MULTI-LEVEL LEARNING IN THE GOVERNANCE OF ADAPTATION TO CLIMATE CHANGE

JAVIER P.E. GONZALES IWANCIW

Propositions

1. Effective adaptation to climate change requires learning.
   (this thesis)

2. Institutional design is essential for the governance of adaptation to climate change.
   (this thesis)

3. In a complex network, each action has many possible reactions.

4. Humility is needed in science to embrace alternative forms of knowledge and understanding.

5. International solidarity is vital in navigating the Anthropocene.

6. The world is one, yet it is easier to treat it as fragmented.

Propositions belonging to the thesis, entitled

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Multi-level learning in the governance of adaptation to climate change

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Preface and acknowledgements

Writing a PhD thesis in the field of adaptation to climate change is for me the summit of a long professional journey. Twenty years ago, in year 2003, I wrote a published report about the role of social participation and learning in Bolivia´s adaptation efforts. The report prepared in collaboration with Prof. Jose Furtado from Imperial College of London ignited my interest in further exploring the connections between adaptation and learning. The same topic motivated me to submit a PhD research proposal at the Public Administration and Policy Group of Wageningen University in year 2013. This PhD thesis is a compilation published 10 years later and includes 4 papers published and submitted to scientific journals on this topic.

As a practitioner in the field, one of the strongest motivations to write this dissertation was to put into the academic language the experience gathered in the field.

This PhD work, also provided me with the opportunity to look deeper into the UNFCCC process and compare cases studies in the Latin American context, complementing research and praxis in studying climate change adaptation policies.

Learning is key to accelerate our human response to the challenges of climate change, and this needs to happen across different levels of governance, stretching from the multilateral process of the UNFCCC, the international technical assistance and funding, national adaptation policies at the country level, and the involvement of broad segments of the society. Multi-level learning should also include the voices of vulnerable groups, women and indigenous peoples who can bring different perspectives and experience to address climate change concerns. Although multi-level learning is an indication of greater collaboration between different actors in the pursuit of shared goals, there are still important gaps across levels of governance in the international regime of adaptation that need to be addressed and scientific work can help identify and address them.

This project has been accomplished with the direct support from many people and institutions, to whom I owe my most sincere appreciation and thanks.

Initially I want to thank and acknowledge to Prof. Art Dewulf and Dr. Sylvia Karlsson-Vinkuizen my supervisors at the Public Administration and Policy Group of Wageningen University, both academic of great renown, who showed me the way, shared generously their experience and provided insightfully guidance to this research. I also what to thank Maarit Junnikkala for her continuous support during my PhD. studies facilitating the communication

Change is the end result of all true learning.

Leo Buscaglia

Abstract

In the last three decades, the governance of adaptation to climate change has become more and more interconnected, involving decision-making processes that span across levels of governance from global to local level and back. On the one hand, multilateral institutions like the United Nations Framework Convention on Climate Change have shaped an international adaptation regime with important implications for adaptation planning and actions at the national and local levels. On the other hand, national and local, public and private actors worldwide are increasingly taking an active role in policy advocacy processes seeking to influence the international adaptation agenda and regime, building the institutions and networks for multi-level governance.

Besides the fact that learning has been stressed as important in academic climate change literature and the UNFCCC as well, the question how to better incorporate multi-level learning in the governance of adaptation for enhancing the performance of adaptation policies remain insufficiently addressed. There is a need to better conceptualize the contribution of multi-level learning to the governance of adaptation and empirical evidence that looks at the interactions across levels of governance is scant. There are only very broad notions about how to integrate multi-level learning in the governance of adaptation, an area where this dissertation aims to make a contribution.

The research objective of this dissertation is to better understand how multi-level learning is integrated in the governance of adaptation within and across levels and how it could be enhanced. This aims to contribute to the broader discussion about the governance of adaptation and specifically enrich the research on multi-level learning by developing a conceptual framework tailored for studying multi-level learning in the governance of adaptation, with a particular focus on Latin America.

Four research questions have guided the examination of the theoretical and empirical aspects of multi-level learning in the governance of adaptation. These questions aim to conceptualize multi-level learning in the governance of adaptation; identify the factors that encourage or hamper multi-level learning; gain insight about multi-level learning linked to adaptation in the Latin American context; and analyze the means to enhance multi-level learning in the governance of adaptation.

The dissertation draws on a systematic literature review to deepen our understanding of the academic discourse surrounding the conceptualization of multi-level learning, the methodologies used to evaluate it, and to identify pertinent research questions and gaps.

Subsequent chapters delve into the examination of multi-level learning within diverse multi-level governance settings. The methodology utilized throughout these studies facilitates an exploration of the factors that enable multi-level learning and conduct systematic observations about multi-level learning linked to adaptation processes in the Latin America context.

Summarizing the findings of this dissertation, firstly a comprehensive definition of multi-level learning was developed, drawing from both social and policy learning approaches. This conceptualization views multi-level learning as the dynamic interplay of social and policy learning processes, evaluated across cognitive, normative, and relational dimensions. It emerges from the interactions between individuals and institutions operating at various governance levels, focusing on pertinent policy aspects related to adaptation to climate change. Subsequently, through analysing various case studies, three pivotal factors shaping multi-level learning within adaptation governance were identified: the international adaptation regime, the configuration and connectivity of multi-level learning nodes and the levels of governance involved in those nodes, and the learning culture expressed through the state and trends in the cognitive, normative, and relational dimensions of multi-level learning, alongside the direction of multi-level interactions. Furthermore, the case studies highlighted that there is a difference between the factors enabling multi-level learning from the aspirations that drive it. Cases show how understanding climate change propels learning. Policymakers' expectations for coherence, efficiency and innovation drive multi-level adjustments, which also foster learning.

The dissertation emphasizes the potential for enhancing multi-level learning by addressing these key factors, highlighting the significant role of multi-level learning nodes in shaping the social and institutional structures of adaptation governance. Furthermore, it underscores the importance to address the cognitive, normative, and relational dimensions of multi-level learning in fostering a learning culture that shapes the capacity of the governance system to deal with adaptation challenges.

Despite intentions to engage actors across governance levels in multi-level learning for the governance of adaptation, significant gaps persist in the involvement of national and local actors in deeper forms of learning.

Finally, this dissertation contributes to the advancement of analytical frameworks for evaluating multi-level learning within adaptation governance. Future research could focus on implementing these analytical frameworks to evaluate multi-level learning dynamics in real-world adaptation governance contexts. Moreover, exploring the practical application of suggested institutional design improvements could offer valuable insights to policymakers and practitioners aiming to enhance adaptive capacity across different governance levels.

Contents

List of tables

List of figures

List of acronyms

CAF	Cancun Adaptation Framework
CCCI	Cities and Climate Change Initiative
CIF	Climate Investment Fund
COP	Conference of the Parties
DIKW	Data, Information, Knowledge and Wisdom
ETF	Enhanced Transparency Framework (of the Paris Agreement)
GCF	Green Climate Fund
IPCC	Intergovernmental Panel on Climate Change
LAKI	Lima Adaptation Knowledge Innitiative
LDC	Least Developing Countries
LEG	Least Developing Countries Expert Group
MER	Monitoring Evaluation and Reporting
MAS	Movimiento al Socialismo (Bolivian Political Party)
MMAYA	Bolivian Ministry of Environment and Water (Spanish Acronym)
NAP	National Adaptation Plan
NAPA	National Adaptation Program of Action
NDC	National Determined Contributions
NWP	Nairobi Work Program
PNC	Bolivian National Waterhsed Plan (Spanish Acronym)
PRAA	Adaptation Project in the Andes (Spanish Acronym)
PPCR	Pilot Project for Climate Resilience
SBSTA	Subsidiary Body for Scientific and Technological Advise
SBI	Subsidiary Body for Implementation
SIDS	Small Ilands Developing States
SNA	Social Network Analysis
SPSR	Strategic Program for Climate Resilience
UN	United Nations
UNFCCC	United National Framework Convention on Climate Change

CHAPTER

1

Introduction

1.1. Background and problem setting

The importance of climate change adaptation to address the climate crisis is broadly recognized. All major reports of the Intergovernmental Panel on Climate Change (IPCC) have steadily stressed the urgency for societies to determinedly address and accelerate adaptation to climate change (de Coninck et al., 2018; Parry et al., 2007; Pörtner et al., 2022).

The Sixth IPCC Assessment Report – Working Group II on Impacts, Adaptation and Vulnerability (Pörtner et al., 2022), states that with increasing global warming, human and natural systems will reach adaptation limits and losses and damages will increase. It underscores soft and hard limits to adaptation; if soft limits are reached, they can be overcome by addressing a range of constraints, primarily financial, governance, institutional and policy constraints whereas hard limits, related to unknow climatic changes and ecosystem disruption cannot be overcome with existing science and additional resources.

In the last three decades, the governance of adaptation to climate change has become more and more interconnected, involving decision making processes that span across levels of governance from global to local level.

Although adaptation currently is carried out by a range of actors and institutions across levels of governance, the multilateral process of the United Nations Framework Convention on Climate Change (UNFCCC) has shaped the governance of adaptation since its adoption. The UNFCCC has delineated the institutional setting, rules and organizations that guides adaptation, sought to facilitate the generation and integration of knowledge generated within policy processes across levels, and outlined the enabling conditions for adaptation across levels of governance.

Against this background, this dissertation seeks to analyse adaptation as a multi-level governance problem in which learning between levels generates the changes and adjustments necessary to increase the performance of adaptation.

Learning has been recognized as a key variable in the governance of climate change adaptation literature (e.g. Armitage et al., 2010; di Gregorio et al., 2019), for example, as a mechanism to identify adaptation options from existing experience (Ensor et al., 2015) and to replicate and disseminate knowledge and experiences and accelerate adaptation responses, through mechanisms of mutual learning (Dodman et al., 2013; Forsyth, 2013).

Others have studied, how learning can be integrated into adaptation governance processes through institutional design (Huntjens et al. 2012; Ison et al. 2015).

Learning is also an intrinsic characteristic of resilience and adaptive capacity in governance regimes (High et al., 2005; Pahl-Wostl, 2009). The literature has suggested forms of social learning to enhance collaboration in governance settings, arguing that progress on adaptation agendas fundamentally depends on new forms of learning (Collins et al., 2009). The literature has also underscored policy learning approaches (e.g. Adger, 2003a; Huntjens et al., 2011) to frame adaptation responses and learn from their implementation.

Learning processes in the governance of adaptation occur at and between different levels, involving different actors with contrasting views and capabilities in the pursuit of adaptation (e.g. Armitage 2008; Pahl-Wostl 2009).

Learning has been stressed as important in academic climate change literature and by the UNFCCC as well, but the question how to better incorporate multi-level learning in the governance of adaptation for enhancing the performance of adaptation policies remain insufficiently addressed.

Notwithstanding the extensive literature on adaptation governance at local, national and regional levels (e.g. Charles, 2012; Taylor et al., 2012; Termeer et al., 2011; Thompson, 2016), there is a need to better conceptualize the contribution of multi-level learning to the governance of adaptation. Empirical evidence is scant regarding the interactions across levels of governance and considering the influence of the international and global levels on adaptation.

This dissertation is oriented to better understand the role that multi-level learning plays in the governance of adaptation, recognizing that adaptation is shaped by different and contrasting interests of multiple institutional and individual actors across different governance levels.

The focus is on the interactions of different levels of governance in the pursuit of adaptation. This includes the role of the UNFCCC adaptation regime to enable multi-level learning; the contribution of multi-level learning to fulfilling the goals and aims of adaptation across levels of governance; and possible means for better integrating learning across levels in the pursue of adaptation.

This research will be conducted with a particular focus on Latin America, where there are sustained efforts to integrate adaptation into different priority sectors and learning processes across levels of governance can accelerate the process and make it more effective.

Section 1.2. presents the aim of this dissertation and presents the research questions. Section 1.3. discusses the key concepts used in this dissertation: the governance of adaptation, multi-level governance, and multi-level learning. In Section 1.4 an overview of the methodological design is presented including the qualitative methods applied to gauge the empirical evidence for the analysis of multi-level learning in the governance of adaptation. Section 1.5 describes the structure of this dissertation.

1.2. Aim and research questions

As presented above, multi-level learning can make a significant contribution to shaping the governance of adaptation. The multi-level nature of the governance of adaptation has been increasingly recognized in the concerned academic literature, as well as by the actors participating in the UNFCCC and the adaptation regime across levels of governance. Scholarly debate about multi-level learning in the governance of adaptation, however, is quite recent and limited.

There are few clear suggestions about the conceptualization of multi-level learning in the governance of adaptation, and how it can be studied systematically. There is a lack of empirical evidence about how multi-level learning works and how well in the pursuit of adaptation. There are only very general notions about what the drivers of multi-level learning are across levels of governance and how the contribution of multi-level learning can be assessed in relation to the governance of adaptation outcomes. In addition, due to the lack of sufficient empirical evidence, there are only very broad notions about how to integrate multi-level learning in the regime of adaptation. The research objective of this dissertation is therefore:

- *To better understand the role of multi-level learning in the governance of adaptation and how it could be enhanced*.

This dissertation aims to contribute to the discussion about the governance of adaptation in general and, more specifically, to the research on multi-level learning by developing a

conceptual framework from which to systematically study multi-level learning in the governance of adaptation. A better conceptual understanding of multi-level learning enables different research questions for empirical studies about the governance of adaptation, like adaptation planning (e.g. Füssel, 2007; Mimura et al., 2015) and learning in adaptation across levels of governance (e.g. di Gregorio et al., 2019; Hanssen et al., 2013; Lidskog & Elander, 2010; Newig et al., 2010).

This research also aims to be policy relevant. A comprehensive understanding about the potential of multi-level learning is key to accelerate and enhance the ambition of adaptation across levels of governance and addressing policy and social goals of enhanced climate justice through knowledge and experience sharing and dialogues.

Multi-level learning has the potential to significantly influence the institutional structure and social dynamic of the governance of adaptation, enhancing its coherence and effectiveness in achieving desired outcomes. Multi-level learning can also contribute to enhanced collaboration, and the social adoption of solutions, enhancing the benefits of adaptation in the longer run. Based on this aim, four research questions have been formulated:

RQ1. How can multi-level learning be conceptualized in the governance of adaptation based on the social learning and policy learning literature?

The question formulated here aims to contribute to the conceptualization of multi-level learning in the governance of adaptation from different theoretical angles and perspectives. Initially the focus will be on how the multi-level governance (e.g. Kerber and Eckardt, 2007; Benz, 2012) and the adaptation literature (e.g. Huntjens et al., 2011; Ison et al., 2015; Siebenhuner et al., 2016) have conceptualized multi-level learning to better understand the theoretical and empirical entry points for addressing learning in multi-level governance settings. Insights from theories on social learning (e.g. Collins & Ison, 2009) and policy learning (e.g. Huntjens et al., 2012) are expected to build a conceptual framework to capture multi-level learning processes and mechanisms and the influence of the wider institutional context.

Answering this research question will frame the properties of multi-level learning in the governance of adaptation and develop the learning lens to be applied in relation to policy

relevant questions of adaptation and contribute to policy actors being able to better design multi-level learning in the governance of adaptation.

RQ2. What are the factors that encourage multi-level learning in the governance of adaptation?

This research question is oriented to obtain the empirical information across levels of governance about the factors that encourage or hamper multi-level learning in the governance of adaptation (e.g. Gerlak & Heikkila, 2011; Armitage et al., 2018) and to better understand what type of outcomes are expected from multi-level learning processes oriented to address concrete adaptation policy goals (e.g. Tschakert & Dietrich, 2010; Armitage et al., 2018). This research question will also serve to refine the conceptual framework of the dissertation with additional empirical evidence from adaptation planning processes taking place across levels of governance and identify characteristics of institutions and governance settings that enable multi-level learning across levels and to the performance of adaptation policies in the governance of adaptation.

RQ3. Where and how does multi-level learning occur in the governance of adaptation in the Latin American context?

This research question aims to explore the empirical manifestation of multi-level learning across levels of governance and through different adaptation policy implementation perspectives and entry points based on case studies in Latin America, where the gaps in the literature are notorious (e.g. di Gregorio et al., 2019). This will also provide insight about the changes produced at the level of institutional settings (Huntjens et al., 2011) and functions and about how different policy actors perceive the role of multi-level learning in relation to adaptation process and regime. Answering this question will provide the empirical evidence needed to nurture the discussion about the contribution of multi-level learning to institutional design in the pursuit of adaptation.

RQ4. How can multi-level learning be enhanced and what are the implications for the governance of adaptation?

Answering this question will identify main challenges and the potential for multi-level learning enhancements in relation to adaptation policy processes and the governance of adaptation. The theoretical approach and the empirical studies served to find elements to

enhance multi-level learning in the governance of adaptation. Both through the incorporation of multi-level learning in adaptation planning processes (Tschakert & Dietrich, 2010), as well as in institutional design and the governance of adaptation (e.g. Pahl-Wostl, 2009; Huntjens et al. 2011). This analysis can contribute and draw conclusions and policy recommendations and guide further research.

1.3. Theoretical framework

A starting assumption for this dissertation is that multi-level learning embedded in the governance of adaptation is a precondition for improving the adaptation outcomes. This argument has been presented quite early in the adaptation debate (Ensor et al., 2015; High et al., 2005; Pahl-Wostl, 2009; Tschakert et al., 2010).

The conceptualization of multi-level learning in the governance of adaptation is grounded in three key concepts and associated literatures which are presented below: the governance of adaptation, multi-level governance, and learning in governance settings.

1.3.1. The governance of adaptation

The fundamental elements of the academic discussion on how to define and frame climate change adaptation, that has important implications for adaptation governance, have been included in the Third Assessment Report of the IPCC (McCarthy et al., 2001) and more recently integrated with the concept of disaster risk reduction (Field et al., 2012) and resilience (e.g. Pörtner et al. 2022). According to this compiled reports adaptation has following features: adaptation has the potential to reduce adverse impacts of climate change and to enhance beneficial impacts; human and natural systems will to some degree adapt autonomously to climate change, but planned adaptation is needed to supplement autonomous adaptation; adaptation is a necessary strategy at all scales to complement climate change mitigation efforts; experience with adaptation to climate variability and disaster risk reduction can be drawn upon to develop appropriate adaptation; adaptive capacity and resilience is needed to withstand the adverse effects of climate change and promote adaptation.

The literature on climate change adaptation recognizes that adaptation involves changes in governance structures to enhance resilience and adaptive capacity (Adger, 2003a; Engle, 2011; Pelling et al., 2005). This implies looking at adaptation as a governance

issue with important implications for institutional design and policy across levels of governance (e.g. Amundsen et al., 2010; Gupta et al., 2008; Lidskog & Elander, 2010; Persson, 2019).

Adaptation together with mitigation is included in the objective of the UNFCCC (Art. 2). But adaptation was overlooked and not given the same priority as mitigation for many years, or it has just evolved with its own pace according to the mandate and provisions agreed (Schipper, 2006). The UNFCCC initiated support for adaptation in developing countries with the Least Development Countries (LDCs) work programme (D5/CP.7) (for further details see Table S3.5 in Supplementary materials). With this program LDCs were entitled to receive financial support and technical assistance for their adaptation efforts. This was followed four years later by the Nairobi work programme on impacts, vulnerability, and adaptation to climate change (adopted at CoP12 in Nairobi and outlined in ANNEX of D2/CP.11) with the twofold objective to enhance understanding about the implications of climate change and make informed decisions (See the same Table S3.5).

From 2007 onwards, adaptation became further framed and institutionalized as an equal pillar to mitigation in the UNFCCC. This was also supported by a more explicit recognition about the implications of dangerous climate in the IPCC Fourth Assessment Report (Parry et al., 2007). The financial commitments made by developed countries between 2009 and 2010 oriented towards adaptation influenced the adoption of the Cancun Adaptation Framework (CAF) ant the establishment of the Green Climate Fund (GCF) under the Cancun Agreement at CoP16 in 2010.

The Paris Agreement established a new set of provisions on adaptation (Article 7) that include the global goal on adaptation, that still need to be defined, including obligations of all parties to plan and implement adaptation actions, and enhanced financial support and technical assistance for developing countries provided by the international community. The Katowice Climate Package adopted at CoP24 in 2018 finished the set of modalities provided by the Paris Agreement for reporting, integrating adaptation in National Determined Contributions (NDCs) and the global stocktake to track and report about adaptation on a continuous basis.

