certificate of participation

Ms. / Mr. _____ has successfully participated in the study of "Social valuation of ecosystem services provided by the Mariño watershed" carried out between October and November 2018 in the communities of Micaela Bastidas, Atumpata and Llañucancha, with the support of the Andean Forests Program. The study seeks to collect local voices on ecosystem services and threats to these in the Mariño region.

You can access further information of the study in Spanish by visiting the website: https://medium.com/@PuraCarlura by November 2019

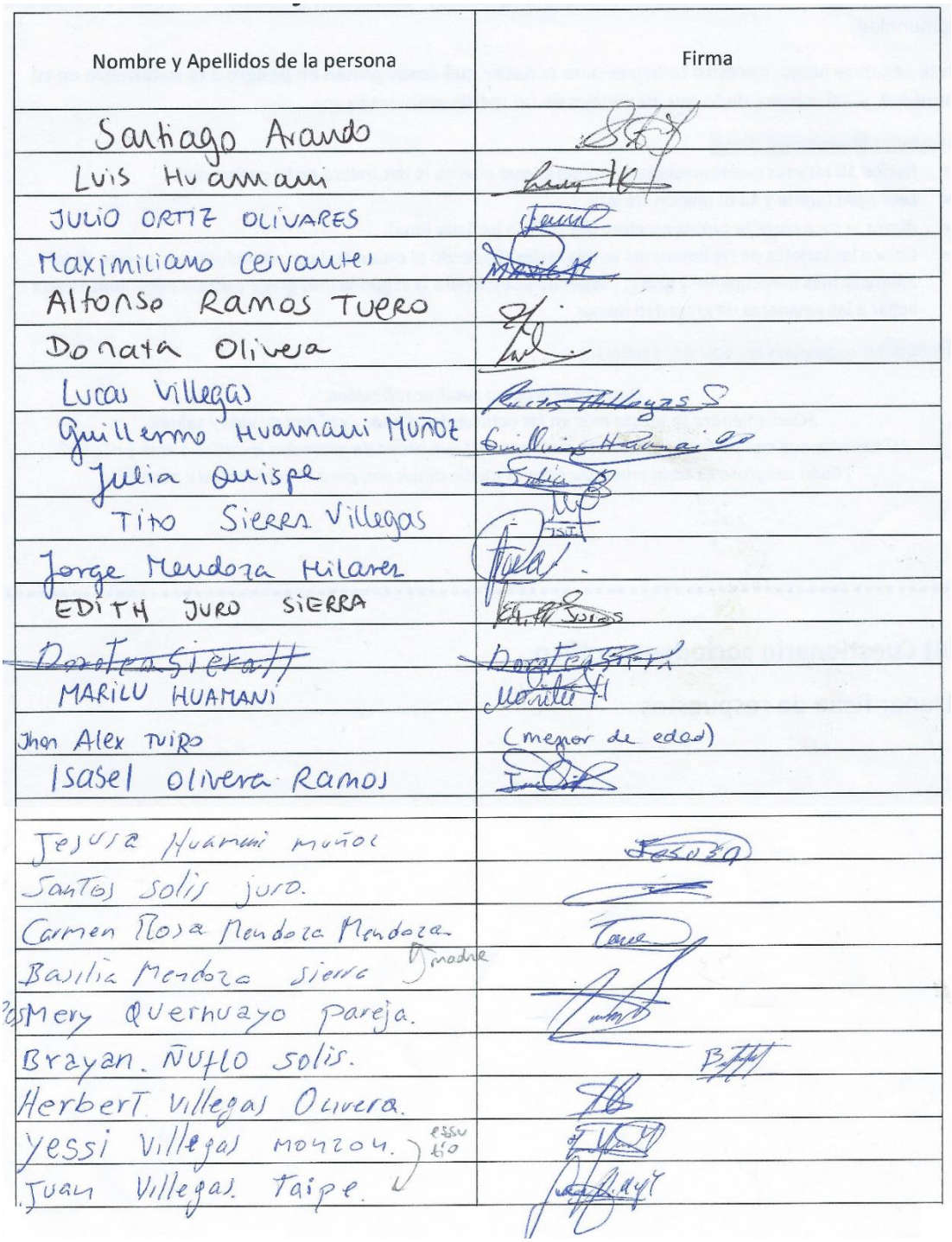
I invite you to continue committing to the conservation of the environment in your community and in the Mariño region. Thanks for your participation.

