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Building Resilience to Climate Change:

Exploring the Contribution of Community-Based Adaptation Projects to Local Resilience in Bolivia

by

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Abstract

Resilience has been acknowledged as the key to sustainability and the concept is being incorporated in climate change adaptation projects. Nevertheless, there is a lack of research on how resilience is applied in the development projects settings and how it actually contributes to the resilience of local systems.

The thesis addresses this gap by examining the case of six community-based adaptation projects in Bolivia (2008 – 2012) that were financed by the Global Environmental Facility. Concretely, the goal is to examine how the application of the resilience principles in the projects contributes to greater resilience of the local communities and the environment. It is done so by examining presence of resilience principles in the projects and then using the findings to discuss the effect of the principles with the theory of resilience thinking and the past studies on the topic in Bolivia. In this way, the thesis is meant to contribute to a greater understanding of how climate adaptation projects can be best implemented to increase the resilience of local systems.

To understand the problem, I employ the theory of resilience thinking and its related concepts, and to account for the development aid context, I use the concept of community-based adaptation. The data is represented by the project documents of the six community-based adaptation projects financed by the GEF between 2008 and 2012 in Bolivia. The documents are analyzed within the framework of a cross-sectional comparative research design with elements of a case study. They are analyzed using content analysis with the resilience principles as themes.

Generally, I found that the projects have a potential to enhance resilience of the local social-ecological systems by promoting the diversity and redundancy of the systems' components (e.g. knowledge systems, management practices, livelihoods), facilitating the interactions within and between the social and ecological domains, fostering holistic understanding of the world and unpredictability which translates into the sustainable natural resource management practices, enganging the people and building their capacity to adapt, transform and take action, and promoting self-organization of the relevant actors.

Yet, not all the principles were present in all the projects. I found that two projects (Alto Seco and Saipina) contained aspects of all the principles and therefore, have potential to increase the resilience of the local communities and the environment by holistically addressing and enhancing the processes in both the ecological and social domain. Resilience in the four project sites without the principle of polycentricity may be hindered by the lack of collective action and self-organization. In addition, the projects in Carabuco and Moro Moro lack the principle of complex adaptive thinking. It means that the communities' understanding of the world they live in as a complex entity with nonlinear unpredictable behavior may be limited and can cause mechanistic management of the local resources which certainly undermines resilience of the system.

There are some conditions under which the positive effect of the adaptation projects would hold true. Firstly, all the actors and knowledge systems have to be treated equally and respected, without enforcement of the external knowledge. Second, the power relations within the systems have to be addressed. Third, the comprehensibility of climate change and human adaptation has to be ensured. Fourth, the goals and purpose of the actions and activities have to be clear. Fifth, the natural resources have to be managed holistically.

Lastly, I recommend investigation of the possibilities for incorporation of the resilience principles into the assessments related to adaptation projects because as I have shown, they facilitate greater understanding of the complex relations between the communities and their environment which is much needed under the current climatic variability.

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List of Abbreviations

CAS	complex adaptive system(s)
CBA	Community-Based Adaptation
FAN	Fundación Amigos de la Naturaleza
GEF	Global Environmental Facility
IIED	International Institute for Environment and Development
IPCC	Intergovernmental Panel on Climate Change
NGOs	Non-Governmental Organizations
REPANA	Reserva del Patrimonio Natural
SES	social-ecological system(s)
SGP	Small Grants Programme
UNDP/PNUD	United Nation Development Program/El Programa de las Naciones Unidas para el Desarrollo
UNFCCC	United Nations Framework Convention on Climate Change
VRA	Vulnerability Reduction Assessment

Chapter 1 Introduction

Increasingly, resilience thinking is recognized for its great potential to complement and improve climate change adaptation (Berbés-Blázquez et al 2017, IPCC 2014, Deppisch & Hasibovic 2013) and contribute to sustainable development that is now threatened by changing environmental conditions. Moreover, there is a growing acknowledgement of resilience as the key to sustainability (Walker & Salt 2006, IPCC 2014).

> *"Sustainable development requires managing many threats and risks, including climate change. Because climate change is a growing threat to development, sustainability will be more difficult to achieve for many locations, systems, and populations unless development pathways are pursued that are resilient to effects of climate change." (IPCC 2014: 1110)*

The advantage of resilience thinking is that it offers an understanding of the complex interactions between man and environment in the time of changing climate, insights into how to maintain a current state or some practical guidelines how to embrace a change.

There were studies that examined resilience of different systems (Jacobi et al. 2018, Jacobi et al. 2019, Linkov et al. 2018), management practices (Jacobi et al. 2015a, b), different tools to assess resilience communities (Cox et al. 2015, Sempier et al. 2010), cities (e.g. Tyler et al. 2016), indicators of effective adaptation (Chong et al. 2015), measuring and monitoring of resilience (Quinlan et al. 2015). Resilience principles were used by Schouten et al. (2012) to evaluate rural policies and by Berbés-Blázquez et al. (2017) to examine adaptation strategies.

As far as I have searched, there was not a study that would use the resilience principles to examine contribution of climate change adaptation projects to resilience of local social-ecological systems. In order to do that, I first investigate the presence of the resilience principles in the Global Environmental Facility's (GEF) community-based adaptation (CBA) projects in Bolivia which is a prerequisite for answering the research question. The main goal of the thesis is to explore how the principles contribute to climate change resilience of the local social-ecological systems by discussing the findings in relation to the resilience thinking

theory and past research on climate change adaptation and resilience in Bolivia. The research question to be answered is,

how does the application of resilience principles in the community-based adaptation projects in Bolivia, financed by the Global Environmental Facility through the Small Grants Programme between 2008 and 2012, enhance resilience of the local social-ecological systems?

The answer to this question is important for improvement of the tools and methods used to design and to assess the impact of climate change adaptation projects. Thereby, contributing to understanding of how resilience principles can be best applied to build resilience of local communities and environment they live in under current climatic variability.

I conduct a qualitative content analysis using resilience principles (by Biggs et al. 2012, 2015) as a set of criteria to assess six CBA projects that were funded through the Small Grants Programme by the GEF and implemented by local organizations in Bolivia between 2008 and 2012. The analyzed data represented by project documents. I have chosen to conduct the study by applying a cross-sectional research design with elements of case study. Guidance regarding methodological considerations of this thesis were mostly provided by Bryman (2012) and Rienecker et al. (2013).

I look at the problem through the resilience thinking lens that provides a theoretical framework of the thesis. Concretely, the concepts of social-ecological systems (Berkes & Folke 1998), complex adaptive systems (Walker & Salt 2006), thresholds (Folke et al. 2010, Walker & Salt 2006)), adaptability and transformability (Folke et al. 2010, Walker and Salt 2006, Berkes et al. 2003), and resilience principles (e.g. Biggs et al. 2012, Biggs et al. 2015, Walker & Salt 2006, Walker 2013, Stockholm Resilience Center 2019) are used to understand the setting. The practical part of the problem – climate change adaptation in development projects, is understood through the concept of community-based adaptation (e.g. Huq & Reid 2007, Forsyth 2013, IIED 2009, Ensor et al. 2018, Dodman & Mitlin 2013, Kirkby et al. 2018).

1.1 Structure of the Thesis

Following the general introduction and thesis structure in Chapter 1, there is a literature review of the studied phenomena in Bolivia. Past studies with focus on impacts of climate change, adaptation strategies and resilience of various systems in Bolivia are reviewed in order to map the field and learn from the findings of the other researchers.

Chapter 2 'Methodology and methods' presents methodological considerations and methods behind this thesis. The thesis takes its point of departure in critical realism. It employs a cross-sectional comparative research design with elements of case study. It follows with a selection of the cases. The material analyzed in this thesis is represented by 14 project documents of six community-based adaptation projects. The quality of the selected documents is also put under closer scrutiny in this chapter. Lastly, the data are examined by content analysis operationalizing the resilience principles into a set of criteria.

Chapter 3 'Thinking through the Resilience Lens' lays down the theoretical foundations of this thesis. It presents the main theory – resilience thinking, and its related concepts (social-ecological systems, complex adaptive systems, thresholds, adaptability and transformability). It also includes a section with the resilience principles described and explained in regards to their ability to enhance resilience of social-ecological systems. Later, the lens of resilience thinking is used to look at climate change adaptation and concretely the concept of community-based adaptation, its underlying principles and drawbacks. The chapter also includes substantiation for the chosen theoretical framework. A short sub-conclusion is situated at last to summarize the basic points of the theoretical framework relevant for answering the research question.

Chapter 4 'Resilience Principles in the CBA Projects' presents the analytical findings of the content analysis based on the seven resilience principles as the set of themes. In the sub-conclusion, it summarizes what principles were found in which project. It also sums up the aspects of the principles that were encountered in the documents.

Chapter 5 'Discussion' discusses the effect of application of the resilience principles in the six projects with the theory and literature review on the topic. It points out some challenges revealed by the discussion and suggests some ways to address them. A sub-conclusion at the end sums up the empirical findings from this chapter and argues that even though, the

principles are present in most of the projects, there are some differences in how they enhance resilience of the local social-ecological systems.

Chapter 6 'Conclusion' summarizes the results of this study and relates them to the research question defined in the beginning. It sums up the effects that the differences in application of the principles have on the resilience of the local SES. It further addresses the contribution of this study to the field of climate change adaptation and the involved actors. As last, few critical points regarding the use of the data, documentation, theories and methods in this thesis are reflected upon and ways to improve it are suggested.

1.2 CLIMATE CHANGE, ADAPTATION AND RESILIENCE IN BOLIVIA

Climate change does not represent a new phenomenon for Bolivia. Due to the country's altitude varying between 90 and 6,542 meters above the sea level (CIA 2019), it is home to diverse landscapes ranging from the Amazonian rainforest to the Andean glaciers that have always been subject to climatic variability. These climate variations have contributed to the development of rich knowledge base of natural processes of local populations that enabled them to adapt to the changing weather patterns and build resilient agricultural systems (Gilles et al. 2013a, de la Riva et al. 2013, Walsh 2010).

However, it is exactly this exceptional biodiversity (World Wildlife Fund 2019) combined with high levels of cultural diversity, poverty, inequality, deforestation and glacier retreat that make this country particularly vulnerable to impacts of climate change (OXFAM International 2009a). Furthermore, the intensity of extreme weather events related to volatile climate together with changing social conditions and other factors challenge the resilient production systems and traditional knowledge that have been developed and maintained over generations (Valdivia et al. 2013a, de la Riva et al. 2013, McDowell & Hess 2012, Baldinelli et al. 2014, Gilles et al. 2013a, b, Oviedo et al. 2016, The World Bank 2017).

The effects of longer dry periods, weakened rainy seasons and greater intensity of extreme events (Seth et al. 2010) on the agricultural sector were examined by The World Bank (2009), Climate Investment Fund (2011) and Julio (2016). Further studies regarding food production systems in the changing climate have been carried out on small farmers (Perez et al. 2010), crop yields in Altiplano communities (Martinez-Cruz et al. 2017), on food systems in semiarid mountainous zones (Ministerio de Desarrollo Sostenible y Planificación 2002), traditional crops (Saxena et al. 2016), on cocoa farming (Jacobi et al. 2015b), on

agrobiodiversity (Jimenez et al. 2013, Zimmerer 2010), soil attributes and practices (Motavalli et al. 2013) and incidence of plagues and plant diseases (Garrett et al. 2013). Social impacts of the climate change were explored by Andersen and Verner (2009), PNUD (2011) and with special focus on the poor by Winters (2012).

With regards to the dependence of most of Bolivian population on the glaciers as a source of water, water availability has been researched by Buxton et al. (2013), Rangecroft et al. (2013), Buxton and Escobar (2013). Other environmental issues that represent an increasing threat to the local systems and were analyzed are wildfires (Devisscher et al. 2016a, b) and floods and droughts (The World Bank 2017). Furthermore, Salamanca (2009) analyzed factors that affect resilience of people living on the hillsides of La Paz.

As mentioned above, indigenous peoples were able to adapt to the changing climate for generations. Therefore, their understanding of the climate change and variability was explored by Boillat and Berkes (2013), McDowell and Hess (2012), Fernández-Llamazares et al. (2015) and Valdivia et al. (2013a). Climate change adaptation strategies of the indigenous communities received great attention as they have potential to be a source of inspiration for a design of current adaptation measures (Boillat & Berkes 2013).

Orlove et al. (2000) investigated forecasting of crop yields and rainfall from observations of stars. Oviedo et al. (2016) looked into how the small fisher communities in the Amazon floodplains use their knowledge of the local ecosystem to adapt the resource management system to the changing climate. Adaptation to changing soil attributes was investigated by Motavalli et al. (2013). Conservation of crop varieties and diversification of cultivated crops and its impact on SES resilience was examined by Escalera and Jacobi (2017), Meldrum et al. (2018), Swiderska et al. (2011) and Baldinelli (2014). In addition, influence of agroforestry and organic cocoa faming on community resilience was analyzed by Jacobi et al. (2014), Jacobi et al. (2017), Jacobi et al. (2015a) who also evaluated resilience of various food systems (Jacobi et al. 2018, Jacobi et al. 2019). Oxfam International (2009b) reports using an ancestral technique of camellones (elevated fields) to deal with flooding in the lowland areas. Villaroel et al. (2014) investigated the role of a traditional community institution *ayllu* in the management of the Sajama National Park. Ancestral practices and knowledge were also compiled to serve as an inspiration for adaptation (FAO 2013, Flores et al. 2017).