Adaptation governance scholars recognize that the CAF and the Paris Agreement have shaped the governance of adaptation with more decided statements and the emergence of multi-stakeholder processes across levels of governance (di Gregorio et al., 2019; Okereke et al., 2009; Persson, 2019). The Paris Agreement explicitly recognize that

"adaptation is a global challenge faced by all with local, subnational, national, regional and international dimensions, and that it is a key component of and makes a contribution to the long-term global response to climate change" (Article 7.2). This formulation confirms the multi-level nature of the governance of adaptation.

The Paris Agreement has been perceived in general terms as legally weak in terms of ensuring compliance (Hall & Persson, 2018). However, the provisions of the Paris Agreement introduce stronger and more formalized adaptation obligations, involving all Parties, not only developing countries, in the pursuit of adaptation across levels, which reinforces the multi-level nature of the governance of adaptation (Lesnikowski et al., 2017). Adaptation will be further strengthened by the preparation of NDCs and National Adaptation Plans (NAPs), the periodic global stocktake to enhance transparency and identify the gaps in achieving national and global commitments and the means to address them through international cooperation.

Moreover, the need to adopt a global goal on adaptation under the Paris Agreement, is a real driver to enhance the institutional coherence and effectiveness of the governance of adaptation across levels (Persson, 2019).

1.3.2. Multi-level governance of adaptation

The governance of adaptation can be understood as a multistakeholder process of governance, taking place across different levels. Looking at adaptation through the lens of governance implies that state and non-state actors become involved to address the problems and obtain the benefits associated with climate change, shaping the agenda and actions of constituents towards climate change adaptation as a public goal (e.g. Huitema et al., 2016; Nieuwaal et al., 2009; Persson, 2019).

In generic terms governance is understood as the structure of institutional settings, including rules and the architecture of institutional functions and organizations, but also the dynamic of social networks and agency, that includes markets, hierarchies and networks (Armitage, 2008; Berkes, 2006; Thompson, 1991).

The concept of multi-level governance emerged out of federal studies in the EU context but rapidly has been also adopted in other contexts. Multi-level governance implies the attempts to bridge the separation along local, national and supranational levels in governance studies (e.g. Benz & Eberlein, 2011; Marks, 2007). The concept of multi-

level governance (Hooghe et al., 2010) defines the dispersion of authority across levels of governance and overlapping jurisdictions over a particular territory. In other words, this means that different levels of governance with different or shared attributions participate in the definition and implementation of public policies.

The multi-level nature of governance has been picked up by environmental governance scholars as well (Betsill et al., 2006; Newig et al., 2009; Paavola, 2007).

One of the central arguments in scholarly literature is that environmental governance needs to take into account complex cross-scale and cross-level interactions affected by the interplay between institutions at multiple levels (e.g. Cash et al., 2006). Multi-level governance, that involves the generation of knowledge and learning, negotiation and advocacy across levels may facilitate solutions to complex problems of the environment. As adaptation measures are slowly being implemented across different levels of governance, the multi-level lens enables the possibility to address the emerging challenges of adaptation across levels.

The discussion about decentralization and the role of subnational governance addressing adaptation is one of those challenges: Environmental governance scholars have discussed around the argument that more decentralized jurisdictions can better reflect heterogeneity of preferences, thus better adjusting to the actual needs of the population and their environment (e.g. Marks, 2007) and make government more accountable and responsive to the governed (Faguet, 2014). Research has raised questions about the coordination and vertical integration needed across levels for the efficient implementation of adaptation policies (Huitema et al., 2016; Juhola, 2010; Rantala et al., 2014), including the mismatches between how issues are framed and addressed at different levels (Dewulf et al., 2015).

The relevance of global and international levels dealing with the challenges of adaptation across levels of governance have also been stressed in the literature, in particular the role of the multilateral process of the UNFCCC and international cooperation networks providing guidance and facilitating learning (e.g. Rietig, 2014; Vinke-de Kruijf & Pahl-Wostl, 2016; Widerberg & Pattberg, 2015). And the emergence of regional programs and networks of collaboration supporting adaptation (e.g. di Gregorio et al., 2019; Kern & Bulkeley, 2009; Lidskog & Elander, 2010).

1.3.3. The building blocks of a multi-level learning concept

Theoretic views of the governance of adaptation suggest that in order to adapt to new situations the governance system also requires flexible institutional arrangements that encourage reflection, learning and innovative responses (Armitage et al., 2010; Huntjens et al., 2012).

In such governance learning plays a central role as a way of keeping knowledge and experiences up to date with continuously changing conditions (Berkhout et al., 2006; Pahl-Wostl, 2009; Tschakert et al., 2010). Some authors see learning linked to the resilience of socio-ecological systems, arguing that, compared to ecological resilience, the resilience of social systems has an additional capacity to foresee and adapt to possible changes (e.g. de Kraker, 2017).

Learning has been addressed in different ways in governance literature. Social learning can be conceptualized as a mechanism of governance regimens to adjust to changing conditions in the context. Adaptation requires learning and the scales and complexities of climate change demand new forms of social learning for concerted action (e.g. Collins & Ison, 2009; Ison et al., 2015), that can make societies more resilient (de Kraker, 2017; Fazey et al., 2007; Pelling et al., 2008). In the climate change literature scholars advocate for enhanced participation of different actors to enhance learning and make their contribution to policy processes more relevant (Collins et al., 2009; McCrum et al., 2009). Social learning can be encouraged by engaging underrepresented groups, supporting social movements that arise from the periphery can generate important paradigm shifts, the need to see things differently and to find more lasting solutions (Leys et al., 2011; Paquet, 1999).

The literature on the governance of adaptation recognizes that climate change adaptation requires not only the active participation of multiple stakeholders – including state and non-state actors – but also changes in governance approaches toward governance structures and dynamics that enable learning and transformation (Termeer et al., 2017; van Bommel et al., 2016).

This dissertation will develop a definition of multi-level learning that relies on social learning (Ison et al., 2015; Reed et al., 2010) and policy learning approaches (Sabatier, 1988; Sanderson, 2002). As it will be explained in Chapter 2, multi-level can be understood in its cognitive, normative, and/or relational dimensions, as the result of

interactions between individuals and institutions from different governance levels on policy-relevant aspects of adaptation to climate change.

Social learning frequently defined in academic literature about adaptation as a convergent change in stakeholders' understanding and perspectives on a particular problem and its possible solutions that goes beyond the individual toward collectives and social networks. According to (Reed et al., 2010) the defining characteristics of a social learning process are: a change in understanding has taken place in the individuals involved; this change goes beyond the individual and becomes situated within wider social units or communities of practice; and the change occurs through social interactions and processes between actors within a social network.

Policy learning in contrast focuses on questions of policy design and implementation (e.g. Hall, 1993; Sabatier, 1988). Different explanations of policy change based on notions of learning have emerged in the policy literature These include notions of policy-oriented learning, the extraction and sharing of lesson in similar or different policy contexts, and the ability of governments to learn from previous policies to adjust the course of action.

1.4. Methodological approach

As outlined above, this dissertation aims to understand the role of learning in the governance of adaptation by exploring the different theoretical approaches in the definition of multi-level learning in the governance of adaptation present in the academic literature, apply analytical tools to review the empirical evidence about multi-level learning obtained through different case studies organized across different levels of governance and triangulate the findings.

To address the objectives and research questions of this dissertation, a diversity of qualitative methods where applied. The main rational for choosing the path of qualitative methods is the complexity of the governance of adaptation where exploratory studies are warranted to better understand relevant issues and explore the connections (Filatotchev et al., 2017).

An initial literature review (Petticrew et al., 2011; Vink et al., 2013) was conducted to know about the discussion and approaches suggested in the relevant literature. This was followed by a content and thematic analysis of the data obtained empirically (Fereday et al., 2006) analysing key variables resulting from the theory in a deductive process as well as from the analysis of the data.

The qualitative analysis was strongly influenced by two contrasting research positions, appreciative inquiry (Coghlan et al., 2003) and a critical analysis (Morse, 2015) to refine the sense of rigor in qualitative inquiry. The first was oriented to dig in the data and obtain hints about multi-level learning and the second one to detect gaps and potential for enhancements. To maintain a sound level of rigor, the analytical tools were also confronted with similar approaches suggested in the literature.

The first research question of this dissertation, about the conceptualization of multi-level learning has been mainly addressed through the systematic review of the literature but refined as the research progressed. The following research papers (Chapters) served to better understand the methodological implications, scope and limitations of the proposed theoretical framework, the derived tools and the possibilities and constraints in obtaining the required data.

The second and third questions will serve to gain in-depth knowledge of the case studies, raise relevant questions for the governance of adaptation in different contexts and across levels of governance, but also to adjust an analytical framework that serves to analyse multi-level learning processes in the governance of adaptation.

The fourth question will be addressed by summarizing principal findings and insight of the research conducted throughout the dissertation, the evidence gathered will also serve to observe, analyse and draw conclusion about the factors that enable and drive multi-level learning and under what circumstances those factors can have a positive effect on multi-level learning processes, but also will serve to better target multi-level learning processes for the achievement of desired outcomes.

In the following sections the research design and methods applied to answer the different research questions are described in more detail.

1.4.1. A systematic literature review

As a starting point for the research project, a systematic literature review served to uncover what is known so far about learning in the governance of adaptation. The research followed similar methodological steps applied in systematic literature reviews, for example, in climate change governance research (e.g. Petticrew et al., 2011; Vink et al., 2013).

The systematic review of the literature served to establish a conceptual basis that allows understanding the main approaches proposed in the literature on adaptation to climate change and the literature on multi-level governance. Moreover, this review served to find the main gaps in the scientific literature on these topics, the central elements of the theoretical discussion on these topics, and where research efforts should be concentrated to obtain more empirical evidence.

The different approaches of learning in those literatures also served to better understand common ways and challenges in the operationalization of multi-level learning in the governance of adaptation. This literature review also addressed the theoretical aspects in order to develop the analytical tools to be applied for identifying multi-level learning for the governance of adaptation.

The results of the systematic literature review have been included in Chapter 2 of this dissertation.

1.4.3. Selection of case studies

A fundamental notion for designing the methods for collecting information is that of levels of governance. At the international or multilateral level of the UNFCCC, the emerging regime of adaptation to climate change is intended to influence the national processes of planning and political integration of adaptation, as well as the processes of adaptation at the local level and how the adaptation is measured and valued.

But on the other hand, the local processes for testing adaptation measures feed back into the national processes and also the multilateral process of the UNFCCC, establishing a series of interactions between the participating actors through levels of governance and generating governance dynamics oriented to respond to the challenges of adaptation.

In this way, in this dissertation, different case studies have been selected to analyse the empirical evidence for multi-level learning, and in turn to refine an analytical framework that allows a better evaluation of the contribution of multi-level learning to adaptation processes. Chapter 3 explores the multilateral adaptation regime established through several important decisions of the UNFCCC. This chapter also served to refine an analytical framework to study the factors and outcomes of multi-level learning in the governance of adaptation. In Chapter 4 a comparison of three cases of adaptation planning

in Latin America, explore the role of multi-level learning enhancing structural and functional factors in the institutional context of adaptation planning.

In Chapter 5, the case study on water governance in Bolivia provides additional analysis of how the policy integration of adaptation involves different networks of actors, defining nodes of collaboration and multi-level learning.

1.4.3. Content and thematic analysis

Content and thematic analysis of the data (e.g. Fereday & Muir-Cochrane, 2006) was the qualitative methodology used throughout the dissertation. This type of methods served to combine theory inspired methods – deductive - oriented to build the analytical lens to better dig into the different aspects of the analysis and explain possible connections and the empirical based – inductive – collection of evidence to better understand how this reflect in a particular context.

The data was mainly collected through the analysis and coding of policy documents, interviews with actors at different levels of governance and decision-making, and direct observations of adaptation processes both at the UNFCCC level and in the identified case studies. Given the multilevel setting of the research question, interviews and data gathering are designed along relevant adaptation learning events or processes that occur across multiple levels of governance where different stakeholders play a determining role.

The review of documentation, interviews and direct observations served to highlight the way multi-level learning is conceived at different levels of governance and explore if the different examples of implementation addressed can highlight common issues.

1.4.4. Social network analysis

Social network analysts (SNA) is grounded on the understanding that a wide range of empirical phenomena can be explored in terms of their structural patterning. Social network analysis seeks to understand networks and their participants and has two main focuses: the actors and the relationships between them in a specific social context (e.g. Serrat, 2017).

Social network analysis was applied in Chapter 4 of this dissertation to explore the structures and dynamics of the social network and graphically outline the significance and relations of the different participant actors and institutions (see Figure S4.1 in the

Supplementary materials). The resulting patterns served to explore further the type of interactions among the different participant and how multi-level learning is connected with those interactions.

1.5. Structure of the dissertation

The main body of the dissertation integrates 4 chapters based on research papers, published or submitted to scientific journals. Each of the chapters respond to the questions posed for this dissertation. In Chapter 2 the results of the literature review are included. This chapter compares the ways learning is addressed in both the general multi-level governance literature and the governance of adaptation to climate change literature, the main congruencies and divergences between these two literature strands and identify promising directions to conceptualize learning in multi-level governance of adaptation. Chapters 3, 4 and 5 are organized along different levels of governance (See Figure 1.1). In chapter 3 the factors that enable and drivers of multi-level learning in the multilateral UNFCCC adaptation regime are analysed. This chapter includes the main theoretical elements and analytical framework to assess multi-level learning in the governance of adaptation applied through the whole dissertation. Chapter 4 compares three adaptation planning experiences in Latin America where multi-stakeholder processes of collaboration is clearly visible and the empirical evidence about the challenges for enhanced multi-level learning has been gathered. And Chapter 5 reports on the ways multi-level learning have contributed to climate adaptation mainstreaming efforts in the water sector of Bolivia.

Levels of governance

Global level: UNFCCC adaptation regime with regional, national and local implications

Regional – national levels: technical assistance on adaptation planning

National – local levels: mainstreaming adaptation

Developing and applying an analytical framework to assess multi-level learning in the governance of adaptation

Chapter 3: How does the UNFCCC enable multi-level for the governance of adaptaiton?

Enabling factors and outcomes of multi-level learning

Chapter 4: Multi-level learning in climate change adaptation planning, comparing three experiences from Latin America

Enhancing the performance of adaptation planning

Chapter 5: Multi-level learning in the governance of adaptation to climate change- the case of Bolivia's water sector

Mainstreaming adaptation at the sector level

Empirical evidennce about the options for enhanced multi-level learning

Chapter 2: Literature Review

Comparison of multi-level governance & climate change adaptation governance literature

Conceptualization of multi-level learning for the governance of adaptation:

as the *interplay of policy and social learning across levels of governance on policy relevant aspects of climate change*

Assessing the cognitive, normative and relational dimensions of multi-level learning

Figure 1.1 Structure of the Dissertation

CHAPTER

2

Learning in multi-level governance of adaptation to climate change – a literature review

Abstract:

The governance of adaptation to climate change is an emerging multi-level challenge, and learning is a central governance factor in such a new empirical field. We analyse, through a literature review, how learning is addressed in both the general multi-level governance literature and the governance of adaptation to climate change literature. We explore the main congruencies and divergences between these two literature strands and identify promising directions to conceptualize learning in multi-level governance of adaptation. The review summarizes the main approaches to learning in these two strands and outlines conceptualizations of learning, the methods suggested and applied to assess learning, the way learning processes and strategies are understood, and the critical factors identified and described. The review contrasts policy learning approaches frequently used in multi-level governance literature with social learning approaches that are more common in adaptation literature to explore common ground and differences in order to build a conceptual framework and provide directions for further research.

2.1. Introduction

The governance of adaptation to climate change (henceforth governance of adaptation) has become a truly multi-level governance affair since the adoption of the Paris Agreement on Climate Change in 2015. Although with the adoption of the United Nations Convention on Climate Change (UNFCCC) in 1992 the global climate regime did pay some attention to adaptation, it was not until the Paris Agreement that adaptation was put on a par with mitigation. The agreement's global adaptation goal cemented a multi-level institutional framework for adaptation that has evolved faster since 2010. This framework includes normative principles for the governance of adaptation, international funding mechanisms, and an adaptation committee under the UNFCCC with advisory, coordination, and capacity-building mandates. Multi-level governance usually involves not only multi-level institutional frameworks but also interactions between various stakeholders across different levels of governance. In the case of governance of adaptation, stretching from global negotiations to local implementation and vice versa, local and national policy development is increasingly influenced by international agreements and policy instruments (e.g. Amundsen et al., 2010; Andonova et al., 2009; Bulkeley, 2001).

Given the newness of governance of adaptation per se in modern society, the already noticeable impacts of climate change, and the newness of a multi-level context for adaptation, it is reasonable to expect that learning will be a key aspect of emerging governance efforts. Learning is recognized in adaptation research as an important governance of adaptation mechanism (Adger et al., 2005; Berkhout et al., 2006; Pahl-Wostl, 2009; Tschakert et al., 2010). It is often described as a key instrument for adjusting the course of action toward enhanced climate resilience and creating knowledge among stakeholders for facing the challenges and uncertainties of a changing climate.

It is against this background that we took the following proposition as the starting point for this study: governance of adaptation could benefit from a better understanding of learning in the multi-level context of such governance (Pahl-Wostl, 2009; Reed et al., 2010). The burgeoning literature on social learning in natural resource management has been systematically reviewed (Rodela, 2011; Rodela et al., 2012), but the intersections of learning across governance levels, including for the governance of adaptation, remain unexplored. This study reviews two strands of literature – governance of adaptation and multi-level governance – as a first effort to gain insights into the role of learning in multi-level governance of adaptation.

We do this by asking the following questions: (i) how is learning defined and conceptualized? (ii) how is learning operationalized, assessed, and measured? (iii) what are the important processes and strategies for learning? and (iv) what factors encourage or hamper learning in a given context? The article proceeds as follows. Section 2.2 describes the methods applied for the literature review and for the general analysis of the literature sample. In Section 2.3, we analyse the answer to our four questions. In Section 2.4 and in the conclusions, we summarize common ground for a conceptualization of learning, main constraints and difficulties in addressing learning in multi-level governance settings, and questions to be addressed in further research.

2.2. Review methodology and literature sample

The objective of this review was to analyse discussions on learning in two literature strands – multi-level governance and governance of adaptation – to gain insights into the role of learning in multi-level governance of adaptation and followed similar methodological steps applied in systematic reviews, for example, in climate change governance research (e.g. Petticrew et al., 2011; Vink et al., 2013).

Our bibliographic search for peer-reviewed journal articles was performed in the databases SCOPUS and Web of Science between July 2014 and March 2017. By the end of 2016, the initial sample comprised 1,084 papers on "governance AND adaptation" in SCOPUS and 1,130 in Web of Science, and 2,405 on "multi-level OR multi-level AND governance" in SCOPUS and 1,970 in Web of Science. We then applied the word "learning" in titles, abstracts, and keywords as an inclusion criterion, resulting in 123 papers on "governance of adaptation" in SCOPUS and 183 in Web of Science, and 147 papers on "multi-level OR multi-level governance" in SCOPUS and 169 in Web of Science. Including the word "learning" in the title indicating a strong focus on this topic, merging the results of SCOPUS and Web of Science, and refining the sample by excluding publications that did not fit the screening criteria, we obtained a final sample of 58 papers in English (see Table S2.1 in the Supplemental materials): 21 papers address only governance of adaptation questions, 32 papers address multi-level governance, and 5 papers satisfy both criteria. Whereas the SCOPUS word search coincides with the title, abstract, and keywords, Web of Science includes publications that use close synonyms e.g. "adaptive governance", "adaptive management", and "multiscale governance" in the title, abstract, and keywords, thereby yielding publications not identified by SCOPUS. Plotting the publication years for this

sample (Figure 2.1) shows a growing interest in learning within these research communities. It is important to note that we did not apply a limitation on publishing year; the oldest publication included dates back to 2002.
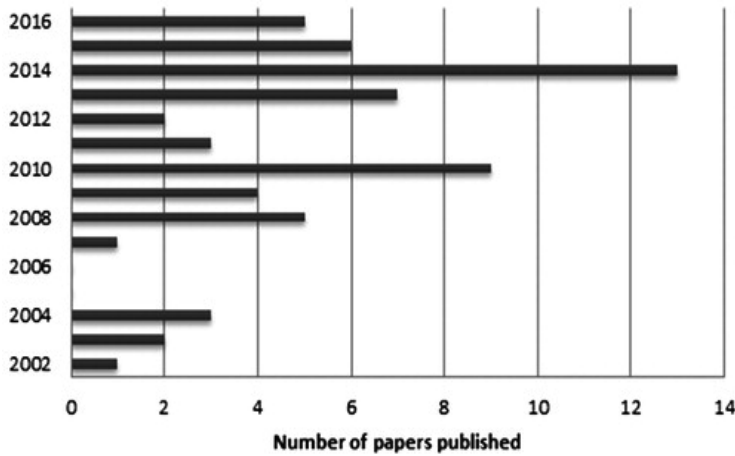
Figure 2.1 Distribution of selected papers for the literature review

The final sample covers a broad range of disciplines within both the environmental and the social sciences. The academic journals in which they were published include topics such as European planning, public policy, and law (7), environmental policy and governance (8), global environmental change (3), water (5), and urban studies (4).