Carla Madueño
Principal investigator
Contact E-Mail

9.4.6 List of Participation

Out of 170 participants, 144 agreed to voluntarily sign the list of participation for recording purposes (signatures made also with fingerprints). Dashed line in signature box for participants refusing signing.

Signatures of Atumpata residents



Nombre y Apellidos de la persona	Firma
Santiago Arando	
Luis Huamani	
JULIO ORTIZ OLIVARES	
Maximiliano Cervantes	
Alfonso Ramos Tuero	
Donata Olivera	
Lucas Villegas	
Guillermo Huamani Muñoz	
Julia Quispe	
Tito Sierra Villegas	
Jorge Mendoza Hilares	
EDITH JURO SIERRA	
~~Dorotea Sierra~~ MARILU HUAMANI	
Jhon Alex Tuipo	(menor de edad)
Isasel Olivera Ramos	
Jesusa Huamani muñoz	
Santos Solis Juro.	
Carmen Rosa Mendoza Mendoza	
Basilia Mendoza Sierra (madre)	
Mery Querhuayo pareja.	
Brayan. Ñuflo Solis.	
Herbert Villegas Olivera.	
Yessi Villegas Monzon. (esposo)	
Juan Villegas Taipe.	

Nombre y Apellidos de la persona	Firma
CELSO SERRANO ARANDO	
Aguida Arteaga.	
Karen Hurtado Olivares	
FELICITAS HUAMANI PAUCAR	
ENRRIQUE CABRERA HUAMANI	
ALFONSO OLIVERA SOLIS	
SANTOS MENDOZA ARANDO	
NICOLAZA SOLIZ ORTIZ	
FELIX LEONIDAS SOLIZ ORTIZ	
ANTONIO HUACHACA OLIVAREZ	
	
MAXIMILIANA ROJAS	
ARMANDO HUACHACA CHOCCLLO	
LINO HUACHACA JURO	
GENARO JURO ESPINOZA	
DOMINGA CHUMBES LLICAHUA	
GREGORIO MENDOZA MUÑOZ	
MARCELINO ORTIZ VARGAS	
JESUS ARANDO ARTEAGA	

Signatures of Micaela Bastidas residents

Nombre y Apellidos de la persona	Firma
Diomedes Núñez Morgolle	—
Alejandrina Barreton	—
Luis Enrique Colca	mena
Noél Gutiérrez	
Maximiliana Pampañaupa Marcolla.	
Maria Jesusa Trujillo Trujillo	
Juana. S Tahua. De chipana.	
Isabel Davalos Valderrama.	
Feliciano Tuero Panuera	Feliciano Tuero P.
Justina Cervantes Gonzales	
Aquiles Huamani Gonzales	Aquiles H.
Santosa Monjon Enciso.	
Damian Portillo Barreton	
Gregoria Huamani Gonzales	
Javier Dávalos Pimentel.	
Jorge Lancho Valenzia	
Santosa Rios Davalos	
Graciela Solis Ferro.	
Julio Caceres Conisilla	
Santos Cáceres Cconisilla	
Santiago Cáceres cconisilla.	
Francisca Juro Daña	
Lazaro Palomino, Ancco Udosque	
Melchor León Torres.	
Marco Visa Quispe	
Raul Chirinos Conisilla	
Lucia Cconisilla Gonzales	