McDowell and Hess (2012), World Bank (2017), Taboada et al. (2017), Boillat & Berkes (2013), Walsh (2010), de Mulczyk (2016) and de la Riva et al. (2013) looked into the variety of strategies Bolivian people use to cope with the climate variability and Jensen and Valdivia (2013) examined the relationship between livelihood strategies and people's climate resilience. Kaenzig et al. (2016) also researched adaptation of the tourism industry in La Paz. United Nations Development Program (PNUD 2011) and Ministerio de Desarrollo Sostenible y Planificación (2002) suggested a series of general adaptation options. Specific adaptation in terms of agritourism was examined by Valvidia and Barbieri (2014), and Ruiz-Mallén et al. (2015) explored options that people living in protected conservation areas have to adjust their livelihoods. Boillat et al. (2013) investigated the interaction of traditional knowledge, urbanization and conservation efforts in the Tunari National Park.

Various factors, including projects and programs, impacting upon people's resilience to deal with the shocks were examined. Examples can be analysis of the influence of NGOs on traditional farmers (Walsh 2010) or of development cooperation projects on community resilience (Robledo et al. 2004), Andersen et al. (2015) conducting research on irrigation programs, Asquith et al. (2002) and Ruiz-Mallén et al. (2017) who investigated the impact of conservation measures on resilience and adaptive capacity of local livelihoods, and Wilk et al. (2018) scrutinized the impact of multi-stakeholder processes on resilience building of the poorest. Chelleri et al. (2016) analyzed community adaptation on Southern Altiplano responding to both the climate change and an increasing demand for quinoa.

The challenges and potential of combining local and external scientific knowledge to adapt to the climatic variability and build resilience was a center of attention of studies such as Valdivia et al. (2010), Gilles et al. (2013b), Gilles (2013), Bohensky and Maru (2011), Cockburn (2015) Figueroa-Armijos and Valdivia (2017), and Fernández-Llamazares et al. (2017). Jacobi et al. (2017) assessed the challenges that this collaboration might bring based on her studies in agroforestry.

As can be observed from the literature review, studies to date have not examined the way resilience principles are integrated into climate change adaptation projects aiming to strengthen adaptive capacity of communities in Bolivia in time of changing climate conditions. Therefore, this research aims to address these gaps.

Chapter 2 Methodology and Methods

Methodological considerations and methods behind this thesis are presented in this chapter. Ontology and epistemology are elaborated on as first represented by the paradigm of critical realism. It is followed by presentation of applied cross-sectional comparative research design with elements of case study. The selection of the cases is also substantiated therein. The chapter proceeds by introducing the documents analyzed in this thesis and the method of collection. John Scott's criteria are used to evaluate the quality of the documents. Consequently, the approach to analyze the collected material – content analysis, is elaborated on together with the selected themes. Reflections regarding use of methods and theory in this thesis are situated after conclusion because it was first after conclusion I could properly evaluate it.

2.1 Critical Realism: Ontology and Epistemology

This thesis takes its point of departure in critical realism. Critical realism does not align with neither positivism nor interpretivism but rather positions itself as an alternative in between them (Archer et al. 2016). In its ontological form, critical realism asserts that *"much of reality exists and operates independently of our awareness or knowledge of it."* (Ibid.) It claims that there is one single reality that is however subjected to multiple interpretations.

Critical relativists claim that knowledge is relative and depending on various historical, social and cultural factors. Science is therefore not free of errors and mistakes and combination of qualitative and quantitative methods is necessary to learn about the reality. Critical realism asserts that reality is ever-emergent, always in a process and undergoing transformations (Fleetwood 2013). This corresponds to the theory of resilience thinking by acknowledging pluralism of knowledge systems and the claim that knowledge has to be constantly revised due to the ever-changing configuration of systems.

Critical realism is not associated with with neither deductive nor inductive approach (Bryman 2012) but it can be characterized rather as *"retroductive reasoning, which entails making an inference about a causal mechanism that lies behind and is responsible for regularities that are observed in the social world"* (Blaikie in Bryman 2012: 29). It concerns itself with generative mechanisms that produce the phenomena of interest by interacting with

the context (Bhaskar 2008). Bhaskar deems the context to be important because it can discern factors that facilitate or hinder the operation of the mechanisms. This elucidation opens space for an introduction of changes to transform the current state.

This last assumption corresponds to the resilience theory which put under scrutiny interactions of the human and ecological dimension and forges them into one system. The resilience principles can be viewed as the factors that influence the operation of the generative mechanisms (interactions of people and environment and slow variables and feedbacks). Once identified, the principles can be enhanced by the social actors to increase the resilience of social-ecological systems.

2.2 Cross-Sectional Comparative Design with Elements of Case Study

A cross-sectional design means that qualitative or quantitative data is collected on usually a set of cases at a single point in time (Bryman 2012). It allows the researcher to detect differences between the cases. This leads us to a comparative design which includes examination of a number of cases using the same methods with the goal to investigate similarities and differences. Lastly, a case study is an intensive examination of one case in order to gain deep understanding of the phenomenon.

In *Social Research Methods*, Bryman (2012) illustrates that it can be difficult to determine what design is used in a qualitative study. Based on this, I argue that this thesis's investigation shows features of cross-sectional and comparative design with elements of case study. It employs a cross-sectional framework through collection of data on the set of resilience principles for six CBA projects on one hand. It consequently applies a comparative design to account for the differences in application of resilience principles and their contribution to resilience of social-ecological systems. And lastly, it contains elements of a case study regarding the fact that the attention is sometimes broad to the unique features of Bolivia as a country especially vulnerable to climate variability. The case study research design complements the cross-sectional comparative one, it does not prevail because Bolivia itself is not the unit of analysis, the projects are.

Reliability and validity of cross-sectional and comparative designs are mainly related to quality of operationalization of the measured concepts (resilience principles in this case). Replicability depends on the extent to which a researcher describes methods used for collection of data, their selection, design and analysis. On the contrary, validity and

generalizability of findings from a case study design is limited. (Bryman 2012) To elucidate this dilemma, the quality of the methods employed in the thesis is addressed at the end in XXX Critical Reflections where the final conclusion on the issue can be drawn.

2.2.1 Case Selection

Bolivia was chosen for its unique position in the global climate change debate regarding its high vulnerability to the climate change impacts due to the high percentage of indigenous population, widespread poverty and inequality, immense biodiversity, high levels of deforestation, its position in a region with high climatic volatility and glacier retreat (Oxfam International 2009a).

The six cases were selected because they can be viewed as role models for climate change adaptation projects. The reasoning behind this claim is that they are funded by the GEF. GEF is an operating body through which the United Nations Framework Convention on Climate Change (UNFCCC), tasked to address climate change at the global level, finances climate change adaptation (The GEF 2019). Based on this, I suggest that the projects that the GEF finances can be in general viewed as role models for climate change adaptation projects. Hence, I considered it an important question to find out whether the projects financed by this global leader contribute to resilience of the local systems. Background information regarding each project can be found at UNDP (2019a, b, c, d, e, f).

2.3 Data Selection and Collection: Documents

The data analyzed in this thesis include documents. On the subject of nature of documents, Bryman (2012) writes that they can have many forms ranging from personal documents, official state documents or deriving from private sources to mass-media outputs and virtual documents such as online internet sources. Despite the fact that documents are being considered as reflecting reality, as windows into reality (Bryman 2012), Atkinson and Coffey (2011) argue that documents are texts written to accomplish something and should be examined for who they are written for and what is their purpose.

In this thesis, I analyze altogether 14 documents (including project concepts, project proposals and fast facts sheets) written in Spanish and English by the agencies implementing the CBA projects in Bolivia. In addition, I examined a brief account of the projects' results from UNDP's website. A list of the analyzed material is placed in the Appendix. This material

was collected because of combination of two factors. First, I knew what kind of material I need to answer the research question. And second, I did not have resources available to collect data in Bolivia in person.

Data Quality

Scott (1990 in Bryman 2012) emphasis the quality of documents of interest and proposes four criteria to assess it. Authenticity asks into the origins of documents, whether they are genuine and unquestionable. Credibility refers to the accuracy of a document and the trustworthiness of reported facts. Representativeness questions the typicality of a document, whether it is typical /representative of its kind. Lastly, the criterion of meaning evaluates the comprehensibility of a document.

The examined material – project documents, can be argued to be clear, comprehensible and very likely authentic because they were written by the specific organizations applying for project funding to the GEF. Furthermore, they were published by the UNDP as the official project documentation. They are representative of its kind as project documents because they have to live up to the standards set up in the context of development aid.

Credibility is up for a question. The purpose of a project concept is to sell the project and a project proposal to get funding and influence decision-making for the project to be chosen. For this reason, the documents may claim and plan to do more than what has actually been done. They document the actions, activities and tools used to implement the intervention. They address goals and background of the projects. Even though, a final report and key results and outputs presented by the UNDP have also been examined, they were far too brief to find out whether all was implemented as it had been planned.

The aim of the study is to examine the presence of the resilience principles in the GEF's CBA projects in Bolivia. In this regard, I believe that the official project documents provide the appropriate data for the analysis. Though, I acknowledge that there is a limitation related to the fact that the documents are only proposals and concepts. For this reason, the research question is answered in terms of the projects' potential to contribute to resilience of the local systems.

2.4 CONTENT ANALYSIS AND OPERATIONALIZATION

The collected data is examined using qualitative content analysis. This type of analysis is carried out by searching for specific themes in existing material (Bryman 2012). A theme is defined by Bryman (2012: 580) as

> *"a category identified by the analyst through his/her data; that relates to his/her research focus (and quite possibly the research questions); that builds on codes identified by the transcripts and/or field notes; and that provides the researcher with the basis for a theoretical understanding of his or her data (...)."*

Following Rienecker et al. (2013) and Ryan and Bernard (2003), I identified the themes in the theory-related material turning the seven resilience principles by Biggs et al. (2012, 2015) into an analytical tool to examine the documents. These principles are by the resilience thinkers considered to enhance resilience of systems. Therefore, I consider them as an appropriate tool to analyze how the CBA projects in Bolivia contributed to greater resilience of the local systems. The seven resilience principles are diversity and redundancy, connectivity, slow variables, complex adaptive systems thinking, learning and experimentation, participation and polycentric governance. They are elaborated on later in this chapter.

First of all, the material was read through in order to get familiar with it and make sure that I understand it. Consequently, the documents were coded in NVivo under the seven themes. Whether a certain principle was present in one of the projects or not was evaluated using rating scale present (if an aspect of the principle was present) and absent (if no aspect of the principle was found). Meanwhile, connections of the principles were drawn when a specific aspect of the project corresponded to more than one principle.

Content analysis is a transparent research with a broad applicability, however, there are some drawbacks to it as well (Bryman 2012). Content analysis depends on the quality of documents which are being analyzed. In this case, the quality of the documents has been already evaluated in the section 2.2 Documents. Bryman suggests that interpretation from the side of a researcher regarding coding entails distortion. I agree and acknowledge that my

understanding of the issue (and also in regards to the Spanish language) may have caused distortion,.

The thesis now moves towards introduction of the theory of resilience thinking, the related concepts and the concept of community-based adaptation together creating the theoretical framework of this thesis.

Chapter 3 Thinking through the Resilience Lens

This chapter presents the theoretical foundations of the thesis. It comprises of the theory of resilience thinking and its related concepts. The resilience thinking theory sets development projects into a broader context of the current climate change and the need to promote resilience of people and environment they live in as a response to it. It became obvious that the concept of community-based adaptation cannot be left out. The contribution of the CBA projects to local SES's resilience cannot be analyzed without defining what the CBA is, what it strives, how and some of its strengths and challenges. Before a short sub-conclusion at the end of this chapter, the choice of presented theoretical framework is substantiated.

3.1 THE THEORY OF RESILIENCE THINKING

Resilience thinking provides a framework for seeing a community, city, farm etc. as a **social-ecological system**[1] (SES) - a system that operates on and across many interconnected time and space scales (Walker & Salt 2006). It is concerned with the way a system changes and copes with disturbances. Resilience represents *"the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks"* (Walker et al. 2004: 2). Placing resilience within the context of climate change it stands for

> *"(t)he capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation."* (IPCC 2014: 5)

As such, resilience emphasizes coping, adapting and transforming as crucial processes to maintain the desirable characteristics of a system (Berbés-Blázquez et al. 2017) and therefore can be interpreted in three ways: (i) response to disturbance, (ii) capacity to self-organize, and (iii) capacity to learn and adapt (Folke et al. 2002).