An initial screening of literature abstracts and keywords enabled us to identify the four questions posed in Section 1. Table 2.1 provides an overview of how these four aspects are considered within the sample.

Table 2.1 Distribution of how learning is addressed in the literature reviewed

	Learning definitions	Methods to assess and measure learning	How does learning take place?	Factors that foster or inhibit learning
Governance of adaptation literature	Explicit definition (13/21)	Define methods (7/21)	Describe a learning process (16/21)	Describe factors (5/21)
Multi-level governance literature	Explicit definition (15/32)	Define methods (7/32)	Describe a learning process (23/32)	Describe factors (9/32)
Studies that address multi-level governance and governance of adaptation.	Explicit definition (4/5)	Define methods (1/5)	Describe a learning process (4/5)	Describe factors (4/5)

This review has some limitations. Given the large volume of learning literature in the context of environmental governance, the review focuses on a very specific subset of the literature, thus capturing only a portion of the discussion on organizational, policy, and social learning in these fields (Argyris, 1976; Bandura et al., 1977; P. A. Hall, 1993).

2.3 Results of the literature review

The results of the literature review with regard to the four questions are presented below.

2.3.1 How is learning defined?

The governance **of adaptation literature** refers mostly to social learning (Baird et al., 2014; Blackmore, 2014; Ison et al., 2015; McCrum et al., 2009; Nuorteva et al., 2010; Shaw et al., 2014; B Siebenhüner et al., 2016; van der Wal et al., 2014) and policy and institutional learning (Huntjens et al., 2011; Rojas et al., 2009; Steele et al., 2014; Thapa et al., 2016). Studies in this category have definitions with a clear emphasis on issues of collective action addressing environmental problems and challenges. In addition, a group of authors relate learning to questions of adaptive governance (Ison et al., 2015; Lynch and Brunner, 2010; Vella et al., 2015) and resilience (Nuorteva et al., 2010). A considerable number of the studies describe learning processes as occurring at the interface between knowledge domains or as a strategy that facilitates knowledge transfer and replication at different levels, without defining and describing it explicitly (e.g. Button et al., 2013; Jabeen et al., 2010; Kashyap, 2004; Silver et al., 2013).

Social learning is frequently defined as a convergent change in stakeholders' perspectives on a particular problem and its possible solutions in light of both their own and other stakeholders' views, interests, and positions with regard to the problem. Such social learning

achieves a change in understanding that goes beyond the individual toward collectives and social networks.

Some studies describe how social learning creates the basis for integrated solutions that require collective support and/or concerted action by multiple stakeholders (Baird et al., 2014; Huntjens et al., 2011; McCrum et al., 2009). McCrum et al. (2009) show that social learning emerges from knowledge exchange and recognize that knowledge is contested, socially constructed, and used in specific contexts. Social learning challenges all actors to consider alternative perspectives, making learning a dynamic and transformative process. Social learning is defined by McCrum et al. (2009) as a form of collective reflection and action to improve the management of human and environmental interrelations.

Some authors recognize that climate change adaptation requires not only the active participation of multiple stakeholders – including state and non-state actors – but also changes in governance approaches toward governance structures and dynamics that enable learning and transformation (Lynch et al., 2010; van der Wal et al., 2014). Van der Wal et al. (2014) draw on the discussion on social learning, highlighting its potential role as a governance mechanism in natural resource management. Nuorteva et al. (2010) see learning linked to the resilience of socio-ecological systems, arguing that, compared to ecological resilience, the resilience of social systems has an additional capacity to foresee and adapt to possible changes, and it is therefore defined as the degree to which a system is capable of learning and adopting new solutions.

Policy learning is another concept evoked by some authors in the reviewed governance of adaptation literature (Huntjens et al., 2011; Janjua et al., 2010; Rojas et al., 2009; Steele et al., 2014). The policy learning concept is used by various authors in the field of public administration and involves the learning process linked to policy. Policy learning, as described in the literature reviewed, generally refers to states as having the capacity to learn from their experiences and modify their actions on the basis of their evaluation of the impact of previous actions. The nature of policy changes varies from new and innovative policies to continuous refinements of past policies.

Changes in policies can reflect learning taking place at the level of formal institutions and governments. Rojas et al. (2009) suggest a process by which lessons from past policies can be integrated into decision-making processes to enhance management and governance. Huntjens et al. (2011) favour organizational learning approaches and apply the concept of double- and triple-loop learning to distinguish different levels of policy learning taking place

in governance of adaptation processes. Steele et al. (2014) draw on new institutionalism approaches as a theoretical lens for understanding and learning from complex questions, such as why particular governance agendas emerge, how they form, how they become mobilized and translated into action, including the role of key actors and collaborative networks in these processes.

The **multi-level governance literature** that addresses learning contains a considerable number of publications concerning the policymaking process. They draw on organizational, policy, and social learning definitions and frameworks and address questions of policy implementation and evaluation (Benz, 2012; Borowski et al., 2008; Kerber and Eckardt, 2007; Paraskevopoulos et al., 2004).

The studies refer to policy learning as a mechanism to address typical questions of public administration, such as maintaining institutional memory (Getimis, 2003), facilitating the adoption and transfer of policies (Benson et al., 2012), or facilitating the adoption of new rules (Paraskevopoulos and Leonardi 2004). Policy learning is also described as a process of collective action, with actors inventing new solutions and changing their policies accordingly (Benz, 2012). Mutual learning is described as taking place when policymakers learn by exchanging information and experiences across the borders of their jurisdiction and between different governance levels (Kerber and Eckardt, 2007).

Social learning is also of interest to multi-level governance scholars. Paraskevopoulos and Leonardi (2004) see the process of social learning as a fundamental mechanism of domestic change in which networks and informal institutions act as mediating mechanisms affecting actors' preferences and appropriation, leading to the reconceptualization of their interests and identities and thus facilitating learning and socialization processes. Social learning is also perceived as a factor of environmental governance, in particular the governance of wicked problems (Löf, 2010; Gerlak and Heikkila, 2011; Pahl-Wostl et al., 2013; Johannessen and Hahn, 2013; Reed et al., 2014). In this context, learning is perceived as a necessary factor in the governance of resilience and adaptive capacity (e.g. Löf, 2010). The literature recognizes the need for governance systems that allow for better integration of different stakeholder views and enable the collective action needed to address environmental challenges. As in the governance of adaptation literature, the concepts of double- and triple-loop learning are adopted in order to describe the levels and depth of such learning (Johannessen and Hahn, 2013; Löf, 2010; Paraskevopoulos et al., 2004; Yuthas et al., 2004).

In the small sample of **literature that integrates governance of adaptation and multi-level governance**, learning is perceived as an interactive process, with Dieleman (2013) applying the experiential learning cycle (Fry and Kolb, 1979); Pelling et al. (2008) highlighting the interplay of institutions and social learning at different governance levels to define policies and build institutions aimed at responding effectively to the challenges of climate change; Leys and Vanclay (2011) describing the dynamic of social learning as a factor of adaptive co-management; and Pahl-Wostl (2009) developing a conceptual framework addressing the dynamics and adaptive capacity of resource governance regimes as multi-level learning processes.

2.3.2 Operationalize, assess, and measure learning

The **governance of adaptation literature** recognizes the difficulties of establishing a common ground of definitions to operationalize and measure learning (e.g. Baird et al.,2014). Furthermore, only a few authors in the sample describe means to operationalize learning, and the approaches are rather divergent (see Table S2.2 in Supplementary Materials for keyword references). Authors tend to identify and describe the learning process and look at the outcomes of such processes in terms of change and transformation at the level of individuals, communities, institutions, and the governance of collectives.

The triple-loop concept is highlighted as an entry to assess and operationalize learning (Pahl-Wostl, 2009; Huntjens et al., 2011; Baird et al., 2014; Siebenhüner et al.,2016) because it highlights different levels of learning, reflected in the type and depth of institutional change, which can serve as an indication of the depth of learning. Authors organize the assessments into various frameworks of typologies, indicators, and tools for assessing different levels of policy learning.

Baird et al. (2014) differentiate between cognitive, normative, and relational learning to assess and measure learning. The authors apply a mixed-methods approach with a focus on quantitative measures, including concept map analysis, social network analysis, and self-reflective questions to gauge indicators for these three types of learning.

Van der Wal et al. (2014) use changes in the convergence of stakeholder perspectives over time to describe and measure learning. The method, based on cultural theory (e.g. Thompson et al., 1990) integrates a set of scoring tables for measuring the convergence of points of view. This type of learning is well described and provides quantitative and visual reports.

Adopting new institutionalism (Connor and Dovers, 2004), Steele et al. (2014) apply an institutional learning framework covering different levels of institutional analysis, including the evolution of problem-solving strategies that encompass problem reframing, reorganization of government through the integration of policy and practice, and the transformative change that arises from the implementation of given policies. Rantala et al. (2014) rely on social network mapping that might change over time to represent relational changes in information sharing among key stakeholders.

An emphasis on policy success, effectiveness, and knowledge transfer characterizes the approaches to measuring learning in the **multi-level governance literature**. Many authors describe the learning process and provide indications of multi-level learning occurring in such processes and the key outcomes of such processes at the level of individuals, collectives, policy, or institutions. Learning occurring across and between scales and governance levels is addressed by looking at learning aggregations – how learning is embedded in social and organizational practices and routines or becomes formally implemented and institutionalized (e.g. Gerlak and Heikkila, 2011). Aranguren et al. (2010) argue that learning and lessons extracted from success stories are a good way to assess the outcomes of learning and innovation.

Nevertheless, there is no unified agreement on how to operationalize learning in the publications reviewed, and the suggested frameworks draw on diverse theoretical backgrounds. (Axelsson et al., 2013) suggest an analytical framework to assess learning that proposes five criteria, including ownership, stakeholder participation, the processes leading to explicit knowledge, observable results, and networks. To address governance and policy formulation problems, Schout (2009) suggests a framework to position organizational learning in the context of governance learning in the EU's multi-level administration. The framework differentiates between three interrelated categories – organizational learning, instrumental learning, and governance learning – to analyze positive or desired changes by policy implementation. Drawing on experience with communities of practice, Reed et al. (2014) describe key elements that encourage learning leading to concerted action. These elements include: the convergence of goals, criteria, and knowledge, leading to more accurate mutual expectations and building trust and respect in relations; co-creation of knowledge needed to understand issues and practices; and/or a change in practices, norms, and procedures arising from the development of a mutual understanding of issues.

Analogous to the governance of adaptation literature, the multi-level governance literature frequently adopts the single-, double-, and triple-loop learning concept (Löf, 2010; Pahl-Wostl et al., 2013; Johannessen and Hahn, 2013). Pahl Wostl et al. (2013) develop a management and transition framework for an operational characterization of learning in case studies over time. The framework builds on action situations defined at a level of aggregation of social processes, building a framework for system assessments of learning taking place in management and policy processes.

The **literature that integrates climate change adaptation and multi-level governance** also draws on multiple-loop learning as a conceptual framework. Pahl-Wostl (2009, 359–360) proposes a list of operational indicators of change processes.

2.3.3 Learning processes and strategies

The **governance of adaptation literature** describes learning processes at the interface between different knowledge domains (Reid, 2016), drawing lessons from experience in facilitating policy advocacy and peer learning (Jabeen et al., 2010; Kashyap, 2004; Nuorteva et al., 2010; Rojas et al., 2009) and as a social learning process that can be initiated by platforms, communities of practice, and deliberative workshops.

For Nuorteva et al. (2010), people's capacity to cope with extreme events is enhanced by experiencing extreme events in the past. Valuable lessons for climate adaptation with regard to agency can be extracted from successful experiences in the arena of water governance, where local stakeholders and governmental agencies have been coping with climate variability and extreme events (Kashyap, 2004). The experiences of the Cities and Climate Change Initiative (CCCI) promoted by UN-HABITAT in Asia (Button et al., 2013) and in West Africa (Silver et al., 2013) are good examples of learning and knowledge transfer among cities and municipal governments. A typology of cities facing similar challenges and solutions can help to organize and transfer knowledge among policymakers and communities, contributing to peer learning and policy implementation (e.g. Button et al., 2013; Silver et al., 2013).

Social learning processes are perceived as deliberative to enhance stakeholder covenants, reduce risk of social conflict, and enhance dialogue; learning platforms and stakeholder gatherings are encouraged to facilitate learning (e.g. McCrum et al., 2009; Button et al., 2013; Rantala et al., 2014).

The **multi-level governance literature** describes similar strategies of learning from past experiences, peer learning, and mutual learning strategies for policy transfer (Benson et al., 2012; Getimis, 2003; Gleeson, 2003; Hogl, 2002; Kerber et al., 2007; Klein, 2010; Metz et al., 2014) including learning from practice (Perrier et al., 2015). For example, Benson et al. (2012) draw on international comparative studies to better understand means for civil society participation. Central in this literature is policy transfer through lessons extracted, defined as a detailed cause-and-effect description of a set of actions that government can consider in the light of experience elsewhere. Various policymaking procedures applied in the context of multi-level governance in the EU and elsewhere for the implementation and transfer of policies are reviewed and analysed (Gleeson, 2003; Kerber et al., 2007; Maurel, 2008; Sabel et al., 2008; van Wijk et al., 2014) analyse and discuss the transferability of 'best policies' recognizing the limitations of benchmarking and 'best policies' for straightforward policy transfer. In this context, the concept of 'thin learning' is used when actors simply 'learn how to apply' a particular policy in place, and 'thick learning' when actors become increasingly aware of different approaches elsewhere or of their own practices and therefore change their policy orientations. Mutual learning, embodied in two-way exchanges of information, benefiting both partners and based on complementary professional backgrounds is considered a critical dimension of successful partnerships (van Ewijk et al., 2015; Zanon, 2010).

Learning is considered key for innovation systems in this literature, understood as clusters and networks of organizations, public agents, and private firms collaborating in pursuing innovation and competitiveness (Aranguren et al., 2010; Bradford et al., 2013; Clar et al., 2014; Mattes et al., 2015; van Ewijk et al., 2015). These networks, which may or may not be encouraged by regional policy, can include, among others, firms, universities, laboratories, business incubators, science and industrial parks, and venture capital providers to build a system that generates new ideas about products, processes, organization, and markets. Much of the literature focuses on region-wide networking where cooperation and innovation are stimulated. Regional development policy offers an interesting interplay between the spatial distribution of economic activity and the interaction of key stakeholders across multiple governance levels. In the case of regional development policies (e.g. Paraskevopoulos and Leonardi, 2004; Benz, 2012; Bradford and Wolfe, 2013), knowledge mobilization and innovation take various forms, including state agency partnerships with prominent think-tanks that report on region-specific trends and priorities, working with

educational institutions to promote youth entrepreneurship and scientific learning, and positioning regional firms in the global marketplace through the development of community-based strategic plans and international benchmarking of economic performance (van Gerven et al., 2014).

2.3.4 Factors that foster or inhibit learning

Both literature strands address and describe factors that hamper, initiate, foster, and also, to some extent, facilitate higher levels of double- and triple-loop learning.

Factors described in **governance of adaptation** research usually relate to the gaps, barriers, and policy approaches that hamper the flow of knowledge and information and constrain the open dialogue among key stakeholders that facilitate social learning. Baird et al. (2014) argue that governance provides a structure based on tradition and processes for determining how power and responsibility are exercised. In addition, the level of integration or fragmentation of the actors in an organization or a social network, as well as the complexity and differentiation of actors and roles, shape the way actors share and disseminate information and knowledge.

Different authors suggest diverse options to remove barriers or further enhance social and policy learning. Rojas et al. (2009) stress the importance of identifying and involving relevant stakeholders in key research stages and decision making such as designing, implementing, planning, and evaluation. However, because of stakeholders' power differentials and diverse interests, this is not straightforward. These authors observe that conflict itself can trigger attitudinal change among stakeholders and be a source of institutional learning, if lessons and experiences are well incorporated into decision making and conflict resolution.

Lynch and Brunner (2010) observe that communities coping with El Niño 1997/98 achieved remarkable learning by putting in place institutional arrangements that ensure the integration of top-down and bottom-up approaches, including the decentralization of decision-making processes. In such settings, learning is encouraged if stakeholders have an open and collaborative predisposition.

Several authors underscore the need for better integrated cooperation structures, characterized by the inclusion of non-governmental stakeholders and governments from different sectors and hierarchical levels to produce and share information needed for

learning. Jabeen et al. (2010) see the need to articulate spontaneous and planned adaptation to better include grassroots experience, knowledge, and coping capacities in governance of adaptation and planning processes, thus encouraging learning.

Huntjens et al. (2011) conclude that better integrated cooperation structures and advanced information management are the key factors leading to higher levels of policy learning in river basin management. They found that advanced information management, characterized by joint/participative information production, a commitment to dealing with uncertainties, broad communication between stakeholders, open and shared information sources, and flexibility and openness to experimentation constitute a prerequisite for facilitating learning processes, building trust, and supporting cooperation.

In the **multi-level governance literature**, Gerlak and Heikkila (2011) conclude that the factors that most influence the types of learning and knowledge mobilization that takes place are the design and structure of institutional arrangements, the dynamic of the social network, and the technological and functional domains of collective settings. The design or structure of institutional arrangements is widely recognized as playing a role in fostering learning, as well as inhibiting or hampering it (Benson et al., 2012; Mah and Hills, 2014). The nature of governance might determine the way institutions and formal and informal networks are formed (Getimis, 2003), and denser institutional environments exert more powerful constraints on the transfer of lessons and learning (Benson et al., 2012). Mismatches in coordination between different governance levels and across scales and the related need for vertical integration to ensure knowledge flows and policy learning are underscored (e.g. Aranguren et al., 2010; Pahl-Wostl et al., 2013).

In relation to policy learning, Benson et al. (2012) note how political factors strongly affect the way lessons are drawn and transformed into public policy. Political systems must consequently possess "the political, bureaucratic and economic resources to implement the policy" (Dolowitz and Marsh 1996, 354, quoted in Benson et al., 2012, 47). Another structural factor stressed by Benson et al. (2012) is the role of political ideologies, political values, or 'culture'. Ideological consistencies between countries can be a significant factor for the possibility of cross-country policy learning, as policies appear to transfer more easily between similar political systems and like-minded actors.

The dynamic of the social network determines the frequency and intensity of interactions among individual members and their ability to trust one another and accept new ideas (e.g. Gerlak and Heikkila, 2011; Reed et al., 2014). The influence and power of individual leaders

or prominent organizations is recognized as relevant for sharing information and knowledge, providing orientations, and shaping the organizational values that frame the acquisition of knowledge and learning; but informal institutions and shadow networks are also effective in integrating different kinds of knowledge and bridging different levels, local to national, and influencing the policy process (e.g. Pahl-Wostl et al., 2013).

The structure and the dynamics of the social network are also highlighted in multi-level governance research addressing innovation systems (e.g. Bradford et al., 2013; Clar and Sautter, 2014). The literature argues for more systemic and integrative approaches where learning is encouraged by regional development policies to integrate firm-level support or infrastructure investments in wider networks to trigger growth or development by leveraging knowledge, talent, and entrepreneurship. In addition, incentives created by competition such as yardstick competition, benchmarking, and the systematization of 'best policy frameworks' motivate participants to improve policies. Competition is claimed to contribute to learning because it creates new information and experience in a continuous process of experimentation by competing actors (Kerber and Eckardt 2007; Benz 2012).

The role of bridging organizations is also stressed by various authors (Johannessen and Hahn, 2013; Reed et al., 2014), for its facilitation and mediation role to connect local and regional collaboratives in the multi-level natural resource governance structure. Bridging organizations act as intermediaries to support networking and cooperation and can assume organizational responsibilities to provide relief for local participants who are generally time constrained.

In addition, factors from the technological and functional domain, such as the procedures and tools to gather and share information, as well as access to communication and information, may determine the ability of a collective to learn. Some authors recognize the importance of reliable information (Johannessen and Hahn, 2013). Changes in the social, political, economic, or environmental context might also trigger learning (Gerlak and Heikkila, 2011).