Nombre y Apellidos de la persona	Firma
Gerardo Nuñez Roman	
Jesus Pimares Sancho	
Maura Camacho Monzon	
Beatriz Valenzuela Monzon	
Albina Caceres	—
Sabina tapia Conisilla	—
Saturnina Monzon Enaso	—
Yesica Peña Pimentel	
Cristhina Portillo Lovaton	
Nicasio Bastidas Solis	
Eugenia Amao Garcias	
Alvaro pimentel Lopinta	
Ronel Damian Lopinta	
Daniel Lobaton Gonzales	
Rosmery portillo peña	
David Arando Espinoza	
Virginia Espinoza Pimentel	
Alejandrina pimentel Torres	
Juan Juro Muñoz	
Felicitas Leon portillo	
Laura pimentel Dario	
Alexander Camacho Cervantes	
Maria Carrasco Rivas	
Madres Chuquinos Cconisllz	
Sabina Tapia Conisllz	
TEODORA DAVALOS	
Leoncio Peña Lopenta	
CIRILA Lopenta	
Martin Lopinta Medina	
Mariano Ccosnilla Gonzalez	
Virgilio Ortiz	
Carmen Vilca	
Luis Alberto Juro	
Nieves Enciso Solis	
Maria Elena Chipana Cmeza de	—
Demetrio Solis Cáceres	—
Mercedes Paucar	
Yeny Huamani	
Celedonia Cáceres	
Andrés Damián	
Valentina Cerero	
Felix otazu	
Isabel Juro Garcias	
Felicitas Lobaton Gonzalez	—

Signatures of Llañucancha residents

Nombre y Apellidos de la persona	Firma
Cipriano Rodriguez	
FORTUNATO RAMOS	
Juliana Ramos.	
Enrique Batallanos	
Feliciano Ramos	—
GERARDO RAMOS TAIPE	
VICTOR QUISPE	
TEÓFILO Rodriguez	
AQUILINO LOPEZ	
Michael Cilla	
Grimaresa Calderón	
Carlos Huamañahui	
Maximiliana Pineda	
Santos Pineda Batallanos	
gertrudes garfias	
Alejandro Dominguez	
JUANA ESPINOZA FERNANDEZ	
CIRILA BATALLANOS PIÑEDA	—
FELICITAS BATALLANOS TAIPE	—
EVA PINEDA BATALLANOS	
MARUJA PINEDA MENDOZA	
GRIMANEZA. HUAMANÑAHUI MENDOZA	
FELIX AEDO RETAMOZO	
LUCIA MENDOZA CHAVEZ	
CARMELA HUAMAN ÑA HUI	
MARIO ANDRES DOMINGUEZ	
Nieves Batallanos	
Gregoria Valverde	
Everson Valer	
Augusto Valer	

9.5 PHOTO GALLERY

Community of Atumpata, sector: lower Atumpata, view from the road.

Community of Atumpata: Upper Atumpata sector. Encounter with farmer during harvest of *haba (fava bean).*

Llañucancha community: lower Llañucancha sector, approaching a household with field assistant.

Micaela Bastidas community, sector: Lower Quisapata, croplands and surveyed households visible in the distance.

Surveying a local representative of the Micaela Bastidas water resources committee with field assistant.

Rural house from Micaela Bastidas made of noble materials (bricks are mixture of clay and local shrubs).

Social valuation exercise (ranking cards on cloth), rural interviewee (left) and research assistant (right), Atumpata, November 2018

Quechua family and myself, Llañucancha, November 2018

9.6 TRIVIA

- More than 7000 data points (ranging from rankings, social variables and GPS coordinates) have been collected in the social valuation study.
- 60 km were walked in 3 weeks at 2300 – 4000 m.a.s.l. altitudes to collect surveys.
- 12 field trips from city of Abancay to study communities accumulate a total traveling time of 40 hours by pick-up.
- 250 kg of donations (sugar) were given to survey participants.