[1] Social-ecological system is defined as a system where social (dealing with governance) and ecological system (communities of organisms) are interlinked (Berkes & Folke 1998). It can be defined at different scales ranging

Walker and Salt (2006) summarized resilience thinking in their book *Resilience Thinking: Sustaining Ecosystems and People in a Changing World*. They explain that resilience thinking is grounded in systems thinking. This kind of thinking is based on the assumptions that (i) people are embedded in social-ecological systems that are inseparably linked together and changes in a social system have impacts on an ecological system and vice versa; (ii) social-ecological systems represent complex adaptive systems where changes are not linear and cannot be predicted, and there is more than one stable state or regime with different structure, function and feedbacks where the system can exist; and (iii) a resilient system has capacity to go through some changes without crossing a threshold into a system with different identity (Ibid.).

As has been said in the previous paragraph, SES are characterized as **complex adaptive systems (CAS)**. CAS do not change in a predictable linear way and their behavior cannot be understood through a study of their individual components functioning (Walker & Salt 2006). Walker and Salt explain that they also have a potential to exist in more than one stability domain with differing structure, feedbacks and function. Into the new stability domain, they can be driven by overcoming a threshold of a slow variable (explain later in this chapter).

Resilience can be distinguished as either **specified** or **general**. Specified resilience is applied to particular aspects of a system (Folke et al. 2010) and is related to the question 'resilience of what, to what?' (Carpenter et al. 2001). The danger of specified resilience lies in the focus on increasing resilience of the particular part of the system to a particular shock[2], hence making it more vulnerable[3] to other kind of disturbances (Cifdaloz et al. 2010). On the contrary, general resilience refers to the overall resilience of all parts to all different kinds of disturbances (Folke et al. 2010) implying that a system copes with uncertainty in all possible ways (Ibid.). In the case of this thesis, resilience refers to the overall general resilience of the SES.

The critical points that once crossed, tip a current state into a new stability domain are called **thresholds** (Folke et al. 2010). Folke et al. (2010: 3) defines a threshold as *"(a) level or amount of a controlling, often slowly changing variable in which a change occurs in a critical*

[2] A shock, a change or a disturbance is understood in this thesis as an event that significantly alters characteristics of a system. It can be both of natural and human origin.
[3] Vulnerability is in this thesis understood as an opposite of resilience.

feedback causing the system to self-organize along a different trajectory, that is, towards a different attractor".

The concept of thresholds is explained by Walker and Salt (2006) in the model of a ball-in-the-basin. They explain that the current state of a social-ecological system is moving in a delimited space (basin) representing all the possible states of the SES that have the same function and feedbacks. The state has a tendency to move towards its equilibrium. The space, as well as the equilibrium, is not stable but changes due to varying external conditions. The edge of the delimited space represents its thresholds, a boundary behind which an alternate stable state (domain of attraction or regime) exists. This alternate stable state (domain of attraction or regime) has different function and feedbacks. The current state can cross into this new stable state when its movement is altered or the space where it moves gets smaller. Therefore, making it easier to slip into a new domain of attraction which is either favorable or unfavorable for society. (Walker & Salt 2006)

To manage resilience of a system, Walker and Salt explain that it is crucial to understand what shapes the space and how the state moves. Adaptation in resilience thinking theory refers not only to adaptability and transformability (Chung 2016). The capacity of actors within a system to manage resilience is called **adaptability** (Walker & Salt 2006: 59). Adaptability (or adaptive capacity) *"captures the capacity of a SES to learn, combine experience and knowledge, adjust its responses to changing external drivers and internal processes, and continue developing within the current stability domain"* (Berkes et al. 2003 in Folke et al. 2010: 3).

Nevertheless, if the system is stuck in undesirable domain of attraction (and resilience cannot be managed for), changing the very nature of the system might be the right thing to do. **Transformability** is *"the capacity to create fundamentally new system when ecological, social, economic, and political conditions make the existing system untenable"* (Walker & Salt 2006: 62). Folke et al. (2010) explicates that transformational change often means shifts in power relations, configuration of relationships, perceptions and worldviews. The process of transformation takes advantage of windows of opportunity to navigate the old untenable system through the threshold to a new stability domain.

3.1.1 Principles of Resilience of SES

There are several resilience principles acknowledged within the research community around resilience thinking and the following paragraphs elaborate on the principles drawn from Biggs et al. (2012, 2015). Diversity and redundancy, connectivity and slow variables (P1 – P3) represent key properties of SES that are to be managed. CAS lens, learning and experimentation, participation and polygovernance (P4 – P7) are important attributes of governing systems that facilitates resilience building. When all are found in a SES they enhance resilience of the system in a case of a disturbance. (Biggs et al. 2015)

P1 Diversity and redundancy

Response **diversity** provides various options for dealing with a change (Walker & Salt 2006). System elements that might show diversity are genes, species, landscape or habitat patches, cultural groups, livelihood strategies, values knowledge systems, actors and governance institutions (Biggs et al. 2012, Biggs et al. 2015). Varying sizes, scales or lifespans of these elements are translated into different ways of responding to a change. Reducing the numbers of elements, species or actors in a system affects the response diversity and hence, the options that a system have to address the disturbance leading to its decreased resilience.

Redundancy stands for the capacity of functionally similar elements that can compensate for each other (Biggs et al. 2012). Hence, elements that perform a specific function in a similar way provide redundancy for that function (Biggs et al. 2015). When one fails, it goes unnoticed in a system because there are others that compensate for the loss. Functional redundancy is crucial to resilience and its reduction strongly affects the system's ability to cope with a change (Biggs et al. 2012, Walker & Salt 2006).

Biggs et al. (2015) suggest different ways how to incorporate diversity and redundancy in to the management of SES, e.g. monitoring, conserving redundancy, maintaining structural complexity in the landscape, diversifying systems of knowledge, perspectives and approaches in governance systems, or change from current maximum efficiency paradigm to a maintenance of resilience of ecosystem services. Nevertheless, a balance between too much and too little diversity and redundancy needs to be found, overly diversified and redundant systems may pose challenges and hinder interactions between the systems' elements (Biggs et al. 2015).

P2 Connectivity

"The way and degree to which resources, species, or social actors disperse, migrate, or interact across ecological and social landscapes" is called **connectivity** (Bodin and Prell 2011 in Biggs et al. 2012: 427). These landscapes are built of different components (patches, habitats) connected by links (species interactions, corridors between habitats). It is the structure and strength of these links that are crucial in terms of the effect of connectivity on resilience (Biggs et al. 2012). Structure refers to the presence or absence, unidirectional or mutual connections (Biggs et al. 2015). Strength is understood as the intensity or the frequency of interactions between the components (Ibid.). In SES, connectivity enables exchange of information and material needed for proper functioning of ecological and social processes, especially in the recovery phase after a disturbance (Biggs et al. 2012). However, it can also facilitate spread of disturbances (Stockholm Resilience Center 2019).

There are different ways connectivity can be incorporated into SES management. Understanding the interactions of different elements to comprehend the effect connectivity has on resilience, identifying vulnerable and resilient components, restoring or creating new interactions or managing the patterns of connectivity (Biggs et al. 2015).

P3 Slow variables and feedbacks

Each transition into a new regime is caused by a loss of resilience due to **slow and changing variables** that determine the dynamics and trajectory of a system (Walker & Salt 2006, Biggs et al. 2012). Slow variables in the ecological domain may be e.g. soil composition and concentration of lake sediments, while worldviews, values, legal systems and traditions represent examples of slow variables from the social dimension. In case of a coral reef, examples of slowly changing variables can be runoff from land and changing sea temperature where excess of one of them can shift the coral reef into a different stability domain (Walker & Salt 2006).

All actors, species and processes are related together in a wide web of connections where change in one variable affects another variable by either increasing or decreasing its tendency. If changes in the second (third, fourth and so on) variable feeds back to the first one, reinforcing it or dampening it, it is called a feedback loop (Walker 2013). A resilient system maintains strong feedback loops and observes them in order to detect potential thresholds (Walker & Salt 2006).

Biggs et al. (2015: 108) therefore argues that *"(a) central aspect of maintaining the resilience of ecosystem services in the face of disturbance and change therefore involves identifying and managing the key controlling variables and feedbacks that underpin and control the configuration of an SES".* Feedbacks can be either strengthened when the contemporary regime is desired, or weakened and even broken so transition into a new more favorable domain of stability if the current one becomes untenable. When thresholds of slow variables are exceeded, *"the feedbacks that keep the system in a particular configuration are unable to counteract the changes"* (Biggs et al. 2015: 113) and regimes shifts take place. Other actions include monitoring slow variables in order to detect thresholds, keeping track of actions that disrupt desirable feedbacks and establishing units of governance that can the obtained information to implement necessary measures.

P4 CAS lens

Understanding of SES as CAS requires a holistic approach. Biggs et al. (2012) explicate that in order to manage resilience, it is necessary to acknowledge that SES are complex systems and their behavior cannot be predicted based on studies of behavior of its parts. SES as CAS are constantly undergoing change and adapting to varying external conditions. Therefore, this principle stresses the role of learning and experimentation, embracement of surprises and disturbances in order to build resilience (Ibid.). Biggs et al. (2015) claim that CAS thinking is especially important for proper operationalization of the other six principles.

Reasoning, decision-making and behavior are based on mental models that claim that knowledge influences awareness which in turn affects behavior (Biggs et al. 2015). Managers within a SES who hold worldviews of reductionist functioning of the world and human domination over nature are responsible for the highly mechanized environmental resource management (e.g. monocultures). These perspectives are deeply entrenched in the current societies. Therefore, in order to build resilience it is necessary to foster thinking that embraces uncertainty and change (e.g. through future scenario planning). Provision of frameworks that facilitate people's embracement of systems view of life is another option. Acknowledgement and appreciation of different knowledge systems, and broader participation and collaboration between different stakeholders facilitate learning and experience sharing. Designing management agencies (e.g. for catchments and national parks) to specific areas may contribute to better management of slow variables. (Biggs et al. 2015)

P5 Learning and experimentation

Learning and experimentation as the fifth principle underlines the necessity to constantly revise existing knowledge, behavior, skills or values in order to facilitate adaptation (Biggs et al. 2012). Biggs et al. (2015: 175) states that *"the recognition of complexity in social–ecological systems (SES) brings with it an assumption that knowledge of SES is always partial, and that knowledge requires continual renewal otherwise it will become obsolete as the system it represents changes."* Experimentation is used to manipulate certain elements or processes within a SES to observe responses and compare outcomes. In addition, monitoring can provide data about changes in the slow variables and feedbacks.

The level of learning ranges from individual, group to social learning where participation plays an important role (see the following paragraph on participation). Nevertheless, Biggs et al. (2015) mention that learning can lead to maladaptation, i.e. the system being worse off if power dynamics are not properly addressed. If challenges posed by power and short-term political objectives are overcome, the processes of learning and experimentation engage actors from different space and time scales to facilitate sustainable management of natural resources.

Biggs et al. (2015) therefore suggest several ways to facilitate learning and experimentation. Creating special spaces for interaction of different stakeholders and organizing workshops to support social learning, support participation of various actors and in that way enable networking. And last but not least, it is necessary to ensure sufficient funding as learning and experimentation demand high financial inputs.

P6 Participation

Fostering participation is crucial to ensure diversity of voices and perspectives and to build trust (Walker & Salt 2006). It refers to *"active engagement of relevant stakeholders in the management and governance process"* (Stringer et al. in Biggs et al. 2012: 436). Engagement of stakeholders can take place in any stage of a process, from problem identification, policy implementation, monitoring to outcome evaluation (Biggs et al. 2012). Diversity may be represented not only in the diverse participation and stages of engagement, but also in the application of different methods and processes (Biggs et al. 2015).

The advantages that diverse participation (scientific and local non-scientific) entails are building trust (Lebel et al. 2006), shared understanding of the SES dynamics (Armitage et

al. 2009) and strengthening of the link between those gathering information and those making decisions (Danielsen et al. 2005). It provides more complete understanding of the situation that may be translated in better decision-making and collective action (Biggs et al. 2012).

Biggs et al. (2015) propose several ways to operationalize the principle of participation in order to build resilience. As first, they mention the need to make goals and expectations clear. Proper stakeholder mapping and analysis is crucial for involvement of the right participants. Leaders that are motivated are essential to mobilize people and lead them through the process. There might also be a need to build capacity and knowledge of the people in order to engage them in the process. As mentioned before, the question of power within a group of participants has to be addressed in order to make sure that all voices will be heard. Lastly, it is necessary to ensure sufficient resources such as time, financing, skills and expertise.

P7 Polycentric governance

Polycentric governance (or polycentricity) refers to the autonomy of e.g. a national park management group to *"make and enforce rules within a circumscribed policy arena for a specific geography"* (Biggs et al. 2015: 228). Independent governance units at different scales can promote learning across scales and compensate for each other when one of them collapses (Biggs et al. 2012). Local governance plays a significant role as local governance units have greater overview of what there is happening in the SES (Ibid.), enable broader participation and therefore, have potential to contribute to the detection of thresholds (Walker & Salt 2006). *"Polycentricity attempts to match governance levels to the scale of the problem"* (McGinnis 1999a in Biggs et al. 2015: 228). Biggs et al. (2015) believe that polycentric governance facilitates the other principles.