The literature also recognizes that exogenous perturbations can be necessary at times to ignite learning by changing the collective's goals, values, and assumptions. External information can possess a certain level of uncertainty and ambiguity and therefore test the capacity to learn. Pahl-Wostl et al. (2013) describe how disasters, such as extreme floods, can give rise to public debate and trigger policy responses. At the same time, those disasters

reframe policy reflections on the appropriateness of policy and management approaches, challenge the appropriateness of past policies, and produce deeper transformations.

The reviewed **studies that integrate multi-level and governance of adaptation** (matching both selection criteria) highlight the following elements. Pahl-Wostl (2009), drawing on comparative analyses, identified integrated cooperation structures (including non-governmental stakeholders, governments from different sectors and different hierarchical levels) and advanced information management (including joint/participative information production, consideration of uncertainties, and broad communication) as the key factors leading to higher levels of social and policy learning.

The identification and coordination of state and non-state actors are underpinned as critical to enhance and foster learning (e.g. Pelling et al., 2008; Pahl-Wostl, 2009; Leys and Vanclay, 2011; Huntjens et al., 2011). Networks are largely governed by informal institutions, and both state and non-state actors may participate. The informality and high flexibility in membership makes networks very interesting for processes of learning and change (Blackmore et al., 2016; Pahl-Wostl, 2009; Pelling et al., 2008; van Bommel et al., 2016). In particular, informal networks may be very flexible in terms of membership and the role and power of actors and connections. They support learning by providing access to new kinds of knowledge and by supporting multiple ways of interpretation. Table 2.2 provides a summary of the major themes emerging from the literature review.

Table 2.2 Major themes in the reviewed literature

Literature subset	Learning definitions	Methods to operationalize and measure learning	Learning processes and strategies	Factors that foster (+) or inhibit (-) learning
Governance of adaptation	Social learning enhances adaptive capacity and resilience in governance settings Higher levels of policy learning encouraged	Different typologies and frameworks to operationalize social learning Loop learning indicators to assess higher levels of social and policy learning	Peer learning Bottom-up/top-down dialogue Science–traditional knowledge interfaces Knowledge sharing Social learning facilitated	Cooperation structures (+) Power relations (-) Participation of formal and informal actors (+) Information management (+) Structure of the social network (+/-)
Multi-level governance	Policy learning enhances the effectiveness, success, and transferability of policies Social learning enhances the quality of policies	Institutional and policy learning addressed Success in the transferability of policies assessed Methods for lessons extraction and transfer Loop learning frameworks	Testing policies Policy transfer and replication Evaluation of the factors that contribute to policy success and failure Triple helix (state–academy–industry) interactions for innovation Regional policy for innovation clusters	Institutions not designed to learn (-) Facilitation and bridging organizations (+) Benchmarking and yardstick competition (+) Vertical coordination (+) Political context (+/-) Innovation environments (+)
Intersection governance of adaptation and multi-level governance	Multi-level learning for the governance of climate adaptation	Experiential learning frameworks Loop learning operational indicators	Experiential learning cycle Loop learning lens is used to describe and map governance case studies	Cooperation structures (+) Shadow networks ignite new ideas and learning (+) Undesired situations e.g. disasters might trigger higher levels of policy learning (+) Information management (+)

2.4 Conceptualizing multi-level learning in the context of climate change governance of adaptation

Returning to the objective of this review – to identify promising directions to conceptualize learning in multi-level governance of adaptation, building on the definitions, methods, processes, and factors assessed in both the multi-level and the governance of adaptation literature – we identify the following key elements.

2.4.1 Defining multi-level learning

In relation to defining multi-level learning in governance of adaptation, we extract the following elements. In the literature on governance of adaptation, emphasis is placed on learning from stakeholder interactions and deliberation at different levels. The focus is on understanding how climate impacts and risks are distributed and how they are handled by different stakeholders with different backgrounds and interests. The assumed goal is to establish a set of rules and institutions to anticipate and deal with such potential impacts (e.g. McCrum et al.,2009; Huntjens et al.,2011; van der Wal et al.,2014).

In contrast, the multi-level governance literature addresses questions of public policy definition, implementation, and transfer, often through mutual learning in international and federal settings (Getimis, 2003; Hogl, 2002; Kerber and Eckardt, 2007). The assumed goal here is to ensure effective coordination between and across governance levels.

For the purpose of further research in the arena of governance of adaptation, defining multi-level learning could build on the definitions of policy learning (e.g. Sabatier, 1998; Bennett and Howlett, 1992) and social learning (e.g. Reed et al.,2010) with a focus on cognitive, normative, and relational learning (Baird et al.,2014) between different governance levels. In the context of governance of adaptation, multi-level learning by individuals and institutions at a certain level of governance can be understood in its cognitive, normative, and/or relational dimensions, as the result of interactions between individuals and institutions from different governance levels on policy-relevant aspects of adaptation to climate change. The assumed goal here is to enhance the capacity of individuals and collectives to respond to the challenges posed by climate change.

2.4.2 Methods for assessing multi-level learning

The multi-level and the governance of adaptation literature recognize the lack of consensus, the constraints, and the gaps in the operationalization of multi-level social and policy learning. Despite the diversity of perspectives and potential entry points, we favour a more systemic approach to the operationalization of multi-level learning in further research, reviewing and assessing the process, performance, capacity, and outcomes of a given governance of adaptation system (e.g. Gerlak and Heikkila 2011; Huntjens et al.2011; Pahl-Wostl et al. 2013), underlining the interplay of policy and social learning across governance levels. We would favour qualitative and comparative analysis, based on semi-structured interviews and document and network analysis, to assess relevant multi-level learning processes and outcomes, and to capture the interaction and convergence over time of stakeholder perspectives in particular knowledge and practice domains. In a similar approach to that of Baird et al. (2014), changes in the cognitive, normative, and relational domains of multi-level learning could be assessed on the basis of a set of indicators and metrics that change over time. In addition, a diversity of approaches and methods could be applied to assess convergence of views among different governance actors, including e.g. cultural theory approaches (e.g. Van der Wal et al., 2014), Q sorting (Raadgever et al., 2008), and discursive approaches for the analysis of documents, focusing on the way in which particular issues or problems are defined, constructed, and framed (e.g. Steele et al.,2014).

2.4.3 Processes of multi-level learning

Both literature branches highlight usual processes of multi-level learning: social learning results from social interactions, and various forms of social and policy learning emerge from the comparison, adoption, and dissemination of policies; and lessons among key stakeholders, peer learning, and learning from other knowledge domains are fundamental learning strategies. However, multi-level learning can also be seen rather as a reflective process of change and transformation (e.g. Huntjens et al.2011; Pahl-Wostl et al.2013; Dieleman, 2013). Effective governance of adaptation can be enhanced by taking stock of actions and experience; reflexive action has been highlighted as a central mechanism of adaptive governance (Boyd et al., 2010; Ison et al., 2015) and experiential learning (e.g. Dieleman, 2013; Fry and Kolb, 1979). If this happens as a facilitated, conscious learning cycle, as a result of stakeholder interactions between different levels of governance, it can

be an important process of multi-level learning (e.g. Huntjens et al.2011; Pahl-Wostl et al.2013).

2.4.4 Factors fostering or inhibiting multi-level learning

Factors that foster or inhibit multi-level learning in the governance of adaptation can reside within the structure and dynamics of governance systems, for example, power and legitimacy relations and the inclusion or exclusion of informal groups. The existence of a supportive and learning-friendly institutional environment can also play an important role, including the existence of policy instruments that encourage multi-level learning, the role of cross-level facilitating organizations, or the instauration of reflexive functions across levels.

In addition, and particularly relevant for governance of adaptation, uncertainty and the potential for unexpected changes in the climate system will test the internal capacity and learning ability of multi-level governance systems, thus triggering the role of challenging situations as focusing events to ignite multi-level learning in governance of adaptation.

2.5 Conclusions

The literature reviewed in the two strands – multi-level governance and climate change governance of adaptation – shows that learning has been considered in the context of climate adaptation and, more recently, in the context of governance of adaptation. However, still only very few scholars address learning in combination with questions of governance of adaptation, and only a limited number in relation to multi-level governance. Despite the growing interest, several researchers have raised critical questions about the state of scholarship emerging at the nexus of learning and governance of adaptation (e.g. Gerlak and Heikkila 2011; Pahl-Wostl et al. 2013; Baird et al. 2014). This literature review contributes to developing a conceptual framework for better understanding multi-level learning in relation to the governance of adaptation, providing an overview of the state-of-the-art of methods to operationalize adaptation learning between governance levels, and identifying promising pathways to encourage and facilitate learning in the context of the governance of adaptation.

Addressing the intersections between these two literature strands is relevant for tackling multi-level governance questions emerging in a global climate adaptation regime. In addition, this research arena would benefit from looking more closely at, and better

integrating, the results and models of the literature on policy and social learning. A 'learning lens' is needed to guide international multi-level governance of adaptation and policy processes, including the design of global and national institutions that encompass mechanisms for capacity building, technology transfer, and reflection on experiences across governance levels.

CHAPTER

3

How does the UNFCCC enable multi-level learning for the governance of adaptation?

Abstract:

Adaptation has become a priority in global climate change governance since the adoption of the Cancun Adaptation Framework and the Paris Agreement. Adaptation to climate change has been increasingly recognized as a multi-level governance challenge in both the United Nations Framework Climate Change Convention (UNFCCC) regime and academic literature. This recognition often includes, explicitly or implicitly, the role that learning can play across governance levels to accelerate and scale up responses to address adaptation challenges. However, there is no comprehensive assessment in academic literature of how multi-level learning has been considered in the UNFCCC regime, what the enabling factors are, and the outcomes of such learning. Drawing on approaches suggested by multi-level governance and learning literature, this paper seeks to fill this knowledge gap by focusing on the ways in which the UNFCCC multilateral process enables multi-level learning for the governance of adaptation and how it could be enhanced. This will be accomplished through a legal-technical analysis of the enabling factors of multi-level learning in the governance of adaptation under the UNFCCC. Qualitative research methods have been applied for the thematic analysis of selected documentation, complemented by interviews and personal observations of adaptation negotiations in the UNFCCC and the Paris Agreement. Results are presented according to three research questions oriented to understand how institutional design of adaptation under the UNFCCC enables multi-level learning; the learning strategies adopted across levels of governance; and the way the UNFCCC regime understands the contribution of multi-level learning for adaptation outcomes.

3.1. Introduction

The Intergovernmental Panel on Climate Change (IPCC) has repeatedly stressed the need to accelerate the depth and breadth of the global response to climate change across scales and levels of governance (e.g. de Coninck et al., 2018; Pörtner et al., 2022). The adaptation response requires not only the scaling up of technological measures, but also the development, testing, and transference of adequate policy measures across countries and the creation of economic and social conditions to enable change and transformation (Pauw et al., 2020).

Despite an initial emphasis on mitigation, adaptation has become central in the United Nations Framework Climate Change Convention (UNFCCC) process, and it has received an increasingly prominent position in the evolution of the international climate regime. The Cancun Adaptation Framework (CAF), adopted under the UNFCCC in 2010, and the Paris Agreement, adopted in 2015, established the institutional framework for enhanced ambition on adaptation worldwide. The Paris Agreement took another significant step forward in making adaptation an equal priority with mitigation, calling for stronger adaptation commitments from states and assessing progress periodically as part of the Paris Agreement transparency framework, in addition to calling for more ambitious funding and technical assistance provided by the international community (Lesnikowski et al., 2017).

The multilateral adaptation regime that is emerging is built up of multiple parallel initiatives involving a range of actors at different governance levels determining climate change policy and actions (e.g. Böhmelt et al., 2014; Okereke et al., 2009), nevertheless, it remains strongly influenced by the UNFCCC mandate and process. Adaptation to climate change is a relatively recent policy domain across all countries and there is much to learn within and across countries on how to design and put in place effective policies and how to design governance. We therefore agree with scholars who consider learning to be an important component in the governance of climate change adaptation (henceforth the governance of adaptation). Learning is recognized for its role in contributing to enhanced understanding of the challenges posed by climate change and anticipating and adjusting the course of action (Pelling et al., 2008; Tschakert et al., 2010); accelerating and scaling up possible responses (Fünfgeld, 2015); for incorporating different views and perspectives, in particular from vulnerable groups (e.g. Jabeen et al., 2010; Naess, 2013); and as a key functionality of governance settings to enhance resilience and adaptive capacity (e.g. Pahl-Wostl, 2009; Bernd Siebenhüner, 2008).

3

The scholarly literature has also recognized the role of learning in the UNFCCC context, for example, to disseminate the results of science (Minx et al., 2017), as well as the need to reflect and learn about progress and how to overcome stagnation in the evolution of the global climate regime (Depledge, 2006; Gupta, 2016; Katharina Rietig, 2019). Furthermore, as described below, the UNFCCC process itself recognizes the importance of learning to promote adaptation.

Governance arrangements and institutions can enable learning (e.g. Collins et al., 2009; Hackmann, 2016; Bernd Siebenhüner, 2008), and there is a small but growing literature exploring the role of learning in process and institutional design for adaptation (Huntjens et al., 2012; Pahl-Wostl, 2009; Sandström et al., 2020).

While the contribution of multi-level learning to institutional and policy design for adaptation is underscored in the scholarly literature and an important set of adaptation rules are defined by the UNFCCC, there is no comprehensive assessment yet of how multi-level learning has been enabled by the UNFCCC regime, and how it can contribute to fulfilling its mandate and goals.

This paper seeks to address this knowledge gap by focusing on the ways in which the UNFCCC multilateral process enables multi-level learning for the governance of adaptation and how it could be enhanced. Our empirical assessment consists of, on the one hand, a comprehensive legal-technical analysis to identify enabling factors for multi-level learning based on a review of UNFCCC documents related to adaptation since the inception of the UNFCCC process. On the other hand, we analyse the drivers for enhanced multi-level learning within the governance system, and the adopted learning strategies. The research applies an analytical framework for the assessment of multi-level learning in the UNFCCC context, based on a review of academic literature and validated through the thematic analysis of UNFCCC documentation.

The paper is structured as follows. Section 3.2 presents the analytical framework to assess multi-level learning for the governance of adaptation and the research questions guiding this paper. In section 3.3, the methods used are described. The data and results are analysed in section 3.4, and in sections 3.5 and 3.6 we discuss this study's findings and contribution to multi-level learning in the governance of adaptation research and draw conclusions.

3.2. Presentation of the analytical framework

The notion of multi-level learning is linked to the conceptualization of multi-level governance (Hooghe & Marks, 2002), which illustrates the interplay and overlaps of different jurisdiction levels in the governance of a particular territory. In this context, the governance of adaptation has been increasingly recognized as a multi-level governance challenge (di Gregorio et al., 2019). Environmental and multi-level governance scholars have frequently argued that adaptation requires a variety of stakeholders to take actions and decisions across different governance levels (e.g. Armitage, 2008; Dewulf et al., 2015) and that institutional arrangements across levels, including the global and international levels, are key to delineating effective adaptation (Armitage, 2008; Vinke-de Kruijf et al., 2016).

Multi-level learning in the governance of adaptation implies that learning takes place not only within, but also across, different governance levels. We understand this type of learning as the interplay of policy learning (Hall, 1993; Sabatier, 1988) and social learning (Reed et al., 2010) processes happening across different governance levels on policy-relevant aspects of adaptation (Gonzales-Iwanciw et al., 2020).

The conceptualization of multi-level learning in the governance of adaptation as the interplay of social and policy learning leads to a focus on the interaction of different actors learning collectively and influencing the objectives and outcomes of the policy process. As stated by Sabatier (1988) different portions of the society or advocacy coalitions influence the policy agenda and their outcomes through their respective interests, capabilities, and belief systems.

The governance of adaptation literature when seeking to assess learning has focused on the factors likely to encourage or hamper learning processes and the outcomes of such learning (e.g. Armitage et al., 2018; Gerlak et al., 2011; Sabatier, 1988). Learning is tightly linked to the notion of change – incremental or transformational – to enhance performance or the ability to produce desired outcomes (Appelbaum et al., 1997; Henderson, 2002). Those changes are reflected as adjustments in the structure and functioning of the governance regime itself (e.g. Armitage et al., 2018; Pahl-Wostl, 2009).

Social learning outcomes are outlined by (Reed et al., 2010) through the following defining characteristics: change in understanding has taken place in the individuals involved; this change goes beyond the individual and involves wider social units including communities of practice; and change occurs through social interactions and processes among actors in a social network. The policy learning literature, on the other hand, discusses learning outcomes

mainly in terms of policy change and the performance of policy measures in addressing desired outcomes (Conzelmann, 1998; Sanderson, 2002). Policy learning is fostered by providing the incentives for enhanced policy performance, institutional design and functioning (Dovers et al., 2010; Sanderson, 2002); including enhanced capabilities for innovation (e.g. Capello et al., 2005; Tschakert et al., 2010).

Most of the factors likely to influence learning processes and outcomes fit within a social network's structure, its dynamics, functional domain, and exogenous factors or disturbances (Gerlak et al., 2011). Factors related to the structure are linked to the level of integration or fragmentation of the actors in an organization, the level of differentiation of actors' roles that encourage or hamper collaboration, information sharing, and the dissemination of learning and ideas (Vink et al., 2013). Factors linked to the dynamics of the social network result from the frequency and intensity of actors' interactions, the facilitative role of leadership, and the social demands and needs that shape a learning culture (Armitage et al., 2018; Gerlak & Heikkila, 2019). In. Factors that fit in the functional domain – for example, as information and communication technologies become available – change how critical information and knowledge is stored, processed, and shared, supporting and reshaping the learning culture. In addition, both the social and the policy learning literature recognize the role of exogenous perturbations, such as economic crises or climate-related impacts, altering social structures and dynamics, in ways that could promote learning.
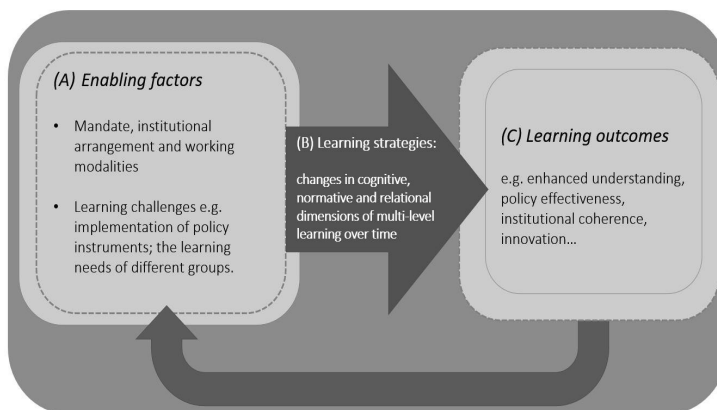
Figure 3.1 Analytical framework of multi-level learning in the governance of adaptation

The visualization describes an analytical framework for the process of multi-level learning: (A) the enabling factors that influence the process including the mandate and institutional arrangements across governance levels and adopted working modalities; and learning challenges and needs of different groups (B) The learning strategies are assessed through changes in their cognitive, normative, and relational dimensions (C) The learning outcomes of the process are coded and analysed through the review process.

Based on this discussion, Figure 3.1 outlines the analytical framework applied for the empirical examination of adaptation related multi-level learning in the UNFCCC context. Mandate and institutional arrangements resulting from key decisions in the UNFCCC context build the fundamental structure that enables multi-level learning. Working modalities is another category of enabling factor for multilevel learning. These are well established in UNFCCC decisions, like institutionalized gatherings for sharing experiences and reporting, and largely define the dynamics of interactions between the actors.

The structure of institutional arrangements can be described as a network of multi-level learning nodes defined as institutionalized or informal arrangements of social and policy learning practices and routines occurring across governance levels (Gonzales-Iwanciw et al., 2021). Multi-level learning takes place within, but also across, those nodes through network interactions, for example, a task force that combines agents' knowledge and experience obtained at different governance levels through different institutionalized procedures. These nodes operate based on formal decisions from the UNFCCC or simply assume roles and functions informally depending on the demand of knowledge interactions and the dynamic of the social network.

We also consider as factors the learning needs and challenges of the general process of adaptation under the UNFCCC, and the learning needs of different negotiation groups resulting from the formal and informal interactions, for example - the information and knowledge needs to support adaptation in Small Island Development States (SIDS).

The learning strategies commonly used in the UNFCCC context across governance levels are assessed through potential changes in the cognitive, normative, and relational dimensions of multi-level learning (Baird et al., 2014; Huitema et al., 2010). Learning strategies produce learning outcomes such as changes and adjustments in the knowledge base, organizational structure, and functioning of the governance regime as part of the emerging learning culture (Newig et al., 2010; Siebenhüner, 2008).

3.2.1. Research objective and questions

This paper's objective is to better understand how the UNFCCC multilateral process, including the Paris Agreement, enables multi-level learning for the governance of adaptation and how it could be enhanced. The analysis of this is guided by the following questions:

- How does the institutional design of adaptation under the UNFCCC enable multi-level learning for the governance of adaptation?

- What learning strategies have been adopted and how they can contribute to multi-level learning in the governance of adaptation under the UNFCCC?

- How does the UNFCCC regime understand the contribution of multi-level learning for adaptation outcomes?

3.3. Methods applied

Qualitative research methods have been applied for the thematic analysis of UNFCCC documentation, complemented by interviews and personal observations of UNFCCC adaptation negotiations and the Paris Agreement. The study's timeframe covers 2001 to 2020, thus starting with the adoption of the Marrakesh accord that sparked the initiation of adaptation working plans in the UNFCCC context. This period is long enough to track relevant evolutions of multi-level learning and its enabling factors.

The analysis focuses on multi-level learning originating at the global level and linked to the UNFCCC multilateral process, such as processes conducted and followed up by UNFCCC bodies and expert groups. As further explained below, examining multi-level learning originating from the global process does not exclude learning taking place at other governance levels. Within the UNFCCC, the global and national levels are represented by default in a multi-level setting, given that the Parties are the constituencies of the UNFCCC process itself and the UNFCCC process has put in place the mechanism to learn from experiences acquired across different levels of governance.

Governance levels were defined in the following way: global (e.g., multilateral processes including UNFCCC); international (e.g., international organizations); regional (involving regional organizations and institutional arrangements, including geographic regions, e.g., the Andean region); national (e.g., national policy processes); and the local level, including local governments and communities.

Our research design with a focus on the global institutional setting, has certainly limitations for tracking multi-level learning in the governance of adaptation across levels of governance. First, we assume adaptation across levels of governance is still strongly defined by UNFCCC rules and orientations. In particular this omits important contextual information at local/national/regional levels that likely involve an even greater diversity of actors and networks. Furthermore, we cannot do a proper analysis of learning outcomes at the levels where they matter most – nationally and locally without more extensive field work at these levels.

3.3.1. The data

The primary data sample comprises 45 documents, and 6 interviews (Tables S3.1 and S3.2 in Supplementary materials) with key players at the multi-lateral level, selected though purposive sampling (Robinson, 2013) to complement the analysis with additional empirical data and personal notes of direct observations of UNFCCC negotiations and body meetings included in Table S3.3 in Supplementary materials. The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Documents for analysis were selected via systematic sampling methods (Koerber et al., 2008), this involves including backbone documents, but also being open to new leads that may emerge during the analysis and consolidating the sample through the saturation of additional qualitative information during the data coding process. The document sample includes key Conference of the Parties (COP) decisions; reports of the Subsidiary Body for Scientific and Technological Advice (SBSTA), the Subsidiary Body for Implementation (SBI), the Adaptation Committee (AC), and the Least Developed Countries Expert Group (LEG); international workshop proceedings; and other selected reports and data (see Table 3.1 for an overview and Table S3.1 in the Supplementary materials for the extensive list of reference documents).

Table 3.1 Document sample for the review of enabling conditions under the UNFCCC

a. COP decisions	COP decisions related to the LDC Work Programme (e.g., D5/CP.7); the NWP (D2/CP.11); the CAF (D1/CP.16); role and functions of the AC (D2/CP17); and the Paris Agreement (D1/CP.21); COP report serving as the meeting of the Parties to the Paris Agreement (CMA1)
b. Selected SBSTA and SBI reports	SBSTA reports (Agenda item 3 on the NWP); SBI reports (Agenda item 7 Matters relating to Article 4, paragraphs 8 and 9, of the Convention)
c. LEG Reports	Reports of the LEG
d. AC reports	Annual reports
e. Workshops and outreach events	Reports of the annual Focal Point Forum; NAP Expo and Adaptation Forum
f. Selected reports	Selected technical and synthesis reports of SBSTA, the LEG, and the AC
g. Personal observations	Report of the 18th AC meeting (Observers) and personal notes.

3.3.2. The analysis

The document analysis combines elements of content and thematic analysis (Fereday et al., 2006). The analytical framework was refined through an interactive hybrid process of inductive and deductive thematic analysis integrating data-driven codes with theory-driven codes. The theory provided the thick structure of the analytical framework, but not the specific terminology as this was adapted to better link to the multi-level learning process in the UNFCCC context. Thus, the resulting coding tree (see Table S3.4 in the Supplementary materials) maintains the analytical framework's key concepts and logic sequence but integrates additional categories resulting from inductive coding.

As learning is not a term frequently used in the reviewed documents, we have applied the wisdom hierarchy (Rowley, 2007) or DIKW model – data, information, knowledge, and wisdom – to identify learning categories and codes.

3.4. Results presented

The results are presented according to the three research questions and aligned with each element of the analytical framework.

3.4.1. Enabling factors

The structure of UNFCCC institutional arrangements on adaptation includes UNFCCC bodies like the COP and the subsidiary bodies – SBSTA and SBI; the UNFCCC Secretariat and the AC; various institutionalized groups of experts, alliances, and partnerships with organizations outside the Convention; established knowledge platforms and institutionalized

workshops and gatherings taking place at the global and regional levels and other arrangements oriented towards providing services for the dissemination of information and knowledge products (see Table S3.6 in the Supplementary materials).

Four COP decisions described below provide the backbone for adaptation under the Convention (see Table S3.5 in the Supplementary materials for a detailed description of these COP decisions), each of them having potential to enable multi-level learning.

The Least Developed Countries (LDC) work programme, adopted at COP 7 in 2001, was designed to address the special needs of LDCs regarding funding and technical assistance. The LDC work programme has served, among other things, to organize national capacities, international funds, and technical assistance for adaptation, including guidance for the application of National Adaptation Programmes of Action (NAPAs) in LDC countries facilitated by the LEG (D28/CP.7; D29/CP.7; LEG 35 para 3).

In 2006 SBSTA adopted the Nairobi Work Programme (NWP) on impacts, vulnerability, and adaptation to climate change at COP 11, as a five-year programme to enhance understanding, knowledge sharing, and collaboration on adaptation (D2/CP.11 ANNEX para 2) which are key enabling factors of multi-level learning. The NWP, after evaluation, received a renewed mandates under the CAF and the Paris Agreement. As described in more detail below, the NWP has engaged a broad range of organizations to contribute their knowledge and experiences to adaptation efforts worldwide, and thus to multi-level learning.

With the CAF (COP 16) and the Paris Agreement (COP 21), the UNFCCC established the guidance for countries to take on "enhanced actions and international cooperation on adaptation". The CAF states that Parties put in place the "institutional capacities and enabling environments for adaptation" (D1/CP.16 para.14 c). It invites all developing countries other than LDCs to put in place National Adaptation Plans (NAPs) and defines the functions of the AC and the LEG to promote, in a coherent manner, the implementation of adaptation and reporting progress to both subsidiary bodies yearly.

The Paris Agreement, for its part, put in place the Nationally Determined Contribution (NDC) as a central mechanism to make progress towards its goal (PA, Art. 2). With NDCs, countries are encouraged to establish adaptation priorities and means for implementation, considering the institutional capacities and enabling environments for adaptation put in place by the CAF. To guide the implementation of NDCs, at COP 24 in 2018, Parties agreed on a set of rules (the Katowice climate package) including the operation of a public adaptation-

efforts registry maintained by the secretariat and additional provisions for the AC and the LEG to enhance the coherence of the work on adaptation, including the institutional arrangements for finance, technology development, and transfer, and capacity building in line with their mandates (CMA.1, decisions 10/CMA.1 and 11/CMA.1).

Two important sets of modalities for adaptation were established in the NWP (D2/CP.11 Annex VI) and the Katowice climate package (CMA. 1). These include basic working modalities such as workshops and gatherings, expert groups, reporting modalities, submissions, and web-based repositories. The Katowice climate package, for its part, defines a set of rules guiding NDC implementation, including the reporting and registry of Parties' adaptation activities and the support provided to, and received by, Parties.

Analysing the UNFCCC mandate and institutional arrangements through a multi-level learning lens led to the identification of a network of multi-level learning nodes (see Figure 3.2) further described below.
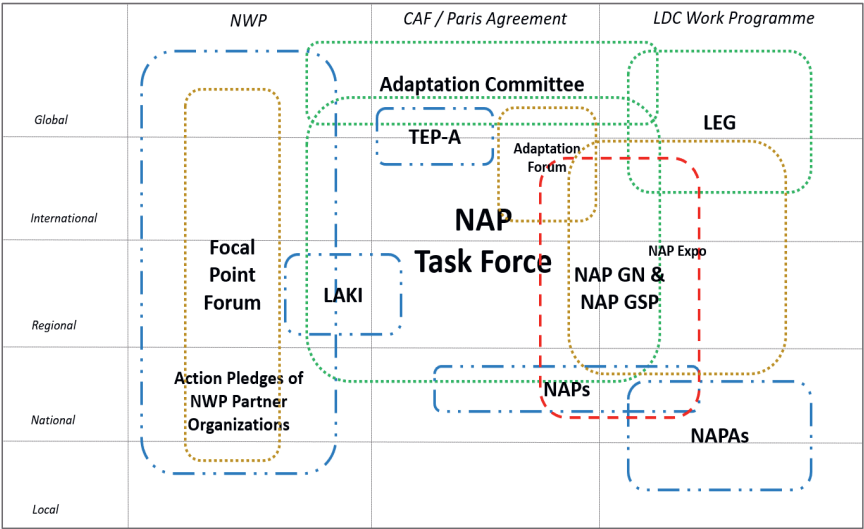
Figure 3.2 Multi-level learning nodes and networks - UNFCCC level

The figure captures multi-level learning nodes with a scope of several governance levels and relevance to different UNFCCC decisions. The overlaps of different dotted spaces denote networks and interactions. A short description of each of the institutional arrangements included in the figure and their respective acronym is listed in Table S3.6 in the Supplementary materials.

Multi-level learning has been enabled on one side through horizontal coordination, which has become more sophisticated with the deployment of the adaptation regime under the UNFCCC. Horizontal coordination was initially prompted by the interactions of the two subsidiary bodies SBSTA and SBI with SBSTA overseeing and conducting the adaptation

agenda under the NWP (SBSTA 25 para. 15), and SBI guiding the LEG and the LDC work programme to ensure that LDC countries' adaptation needs are adequately addressed. The SBSTA has also promoted coordination with other bodies and organizations under and outside the Convention – for example, introducing and disseminating the results of science to the NWP process in coordination with the IPCC – but also inviting other UN system bodies to introduce other important considerations and synergies into the NWP process (e.g., SBSTA 29, para. 85).

The LDC work programme itself is a node of multi-level learning (Figure 3.2) in which the experiences of LDCs and the LEG on the implementation of NAPAs across local, national, and global levels have been gathered. With the Paris Agreement, the LEG is expected to assume a more prominent role, disseminating the experiences gathered by the implementation of NAPAs in the new context of more widely adopted NAP implementation processes (Report LEG 2020 para. 11; AC-SB 39 para. 24–25).

The AC and the NAP task force (central in Figure 3.2) also form a multi-level learning node, putting in place the institutional arrangements and capacities for adaptation planning through NAPs and promoting and sharing experiences on adaptation across governance levels. The AC (D2/CP.17 para. 92–93) has become central in the coordination with relevant organizations at different governance levels, including with both subsidiary bodies by the identification of concrete opportunities for scaling up adaptation (D1/CP.21 para 124, 128).

The NAP task force has the potential to prompt multi-level learning through national implementation (AC-SB 47; AC-SB 47 para 51), technical assistance provided by NAP task force members and outreach events like NAP Expos. However, the empirical base around NAPs is still limited as stated by one of the interviewees. While the NAP mechanism was approved in 2010 in Cancun, financing was only available in 2016 once the GCF became operational, so the countries are only beginning to have very initial experiences with their NAPs (I4).

Another feature supported by the structure of mandates and institutional arrangements is cross-level interactions with the intention to encourage learning from Parties' and other stakeholders' experiences gathered from adaptation actions and policies across different levels of governance. The NWP (Figure 3.2 left) has triggered multi-level learning through action pledges proposed by partner organizations implemented at different governance levels and facilitated by active stakeholder engagement, established register procedures, and the

focal point forum oriented to learning from experiences generated in the context of the NWP (e.g., SBSTA 25 para. 17; SBSTA 28 para 13; SBSTA 30 para.13).

The catalytic role of the NWP for enhanced action on adaptation has been frequently underscored (e.g., SBSTA 29 para 14). For example, at the end of the first five-year period of the NWP, SBSTA recorded 136 NWP partner organizations and 84 submitted action pledges (SBSTA 30 para. 13). Three years later, the number had almost doubled to 265 NWP partner organizations and 175 action pledges (SBSTA 37 para. 13). The continuous engagement of different types of organizations, including underrepresented stakeholders such as indigenous groups (SBSTA 33 para. 15) has the potential to produce relational forms of multi-level learning. Nevertheless, as stated by an advocate interviewed - raising the voices of the most vulnerable are still high on the agenda of observer organizations (I1).

3.4.2. Learning Strategies

In the case of learning strategies, we identified eight categories included in Figure 3.3.
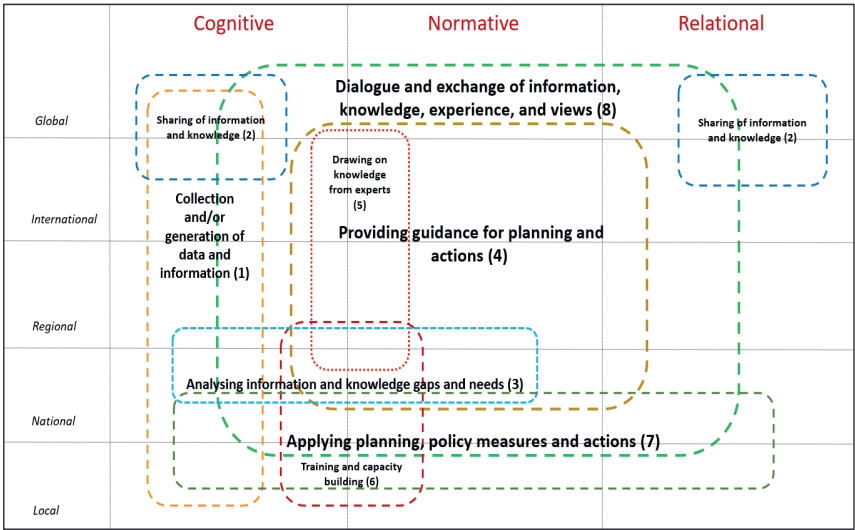
Figure 3.3 Learning strategies - UNFCCC level

This figure includes the eight (see numbering) learning strategies resulting from the coding of the data. The dotted lines schematically describe a space defined by the governance levels and the cognitive, normative, and relational dimensions of multi-level learning related to each learning strategy (one colour associated with one strategy).

Making relevant information available at different governance levels is a central learning strategy on adaptation in the UNFCCC such as the collection and generation of data and

information (1) on impacts, vulnerability, and adaptation (D2/CP.11 ANNEX para 2). Parties have often been encouraged to share relevant information (2) on impacts, vulnerability, and adaptation and to include that information in official reports and dissemination and public awareness efforts. The UNFCCC secretariat the Global Environmental Facility and other UN agencies, are often requested to compile and share relevant information to advise negotiations and decision-making at different governance levels. The interviewees recognize information and knowledge sharing as a central and continuous strategy applied to promote learning (e.g. I1, I6).

Analysing information and knowledge gaps and needs (3) is another strategy formally used at different governance levels. Parties are encouraged to report on gaps and needs concerning information, knowledge, and other means of implementation (e.g. LEG 35, pp.26-27). Regarding the learning needs of different groups, the Lima Adaptation Knowledge Initiative (LAKI) put in place regional dialogues with Parties and other stakeholders to identify knowledge barriers that impede the implementation and scaling up of adaptation action. A former AC member recognised the role of the NWP in gathering and sharing relevant information "however everybody sharing information in web repositories can produce an info-dump, there is a need of other strategies to encourage learning" (I6, 18'-19').

The UNFCCC bodies and other partner organizations are often requested to provide guidance (4) for putting in place concrete adaptation actions and better planning, monitoring, and evaluation of adaptation policy measures (e.g. Report LEG 2020). As stated by an international NGO interviewed - the learning challenges emerge by the adoption of different adaptation policy approaches (I5). Additional guidance and training is needed to facilitate the adoption of policy measures, those processes have often drawn on knowledge from groups of experts (5) in charge of compiling the best knowledge available, experiences, good practices, and lessons learned for preparing and refining guidelines, methods, and tools adjusted to national circumstances (e.g., PA Art. 2 para 2). In these cases, training activities (6) and validation with the engagement of different stakeholders across governance levels is a frequently used learning strategy.

The application of policy measures and actions (7) requires a set of cognitive, normative, and relational features and the engagement of different types of stakeholders, including the local communities and thus multi-level learning. Conducted activities to exchange knowledge, experiences, and views (8) are desired in formats that allow dialogue and mutual

learning across levels of governance, because such a process has the potential to better engage stakeholder participation and ownership.

More and more, there is a tacit recognition of the importance of local and indigenous knowledge, in addition to scientific knowledge, for applying and disseminating adaptation actions and good practices at the local and national levels, and engaging different views for policy design and scaling up solutions (D1/CP.16 para. 12). However, despite the recognition of the role of different types of knowledge, the data also signal remaining constraints, due to power asymmetries, and the lack of effective collaboration and mutual learning among the stakeholders. In the context of NAP′s, for example, training provided by international organizations at the national and local levels has been confronted with the limited appropriation, stewardship of national actors for more integrative approaches and policy alignment" (I5, 28').

3.4.3. Learning outcomes

The UNFCCC text repeatedly portrays expectations that information and knowledge sharing on adaptation will lead to a better understanding of the causes and risks of climate change. The NWP, for example, is formulated in terms of improving "their understanding and assessment of impacts, vulnerability, and adaptation" and making "informed decisions on practical adaptation actions and measures" (see D2/CP.11 ANNEX para 1). The LDC work programme also underscores similar expectations, calling for "research programmes on climate variability and climate change, oriented towards improving knowledge of the climate system" (D5/CP.7 para 7 vi).

At the end of the first phase of the NWP, Parties recognized progress on the first part of the work programme's objective, which focuses on improving understanding (and thus learning), but saw less progress in the NWP's second part: practical adaptation actions and measures (NWP Report 2008 para 16). The interviews underlined the fact that adaptation has become a priority in the last ten years and thus it is not surprising that adaptation has recently started to gain the needed momentum (e.g. I4, I6).

The scaling up of adaptation actions is another outcome that can be linked to multi-level learning. Parties have adopted the CAF's enhanced action on adaptation (e.g., D1/CP.16 para.12) and enhanced ambition (e.g. PA Art. 6 para 8a), referring to the scale of implementation needed for adaptation to be effective across different levels of governance.

It is interesting to note that the changes in the discourse and approach toward adaptation in UNFCCC have removed some of the barriers to multi-level learning. Scholars have, for example, referred to the COPs in Copenhagen and Cancun as game changing in the North-South relations (Freestone, 2010; Hourcade et al., 2015) , previous negotiations marked by strong divide among developed and developing countries, considered one of the major barriers to more open dialogue, multi-level collaboration, and learning (Depledge, 2006).

The CAF is the central instrument for promoting enhanced actions on adaptation, envisioned to be accomplished with a series of measures including the role and functions of the AC (D1/CP.16 para. 20) and the formulation of NAPs (D1/CP.16 para. 15–16). NAPs are oriented to facilitate policy replication through peer learning and technical assistance (AC-SB 41 para. 84). The interviews underscore the NAP process function as a learning vehicle putting in place additional capacities at the country level for fostering adaptation (e.g. I2, I5, I6). As explained by an officer of a multilateral fund - the NAP is oriented to build on adaptation capacities already in place at the country level and reinforce those capacities mainstreaming adaptation in priority sectors and territories (I3).

The design and functions of institutional arrangements are expected to play a significant role in ensuring the coherence and effectiveness of adaptation policies (e.g., D2/CP.11 ANNEX para 2 (a); D1/CP.21 para 125; AC-TP2014 p. 9) which is an important outcome of multi-level learning. The CAF and the Paris Agreement put additional emphasis on reinforcing the global governance of adaptation, including the institutional arrangements, funding, and technical assistance to conduct the process (D1/CP.16; PA art.7). A former AC member interviewed, states that there is "a need to enhance the coherence of different adaptation efforts, perceived as going in different directions, the CAF provided the orientation towards a more coherent process" (I6, 12'-13'). For example, the evaluation of implemented adaptation projects can trigger learning linked to the capacities needed for better planning of adaptation across sectors as stated by a multilateral fund officer interviewed: "One of the lessons learned by the fund is that in addition to the capacities needed to withstand the impacts of climate change funded by the projects, we can use the projects to build resilience - adaptation is rather cross-cutting integrated across different sector activities" (I2, 15´-17´).