Of great importance is also connection and cooperation of the different levels of governance in order to facilitate functional redundancy and increase resilience of the SES. Collaboration can happen in different ways e.g. information-sharing, coordination, problem-solving or internal conflict resolution (Biggs et al. 2015). Anyway, Biggs et al. (2015) state that the shortcoming of this approach is that there is still lack of understanding of how the principle can be operationalized.

3.1.2 Critique of Resilience Thinking

Resilience has become a buzzword in the time of changing climate. Resilience can be defined in various ways (intrinsic to individual or holistic, competencies of people or favorable functioning in the face of adversity, etc. (Van Breda 2018). Van Breda (2018: 2) argues that *"(t)he term resilience has, to at least some extent, become an empty word that can be filled with almost any meaning".* Multiple meanings make some researchers to question the validity of the concept (Ibid.).

Resilience thinking has been criticized for taking little consideration of power relations within a defined system (Brown 2014). As mentioned in the P5, building resilience requires participation of actors with diverse backgrounds (literacy, income, gender, occupation, etc.), which might lead to unequal benefits or come at a cost for someone (Cote & Nightingale 2012). Ensor et al. (2018) suggest a question necessary to ask 'whose resilience are we building?'. He proposes that development interventions that aim to build system resilience ought to embed the local power dynamics into the resilience thinking framework.

Further critique is connected with the attempt to keep the system in the current domain of attraction and therefore, maintaining the status quo (Robinson & Carson 2015) which may be favorable especially for those in power. Critical points derived from the use of resilience thinking theory in this thesis is situated in section 5.2 Critical Reflections.

3.2 CBA AS CLIMATE CHANGE RESILIENCE BUILDING

3.2.1 Adapting to Climate Change

Adaptation is understood as *"(t)he process of adjustment to actual or expected climate and its effects"* (IPCC 2014: 5). The objective of human adaptation measures in regards to climate change are either to moderate harm, avoid it or exploit opportunities that arise from the situation (Ibid.). It seeks to enhance resilience of a system to the changing climate conditions (Chung 2016). Navigating SES through climate change requires managing social inequalities and therefore, adaptation that will lead to an essential change is required (Yan, Galloway 2017).

Adaptation can be either reactive or pro-active (Yan & Galloway 2017). Reactive adaptation is not planned in advance and takes place as a disturbance strikes (e.g. reconstruction of the area hit by floods) responding usually to a specific kind of shock.

Nevertheless, focusing on one specific threat increases vulnerability to other shocks. On the contrary, pro-active adaptation embraces the measures that are taken to prevent loss of lives or economic value. In this sense, it is resilience that represents the capacity of a system to stay within the same stability domain while undergoing changes. Pro-active adaptation may be difficult to push through as it involves anticipating for a disaster that has not taken place yet and representing interests of future generations. Yan and Galloway (2017: 8) state that *"(o)vercoming the inertia of the status quo is one of the largest hurdle)s that needs to be overcome in order to meaningfully adapt to change"*.

Poor people in low-income countries are most vulnerable to climate change due to the reliance of their livelihoods on the environment and natural resources. Assisting the poor in climate change adaptation was therefore deemed as crucial in order to lower the impacts (Huq & Reid 2007). In this way, development assistance was recognized as increasing resilience of the vulnerable communities (Adger 1999) and adaptation measures started to be incorporated into development initiatives (Ayers & Dodman 2010). One of the approaches where adaptation is understood as synonymous with development is community-based adaptation.

3.2.2 The Concept of Community-Based Approach to Adaptation

A community-based adaptation project usually looks like a development project and a difference lies in the inputs to the intervention (Huq & Reid (2007). CBA is a tool to help poor vulnerable communities to adapt to climate change (Huq & Reid 2007). It is *"a form of adaptation that aims to reduce the risks of climate change to the world's poorest people by involving them in the practices and planning of adaptation"* (Forsyth 2013: abstract). CBA is based on learning-by-doing where *"the learning comes from the practice itself"* (Huq & Reid 2007:2).

Vulnerability of poor communities to climate change is often rooted in deeper social inequalities, hence, CBA is not likely to be successful unless approaching the problem from a more holistic perspective (IIED 2009). Speaking of community, community is seen through the lens of resilience thinking as a social-ecological system where humans and environment are inseparably linked together in a complex web of interactions and has capacity to influence the current domain of attraction and its thresholds.

CBA represents a participatory approach to adaptation where communities are involved in the assessment of climate change impacts, designing strategies and responses

supporting resilience of their livelihoods (Ensor et al. 2018). In this sense, CBA is *"based on the premise that local communities have the skills, experience, local knowledge and networks to undertake locally appropriate activities that increase resilience and reduce vulnerability to a range of factors including climate change"* (Dodman & Mitlin 2013: 640-641). Moreover, the role of NGOs and governments is to facilitate and support the process but they cannot direct the adaptation efforts (Kirkby et al. 2018).

A critique emerged that local interventions are not sufficient because climate change impacts are no longer local but cross boundaries and borders (Burton 2008 in Dodman & Mitlin 2013). Based on this criticism, researchers concerned with CBA began to examine the possibility of scaling the CBA approach up from local to regional, national and even global levels of decision-making (Schipper et al. 2014). In a horizontal direction – scaling out, the local experiences and knowledge regarding climate change adaptation is supposed to be applied in interventions on larger scales, or expanded over larger geographic areas (Ibid.) Yates (2014) argues that CBA has to be expanded beyond the borders of a single community in order to contribute to increased adaptive capacity of the local communities.

Participation

The CBA approach has emerged from participatory development (Chung 2016). Participation represents an essential element of community-based adaptation. The goal, defined as community empowerment is supposed to be achieved through active participation (Chung 2016). In the case of CBA, it attempts to empower communities to mobilize and use their own knowledge and community processes to take appropriate actions (IIED 2019). Regarding the fact that vulnerability is often underpinned by various social factors, empowerment in terms of adaptation to a specific climate risk that does not tackle the underlying determinants is not sufficient to increase people's resilience.

CBA attempts to build resilience bottom up. Good CBA interventions involve local people in all stages of the process, in the assessment, planning and implementation all the way to the phase of evaluation (Kirkby et al. 2018). The participatory process ensures that development of adaptation measures is driven by *"local priorities, concerns, vulnerabilities and capacities – as articulated by the people themselves"* (Ibid. 580). The methods used by CBA during the whole process might range from participatory research, different forms of participatory assessments (e.g. risk, vulnerability), discussions, focus groups, etc. In account

has to be also taken the fact that climate change in a sense of current debate may be a phenomenon unknown to some communities (Huq & Reid 2007).

Corresponding with resilience thinking, CBA regards **local knowledge** as a rich source of information that might serve as an inspiration for the design of future adaptation strategies (Kirkby et al. 2015, Boillat & Berkes 2013). Looking through the resilience lens, poor communities dependent on their environment hold great knowledge about the natural processes and feedbacks, and therefore may provide insights about the thresholds of the current system. Scientific and non-local inputs of information such as meteorological projections and technical information about suitability and feasibility of different options are also necessary in order to design the most appropriate adaptation solutions. Hence, in many adaptation interventions, CBA projects try to engage both local and non-local scientific knowledge in a production of locally suitable adaptation options (Armitage et al. 2011).

Challenges of CBA

Mohan and Stokke (2010) argue that by focusing heavily on 'the local', participatory development tends to neglect local inequalities, power relations and national, transnational, economic and political forces. Similarly, Dodman and Mitlin (2013) criticize the assumption of CBA that community is a homogeneous entity and lack of accounting for exclusion within the communities.

Green (2000: 69) states that participatory development does not always refer to *"participation in broad-based political movement which seek to bring about radical social change, nor even in established political institutions."* But as Yan and Galloway (2017) argue that adaptation that leads to a radical change is required in order to withstand future changes. Hence, it suggests that participatory development that does not address power relations and inclusion of poor people in wider political representation is unlikely to lead to successful climate change adaptation. It therefore implies for CBA, that in order to be successful it has to deal with the issues of power and include local people in social and political processes.

The focus on local context may represent a disadvantage as too narrow focus on the social, physical, economic and political (Forsyth 2013) context of poverty may result in neglect of important driving forces of community vulnerability. In this sense, resilience thinking becomes very useful as it compensates for this drawback of CBA by accounting for a wide context in which the community exists. Kirkby et al. (2015) suggests that another

challenge related to 'the local' is subordination of local knowledge to Western scientific paradigm. It is the Western paradigm that dominates the international climate change debate and it has been documented e.g. by Jacobi et al. (2017) that demonstrated that knowledge of local agroforestry farmers in Bolivia were not given the same value as the external scientific knowledge.

Related to the issue of 'the local' is also the problematic of sensitivity to local cultures (Kirkby et al. 2015). Bolivia has over 30 indigenous nations with different understandings of the world, beliefs and traditions. Kirkby et al. (2015) suggests that local cultural beliefs can contribute to people's vulnerability (e.g. gender norms) by hindering development of their adaptive capacity. Hence, it is important that development practitioners remain empathetic and sensitive and try to incorporate these cultural particularities as a resource in the process of CBA.

Kirkby et al. (2015) also mention mainstreaming of adaptation into local governmental agendas as representing a challenge. It is lack of collaboration between government and implementing organizations, corrupt and unstable political systems or lack of technical skills, funds and other resources that may inhibit integration of CBA into local and national planning. For further elaboration on the challenges related to implementation of CBA see Kirkby et al. (2018) and Ayers and Forsyth (2009).

3.3 Choice of Theoretical Framework

In this thesis, I investigate whether CBA projects in Bolivia had potential to contribute to greater resilience of local communities and environment they live in if implemented as stated in project proposals. To do this, I combine the theory of resilience thinking and its related concepts together with the concept of community-based adaptation.

It is the fusion of the two that allows me to answer the research question. The theory of resilience thinking explains how the projects' stakeholders within the social-ecological systems can shape the capacity of the system to respond to climate change and what they can do to enhance the capacity. The concept of SES elucidates the embeddedness of the communities in their environment, which is important to understand their interconnectedness and the influence they have on each other.

The concept of thresholds is included because it explicates the importance of the factors such as precipitation or soil composition in the functioning and configuration of the current systems which the communities are part of. It explicates the influence communities have over the environment and its ability to provide vital ecosystem services. Adaptability and transformability are understood to be the capacities that the CBA projects aim to strengthen to build resilience of the local communities. The notion of complex adaptive systems sheds light on the unpredictable nature of climate change and the need to approach it holistically. The resilience principles are used as a set of criteria to evaluate the projects.

As such it provides a comprehensive framework for understanding the context of the thesis – human adaptation to changing climate. CBA is a necessary complement to narrow the broad focus of resilience thinking to development interventions aimed at adaptation to climate change. Resilience thinking together with CBA provides this thesis with a unique opportunity to understand the complex reality of adaptation and strive for development in the context of climate change.

Regarding the combination of theoretical framework, data and method for analysis, I consider it appropriate and sufficient to answer the research question. The reason is that it provides a framework that hangs together and allows for exploration of the research question. If one of them would be changed, the other two would lack behind in their ability to account for the problem (e.g. incorporation of political ecology to account for the power dynamics related to man-nature relationship would not bring any contribution because the data lack the ability to account for that). In addition, research question would differ as well. Therefore, I consider the presented theory, methods and data as well combined and relevant.

3.4 SUB-CONCLUSION

The main theoretical framework consists of the theory of resilience thinking. The theory of resilience thinking attempts to explain the ways systems cope with changes and disturbances. By systems, it is meant social-ecological systems that embed people and natural world in mutual interaction. It argues that a SES may exist in several different states and that actors within the SES have ability to influence the configuration of the system by moving it towards or away from the points that would tip the system into another stability domain. In this way, the actors have an ability to influence the capacity of the system to cope with changes.

Through the concept of resilience principles, the theory sheds light on how people can enhance resilience of a system or direct it towards a new state when the old ones become unfavorable. The theory and principles help me understand how the local communities can influence the capacity of the SES, wherein they are embedded, to deal with climatic variability.

The focus of the thesis on six projects based on community-based adaptation led to incorporation of a concept of the same name. CBA argues that local communities have to be involved in planning and design of climate change adaptation measures. The aim is to strengthen and mobilize their capacities to take appropriate actions. The concept of CBA helps to situate the projects within context of a worldwide need to climate-proof development interventions as resilience is seen as a prerequisite of sustainable future.

Lastly, it became obvious that resilience thinking and CBA have a weakness in common. Attention paid to power dynamics in regards to local processes and interactions on different time and space scales influences whether resilience is built or eroded. Both resilience theory and CBA are criticized for lack of accounting of this issue. This drawback may represent a limitation of the thesis. However, it does not impair my ability to conduct the research.