Another expected outcome of multi-level learning identified in the data is the need to increase the capabilities for innovation about adaptation across different levels of governance. The reports of the AC recognize that innovation capabilities can be enhanced by "striving to reinforce the interface between science, policy, and practice…" (AC-SB 49

para. 55). This collaboration, between actors, across science, policy and practice, is expected to contribute to the "sharing of data between relevant actors, encourage policy learning related to best practices and common issues, and reallocate resources from operations and maintenance to innovation and addressing complex problems" (AC-TP2017 para 32). Other references stress that innovation capabilities can be enhanced by facilitating public-private partnerships, introducing corporate-driven R&D, and facilitating endogenous development of technologies through national innovation systems, using the existing channels for the dissemination of good practices.

3.5. Discussion

The objective of this paper is to understand how the UNFCCC enables multi-level learning for the governance of adaptation and how it could be enhanced. We chose to review the UNFCCC multilateral process of adaptation as an entry point to analyse multi-level learning in the governance of adaptation across levels of governance. The analysis carried out provides empirical evidence about the enabling factors for multi-level learning in the UNFCCC adaptation regime, the learning strategies adopted, and the way the UNFCCC regime understands the contribution of multi-level learning in relation to adaptation outcomes. Learning outcomes as expected by the UNFCCC are analysed according to criteria highlighted in social and policy learning literature as presented in section 3.2.

The paper describes multi-level learning originating at the global level and raises questions about its implications across other levels of governance. According to our data, there is a clear recognition in official documents and interviews about the importance of adaptation learning in the UNFCCC context, for example, the role of the NWP contribution to the understanding of the potential impacts of climate change beyond science involving different type of stakeholders across levels of governance, as well as the potential role of the NAP process triggering policy learning across levels of governance. Moreover, the same data shows the need for enhanced institutional coherence and effectiveness of the current adaptation regime to address its goals and fulfil its mandate.

Environmental governance and organizational learning scholars recognize multi-level learning as a key functionality of governance settings to enhance resilience and adaptive capacity (Gerlak et al., 2019; Pahl-Wostl, 2009; Siebenhüner, 2008). One of the central questions underscored by these scholars has been how to maximize, through institutional design, the adaptive capacity of human societies, bearing in mind likely but relatively

unknown impacts of global environmental change (Armitage, 2005; Huntjens et al., 2012). These scholars have also argued that the performance of the governance system in terms of adaptation is an indication of its resilience and adaptive capacity (e.g. Adger et al., 2005; Plummer & Armitage, 2010).

The analytical framework applied for this purpose resonates with a scholarly discussion about the factors and outcomes of learning in environmental governance settings (Armitage et al., 2018; Baird et al., 2014; Gerlak et al., 2011; Sanderson, 2002). Looking at the outcomes of the process brings us to the discussion about learning loops frequently mentioned in the learning literature (e.g. Pahl-Wostl, 2009, Gupta, 2016).

Our research fits within this broader discussion, the data gathered provide relevant examples of the potential adjustments needed at the level of institutional design in the international adaptation regime for enhancing multi-level learning, like for example further facilitating the opportunities of developing countries stakeholders and networks to learn from adaptation elsewhere; the importance to design multi-level learning to trigger catalytic transformation towards enhanced resilience and the scaling up of adaptation across levels of governance; and the roll of multi-level learning in planning and evaluating adaptation across levels of governance.

3.6. Conclusions

Given the objective and questions of this research, one central conclusion is that analysing the enabling factors and outcomes of multi-level learning is a good entry point for understanding the potential, orientation, and learning loops of such learning as suggested by the concerned literature (e.g. Pahl-Wostl, 2009, Armitage et al., 2018). The three elements of our analytical framework i.e. enabling factors and drivers, learning strategies and learning outcomes provide a comprehensive picture of multi-level learning for the governance of adaptation, including a better understanding of the cognitive, normative, and relational dimensions of such learning and its orientation towards enhanced performance to achieve desired outcomes.

Applying a multi-level learning lens to questions of institutional design opens the possibility to look at the dynamic of the social network, negotiations among different groups, and collaboration processes as the necessary elements for enhanced adaptive capacity across levels of governance. The identified factors and drivers are key for enhancing the

performance of the governance system, achieving adaptation policy goals like adaptive capacity and resilience.

A fundamental assumption for our (and future) research is that learning can be assessed through changes in governance and its performance for achieving desired outcomes. However, given the complexity of the UNFCCC adaptation regime, it is difficult to attribute the changes and adjustments in the governance system solely to multi-level learning.

It was not within the scope of the paper to determine evidence for what learning has been gained across levels, due to the multilateral adaptation regime. The paper was rather oriented to analyse the institutional design as an enabling factor of multi-level learning. A legal-technical analysis of the text of adaptation under the UNFCCC and the Paris Agreement was a necessary entry point to assess multi-level learning in the governance of adaptation. The analysis of UNFCCC documents over a considerable time span provided the basis for tracking the evolution of the adaptation regime and its potential to bring multi-level learning. Nevertheless, we consider it is essential to do further analysis at other levels of governance, testing our principal findings and assumptions about multi-level learning in the governance of adaptation and how this plays out in practice over time.

Future research can aspire to assess the outcomes of multi-level learning as applied across levels of governance, including the national and local levels; and obtain additional empirical evidence about how and (how well) multi-level learning nodes work concerning adaptation policy processes and achieving adaptation goals.

3

CHAPTER

4

Multi-level learning in climate change adaptation planning: comparing three experiences from Latin America

Abstract:

With the adoption of the Paris Agreement on Climate Change, adaptation has become more visibly important for responding to the climate crisis. Countries are encouraged to put in place policy measures to implement their Nationally Determined Contributions (NDC) including National Adaptation Plans (NAPs) to address the needs of adaptation across sectors and governance levels. Multi-level learning implies learning across international, national and local levels of governance and is of particular importance to guide countries' adaptation planning efforts and to enable them to benefit from the experience and lessons learned obtained at other levels around the world. The objective of this paper is to assess the contribution of multi-level learning to adaptation planning in Latin America by analyzing and comparing learning across levels in three illustrative cases in Latin America: integration of climate change adaptation in watershed planning in Bolivia; ecosystem-based adaptation in Ecuador; and adaptation planning in small-scale agriculture in Honduras. The three research questions formulated cover the learning needs of adaptation planning, the structure and dynamic of the social network that enables multi-level learning nodes, and the strategies adopted by the stakeholders to learn on adaptation planning. In the three cases, adaptation planning functions can be enhanced through changes in multi-level learning nodes and the governance levels involved and through adjustments in the cognitive, normative and relational dimensions of multi-level learning and the direction of such learning.

4.1. Introduction

Since the adoption of the Paris Agreement, adaptation has gained prominence in the global response to climate change. The multilateral process of the UNFCCC and the academic community both increasingly recognize that adaptation is not only a locally circumscribed process of national concern, but a multi-level governance challenge. This implies the need for enhanced coherence across different levels of governance to facilitate planning adaptation and learning (Amundsen et al., 2010; di Gregorio et al., 2019).

The assumption of this paper is that if learning is taking place across levels of governance (henceforth multi-level learning) it will motivate and support countries to organize their own adaptation policies and implementation processes and learn from other country experiences.

Multi-level learning is encouraged, for example, through international cooperation networks among different types of stakeholders across levels of governance (di Gregorio et al., 2019; Howes et al., 2014); the accumulation of knowledge by international and multilateral organizations about what works in term of international cooperation and technical assistance (Vinke-de Kruijf et al., 2016); and scaling up tested solutions through mechanisms of peer learning at local, national and international levels (e.g. Fünfgeld, 2015). Furthermore, adaptation literature underscores that learning enhances the effectiveness of climate change adaptation policies (e.g. Huntjens et al., 2011), and enhances the adaptive capacity of governance systems (Diduck, 2010; Pahl-Wostl, 2009), thus also contributing to institutional design and arrangements at different governance levels needed to support adaptation policies (e.g. Crona et al., 2012; Huntjens et al., 2012).

This paper addresses the question how processes of multi-level learning between stakeholders across governance levels support the capacities for adaptation planning, including how the necessary institutional arrangements look like for this to happen. We answer this question empirically assessing multi-level learning in three selected cases in Latin America outlined in the next section.

The paper is organized as follow. In section 4.2 the theoretical background is described, section 4.3 presents the methods, section 4.4 the results and sections 4.5 and 4.6 cover the discussion of the results and conclusions.

4

4.2. Analytical framework and research questions

Multi-level learning is linked to the notion of multi-level governance (Hooghe et al., 2010) and has been defined as the interplay of policy learning (e.g. Sabatier, 1988) and social learning (M. M. S. Reed et al., 2010) across levels of governance. Multi-level learning can be understood in its cognitive, normative, and/or relational dimensions as the result of interactions between individuals and institutions from different governance levels (Gonzales-Iwanciw et al., 2020).

Social learning is frequently defined as a convergent change in stakeholder's perspectives on a particular problem and its possible solutions, in light of both, their own and other stakeholder's views, interests, and positions with regard to the problem, such learning achieves a change in understanding that goes beyond the individual toward collectives and social networks (Ison et al., 2015; M. M. S. Reed et al., 2010). In contrast, policy learning is referred as a mechanism to address typical questions of public administration, such as facilitating the adoption and transfer of policies (A Benz, 2012), the adoption of new rules, or maintaining institutional memoir (Getimis, 2003).

Adaptation scholars have stressed the importance of multi-level learning in adaptation planning settings, and a central question in this research is how multi-level learning support relevant policy processes that enhance the ability and performance of the governance system to deal with climate change challenges (Fazey et al., 2007; C. J. A. M. Termeer et al., 2017). An entry point suggested by environmental governance scholars is to assess a set of institutional functions that together increase the adaptive capacity of a governance system (Grothmann et al., 2013; Gupta et al., 2010).

Drawing on organizational learning, multi-level learning can be evaluated, analysing the factors that foster learning and the outcomes of such learning. (e.g. Armitage et al., 2018; Gerlak et al., 2011).

The analytical framework utilized for our empirical examination of multi-level learning is presented in Figure 4.1.
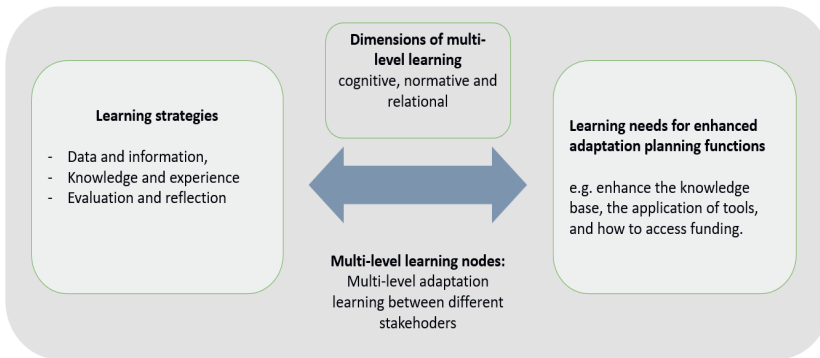
Figure 4.1 Multi-level learning analysis categories

Multi-level learning is assessed through *changes in its cognitive, normative and relational dimensions* and in the network of multi-level learning nodes. Those changes are analysed in relation to the learning needs of performing adaptation planning functions and the adopted learning strategies.

A central element in this framework is the structure of *multi-level learning nodes*, defined as institutionalized arrangements of social and policy learning practices and routines occurring across levels of governance (Gonzales-Iwanciw et al., 2021). Multi-level learning nodes provide a good picture about the structural factors that enable multi-level learning, like the role of networks in multi-level governance (di Gregorio et al., 2019; Ziervogel et al., 2017). Understanding the structural factors also provide the backdrop to analyse the relations between social units and organizations within the social network, looking at interaction between different stakeholders.

The framework is designed to help understand how multi-level learning enhances adaptation planning by analysing the *learning strategies* applied by different stakeholders to address *learning needs* for enhanced adaptation planning functions.

Adaptation planning functions are categorized based on similar research (Dixit et al., 2012; Füssel, 2007) and UNFCCC guidance (LDC Expert Group (LEG) 2012) in six categories:

(1) Coordination involves organizing and aligning efforts among various stakeholders for effective adaptation planning;

(2) Knowledge base and prioritization refer to the acquisition and prioritization of relevant information essential for informed decision-making in adaptation strategies;

(3) Policy integration focuses on incorporating adaptation considerations seamlessly into existing policies and frameworks;

(4) Funding pertains to securing and allocating financial resources to support successful adaptation initiatives;

(5) Implementation involves the practical execution of adaptation measures based on established plans and strategies;

(6) Monitoring, Evaluation, and Reporting (MER) entail systematically assessing and communicating the progress and impact of adaptation efforts.

Multi-level learning is also assessed through changes in its *cognitive*, *normative* or *relational* dimensions (Baird et al., 2014; Haug et al., 2011) influencing over time learning strategies applied for adaptation planning. Cognitive learning is linked to the factual learning without changing underlying norms, values or belief systems; normative learning encompass a change in norms, values, and belief systems and relational learning results from enhanced trust, improved understanding of mindsets of others (Huitema et al. 2010).

We used the learning categories included in DIKW model (Data, Information, Knowledge and Wisdom) or wisdom hierarchy for coding and analysing multi-level learning strategies, (Rowley, 2007).

The objective of this paper is to assess the contribution of multi-level learning to adaptation planning in Latin America by analysing and comparing learning across levels in three illustrative cases in this continent. Based on the analytical framework presented above our empirical analysis in three Latin American cases is guided by the following questions:

- What are the cognitive, normative and relational dimensions of multi-level learning needs for enhancing adaptation planning functions in the three cases?
- What is the role of the identified multi-level learning nodes in addressing those needs and what are gaps?
- How do different multi-level learning strategies address the cognitive, normative and relational learning needs and what are the gaps?

4.3. Methods

The study relies on a comparison of three selected cases of adaptation planning in Latin America. Data collection, case selection and a description of methods used for analysing empirical data are described below.

4.3.1. Data collection

Document analysis and expert opinion obtained through semi structured interviews are the primary sources of data for the analysis. The documents (See Table S4.1 in the Supplementary materials) include a sample of policy documents (n=49) obtained through web page searches and consolidating the sample by selecting the most relevant documents while being open to new directions that emerged during the review (Bowen, 2009; Kemper et al., 2003).

The document analysis was supported by 20 face-to-face semi-structured interviews conducted between 2018 and 2022 with key players selected though purposive sampling (Robinson, 2013) and include a diversity of stakeholders identified at different levels of governance, including government officials, international and multilateral agencies and civil society groups (see Table S4.2 in the Supplementary materials).

4.3.2. The cases

The selection of cases was driven by the following criteria: diversity of approaches and entry points to planning adaptation at the country level; the clear presence of multi-level learning and an indication of sustained adaptation processes within the cases beyond a particular project or program.

Considering the complexity and scale of the entire country's National Adaptation Plan (NAP), we opted to focus our documentation on multi-level learning processes in each of the cases within a specific sector of the NAP.

Integration of climate change adaptation in watershed planning in Bolivia:

Water is a priority for Bolivia´s adaptation planning efforts as is highlighted in different official documents (e.g. PNC 2017, NDC Bolivia 2022). Various internationally funded projects, including a basket fund of budgetary support, and climate change funding have

accompanied adaptation planning efforts in the water sector (GEF 2007; SPCR Bolivia). International support and technical assistance have included capacity building processes for better planning of adaptation in priority watersheds (e.g. PDC Rocha), and the implementation of climate change adaptation projects in different subsectors; including drinking water, irrigation and watershed protection. Climate change adaptation has been integrated across levels of governance, including in the preparation of guidelines and tools for watersheds plans and project design, the integration of climate change considerations in water governance (GAD CBBA 2015, AFD Bolivia), and strengthening hydrological measurements and modelling (BH Bolivia 2016). The resulting experience, mainstreaming climate change adaptation at the level of watershed planning, is relevant for reducing climate related risk in the sector and for policy learning to extrapolate this experience to other subsectors and climate change adaptation policy in general (Lima-Quispe et al., 2021).

Ecosystem based Adaptation in Ecuador:

The experience of Ecuador in integrating adaptation together with other relevant processes of land use change and biodiversity conservation at different scales and territorial entities, including cities, key ecosystems and indigenous territories is noteworthy (Dupuits et al., 2022). Ecuador started the formulation of its NAP in 2015 with international support (e.g. NAP-GSP Ecuador). The country is implementing Ecosystem based Adaptation (EbA), in collaboration with different stakeholders and international technical assistance in different types of ecosystems, including mountain, coastal and urban regions (e.g. CIIFEN 2019; PBA 2017). The country has integrated EbA with its NAP that was conducted as a multi-stakeholder process addressing different sectors (MAE, UICN & GIZ 2019). This approach addresses the protection of key environmental functions, including water sources, biodiversity hotspots, forests and carbon sinks and enhancing socio-ecological resilience (e.g. Baum et al., 2021). As it will be presented below, one of the challenges is to give EbA and institutional basis within adaptation planning in Ecuador. Multi-level learning in the governance of adaptation can support the policy processes needed for such integration.

Adaptation planning in small-scale agriculture in Honduras:

Reducing the vulnerability of small-scale agriculture is central in Honduras´s adaptation planning efforts (e.g. SAG 2015; Alianza Corredor Seco 2017). Climate change poses additional threats to already vulnerable rural livelihoods in key ecosystems in Honduras like the dry Corridor (Alianza Corredor Seco 2017, CABEI 2021). It is expected that climate

change will affect rural livelihoods and agricultural value chains, including of food security crops like maize and beans, and export-oriented crops like coffee and cacao (Bouroncle et al., 2017; Donatti et al., 2019).

Adaptation efforts have been integrated within Honduras NAP endorsed by the Secretary of Environment in 2018 (SERNA 2018) and received international climate funding to address the priorities linked to food security and value chain development (e.g. SPCR Honduras; NAP-GSP Honduras; CIF 2020). These projects consider issues such as better access of the farmers to technical and financial services, including the diversification of crops and rural livelihoods, water usage and a series of adjustments along different activities of value chains and markets to ensure resilience of the system in the long run (Bouroncle et al., 2017; Donatti et al., 2019). Agriculture policies require sophisticated forms of public-private coordination to manage climate risk and encourage technical assistance and innovation for small scale agriculture, thus also requiring the participation and learning of multiple stakeholders across levels of governance.

4.3.3. Data analysis

The analysis of the documents and interviews combines content and thematic analysis (Fereday et al., 2006) with a mixed deductive and inductive coding of the data, and its organization into major themes and categories, see the analytical framework in Figure 4.1 and the coding structure in Table S4.3 in the supplementary materials.

Social network analysis (SNA) (e.g. Serrat, 2017) is used to analyse and compare *multi-level learning nodes* between the cases and study their position within the social network. The data for SNA was obtained looking at the organizations involved in the planning process and edges, connections or relationships between them. SNA tools like Gephi are used to obtain different network metrics (e.g. network diameter, degree of centrality of the nodes) and apply different distribution algorithms for a better visualization of the social network (See Figure S4.1 in Supplementary materials).

We have adopted the following categorization of governance levels for the analysis: global, including for example, UNFCCC and the Adaptation Committee facilitated activities; international, including activities and partnerships of bilateral and international agencies; regional, including regional programs and agencies; national, activities carried out by

national agencies and with a national scope; and local, activities happening at different subnational levels including subnational regions, municipalities and communities.

4.4. Results

This section addresses the results based on the research questions. Section 4.4.1. present the multi-level learning needs in relation to the selected adaptation planning functions. Section 4.4.2. analyses the role of multi-level learning nodes addressing those needs and potential gaps. And section 4.4.3 present multi-level learning strategies used by the actors to address those needs and where are the gaps.

4.4.1. Adaptation planning functions and multi-level learning needs

A summary of the learning needs for each adaptation planning function in the three cases is presented in Table 4.1.

Table 4.1 Learning needs identifies in the three case studies.

Adaptation planning functions	Watershed planning in Bolivia	Ecosystem based adaptation in Ecuador	Small-scale agriculture in Honduras
Coordination			
Cognitive	*N/A*	*N/A*	*N/A*
Normative	*(N↔L) Define roles and competencies.* *(I↔N↔L) Organize cross sectoral coordination for water and sanitation and irrigation projects.*	*(N↔L) Organize vertical integration with subnational governments.*	*(N↔L) Integrate extension services across levels.*
Relational:	*(N↔L) Involve different types of stakeholders e.g. farmer associations, communities and water operators.*	*(N ↔ L) Involve different types of stakeholders e.g. municipal entities, water funds and protected areas.*	*(N↔L) Coordinate with the farmers.* *(I-N-L) Coordinate along priority value chains.*
Knowledge and prioritization			
Cognitive:	*(I↔N) Expand the knowledge base about glacier melting, hydrological balances and climate change scenarios.*	*(I↔N↔L) Expand the knowledge base about ecosystem services.* *(I↔N) Characterize ecosystems functions and services.*	*(R↔N↔L) Understand the impacts on food systems and small farmers.* *(N↔L) Identify coping strategies*
Normative:	*(I↔N) Standardize methods and data requirements for modelling.*	*(I↔N) Test EbA and other tools for territorial planning at the local level.*	*(I↔N) Define data requirements for agricultural insurance.*
Relational:	*(N↔L) Knowledge dialogues between local practices of water governance (use and customs) and national water use regulations.*	*No data*	*(N↔L) Conduct knowledge dialogues between local practices of the farmers and agronomic science.*
Policy integration			
Cognitive	*(I↔N) How to better integrate climate change into watershed planning.*	*(I↔N↔L) Apply the EbA approach.*	*(I↔N↔L) Apply the Climate Smart Agriculture (CSA) approach.*
Normative:	*(I↔N) Apply tools for watershed planning.*	*(I↔N↔L) Apply the EbA approach.*	*(I↔N↔L) Apply the Climate Smart Agriculture (CSA) approach.*
Relational:	*(N↔L) Knowledge dialogues between local practices of water governance (use and customs) and national water use regulations.*	*No data*	*(N↔L) Conduct knowledge dialogue between extension services and the farmers*

Adaptation planning functions	*Watershed planning in Bolivia*	*Ecosystem based adaptation in Ecuador*	*Small-scale agriculture in Honduras*
Funding			
Cognitive:	*No data*	*(R↔N↔L) Prepare projects oriented to climate funds.*	*No data*
Normative:	*(N↔L) Define concurrent funding (I↔N) Learn from sector wide funding to mainstream adaptation in the sector.*	*(N↔L) Define concurrent funding.*	*No data*
Relational:	*(N↔L) Define the institutional arrangements e.g. the protection of water sources.*	*(R↔N↔L) Identify and apply business models e.g. water funds.*	*(N↔L) Identify microfinance services for the farmers.*
Implementation			
Cognitive:	*(N↔L) Extract lessons from the experience in priority watersheds.*	*(N↔L) Extract lessons from the experience in priority sites.*	*(N↔L) Extract lessons from the experience in priority crops and value chains.*
Normative	*N/A*	*N/A*	*N/A*
Relational:	*(N↔L) Dialogue among different groups e.g. municipalities, local communities, irrigation associations, water utilities.*	*(N↔L) Dialogue with different groups e.g. municipalities, protected areas administration, water fonds, indigenous groups.*	*(N↔L) Dialogue among different groups e.g. the private sector, small scale farmers, agricultural extension services to apply measures.*
Monitoring and evaluation			
Cognitive	*(I↔N↔L) Define a set of adaptation indicators.*	*(I↔N↔L) Define a set of adaptation indicators.*	*(I↔N↔L) Define a set of adaptation indicators.*
Normative:	*(I↔N) Apply UNFCCC reporting guidelines and indicators.*	*(N↔L) Define a set of EbA indicators. (I↔N) Apply UNFCCC reporting guidelines and indicators.*	*(I↔N) Apply UNFCCC reporting guidelines and indicators.*
Relational:	*(N ↔ L) Translate climate change terminology with the sectors involved.*	*(N ↔ L) Translate climate change terminology with the sectors involved.*	*(N ↔ L) Translate climate change terminology with the sectors involved.*

Notes:

Multi-level learning levels: International (I) Regional (R) National (N) Local (L)
No data: No relevant or clear data obtained from the review of the case study
N/A: Does not apply for the corresponding function, but the dimension might be fulfilled through another function, for example in the case of implementation the normative aspects are at the level of policy integration and funding.

Coordination

In all the cases, learning needs are related to the cross sectoral and cross level coordination efforts. Cross-sectoral coordination requires enhanced institutional capabilities including forms of relational learning to address overlaps and synergies between different government departments to perform well. In the case of Ecuador and Honduras the NAP is the natural platform for cross-sectoral coordination, relational learning is needed for enhanced coordination (Interviews CS4, IC6). In the case of watershed planning in Bolivia, learning is needed to facilitate vertical integration across institutional functions and budgetary concurrence (Interviews IC1, FI1).

Knowledge base and prioritization

The three cases provide different entry points to the multi-level learning needs of knowledge base and prioritization. In the Bolivia case, there is a need to integrate climate change scenarios in hydrological balances for decision making around watershed planning (BH

Bolivia 2016). In the Honduras case, the national and local levels need to learn about how to enhance the coping capacity and adaptability of the farmers to new situations (CGIAR 2014; INNOVA; Interview IC7). Whereas in Ecuador, knowledge needs are related to the characterization of ecosystem functions for decision making (MAE, UICN & GIZ 2019; ProCambio II; Interview IC6). In allcases there are gaps in the interface science – decision making (Interview SC2, FI1, IC3).

Policy integration

The three cases highlight the need to share information and knowledge about methods and tools for integrating decision making across different sectors and levels of governance (Interviews G1, G2, IC6). In all the cases policy integration involves cross sectoral efforts to educate the stakeholders including decision makers at the national and local levels about the implications of climate change adaptation and possible solutions.

In the case of Bolivia there is a need to learn about the application of adaptation tools at the national and local levels, like the integration of climate change adaptation in watershed planning instruments (e.g. SPCR Bolivia).

In the case of Ecuador multi-level learning is needed across EbA stakeholders to enhance the capacities of municipal governments and territorial entities to better plan for the conservation and restoration of key ecosystem functions (e.g. UICN & GIZ 2019; CONDESAN 2021). The interviews in Ecuador highlight this need: "We have two separate processes that need to be streamlined, one to apply EbA with municipalities and a second one at the level of municipalities institutions to integrate climate change considerations at the level of territorial planning" (IC6).

In the Honduras case, multi-level learning is needed to strengthen the capacities of public agencies to integrate climate change adaptation in agricultural extension services to the farmers (SAG 2915; AECID 2018; CGIAR 2014; INNOVA). Relational forms of learning are needed among the stakeholders, including private sector agents present in value chains to facilitate the adoption of adaptation measures (IFPRI 2019; IFAD 2020).

Funding

In relation to funding in all the cases, multi-level learning is needed to enhance the capacities of national and local stakeholders to better access international climate funding. The conditions and rules that countries need to put in place to facilitate access to climate funding

are evolving rapidly (Interview FI4). Training programs prepared for that purpose attempt to, for example, enhance the capacities of financial institutions at the national and local levels to apply financial products in resonance with adaptation priorities (PNUD Guia Financiamiento Climático, PFA 2013).

In Bolivia and Ecuador, the experience around 'water fonds' is generating opportunities for multi-level learning across regional, national and local platforms. In Ecuador international funding supported well-designed business models oriented to pay for water conservation and other ecosystem services like biodiversity and ecotourism (ProCambio II, Interview IC6). The involvement of public stakeholders in these institutional arrangements is attracting the interest of Bolivian agencies (Interviews IC1, FI1).

Implementation

In the three cases, the experience obtained from intervention models at the local level is relevant for analysing the success factors and obtaining lessons learned for scaling up the intervention. In the three cases multi-level learning is needed to refine successful intervention models and replicate those experiences in similar or different contexts.

In the case of Bolivia, for example, it is vital to make sure that the projects in the water sector are climate proof (PNC Evaluation 2013, 2017). Multi-level learning can contribute to share this experience with other priority sectors (Interview IC4).

In the case of Ecuador, multi-level learning is needed to showcase EbA as a possible planning approach to different stakeholders, including municipal bodies and national ministries (Interview IC6).

In the case of Honduras, multi-level learning is needed for the adoption of an intervention model for agricultural resilience. Climate Smart Agriculture (CSA) still need to be tested as an implementation model (Interview IC7). CSA combines agricultural extension service with new financial and non-financial services to encourage CSA by connecting farmers to agricultural value chains (SAG CGIAR, SAG 2015).

Monitoring and evaluation

In relation to monitoring and evaluation the three cases implement M&E tools and guidelines with different grades of success. Multi-level learning can contribute to the effective application of M&E guidelines and tools. One of the challenges highlighted by different interviewees is the lack of a unified framework and indicators for tracking adaptation (e.g.

interviews G3, G5, IC4). In all the cases M&E of adaptation demand enhanced capacities to translate climate change specific knowledge and terminology to the specific needs of the sectors involved, linked to normative and relational forms of multi-level learning.

4.4.2. Multi-level learning nodes

Social network analysis was applied to assess the role of multi-level learning nodes in relation to multi-level learning that needs to take place for actors to carry out the various planning functions (see Figure S4.1 in the Supplementary materials). Between four and six learning nodes were identified for each case (See Table 4.2) divided into three types: policy oriented (P1, P2, P3, P4 and P5) knowledge oriented (K1, K2, and K3) and implementation oriented (I1, I2, I3, and I4) which are described further below.

Table 4.2 Multi-level learning nodes identified in the case studies.

Integration of climate change adaptation in watershed planning in Bolivia:	
P1	National Watershed Plan coordination platform (*PNC*) that involves different stakeholders linked to a central water sector policy implemented since 2007 and supported by international cooperation organizations.
K1	Glacier melting and hydrological research activities have brought together different research institutes and international cooperation programs.
I1	Expert group of irrigation projects and climate change risks has brought together different experts in the field with the aim to integrate climate change adaptation considerations at the level of project guidelines.
I2	Collaboration group on business models for the protection of water sources
Ecosystem based Adaptation in Ecuador:	
P2	*EBA Regional Program* conducted initially in Colombia and Ecuador is putting in place the methodological framework for the implementation of Ecosystem base adaptation in Ecuador
P3	NAP Platform (*PLANACC*) is receiving international support funded by the Green Climate Fund
P4	Implementation group of climate change provincial strategies
K2	Biodiversity and climate change research activities has brought different research institutes and international cooperation programs
I3	Climate funding capacity building facilities
Adaptation planning in small-scale agriculture in Honduras:	
P5	Interinstitutional efforts of adaptation in the dry corridor
P6	National Adaptation Plan platform
K3	Collaborative efforts about climate risk in the agriculture sector
I4	Agriculture innovation hub

The table includes three types of nodes applicable to the three cases: Policy nodes (P) are multi-stakeholder spaces oriented to define and put in place adaptation policies; Knowledge nodes (K) are platforms or collaboration spaces oriented to enhance the science needed in the specific sector addressed; and Implementation or innovation nodes (I) are multi-stakeholder spaces oriented so solve concreate aspects of implementation.

Policy nodes build around a given policy or national plans fulfilling coordination and policy integration functions. In the case of Bolivia, the National Watershed Plan Coordination Platform (P1) has served as a sector wide umbrella to promote dialogue and multi-level learning among the stakeholders, including international cooperation and technical assistance (Interviews G1, IC4). In the case of Ecuador, the NAP platform (PLANACC) (P3) fulfils cross sectoral coordination functions and is central to fostering the adaptation agenda at national and local levels (Interviews G2, IC6). Two other policy nodes - the EBA Regional Program involving regional activities in Colombia and Ecuador (P3) (e.g. MAE, UICN & GIZ 2019) and a strategy to integrate climate change adaptation at the level of provincial strategies (P4) - build the landscape of policy nodes supporting EBA in Ecuador (Interview IC6). In the case of Honduras two collaboration platforms build the structure for policy development and multi-level learning: Inter-institutional efforts on adaptation in the dry corridor (P5) and the National Adaptation Plan platform (P6) (Interview IC5, CS4).

Knowledge nodes have very similar settings in the cases analysed, expanding the knowledge base for decision making. In Bolivia, a group of research institutions and projects with permanent support from international research programs, like tropical glaciers (Francou et al., 2003) has been expanding the cognitive base for decision making (K1). Similarly, in Ecuador biodiversity and climate change (K2) has motivated research institutions to produce and share relevant information about ecosystems, biodiversity and climate change (Foden et al., 2009) and in Honduras concerns about climate risks in the agriculture sector (K3) has brought together a number of research activities (e.g. Bouroncle et al., 2017).

Implementation nodes gather practitioners from different organizations to share information and experiences, fulfilling implementation functions. In Bolivia, we identified two nodes: An ad hoc expert group with the mandate to include climate change adaptation considerations at the level of irrigation projects guidelines (I1) and a group of organizations exchanging experiences about intervention models and funding schemes for water protection (I2) (Interview IC4).

In Ecuador a group of organizations are collaborating around a school to develop capacities for funding climate change projects (I3) and in Honduras an innovation platform for climate smart agriculture is developing intervention models to support adaptation efforts at the level of small farmers and value chains (I4) (Interviews IC, CS4).

The structure of the social networks (See Figure S4.1 in the Supplementary materials) provides relevant information about multi-level learning processes taking place, inferring

potential of close collaboration or similar interest among different stakeholders in relation to climate change adaptation, but also potential gaps or areas of lack of communication. The same figure S4.1 in the supplementary materials, provides relevant information about which stakeholders play a more prominent role in adaptation planning and have the potential to highlight learning needs related to the identified planning functions.

For example, Bolivia, the PNC Coordination Platform (P1) has had a prominent and central role defining the adaptation agenda and thus promoting multi-level learning in the water sector (Interviews G1, IC1). In the case of Ecuador, the EBA Regional Program (P2) and the NAP Platform (PLANACC) (P3) have a more prominent position within the social network and have also played a significant role bringing together stakeholders at the national and local levels to share their adaptation experiences (Interview IC4). In Honduras, in contrast, the central space of the social network is filled by the NAP Platform (P6) and both secretariats of environment (SERNA) and agriculture (SAG) and multilateral banks funded activities, which have guided the adaptation agenda and promoted multi-level learning (e.g. SPCR Honduras).

With regards to the structural gaps resulting from lack of interaction or collaboration among the stakeholders, for example, in Bolivia, the group of actors carrying out research about glacier melting and hydrology (K1) is highly specialized and only connected through a limited number of bridging edges. The network also presents lack of linking edges to a group of actors developing business models for the protection of water sources (I2) (Interview IC4), signalling gaps to be addressed.

In the case of Ecuador, the social network also presents structural gaps or lack of 'formal' connections among certain groups, for example (K2), projects or groups of institutions working in different geographic regions (e.g. Andes and Amazon) and active in different thematic areas (e.g. municipal development and biodiversity conservation). This observation is confirmed by Interview IC6, since provincial strategies and municipal plans are the natural arena for enhanced integration of EbA, however the EbA is still not formally adopted by the government for territorial planning at the level of municipalities (Interview IC6).

In Honduras, the four identified multi-level learning nodes are all connected in some ways through and distributed within the social network (Interviews G4, G5).

In Honduras, the interviews IC5, CS4 recognize both the leadership of the Secretary of Agriculture in the coordination of different programs and the limitation of governmental

actors to address all the needs and demands of agriculture and the farmers, due to the size and complexity of the agriculture sector (Interview CS4).

Looking at the roles of multilateral and international actors in multi-level learning, we observe very similar settings in all three cases. For example, the GEF NAP Global Support Program (NAP-GSP) supported the formulation and implementation of the NAP in Ecuador and Honduras with important implications in the way the NAP process is implemented, lessons extracted and reported in both cases (NAP-GSP Ecuador, NAP-GSP Honduras). The same is true for activities of the Climate Investment Fund (CIF) – Pilot Project for Climate Resiliente (PPCR) in Bolivia and Honduras (SPCR Bolivia and SPCR Honduras) funding important sector wide interventions and lessons learned (Interview FI2). In the case of PPCR learning is encouraged across levels of governance, including at the level of local communities, addressing gender gaps and the needs of the most vulnerable in project design and evaluations, but also bringing together practitioners across levels of governance to evaluate the outcomes and impact of interventions and learning (Interview FI2).

Other national and local actors, including research and civil society groups also play a significant role in multi-level learning as knowledge nodes or bridging organizations, addressing new or less recognized themes and involving less represented groups (e.g. Interview CS1, CS4).

4.4.3. Multi-level learning strategies

The third research question is concerned with the ways multi-level learning took place to address the identified learning needs across levels and the gaps, see summary in Table 4.3 and discussion below. Learning strategies have been identified inductively and grouped in the three categories included in Table 4.3.

Table 4.3 Learning strategies

	Watershed planning in Bolivia.	***Ecosystem based adaptation in Ecuador.***	***Small-scale agriculture in Honduras.***
Collecting and sharing key data and information			
Cognitive:	*(I ↔ N) Conducting measurements and data collection e.g. glacier melting.*	*(I ↔ N ↔ L) Collecting data about key ecosystem features like biodiversity, carbon storage and water e.g. endangered species (IUCN).*	*(N ↔ L) Enhancing the collection of agrometeorological data and forecasting.*
Normative:	*(N → L) Enhancing the coverage of key data and information for decision making e.g. hydrological balances in key watersheds.*	*No data*	*(N → L) Enhancing farmers access to key information e.g. climate information and early warning systems to cope with climate risks.*
Relational	*N/A*	*N/A*	*N/A*

	Watershed planning in Bolivia.	*Ecosystem based adaptation in Ecuador.*	*Small-scale agriculture in Honduras.*
Acquiring and sharing knowledge and experiences			
Cognitive:	*No data*	*(R ↔ N ↔ L) Conducting case studies for the integration of EBA with other existing frameworks e.g. water fond and territorial planning entities.*	*(R ↔ N ↔ L) Compiling of best practices.* *(N ↔ L) Training of trainers e.g. the agriculture extension services.*
Normative:	*(N ↔ L) Integrating climate change adaptation and disaster risk reduction in watershed planning.* *(I → N → L)) Applying tools and methods for integrating climate change adaptation in watershed planning instruments.* *(N → L) Training of operators e.g. watershed planning consultants*	*(N ↔ L) Understanding key ecosystem functions and the application of EBA models including the social acceptance.* *(I → N → L) Making guidance available for the application of EBA models.*	*(I → N → L) Developing and scale up of application models e.g. resilient agriculture of climate smart agriculture.*
Relational:	*(N ↔ L) Promoting knowledge dialogues e.g. drought forecasting involving local and indigenous knowledge.*	*(N ↔ L) Promoting dialogues with key stakeholders to come up with institutional arrangements and implementation.*	*(N ↔ L) Promoting knowledge dialogues between local observers and meteorological services.*
Evaluating and reflecting			
Cognitive	*N/A*	*N/A*	*N/A*
Normative:	*(N ← L) Extracting lessons learned at the level of the program.*	*(I ↔ N ↔ L) Analysing information and knowledge gaps and needs in the NAP process.*	*(N ← L) Extracting lessons learned by implementation of the program.*
Relational:	*(N ↔ L) Stakeholder dialogue encouraged by the need to take action.*	*(I ↔ N ↔ L) Participation in different dialogue spaces in the NAP platform.*	*(R ↔ N ↔ L) Multi-stakeholder evaluation of the impact of interventions and lessons learnt at the level of programs.*

Notes:

Multi-level learning levels: International (I) Regional (R) National (N) Local (L)
No data: No relevant or clear data obtained from the review of the case study
N/A: Does not apply for the corresponding dimension.
↔, ←, →, the main direction of multi-level learning

The *collection and sharing of key data and information* about the trends in climate change and its potential impacts on different sectors and on societal groups is a fundamental strategy adopted to gain more understanding about the consequences and risk of climate change across the cases. This cognitive strategy has typically been bidirectional between the international/national and/or national/local level and contributed to broadening up the information and knowledge base for the development and putting in place of adaptation policies and measures (e.g. BH Bolivia 2016; CATIE 2017). Gathering and sharing relevant data and information is often followed by analysing data and information gaps and organize new projects oriented to address those, making this learning strategy unidirectional from the national to the local level (e.g. BUR1 Honduras). A key learning strategy is the standardization of methods and data requirements which is linked to the requirements of science and decision making, with important gaps identified along the cases in the interphase between climate science and decision making, for example to make the results of climate change models comparable across scales and timeframes and support decision making across levels of governance (e.g. Interviews G1, CS4).