I have elaborated on all considerations related to methodology, methods, design and theory that underlie this thesis. Hence, the next chapter proceeds with a presentation of the analytical findings.

Chapter 4 Resilience Principles in the CBA Projects

To begin with, the organization of this chapter is explained. Analysis is divided into subchapters with each one examining the material through the lens of one resilience principle. If a certain aspect of a principle has been already elaborated on in relation to a previously analyzed principle, there is a reference in the brackets indicating the place.

As mentioned in the section 2.2 Documents and Their Quality, the analyzed material was in English and in Spanish. For the sake of consistency of this thesis, quotations taken from material written in Spanish, are translated to English and the original text can be found in the footnotes.

4.1 Presence of the Resilience Principles

4.1.1 P1 Diversity and Redundancy

In Alto Seco, local knowledge was used to identify different alternatives for an establishment of an irrigation system. In terms of biodiversity and environmental management, the CBA projects established three protected areas (REPANA). *"(…) of 150 ha where there are important sources of water will be achieved through establishment of the REPANA (…) management under the REPANA will allow for recuperation and protection of wildlife flora and fauna (…)."*[4]

In Ancoraimes, the CBA project diversified sources of information about weather patterns and climate change by making an inventory of bioindicators for farmers derived from local knowledge. Followingly, it also aimed to compare this data with the data obtained scientifically from a meteorological station. *"The use of local traditional knowledge of bioindicators in agricultural production is valued/appreciated and evaluated scientifically with data obtained from a local meteorological station, (…)."*[5]

[4] *"protección de 150 ha. bajo régimen de REPANA en donde se encuentran importantes fuentes de agua (…)el manejo bajo régimen de REPANA, permitirá también la recuperación y protección de la fauna y flora silvestre (…)."*

[5] *"Se revalorizará el uso de conocimientos locales/tradicionales sobre bioindicadores en la producción agropecuaria y validar científicamente está información con los datos de una estación meteorológica local, (...)."*

Agroforestry techniques accompanied by integrated crop management were also introduced in the communities of Ancoraimes. Furthermore, the CBA project in Ancoraimes addressed food security by diversifying the agricultural production. The local communities were provided with better-adapted varieties of crops, fruit trees and species. As the different varieties of crops and species respond to the climate variability in different ways (i.e. response diversity), they provide functional redundancy improving the food security of the farmers facing the climate change. *"Families diversify agricultural production by utilization of varieties and species that are adapted to local climate conditions (...)."* [6]

In Moro Moro, the perspectives had been diversified through meetings between the communities, mayor and other local actors in order to understand historical climate variability, its impact and to improve local planning regarding the climatic variability. Local observations of environment were complemented by a local system for monitoring the flow and quality of the local water sources.

Reforestation was applied in Moro Moro where it was done in order to protect the key aquifers and in Batallas to conserve the soil through restoration of tree nurseries. *"The project also restores a communal tree nursery by reforesting it with tree shrubs, protects the soil by incorporating in it organic matter, improving its structure, and facilitating water filtration (...)."* Besides that, the restoration of the tree nursery in Batallas was also supposed to secure *"tree and shrub supply for commercial purposes"*, hence, providing additional income.

Another project situated in Carabuco improved food security and income of the communities through introduction of certified local varieties of lupine seeds which contributed to the diversification of their agricultural production, diet and income. The CBA project in Carabuco was also the only one which aimed to diversify the range of options (safety nets) available to the seed producers in case of agricultural losses by establishing a saving and credit scheme. *"A savings and credit intervention model is created to support the income-generating activities of the project. Proceeds from the sales of production outputs from the project goes to a fund and are used for the seed producers to cope with losses caused by climate change and/or expand/improve the technology for crop production."*

In Saipina, cultivation of cherimoya fruit trees was improved through an introduction of agroforestry techniques diversifying approaches to the natural resource management. In

[6] *"Familias diversifican la producción agropecuaria, mediante la utilización de variedades y especies que se adaptan a las condiciones climáticas locales (...)."*

addition, it represents an alternative source of firewood and forage and therefore, contributed to the prevention of deforestation. Experience regarding application of the different approaches was supposed to be later shared between the communities.

4.1.2 P2 Connectivity

The principle was found to be present in the CBA project in Ancoraimes. There, special spaces were designed where experience from combining the bioindicators and scientific data, and from the application of integrated crop management and agroforestry, was meant to be shared and exchanged between the families, communities, municipalities and the others (P1). The analyzed documents state that the meteorological data will be provided to the local communities in Ancoraimes through establishment of the local meteorological station (P1).

In Moro Moro, the project attempt to connect the local actors from the different scales within the municipality and engage them in finding solutions to the climatic variability (P1). *"Meetings between communities, mayor and other key local actors in transferring knowledge on climate change impacts and adaptation solutions, to improve local planning"*.

In Saipina, an agreement about technical and economic cooperation between the municipality and the communities was made to implement climate change adaptation measures. The project further brought together the communities from the middle and upper part of the basin in order to exchange experience in agroforestry techniques (P1). Moreover, the communities living in the municipalities of Saipina and Comarapa and in the Oconi basin have agreed on norms regulating the use of water.

The CBA project in Carabuco created an organization of 18 environmental promoters (coming from the communities) trained in topics such as environment, climate change, agroecology and elaboration of projects. *"Local abilities of adaptation to climate change strengthened through environmental promoters."* The task of the environmental promoters was to implement environmental action, promote sustainable natural resource management and to share and spread the experience. Moreover, a group of 75 seed producers from four communities was created to strengthen their capacity in the production of certified seeds and exchange experience regarding organization of the production and the management techniques.

4.1.3 P3 Slow Variables and Feedbacks

In Alto Seco, the irrigation system with dams was established in order to store rainwater and provide irrigation to agricultural production in case of lack of precipitation (P1, P2). *"(…) with the establishment of an irrigation system the physical structure necessary to ensure production in current climate change is set up (…)"*.

In Ancoraimes, the challenge of spreading pests and diseases due to the temperature increase was addressed by a promotion of agrobiodiversity through introduction of diversified seeds and agroforestry conducted by *plantation of "new fruit trees adapted to the environmental conditions of the community"* on the edges of the plots (P1, P2). Implementation of *"crop rotation, incorporation of solid and liquid fertilizers usage"* through soil conservation techniques and integrated crop management were meant to put in practice sustainable use of natural resources.

Scarcity of water in Batallas caused by the climate variability and other pressures was addressed by watershed management measures, *"rehabilitation of forest nurseries"* and *"planting of seedling trees"* which were later on used to reforest the river basin and *"aquifer recharge areas to protect water resources"*, and by *"(s)etting up protection systems for water sources"* such as *"filtration ditches and natural walls"* (P1, P2). It also aimed to *"establish soil conservation practices that increase the permeability of the soil".* In Saipina where the CBA aimed to improve the production of cherimoya while conserving the soil, new agricultural practices based on agroforestry were implemented and new agroforestry systems were established (P1, P2).

In Moro Moro, in order to *"minimize increasing contamination, sedimentation and flood erosion risks",* the project aimed to reforest the key aquifer zones and lands without vegetation (P1). Furthermore, the project also suggested development of a scheme of payments for environmental services where the private landholdings would be included.

Slow variables from social dimension were addressed in Carabuco where the environmental promoters (P2) were supposed to *"foster continued community use of sustainable soil and water management".* Social slow variables were also mentioned in the Saipina CBA project: *"there has also to be a transformation on their [community members'] consciousness of the problem so that the measures that will be taken will continue to be implemented after the Foundation has left (…)".*

In the analyzed material, I found that a monitoring committee was supposed to be established in Ancoraimes under the Secretary of Agriculture and Transport to keep a track of the agricultural activities and diseases. The committee was also supposed to release recommendations for the upcoming agricultural year. The meteorological station was set up Ancoraimes in order to monitor the weather patterns (P1, P2). The CBA project in Moro Moro addressed the principles of slow variables and feedbacks by setting up *"a system for local monitoring of changing flow and quality of principle water sources"* which was meant to be linked to the national meteorological network (P1).

4.1.4 P4 CAS Lens

The case of three established protected areas REPANA in Alto Seco was already addressed in all three of the previous principles (P1, P2, P3). Anyway, the project was found to contain aspects of the CAS thinking principle as well. The CBA project restricted the access to the three areas with important sources of water in order to regulate its use and allow for its recuperation.

The CBA project in Saipina embraced CAS thinking in a different way (P1, P2). The implementing organization FAN stated that

> *"(...) we must say that these forests are not the most important for water production, as the Oconi River originates in the higher part of the basin (...). In this sense, conservation projects of the water production ecosystems must also include these communities and Comarapa Muncipality, (...) aiming at communal norms strengthened through bylaws that will consolidate the steps made for the conservation of the higher parts of the basin."*

Similarly, they also acknowledged that people's understanding of climate change has to be transformed in order to facilitate adaptation. The water management in Batallas (P3) established on the territories of the Huancalli and Tuquia communities aimed to address the water scarcity through the combination of soil conservation measures, rehabilitation of riverbeds and use of rainwater.

4.1.5 P5 Learning and Experimentation

Conducting the analysis, I encountered that in Alto Seco, *"meetings with locals were organized to determine mechanisms of appropriation of the areas to be protected"*[7]. The CBA project in Ancoraimes supported *"experience sharing (P-1,4) between families, communities, municipalities and others"*[8] and for socialization of results from the use of bioindicators and the meteorological data. In Saipina, the project organized the meeting for the communities of the upper and middle parts of the basin to exchange experiences with water and soil management introduced by the project. The CBA project in Moro Moro planned to *"(b)ring consideration of climate change risks and adaptation to local and regional policies through a regional workshop on lessons learned from the Moro Moro project"*. Additionally, the meetings in Moro Moro between the different local stakeholders (communities, mayor and others) (P1, P2) can be also argued to facilitate mutual learning about realities of climate change.

Establishment of the local meteorological and hydrological stations in Moro Moro and Ancoraimes (P1, P3) is also relevant for this principle. The CBA project in Batallas establishing a tree nursery (P1, P2, P3) counted with a monitoring of *"several specific parameters (plant diameter and height) during the first few years of the project to determine the gain in biomass and to create a future plan for carbon compensation."*

In Alto Seco, awareness raising took place to strengthen their abilities to manage the protected areas REPANA and use the water resources efficiently (P1 - P4). Similarly, it also aimed to *"increase the capacity of the resource dependent communities through awareness raising, better use of climate information, future climate projections under different scenarios and use of alternative resources"*[9]. More capacity buildings workshops were done with the farmers to teach them to manage the irrigation system. Some activities to raise awareness of the local actors about water as a resource were organized too.

In Ancoraimes, the focus of the capacity building and awareness raising activities was slightly different than in the first case. *"Awareness raising workshops for children, adolescents and their families on climate change adaptation, (...)"* were hold together with

[7] *„Reuniones con interesados locales para determinar mecanismos para adquirir propiedades que sería protegido"*
[8] *"(...) intercambio de experiencias (P-1,4), entre familias, comunidades, municipios y otras (...)"*
[9] *„(...) Fomentar la capacidad de adaptación entre las comunidades que dependen de recursos naturales a través de la generación de conciencia, mejor el uso de información climática y criterios para prospecciones futuras de clima bajo diferentes escenarios incrementales, y usos de recursos alternativos (...)".*

educational festivals where the goal was to share the community's experience with adaptation to climate change. In addition, special didactic guides for teaching about climate change were elaborated for the teachers in the secondary schools.

Establishment of a tree nursery in Batallas (P1, P3) was followed by a series of *"workshops for students, municipal authorities, and communities on climate change, natural resources, and the environment"*, *"theoretical-practical workshops on spreading and managing tree nurseries"*, *"workshop to establish norms and responsibilities for the nursery committee or administrative board"*, and lastly a workshop on the possibilities for generation of resources for preservation of the protected areas.

In Carabuco, workshops were held with the locals to train them in the management connected with the established production of certified lupine seeds (organization, business and administration management, application of standards) (P1). Other sessions were held

> *"to improve the commun[i]ties' skills on the production of certified seeds which include the identification of the most suitable plots of lands for seed production, installation of seed plots, management of lupine seed crop, pest control for crop plant seedlings and an agricultural calendar."*

Similarly, the producers of certified lupine seeds participated on a capacity building workshop about management techniques of the certified seeds production.

The environmental promoters in Carabuco (P2, P3) not only represent an element of connection between the involved communities but they were meant to facilitate learning *"of the population of the Municipality to face adverse phenomena caused by climate change"* by *"carrying out of practices and knowledge transfers, accompanied by sharing of experiences and organizational strengthening, aspects that will allow for a better appropriation of the adaption measures of the community (…)"*.

The CBA Carabuco project involved a research as one of the goals were to establish *"experimental smallholdings to evaluate periods and seeding densities, plague and pests resistance, and varieties"* of lupine in order to compare them in terms of adaptation, yield and productivity.

In Moro Moro, awareness raising workshops, courses and student competitions related to climate change adaptation were organized among the local government members and municipal residents including *"(a) workshop to train schoolteachers to integrate climate change into their activities"*. In addition, *"(l)ocal knowledge regarding natural resources and changing climate [was meant to be] used to inform municipal planning"* through the meetings between the communities, mayor and other stakeholders (P1, P2). The establishment of the meteorological station in Moro Moro required capacity buildings in monitoring and analysis technologies (P1, P2, P3).

In Saipina, workshops raising awareness about climate change risks, a need for adaptation and sustainable use of water and land were planned to be held including sessions with children in schools. Another focus of trainings was to improve their capacities *"to implement improved cherimoya/agroforestry systems through meetings, trainings, and knowledge exchanges"*.

4.1.6 P6 Participation

Inclusion of stakeholders' perceptions and knowledge in the CBA projects in Bolivia was done through different participative methods. Regarding the CBA nature of the project, the principle of participation is vastly present as participation represents one of the pillars of CBA. In the following paragraphs, the material is examined for the principle of participation.

In Alto Seco, participation of the local communities was required to design mechanisms to acquire plots that would be protected (P5). Similarly, the different alternatives for the establishment of the irrigation system were identified in a participative manner (P1, P2, P3, P5). Local communities also participated in the very early stage of and identification of the project proposal and assessment.

The communities involved in the CBA project in Ancoraimes participated in an identification of problems related to their low food security. Through a process of participatory investigation, three local agricultural practices were revived. Similarly, *"the families will take part in a participative investigation generating experiences and lessons learnt in climate change adaptation"* in regards to the introduction of the new fruit trees.

Regarding the CBA project in Batallas, the project proposal states that *"(t)hrough interviews and private and group discussions they [stakeholders] have identified problems, provided basic information, set out alternative solutions, and expressed the need for carrying*

out this project." The document also states that *"(a)ll events and works will involve the participation of the beneficiary communities, communal and municipal authorities, and primary and secondary school students in the locality of Batallas."*

In Carabuco, vulnerability of the communities regarding climate change was assessed under a presence of community members from all four involved communities. The members of the local community participated in the experiments conducted in the cultivation of lupine. In addition, the workshop for community representatives to agree on rules regulating the association of the lupine seeds producers was organized in a participative manner (P1, P2, P5). The community's participation was also ensured by giving them the responsibility to construct a storehouse for the lupine seeds: *"the beneficiaries will be responsible for a construction of the storehouse, as well as for the provision of local material and labor, the project will provide external materials to set the infrastructure in place."*[10] The environmental promoters (P2, P3, P5) were trained to facilitate learning, build the local capacities and provide leadership in terms of the climate change adaptation efforts.

In Moro Moro, the local adaptation plan was designed through a participatory process between local and external scientific knowledge using *"(p)articipatory analysis of historical climate variability and its impacts on production and other factors (...)" (P2)*. The local communities also participated in the *"development of a community plan for protecting key hydrological recharge zones [(aquifers]) through reforestation" (P1, P3)* The community was also to be enabled to participate in the collection of climate data through the establishment of the meteorological station.

All six projects bear elements of participation in the vulnerability assessments that were conducted. The GEF's CBA program generally uses participative methodology of vulnerability reduction assessment (VRA) to evaluate and monitor changes (Droesch et al. 2008) so it can be assumed that vulnerability assessments were done in all CBA projects in Bolivia. The goals and objectives of the project in Saipina were set up together with the beneficiaries through several meetings.

[10] *"(...) esta construcción estará a cargo de los beneficiarios tanto del aporte de materiales locales y la mano de obra para la implementación de la infraestructura el proyecto aportará los materiales externos."*

4.1.7 P7 Polycentric Governance

Using the eludication of Biggs et al. (2015), some aspects of polycentric governance were found in the establishment of the protected areas REPANA in Alto Seco where the norms and rules were set up by the four local communities in order to regulate the use of water and protect the springs (P1 – P5).

The CBA project in Saipina could be also argued to contain elements of the principle due to the agreement on rules and norms of water use between the communities living in the upper and middle sites of the river (P1, P2, P4, P5).

4.2 SUB-CONCLUSION

From the analysis, it is evident that resilience principles are to a great extent present in the six case studies of CBA in Bolivia. Concretely, elements of all the principles have been detected in two projects, namely Alto Seco and Saipina. Batallas and Ancoraimes cases lacked the principle of polygovernance. And two principles – CAS lens and polygovernance, were not found in CBA projects in Moro Moro and Carabuco.

Throughout the cases, the principle of diversity and redundancy was applied in terms of knowledge and perspectives, landscape heterogeneity, agricultural production, management practices, livelihood strategies and safety nets. Connectivity has been encountered to address the interactions across scales within the municipalities, between the actors (municipalities, communities, families, environmental promoters, seeds producers), between the landscape components and ecosystems and between the actors and the environment. Slow variables and feedbacks were managed by enhancing ecosystem services and natural processes through the establishment of the protected areas, regulation of use of natural resources, the monitoring and awareness-raising. Fostering of CAS was done through the holistic management of natural resources, the monitoring and awareness raising. Learning and experimentation was facilitated by the capacity buildings, trainings, awareness raising through the monitoring, the creation of opportunities for interaction, the diverse participation and networking. Broader participation was promoted by the creation of the associations, engagement of the stakeholders in the various stages and processes of the projects using the different methods to mobilize the capacity of the local communities. Aspects of polycentric governance were addressed by establishment of the protected areas and the agreements regulating activities in relation to the management of the river basin.

Chapter 5 Discussion

In this chapter, the analytical findings are discussed with the theory of resilience thinking and the past studies on the topic in order to detect in what way the resilience principles may potentially enhance resilience of the local communities. Sub-conclusion at the end compares the cases in terms of the resilience principles they contained and elucidates what effect it may have on resilience of the local communities and the environment.

5.1. The Effect of Resilience Principles

5.1.1 Promoting Diversity & Redundancy

The analyzed CBA projects were found to diversify the knowledge and perspectives upon which the adaptation measures were based. Both CBA and resilience thinking view local knowledge as important point of view that brings understanding of local realities of a SES (Kirkby et al. 2015, Boillat and Berkes 2013). There are studies that confirm the positive effect of multiple knowledge sources to enhance resilience of SES (Valdivia et al. 2010, Fernnández-Llamazares et al. 2017, Jacobi et al. 2017, Escalera & Jacobi 2017). Even though inclusion of the most vulnerable in participative processes is important to design adaptation measures, Wilk et al. (2018) argues that if power of their representatives is limited, the designed adaptation measures may not contribute to their increased adaptability and consequently resilience. To solve this problem, they suggest giving more power to the representatives of the poor.

The analyzed documents indicate that the CBA projects put a great emphasis on building resilience through response diversity and functional redundancy by addressing the heterogeneity of landscape, agricultural production and management practices. According to Biggs et al. (2015) the reforestation in Moro Moro and Batallas had a potential to not only diversify the landscape and the local soil and water management practices, but also improved the water availability, and serve as a barrier diminishing the adverse impacts of extreme weather events.

The application of agroforestry in agriculture (Saipina, Ancoraimes) facilitates enhancement of several ecosystem services because it improves the soil composition, stores water and hinders erosion. As can be observed, the forestry activities were present in four out

of the six projects. Forestry activities as a form of adaptation to climate change are favored due to existing evidence of its positive effect on promotion of sustainable livelihoods (e.g. Robledo et al. 2004). In addition, the resilience-enhancing effect of agroforestry in cocoa production in Alto Beni was found by a research group led by Johanna Jacobi from the University of California (Jacobi et al. 2014, Jacobi et al. 2015a, Jacobi et al. 2015b).

The introduction of better-adapted varieties and diversification of cultivated crops (identified in Carabuco and Ancoraimes) increases availability of food and fodder as the different kinds of crops and species react to the climate shocks in various ways. Positive effect of a crop diversification on SES resilience was found by Baldinelli (2014) and Meldrum et al. (2018). It was also documented it is possible to take advantage of the higher average temperature in the highlands and diversify the production by crops that in the past, were possible to grow only in the lower altitudes (Taboada et al. 2017).

Meldrum et al. (2018) demonstrates increase in a cultivation of crops that are more resistant to varying climate. However, they also explicate that some native crops (e.g. isaño and oca) have become more vulnerable and are substituted by commercial crops that are paradoxically more sensitive to climate shocks (also Jiménez et al. 2013 in the case of potatoes). *"The displacement of local crops and varieties reduces response diversity in farmers' crop portfolios and therefore their capacity to adapt to climate shocks and long-term change."* (Meldrum et al. 2018: 726). To strengthen resilience of Andean farmers, they suggest actions that would maintain and expand the variety of cultivated crops (Ibid.).

Lastly, Zimmerer (2010) investigated interactions of irrigation systems with agrobiodiversity and came to a conclusion that irrigation systems that are based on traditional indigenous knowledge contribute to higher yields and agrobiodiversity conservation and increase resilience of the local SES. In addition, the irrigation systems also diversify sources of water necessary for the agricultural production, hence, providing functional redundancy. Yet, he adds that if the use of the other natural resources and issues of power are not addressed, it only leads to partial success in terms of resilience building.

Protected areas such as those in Alto Seco have a potential to conserve diversity and allow for recuperation of natural resources (water springs and biodiversity of species) and the functions they provide. Ruiz-Mallén et al. (2015) and Asquith et al. (2002) both agree with the theoretical assumption that conservation efforts have a potential to contribute to greater resilience of SES. However, they also argue that they have to be designed participatively in

collaboration with the local communities. In this way, they support flourishing of the biological and cultural diversity. On the contrary, if the local communities are excluded from the process, the conservation may contribute to increased biodiversity nevertheless, it adversely affects cultural diversity (Ruiz-Mallén et al. 2015, Asquith et al. 2002, Boillat et al. 2013). Implications for the case of Alto Seco is that regarding the fact that the local population participated in the process of the establishment of the REPANA from the early beginning and they were meant to be in charge of its management, I argue that it may increase resilience of the local communities by enhancing the biological and cultural diversity.

Applying resilience thinking, I assume that the establishment of the tree nursery in Batallas and the cultivation of certified seeds of lupine in Carabuco (linked to the credit and saving scheme) can be also argued to diversify the livelihood strategies leading to diversification of income (safety nets) and greater capacity of the local subsistence producers to adapt to the changing environmental conditions resulting in higher resilience of the local SES (Adger 1999, Biggs et al. 2015).

5.1.2 Strengthening Interactions

The theory of resilience thinking and the concept of CBA both assume that interactions between actors on or across scales facilitate social learning. Past studies disagree with that straight forward relationship. Fernández-Llamazares et al. (2015) and Gilles (2013) bring evidence that provision of climate change information to local communities did not influence their perception of climate change. The reason was lack of trust of the local actors in the scientific data. It suggests that connecting the traditional communities to the scientific data is not enough, and there is a need to find a way how to present the meteorological data to the local communities so that they will understand (Ibid.). Nevertheless, I suggest that the Ancoraimes case may not experience this challenge as the local communities themselves were supposed to collect the meteorological data and received capacity building trainings to do so.

Interactions of communities with other actors, experience sharing and knowledge exchange are claimed to facilitate social learning increasing people's capacity to adapt to changing conditions and hence, contribute to greater resilience (Biggs et al. 2012, Escalera & Jacobi 2017). The projects in Saipina, Moro Moro and Carabuco are likely to increase resilience of the local communities regarding the clear purpose of the cooperation. This argument corresponds to Escalera and Jacobi (2017) who found that inter-communal dialogues enhance resilience of local SES through facilitation of social learning. Nevertheless,

Salamanca (2009) shows that cross-scale interactions regarding challenges from climate change is not always easy and does not increase resilience of local actors. He demonstrates lack of interest of local governance units to help people living on the hillsides of La Paz to reduce their vulnerability to landslides. In comparison to the other three project sites, lack of common understanding of the goals and purpose of the cooperation may lead to confusion and different expectation resulting in lack of trust and willingness to share and cooperate.

Establishment of the association of seeds producers is considered to increase the producers' adaptability and to contribute to the local resilience. The argument is backed up by the study made by Jacobi et al. (2015a, b). They found out that the associations, uniting the local producers from the organic cacao farms, increase their adaptability and resilience through a facilitation of information, exchange of experience, certification, etc. Though, the existence of the connection is not always guarantee of success and strength of the interaction, the frequency of the interaction plays a role as well (Biggs et al.2015). Hence, meeting of the seed producers association should happen on a regular basis to ensure its contribution to the resilience of the local SES.

Zimmerer (2010) conducted a research in the inter-Andean valleys of the Cochabamba region and found that a landscape consisting of a matrix of irrigation structures combined with patches of diversified agricultural production increases connectivity between the system's ecological components, and enhances resilience building through provision of habitat, soil nutrients, gene flow and water supply. Applying this to one of the case studies, irrigation system established in Alto Seco to improve food security has a potential to contribute to the local SES resilience if combined with sustainable land use practices and conservation of agrobiodiversity.

Another aspect of the Alto Seco case connected to the principle of connectivity is the establishment of protected areas (P1). Through the lens of resilience, these protected areas have potential to facilitate recolonization of the area hit by extended dry periods common in the SES. They represent an important component of the system. It can be also confirmed from another perspective. Devisscher et al. (2016) studied resilience of the systems under wildfire risk in Chiquitania. Their findings corroborate the significance of protected areas as a bottleneck for fires, i.e. protected areas may inhibit fires by breaking the continuity of grasslands. There was no reference found in the analyzed material in connection to fire management, however I suggest that it may soon become a hot issue regarding the extended

dry periods the SES of Alto Seco suffers. Same can be applied to the reforestation of the areas of the river basins in Batallas and Moro Moro which in addition has a potential to improve the water cycle in the SES and provide habitat (P1).

5.1.3 Fostering Holistic SES Management

Zimmerer (2010) found that combination of small- or medium-sized irrigation systems and cultivated fields with high agrobiodiversity supports positive reinforcing feedbacks in form of higher agricultural yields (through provision of organic matter, soil nutrients, water supply). I therefore assume that creation of the irrigation system in Alto Seco can enhance resilience if combined with agricultural practices that enhance agrobiodiversity. Moreover, the established REPANA allow the natural resources to recuperate and it keeps track of the actions that adversely affect the configuration of the SES such as deforestation or expansion of the agricultural frontier (Biggs et al. 2012).

Regarding the fact that livelihoods of most of the communities participating in the CBA projects depend on natural resources, it is not a surprise that the principle of slow variables and feedbacks from the ecological domain was addressed by all six projects. Reforestation, agroforestry, establishment of protected areas and promotion of agrobiodiversity were the practices that the projects introduced.

Looking through the lens of resilience, these approaches of slow variables management are considered to enhance the feedbacks that maintain the current configuration of the SES which the communities are part of so it keeps providing the desired ecosystem services (Biggs et al. 2015). Robledo et al. (2004) agrees with the theory and shows that forestry protects the soil from erosion caused by water and wind, protects against morning frosts, improves water cycle, stabilizes the soil, increases nutrient content and in addition, protects crops against storm winds (also Motavalli et al. 2013). Jacobi et al. (2015b) agrees by demonstrating higher resilience of agroecosystems of cocoa production under agroforestry than under monoculture. Confrontation with the past studies suggests that in this regard, the CBA projects have potential to contribute to resilience of the local communities and the environment they live in as long as they are addressed holistically.

Biggs et al. (2015: 130) argue that monitoring of slow variables and feedbacks *"ensures that important underlying changes in SES are detected and that timely adjustments in management can take place where needed (...)".* Nevertheless, monitoring of slow

variables does not guarantee implementation of adaptation measures in case of approaching thresholds because of e.g. competing interests (Biggs et al. 2012) or lack of interest (Salamanca 20009). Hence, Biggs et al. (2012) suggest creation of governance structures that would be able to respond to acquired data in a timely efficient manner. Therefore I suggest that the monitoring activities in Ancoraimes and Moro Moro should be connected to the local authorities that may issue regulations when needed.

Values, traditions and worldviews represent slow variables that shape human's behavior (Biggs et al. 2015) and hence, the management of natural resources. Regarding the environmental promoters in Carabuco and 'the need to transform consciousness' in Saipina, it can be viewed that the task was to weaken old habits (slow variables) of local communities (e.g. deforestation or unsustainable water use) to transform their understanding of local environment and make them see the importance of the application of sustainable management practices for their resilience.

The creation of the payment schemes for ecosystem services is deemed to address missing feedbacks between the drivers and impact (in case of Moro Moro, soil degradation, deforestation, loss of habitat, decrease biodiversity, etc.). If implemented in Moro Moro, these payments schemes would obligate those depleting the natural resources (private landholdings cultivating for export) to compensate the local subsistent communities who suffer the impact in the terms of decreasing size of the plots, decreasing productivity and fertility, increased erosion, etc. In this way, the pressure put on the environment to deliver ecosystem services can be lowered and their recuperation and resilience enhanced.

5.1.4 Promoting Understanding of Complexity

Spatial management approaches (e.g. REPANA in Alto Seco or the dialogues between the communities situated in different parts of the river in Saipina and Batallas) are considered to contribute to the development of CAS thinking (Biggs et al. 2015) by holistically accounting for the dynamics of the processes that take place in a delimited space. However, as Biggs et al. mention, there is a chance that some factors cannot be managed for as they are rooted outside the delimited management area. This claim is supported by the study of Devisscher et al. (2016) who found protected areas in Chiquitania being prone to fires originating outside of the territory. The implication for the projects in question is that collaboration of the local communities within the SES with the communities living in the surrounding SES or with SES defined at a higher level is recommended to increase resilience of the projects sites area.

Referring to the cases where the diversity of knowledge was valued in the section 4.1.1 (P1), it can be assumed that the incorporation of different perspectives into the design of the adaptation options can be seen as acknowledging epistemological pluralism, a step that is according to Biggs et al. (2015) necessary for fostering thinking in the framework of complex adaptive systems. They claim that *"(...) fostering CAS thinking generally need to be grounded in a collaborative knowledge-building process, involving managers, scientists and resource users"* (Biggs et al. 2015: 162). This argument is supported by Valdivia et al. (2013b) who propose collaboration between scientific and local traditional knowledge as a solution to build a knowledge base for climate change adaptation. However, Jacobi et al. (2017) and Cockburn (2015) found that even though based on collaboration of the two knowledge systems, it does not guarantee their equal contribution to the problem due to the skepticism about local knowledge, lack of communication or preference for ready-made solutions. A question for further research could be to examine the extent to which the traditional local knowledge was treated as equal to scientific knowledge under the CBA projects in Bolivia.

Additionally, the need to transform the community's consciousness in the CBA project in Saipina (P3) can be viewed through the CAS lens as an attempt to influence and change the mental models. According to Biggs et al. (2015), knowledge influences awareness and consequently, awareness goes on to affect behavior. It would therefore mean that the awareness raising would foster CAS thinking in the engaged communities leading to sustainable use of resources and resilience building. Nevertheless, Biggs et al. (2015) also points to the fact that elements of CAS thinking are present in some practices of traditional knowledge holders. Ironically, evidence provided by Walsh (2010) and Ruiz-Mallén et al. (2017) suggest that interventions aimed at building sustainable environmental and agricultural practices happen to negatively affect people's adaptability by replacing their holistic understanding of the world with Western mechanistic view of life. Therefore, I suggest that the attempt for consciousness transformation in Saipina had a potential to be successful but only if it was sensitive to local worldviews and took them as a point of departure.

5.1.5 Encouraging Continuous Learning

According to the theory of resilience thinking, there is a necessity to keep revising knowledge because systems constantly change. Monitoring provides information about changes that take place in the SES and may even help to discover system's thresholds. Based on Biggs et al. (2015), the monitoring of environmental parameters represented in the above

mentioned cases is important for the management of the slow variables (soil composition, precipitation, temperature) and maintenance of the current configuration of SES. As a kind of social learning, it is in agreement with the concept of CBA that the process of acquiring the data engages stakeholders and gives them opportunity to reflect upon the information, use it to adjust their agricultural activities and in that way contributes to their adaptability. The same applies to the experimental activities in Carabuco which are generally common in CBA projects because they allow stakeholders to reflect upon the findings. Seen through the resilience lens, experimentation in the cultivation of lupine can help to understand how the local SES works.

Reliability of the bioindicators, used in Ancoraimes for comparison with the meteorological data, can be questioned and I suggest that the scientific data can be used to test the efficiency of the bioindicators. A study conducted by Riva et al. (2013) in Charazani, Bolivia found that traditional indicators have lost their efficiency due to the changing environmental conditions and altered transfer mechanisms. Therefore, I argue that their reliability should be scrutinized before put in practice in future projects.

The awareness raising activities found in the CBA projects are activities that are according to Huq and Reid (2007) necessary to ensure people's understanding of the necessity to adjust their behavior face to face climate change. It also contributes to their capacity to transform the systems into more favorable ones through the promotion of CAS thinking which may become very useful due to the increased speed of environmental changes. Talking generally about CBA projects, they are also supposed to strengthen the capacity of the local communities to take appropriate action in order to adapt to the climate variability demonstrated by droughts, more frequent extreme weather events, scarcity of water, spread of pests and diseases, etc.

Proponents of CBA interventions claim that local communities have capacity to respond to climate changes but there is a need for their empowerment. As an example confirming this claim can serve the tree nursery in Batallas, it was already there before the project came but it was not doing well and needed new inputs and ideas which the project has provided. The existence of local capacities is further illustrated by a project done by OXFAM in the department of Beni. The project was designed to deal with seasonal droughts and floods and their consequences. An old indigenous system of camellones was revived and with the contribution of science put in practice (OXFAM 2009b). Similarly, the existence of local

people's capacities to contribute to climate change adaptation was found by Fernández-Llamazares et al. (2017), Boillat and Berkes (2013) and Jacobi et al. (2017). Local traditional knowledge and capacities are a common cornerstone of both, CBA and resilience thinking theory.

This example as well as the case studies point to another aspect that is claimed to be important by the proponents of CBA and resilience thinking. It is diversity of perspectives. As one of the pillars of both CBA and resilience thinking, ensuring diversity of voices and facilitating experience sharing and learning is seen as increasing people's adaptability and facilitating mutual learning and understanding of the complexity of a phenomenon. The study of the inter-communal dialogue conducted by Escalera and Jacobi (2017) provide an evidence of the positive effect of regular interactions between the actors to share experience, on their capacity to adapt to the changing climate. It allows for development of locally suitable adaptation options (Armitage et al. 2011) which is illustrated by e.g. the case study from Alto Seco where local community participated on the design of different irrigation options or the case study from Moro Moro. Collaborative learning was found to have a positive effect on people's ability to deal with climate change impacts and spur innovation in the Bolivian Highlands (Figueroa Armijos and Valdivia (2017). However, as already mentioned before and documented by Jacobi et al. (2017) and Wilk et al. (2018), inappropriate treatment of local knowledge may cause unsuitable adaptation solution to be imposed, decrease resilience of local SES and even lead to maladaptation. To address this challenge, Biggs et al. (2015: 191) suggest that *"adequate conditions that foster understanding of others' perspectives and experiences"* have to be facilitated.

Lastly, the question of how sustainable the learning processes, monitoring and meetings of the different projects' actors are, can be raised regarding the great financial investment that this process requires (Biggs et al. 2015). The CBA projects had duration between one and two years during which the financial resources were provided by the intervening organizations. The challenge not only for these six CBA projects but for all development interventions are their financial (not only) sustainability. However, I found that at least one of the CBA projects (Batallas) showed hints of accounting for the future financial resources by conducting a workshop on generation of financial resources to manage the protected areas.

5.1.6 Engaging Diverse but Relevant Actors

Biggs et al. (2015) present capacity building workshops as one of the ways to operationalize the principle of participation. The capacity buildings that were identified in all the six case studies are therefore seen as enabling the local people to participate in the different processes by raising their knowledge and skills.

Following this logic, the communities' participation on the monitoring of water and weather attributes and the experiments in the production of lupine seeds enhances their ability to take actions based on the observed data. There have been several studies (Valdivia et al. 2010, McDowell & Hess 2012, Boillat & Berkes 2013) that have documented farmers taking adaptation measures and adjusting their agricultural activities based on their climate observations. Danielsen et al. (2005) adds that monitoring may lead to shifts in perceptions and attitudes which in turn may lead to transformational change (Folke et al. 2010). In addition, according to Lebel et al. (2006) participation of various stakeholders is believed to enhance not only social learning (see P5) but to build trust upon which collective action can be taken. Hence, I suggest that the participative information-gathering techniques the projects planned to employ have a potential to increase the people's transformability.

Bohensky and Maru (2011) look critically at the integration of scientific and indigenous knowledge and suggest that there are four critical features of the integration: frames, social context, modes of evaluation and knowledge bridgers. After applying resilience theory to the problem, they conclude that for the contribution of indigenous knowledge to SES resilience, it is necessary to ask the question 'which social-ecological systems are these integration processes building the resilience of, for whom, and on which scales in time and space?'. A study done by Wilk et al. (2018) agrees with this argument and suggests that representatives of the marginalized and implementation groups have to be given greater responsibility, otherwise *"it is likely that the interests and priorities of more powerful actors will dominate and not contribute to increasing the resilience of the most vulnerable"* (Wilk et al. 2018: abstract). Based on these studies, I suggest the six CBA projects to be examined for whose resilience was actually supposed to be built because it is unfortunately, out of the scope of this thesis.

In agreement with the participatory approach typical of CBA, the stakeholders in the six CBA projects were found to be involved in various phases of the projects, concretely identification, formulation, implementation and monitoring. In that way, only participation in

the evaluation phase (which was not encountered during the analysis) is missing for the project to be deemed as a good CBA intervention according to Kirkby et al. (2018). Regarding the fact that stakeholder analysis is a part of the process of project design, it is assumed that the right stakeholders were included. However, as CBA is known for its lack of accounting for power relations (see *Challenges of CBA* in section 3.2.2), it can be argued that inclusion or exclusion of some stakeholders who had or had not the right to participate might have taken place. The participation of the local communities in the different phases of the projects have a potential to increase the local resilience by engaging the local capacities that have the deepest and most relevant knowledge of the systems.

5.1.7 Supporting People to Self-Organize

There is evidence supporting a positive effect of local management institutions on resilience of SES put forward by Villaroel et al. (2014). They found that the old indigenous system of ayllus (institutional body governing land use in a specific region) connected to broader indigenous organizations and national policy levels, has been successfully managing the Sajama National Park for generations. Thanks to the fact that

> *"any action to address emerging challenges must be implemented in coordination and agreement with local actors and their collective institutions. This is one of the reasons why, since the establishment of the management committee, Sajama National Park is widely accepted among local people and is known to be one of the best examples of participatory park management in Bolivia."* (Villaroel et al. 2014: 367)

Paradoxically, past research also shows that lack of involvement of local communities in the design and implementation of conservation measures leads to their decreased adaptability due to restrictions on access to land and natural resources (Ruiz-Mallén et al. 2015, West et al. 2006). However, in the case of the Alto Seco and Saipina projects the community members themselves agreed on the norms and rules that were supposed to regulate the access to some areas and the use of natural resources. Therefore, I suggest that these proceedings can be viewed as a first step towards successful management of the areas that may contribute to resilience of the local SES.

There is another aspect that has to be considered, though. As illustrated in the study conducted by Villaroel et al. (2014), there has to be connection with other governance levels

for the management agency to build resilience in SES (Biggs et al. 2015). This element was found in the case of the CBA in Saipina where there was an agreement between the municipality and local communities made about economic and technical cooperation on local adaptation measures.

5.2 SUB-CONCLUSION

The discussion of the findings with the past studies and the theory, revealed the ways in which the application of the principles in the CBA projects may contribute to greater resilience of the local SES.

The projects in Saipina and Alto Seco contain aspects of all the resilience principles. The potential that it will contribute to greater resilience of the local systems through a resilient supply of ecosystem services is high because it holistically accounts for the nature and structure of the systems and processes therein and matches the management institutions (REPANA and watershed norms) to the local scale of the environmental problem.

In comparison, the other four projects do not show signs of establishment of local management agencies. It means that compared to Saipina and Alto Seco, the projects in Moro Moro, Batallas, Ancoraimes and Carabuco do not have local institutions designed especially to would regulate use of natural resources. They are dependent on the higher levels of governance that have less knowledge about the processes at the lower scales and may result in late and inappropriate responses to the changes in the feedbacks and slow variables in the local SES. While in Alto Seco and Saipina, the local monitoring and observations can be immediately used to guide actions in case of changes in the system because they have the autonomy to self-organize and respond in a timely efficient manner. The communities in the other four project sites do not have the autonomy to self-organize which may hinder collective action towards climate change resilience building.

In addition, the projects in Carabuco and Moro Moro lack the principle of CAS. This principle is deemed to be crucial for the operationalization of the other five principles. The absence of this principle could hinder the understanding of the complexity of the system and nonlinearity of the processes which is crucial for sustainable management of the natural resources in times of changing climate. Compared to the project sites in Alto Seco, Ancoraimes, Saipina, and Batallas where the holistic understanding of the local environment is fostered, there is a chance for continued mechanistic linear view of nature which strongly

undermines capacity (both adaptability and transformability) of the local systems to deal with future climate variability.

Lastly, challenges in regards to the application of the principles such as reliability of bioindicators, balance of knowledge systems, comprehensibility of the topic and power dynamics, were encountered. They represent conditions under which the application enhances resilience of local communities and environment they live in.

Chapter 6 Conclusion

This final chapter recapitulates the aim, applied methods and theories and answers the research question by presenting the findings from the analytical section and discussion. At the end, some critical reflections regarding the way the research was conducted are included.

6.1 Towards Resilient Social-Ecological Systems

The aim of this research was to explore how the application of the resilience principles in the CBA projects in Bolivia enhances resilience of the local SESs to the changing climate. The answers to the question are based on the analyzed data, review of past studies in the area, the theoretical framework and methods.

The material analyzed in this thesis is represented by the project documents (project concepts, proposals, fast facts sheets). They were collected from the UNDP's website based on their relevance for answering the research question. The literature reviewed consists of studies and reports about climate change adaptation measures in Bolivia and their contribution to resilience of the local social-ecological systems.

The theoretical framework, including the theory of resilience thinking, related concepts and the concept of community-based adaptation, has contributed with the comprehension of the resilience principles and the way their application in the CBA projects enhances resilience of the SES. The research was done using qualitative methods, content analysis and a cross-sectional comparative design with elements of a case study. The material was analyzed by turning seven resilience principles by Biggs et al. (2012, 2015) into a set of criteria.

The thesis aimed to answer the following research question.

How does the application of resilience principles in the community-based adaptation projects in Bolivia, financed by the Global Environmental Facility through the Small Grants Programme between 2008 and 2012, enhance resilience of the local social-ecological systems?

The question was answered by the discussion of the analytical findings with the resilience thinking theory and the past studies on climate change adaptation and resilience in Bolivia. I

therefore conclude that the application of resilience principles in the CBA projects (if implemented as was described in the analyzed material) enhances resilience of the local SES by

- promoting the diversity of perspectives, knowledge systems, actors and their experiences, landscapes, management approaches, agricultural production,

- facilitating interactions of the actors (if all understand the importance of their contribution, and if goals and purpose are clear) and the components of the social and ecological sphere,

- enhancing ecosystem services and contributing to the sustainable management of natural resources (if managed holistically),

- fostering the understanding of the complex and interdependent relationship of man and nature, unpredictability and nonlinearity (if attention is paid to not to impose and force external ways of thinking on local communities),

- building the people's capacity to take action, adapt and transform – through the awareness raisings, trainings and participative methods (if done in a way they understand, and if all knowledge systems and actors involved are treated equally and with respect),

- involving the communities in the management agencies governing local natural resources.

Thanks to the partially comparative design, I found that differences in the occurrence and application of the principles lead to different ways through which resilience of the local SES is enhanced. The projects in Saipina and Alto Seco have great potential to contribute to the resilience of the local SES because they show elements of all the resilience principles. The projects in Moro Moro, Batallas, Ancoraimes and Carabuco lack the principle of polygovernance which may adversely impact systems' resilience by hindering collective action. In addtition, Carabuco and Moro Moro were not found to contain aspects of CAS thinking.

Polygovernance and CAS thinking are claimed to be crucial in regards to the implementation and facilitation of the other principles. Hence, due to the absence of both principles, there is a chance that the resources in Carabuco and Moro Moro will be governed by institutions that are not aware of what is happening down on the ground and therefore cannot quickly respond to the changes in the configuration of the SES. And together with the lack of understanding the complexity of interactions between human and nature, it may lead

to exploitative management practices that undermine climate change resilience of the local SES.

The way this research was conducted is relevant for several actors. For the research community, I have brought the evidence that the resilience principles have a potential to serve as criteria to assess projects' contribution to local SES resilience and I suggest examination of ways in which they can be incorporated into the project cycle. For development agencies, I have shown that resilience principles represent a useful tool to gain deeper understanding of the interdependence of communities and their environment and a potential tool to evaluate project's overall influence on resilience of systems. For policymakers, I have demonstrated the need to proceed holistically in climate change adaptation at the governmental level to embrace the complexity of relationships within a defined system and foster its resilience to future climatic variability.

6.2 CRITICAL REFLECTIONS

I have devoted the very last part of the thesis to reflect on the research process and address the reservations regarding the data, documentation, theories and methods (for gathering the data, analysis and design) employed in the thesis.

The data and documentation

I believe that the data were relevant and sufficient to answer the presented research question. However, some documents were not available for certain projects implying that different number of documents was analyzed in relation to some projects compared to the others. To address this, I tried to get in contact with the responsible for CBA projects in Bolivia. Nevertheless, I have not received any answer.

The studied material represented documents that were designed before the projects took place (project proposal, project concepts) and the key results sheets and one final evaluation including all the cases were far too brief to determine whether all the planned activities and actions took place. Hence, the lack of knowledge in regards to this problem represents a limitation to the ability to determine presence and effect of some principles. Although, data collected from field observations, focus groups or interviews would better account for the reality of the problem, due to the limited resources, project documents available on the UNDP's website were used.

The documentation of resilience building and climate change adaptation in Bolivia could be strengthened by studies from the Latin American region to allow for richer discussion of the findings with results from other investigations. However, I considered the presented review of past studies as sufficient e and relevant because they represent past studies on the same topic from the country of interest.

Theories

The theories were relevant and sufficient to answer the research question. However, I was constantly encountering the issue of power dynamics when discussing the findings with the past studies on the subject in Bolivia. To address my research question and taking regards to the available data, the theories were sufficient. But if qualitative data would be collected in the field by participative methods, the theory of resilience thinking and the concept of CBA would have to be complemented by e. g. the theory of political ecology in order to account for the power relations.

Methods

For the data gathering

As mentioned before in relation to the reservations about the analyzed data, gathering data by field research (observations, focus groups, interviews) would be more appropriate method facilitating greater understanding of the circumstances than search for documents that partially catch the reality. Nevertheless, field research in Bolivia was not feasible due to the time and financial constraints.

For the analysis

I encountered some difficulties by turning the resilience principles by Biggs et al. (2015) into the analytical tool. First, the possibilities to operationalize the principles are very broad and almost all-embracing. Second, in the later phase of writing and discussing the findings, it was difficult to decide whether a certain principle was present in a specific project or not due to their high interconnectivity and the fact that, as I gained greater and greater understanding of the way how to apply the principles, I was beginning to see that it could relate to another principle as well. Therefore, there is chance that if I conducted the analysis using the same methods again, I would find more aspects of the principles in the projects.

Based on these reservations, I would suggest that for next time, it may be a good idea to have more levels of evaluation such as present, somewhat present and absent, instead of just two – present and absent. Consequently, greater understanding could be also gained by scrutinizing the way they are implemented. Similarly, more strict criteria or division of each principle into several categories may come in handy to give the analysis greater order. For example, examining aspects of diversity such as livelihood strategies or number of species for variety, disparity and balance (see Biggs et al. 2015). An option could also be to analyze just selected number of resilience principles, however the pitfall here might be the low ability to account for the interdependence of the principles.

For the design

Last suggestion for improvement of the method for analysis is connected with the critique of methods for design. Cross-sectional comparative design with elements of case study was suitable to answer whether the principles were present or not and discuss the effect. Though, it may be beneficial to have just one project next time, which implies only application of the case study design. That would allow for exploration of the links between related principles into greater depth and to see how they influence each other in the defined settings.

Lastly, I look at the thesis through the criteria for quality of t research methods by Yin (2009). Turning the principles into the analytical tool to analyze the material contributed to the validity through in my opinion correct operationalization of the studied concepts. Second, the internal validity is difficult to assess as I could not directly observe the effects that the application of the principles had on the SES and I inferred the effects based on the theory and the documentation of previous studies. Third, the external validity is concern with the ability to generalize the findings. Even though, findings resulting from case study designs cannot be generalized and nor is it the goal of the study (Bryman 2012), I would argue that the findings related to the positive effect that the different tools, activities and actions have on the SES resilience are generalizable as they are acknowledged within the resilience community. I tried to address the last criteria of reliability by describing the procedure into detail making it transparent and easy to be replicated.

There are certainly aspects in which this thesis could be strengthened and improved. Yet, in the light of all the reservations and quality criteria assessment on one hand and their justification on the other, I conclude that it is a valuable contribution to the research on adaptation and resilience of systems under current climate change.

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Appendix

Table of analyzed documents

	Title of the document	Reference
1	Project concept of CBA project in Alto Seco	ICO (2008)
2	Project proposal of CBA project in Batallas	UMSA (2008)
3	Fast facts sheet of CBA project in Batallas	UNDP, and GEF (2019a)
4	Project concept of CBA project in Carabuco	CUNA Association (2008a)
5	Project proposal of CBA project in Carabuco	CUNA Association (2008b)
6	Fast facts sheet of CBA in Carabuco	UNDP, and GEF (2019b)
7	Project concept of CBA project in Moro Moro	Fundación Natura Bolivia (2008a)
8	Project proposal of CBA project in Moro Moro	Fundación Natura Bolivia (2008b)
9	Fast facts sheet of CBA project in Moro Moro	UNDP, and GEF (2019c)
10	Project concept of CBA project in Saipina	FAN (2008a)
11	Project proposal of CBA project in Saipina	FAN (2008b)
12	Project proposal of CBA project in Ancoraimes	Plan Internacional Inc. (2008)
13	Fast facts sheet of CBA project in Ancoraimes	UNDP, and GEF (2019d)
14	Country Program Report 2008-2012	UNDP (2019g)
15	Summary of key results and outputs *	UNDP (2009a, b, c, d, e, f)

* Key results and outputs of all projects presented on UNDP were put together in one document to allow for analysis in NVivo.