Acquiring and sharing knowledge and experiences "learning by doing" is a strategy frequently mentioned and adopted by the stakeholders to obtain experiences from practice and test interventions models (e.g. MMAyA 2013; PBA 2017; PROAMAZONIA). Multi-level learning will then be encouraged from international, and national levels in a unidirectional way in the form of normative learning, standardizing and validating methods, approaches and tools and training on those methods and tools, increasing the number of practitioners involved in communities of practice at national and local levels to implement identified adaptation measures, evaluate their impact and learn from them (e.g. MAE, UICN & GIZ, 2019; CABEI 2021).

In the three cases the integration of climate change adaptation at the level of the sectors involved imply the application of similar approaches in national planning processes (e.g. LEG 2012). In Bolivia, the government applies watershed plans as the main policy instrument for adaptation planning (e.g. PDC Rocha 2015). In Ecuador the EbA framework serves the same purpose (Interview IC6, Programa ABE Manual de líderes). The NAP processes, as adopted by all the countries allows comparisons and refinement through learning, this learning takes place at the international and global levels but less at the national and local levels.

In all cases there are attempts to enhance forms of relational learning by incorporating local knowledge in regional and national planning processes, thus increasing the possibilities for multi-level learning between local stakeholders and decision makers. In Honduras, this involves complementing climate observations of small farmers with the observations of meteorological services in agroclimatic platforms (e.g. SAG CGIAR, Interviews G5, CS4). The co-creation of knowledge or dialogue of knowledge is applied, for example, to combine the local or traditional knowledge with the considered scientific or academic knowledge (AECID 2018, pp.44). The interviews suggest that for this type of relational learning particular skills are needed, like the recognition that local knowledge is relevant and valuable (Interviews CS1, FI1, FI2).

In relation to the *evaluation and reflecting* learning strategy, the evaluation of information and knowledge gaps and needs is a frequent learning modality encouraged by the UNFCCC process and reflected in official documents (e.g. ENT Honduras, BUR1 Honduras). This strategy is forward-looking and oriented to "fill the gaps" in data, information and knowledge.

Furthermore, the evaluators have the possibility to reflect about the policy process, assess 'what works and what does not' and share the findings with the stakeholders and decision makers. The disadvantage is that the different stakeholders do not always fully participate or are aware of the reflection and the lessons learned (Interview FI2), making this type of learning unidirectional from the local to the national level.

There is little evidence in the three cases that evaluative or reflective processes among key stakeholders are conceived and maintained over time. A more evaluative or reflective process among the stakeholders can be encouraged by the participation of different stakeholders in planning platforms such as the EbA platforms (Interview IC6, CS4). But it is also hampered by the lack of collaboration among stakeholders, corporative positioning and competence in getting access to climate funds and the lack of coordination, stewardship and clear governmental policies (Interview IC1, CS4).

4.5. Discussion

The examined cases demonstrate how a network of multi-level learning nodes, emerging around adaptation agendas, addresses the multi-level learning needs of adaptation planning and the learning strategies adopted by stakeholders to meet those needs. The cases also offer relevant information about the cognitive, normative, and relational dimensions of multi-level learning, as well as the levels of governance and direction of such learning, highlighting important trends and gaps in how multi-level learning can be enhanced.

The structure of the social network, such as the degree of interconnectedness and centrality of certain stakeholders, influences stakeholder participation. Furthermore, the level of collaboration, for example involving certain stakeholders in defining policy priorities, also determine their opportunities to learn about the process. The analysis also highlights gaps, limited participation of certain actors such as local actors and the lack of collaboration, and even competition among stakeholders, resulting in limited opportunities for multi-level learning.

A network of multi-level learning nodes show which levels of governance are involved in different planning functions including the predominance of international technical assistance applying similar methods and tools across the cases. The network further shows difficulties in the coordination and lack of collaboration among different cooperation programs and gaps in the involvement of national and local actors.

The cases also show progress and gaps related to the cognitive, normative and relational dimensions of multi-level learning in relation to adaptation planning in each of the cases and analyse similar patterns and differences among them. Cognitive dimensions of multi-level learning were principally enhanced through the need to expand the information and knowledge base for decision making.

The normative dimensions of multi-level learning are strongly linked to the application of internationally defined adaptation planning frameworks in various country processes, such as the technical guidelines for NAP (LEG 2012), and the evaluation of results according to predefined criteria by technical assistance agencies and funders.

The results show that multi-level learning is not always reciprocal or bidirectional. In the case of normative learning, reflection on assumptions and imperatives primarily occurs at the level of the agencies that drive the processes, rather than across all actors involved. This represents an important gap, limiting deeper learning processes among stakeholders at national and local levels and hindering more autonomous action and transformations in adaptation planning at these governance levels.

The cases also highlight a lack of participation of different stakeholders in more relational forms of multi-level learning like reflective spaces or in the evaluations. The evaluation of the programs are generally conducted by 'experts' who usually do not involve the different actors, so that they can participate in the reflective process and obtain their own lessons learned. This is another gap identified with implications in the lack of ownership, leadership and agency of those actors.

4.6. Conclusions

With this research we have confirmed two key factors through which adjustments in multi-level learning can be guided to enhance adaptation planning. This is the network and structure of multi-level learning nodes, including the levels of governance involved in that network; and the changes in the cognitive, normative and relational dimensions of multi-level learning and the direction of such learning.

The configuration of multi-level learning nodes and the governance levels engaged in these nodes offer valuable insights into how effectively various planning functions within the governance system are carried out. This includes understanding the specific roles and relationships among actors, thereby assessing their capacity to set priorities and influence adaptation agendas. Furthermore, it sheds light on the overall coherence and effectiveness

of different multi-level learning nodes and strategies working together for the sake of adaptation.

The learning strategies adopted by stakeholders in various cases reveal both common approaches and significant gaps in the engagement of national and local levels of governance, as well as the direction of multi-level learning. These observations indicate trends and disparities about at which level learning predominantly occurs, and who benefits most from such learning. Addressing these gaps offers an entry point to enhance multi-level learning in adaptation planning, particularly by reassessing how stakeholders' contributions at these levels are perceived and their implications for fostering stakeholder ownership and deeper learning.

The results highlight that the prevailing focus on cognitive aspects must evolve towards a greater emphasis on enhancing actors' capacities for deeper multi-level learning in the normative and relational dimensions.

As outlined in the methods section, we chose to narrow our focus to specific sections rather than encompassing the entire National Adaptation Plan (NAP) in each of the cases. While this decision may have restricted our capacity to comprehensively capture all potentially significant aspects relevant to multi-level learning in the governance of adaptation within each case, it facilitated a more in-depth examination within a clearly defined scope.

To deepen our understanding of how multi-level learning impacts the efficacy of adaptation planning, further empirical research integrated with real-world adaptation planning processes is imperative.

4

CHAPTER

5

Multi-level learning in the governance of adaptation to climate change- the case of Bolivia's water sector

Abstract:

The efforts of Bolivia's water sector to adapt to climate change include the mainstreaming of adaptation in water policy instruments and broad capacity building processes supported by climate funds and international cooperation. These sector-wide adaptation experiences in the country present important learning challenges across different governance levels. This paper analyzes multi-level learning in the governance of adaptation taking place in the water sector in Bolivia, by focusing on changes in the cognitive, normative and relational domains of learning. The analysis is guided by three questions: (i) Which institutional arrangements enable multi-level learning in the governance of adaptation in Bolivia's water sector?; (ii) What are the cognitive, normative and relational dimensions of learning in these arrangements?; (iii) What are the implications of multi-level learning for shaping desired outcomes in the governance of adaptation? The case contributes to understanding multi-level learning processes in the governance of adaptation including the role of national and international climate change policy instruments in these. In addition the study provides methodological insights for assessing multi-level learning.

5.1 Introduction

Climate change adaptation has become subject to multi-level governance since the adoption of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. The system of multi-level governance has gradually evolved through the implementation of a set of rules and institutions put in place under the UNFCCC, including, among others, the Nairobi Work Programme on Impacts, Vulnerability and Adaptation to Climate Change (NWP), the Cancun Adaptation Framework (CAF) and the Paris Agreement. The rules, processes and institutions established at different governance levels include specific mechanisms for engaging with stakeholders and specific policy measures and systems for monitoring, evaluating and learning from implementation experiences. The Paris Agreement adopted a global adaptation goal, and invited countries to include adaptation targets in the Nationally Determined Contributions (NDCs) submitted to the UNFCCC every five years. Other elements of this multi-level governance system include the preparation of National Adaptation Plans (NAPs) and capacity building strategies supported by multilateral agencies.

The scholarly literature on the governance of climate change adaptation (henceforth the governance of adaptation) has typically positioned learning as a mechanism for adjusting desired outcomes and enhancing the effectiveness of adaptation (Tompkins et al., 2005; Tschakert et al., 2010). Learning has been perceived as a mechanism to scale and speed up the impact of global adaptation interventions (Berkhout et al., 2006; Fünfgeld, 2015; Kern et al., 2009). These objectives are achieved through mechanisms such as peer and mutual learning, policy transfer and evaluation. Learning has also been identified as key for incorporating different stakeholder perspectives and experiences into adaptation, in particular the knowledge and experience of vulnerable groups, indigenous wisdom and gender perspectives (Adger et al., 2012; Armitage et al., 2011; Pelling et al., 2008).

Multi-level learning is recognized as a key element of the governance of adaptation in academic literature (Leys et al., 2011; Pahl-Wostl, 2009; Pelling et al., 2008). However, the academic discussion on approaches to multi-level learning in adaptation governance has different entry points and approaches. There is no unified vision about how to describe and assess multi-level learning in relation to adaptation across different governance levels. A systematic literature review of multi-level learning in the governance of adaptation, see Gonzales-Iwanciw et al. (2020), highlights promising paths for operationalizing and

assessing multi-level learning suggested in the literature. One option to assess the process and outcomes of multi-level learning is to track the incremental and transformational changes in the cognitive, normative and relational dimensions of multi-level learning in a particular governance setting over a time span.

Drawing on a case study of efforts to mainstream adaptation in Bolivia´s water sector, the objective of this paper is to identify key institutional arrangements that promote multi-level learning in the governance of adaptation.

The water sector in Bolivia serves as a case of multi-level learning in the governance of adaptation for two reasons. Firstly, it is an example of explicit efforts to mainstream adaptation across different governance levels, both sector wide and through vertical integration. Secondly, Bolivia received substantial funding and technical assistance from multilateral agencies to implement adaptation measures and build additional capacities within the water sector.

The paper is structured as follows. In sections 5.2 and 5.3 we describe the theory, objectives and methods applied for carrying out this case study. In section 5.4 we analyze the data and present findings. In section 5.5 we discuss the findings and contribution of this study to multi-level learning and the governance of adaptation research and draw conclusions.

5.2 Theoretical framework presented

Learning is considered a key mechanism for the governance of adaptation (Crona et al., 2012; Folke et al., 2005; Huntjens et al., 2012; Pahl-Wostl, 2009), and has also been identified as a key variable in multi-level governance studies (e.g. Armitage et al., 2010; Schout, 2009). Thus, it is reasonable to expect that effective adaptation requires policy processes that support learning across levels of governance (Adger et al., 2005; Pahl-Wostl, 2009; Pelling et al., 2008). The notion of multi-level learning draws on the conceptualization of multi-level governance (Hooghe & Marks, 2001) whereby governance of a particular territory is the result of complementary and overlapping jurisdictions across different governance levels such as global, regional, national, provincial, local.

The approach used in this study for assessing multi-level learning in the governance of adaptation builds on definitions of *policy learning* (e.g. Bennett et al., 1992; Hall, 1993; Sabatier, 1988) and *social learning* (Reed et al., 2010), with a focus on cognitive, normative,

and relational learning (e.g. Baird et al. 2014) between different governance levels as described in multi-level governance and adaptation governance literature.

Policy learning is frequently connected with the effectiveness and transfer of policy, see e.g. Kerber and Eckardt (2007) and (Newig et al., 2009). Policy learning is an important factor for policy change over time, resulting from the manner in which elites from different advocacy coalitions gradually alter their belief systems over time partially as a result of formal policy analyses and learning (e.g. Hall 1993; Sabatier 1988). Governments can learn from their experiences and modify their present actions on the basis of their interpretation of the outcomes of previous actions. In addition, policy learning can support policy transfer if lessons can be captured and transferred accordingly across different governance settings (e.g. Huntjens et al. 2011). This is highly relevant in the case of the emerging climate change adaptation regime where all countries are facing a new policy challenge.

In contrast, social learning has been described in adaptation governance literature as the convergent change in stakeholders' views, interests and positions with regards to a particular problem due to social interaction that goes beyond individuals towards collectives and social networks (Pahl-Wostl et al., 2007). Social learning requires, in addition to formal policy processes, networks and informal institutions if it is to lead to changes in actors´ preferences and re-conceptualization of their interests and identities. Social learning can then enable socialization processes and enhance the legitimacy and effectiveness of adaptation processes (Adger et al., 2005; Pelling et al., 2008; Rantala et al., 2014). In particular, the role of social learning in relation to adaptive capacity and adaptive governance has been emphasized (e.g. Folke et al 2005; Pahl-Wostl 2009).

In synthesis a definition of multi-level learning in the governance of adaptation, can be understood as the interplay of policy and social learning processes, producing changes in the cognitive, normative, and/or relational dimensions of learning across multiple governance levels on policy-relevant aspects of adaptation to climate change.

Drawing on the case study of the mainstreaming of adaptation in Bolivia´s water sector, the objective of this paper is to identify key institutional arrangements that promote multi-level learning in the governance of adaptation. The relevant literature on policy and social learning (Benson et al., 2012; Gerlak and Heikkila, 2011; Getimis, 2003; Sabatier, 1988), recognizes that multi-level learning processes are promoted or hampered by a series of factors, including: political and policy change , governance and the structure of the social network; the nature of supporting institutions and bridging organizations; technological and functional

aspects (e.g. procedures and tools to gather and share information); and exogenous perturbations (e.g. changes in market conditions, conflicts and natural disasters).

The entry point of our research on multi-level learning processes is the concept of multi-level learning nodes. This refers to institutionalized arrangements of social and policy learning practices and routines occurring across levels of governance.

These arrangements evolve over time generating incremental or transformational change in the *cognitive*, *normative* and *relational* domains of multi-level learning (e.g. Baird et al., 2014; Haug et al., 2011; Huitema et al., 2010). Changes in the *cognitive domain* are basically linked to the accumulation, acquisition, and re-organization of knowledge (e.g. Haug et al. 2011; Baird et al. 2014). Changes in the *normative domain* are linked to the need to standardize data, methodologies and tools for different purposes. In some cases, as described by Haug et al. (2011, p.9), this is related to reflexive learning, conceptualization and double loop learning. In the *relational domain* changes can happen in, for example, trust, the ability to cooperate and understanding of the mindset of others (Huitema et al. 2010; Haug et al. 2011).

The outcomes of multi-level learning in the end needs to be appraised in terms of the adaptive capacity and resilience within the water sector to deal with potential impacts of climate change (Adger et al., 2005; Gleeson et al., 2014; Huntjens et al., 2011).

The following guiding questions have been identified for achieving our research objective:

(i) Which institutional arrangements enable multi-level learning in the governance of adaptation in Bolivias´ water sector?

(ii) What are the cognitive, normative, relational dimensions of learning in these arrangements?

(iii) What are the implications of multi-level learning for shaping desired outcomes in the governance of adaptation?

5.3. Methodology presented

We use a qualitative, exploratory case study of mainstreaming adaptation in Bolivia's water sector as an example of (potential) multi-level learning in the governance of adaptation. The qualitative and exploratory case study is based on document analysis and interviews with key informants in Bolivia. The analysis focuses on the 2008 – 2018 period, which fits with the initiation of formal water sector climate change adaptation planning efforts (See Figure

5.1). The reason for this long time frame is the underlying understanding that the process of policy change, and multi-level learning therein requires a longer time perspective for observing incremental or transformational changes over time.

5.3.1 Outline of the case study

Adaptation policy in Bolivia has been predominantly defined by UNFCCC orientations and international funding. The country ratified the UNFCCC in 1994. Since then, Bolivia has implemented a series of policy instruments to promote adaptation. Climate change policy at the national level is put in place and operationalized by different departments of the Ministry of Environment and Water (Ministerio de Medio Ambiente y Agua or MMAyA). The mainstreaming of adaptation in the water sector falls under the same ministry.

The study period 2008 – 2018 falls within the administration of more than a decade of the Movimiento al Socialismo (MAS) in Bolivia, characterized by relative political stability and centralism. Despite serious institutional constraints in the water sector, this stability secured the continuation of water policies, including the conceptualization of ´water as a human right´ and three consecutive phases of the National Watershed Plan (Plan Nacional de Cuencas or PNC). The PNC is one of the main water sector policies and planning instruments. Water rights in Bolivia are still governed by an act of 1876 and a law of 1906. In the last decades many attempts to modify this framework failed due to sector lobbyist and social turmoil exemplified by the well documented water war in Cochabamba in year 2000 (e.g. Bustamante, 2004; Driessen, 2008).

During our study period Bolivia also led a global campaign to get Mother Earth Rights recognized in UN Forums. At home the government adopted the Mother Earth Framework Law (Law 300) in 2012 and established a ´Mother Earth Authority´ linked to the Ministry of Environment and Water (MMAyA) in charge of implementing adaptation programs and supporting the UNFCCC process. The operationalization of the Mother Earth Law was not rid of contradictions, an analysis of these factors would clearly go beyond the scope of this study, for additional information about this see (Aguirre et al., 2010; Hirsch, 2017; Villavicencio-Calzadilla et al., 2018). Linked to the new framework law was the ratification of the Paris Agreement with the submission of Bolivia´s NDC in 2016 and providing additional guidance to the sectors and territorial bodies to consider Mother Earth Rights.

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Such rights include the regeneration capacity of ecosystems and water bodies including the maintenance of critical environmental functions of the water cycle.
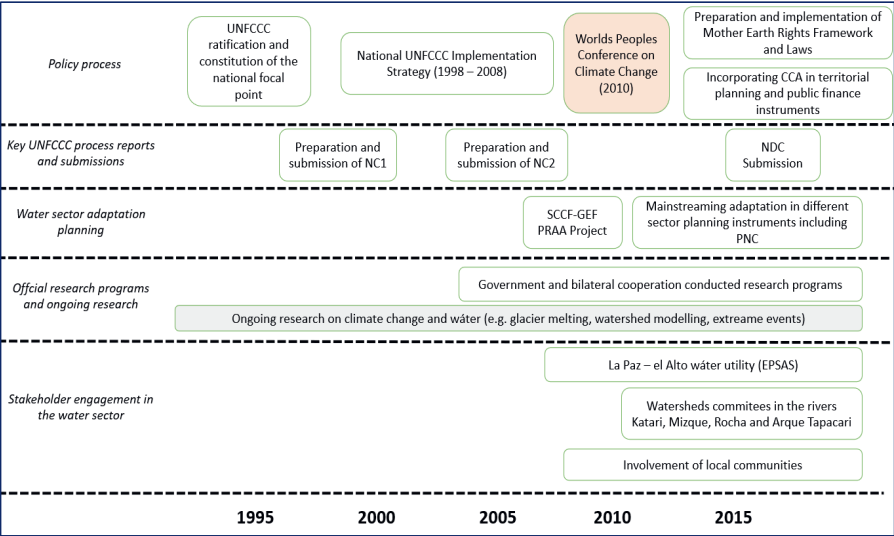
Figure 5.1 Timeline of climate change policy implementation in Bolivia´s water sector

The rows represent the formal efforts of the Bolivian government in relation to climate change policy and mainstreaming efforts of the water sector.

The concerns about adapting to climate change in Bolivia's water sector have been expressed in early policy documents (e.g. ENI and NC1) [See Table 5.2 and Table S5.1 in the Supplementary materials for a full reference of policy documents used in this study]. Bolivia has developed an adaptation agenda within the water sector since the preparation of First National Communication NC1 in year 2002. In particular glacier melting attracted the interest of scholars, policy makers and the media. Early research conducted along the Andes by glaciologist and hydrologists (e.g. Francou et al., 1995; Ramírez et al., 2001; Wagnon et al., 1999) highlighted potential risks of glacier retreat for water provision systems in major cities along the Andes in particular the city region of La Paz – El Alto (e.g. Soruco et al., 2015).

The water sector considers the impacts of climate change and adaptation in key policy documents at different levels of governance (e.g. SPCR; PNC II; ADA; PDC – Mizque), in particular the National Watershed Plan in its three phases from 2007 to 2020.

Two internationally funded projects supported efforts of mainstreaming climate adaptation in the water sector. In 2008, Bolivia, together with other Andean countries, received support

from the Global Environmental Facility's Special Climate Change Fund (GEF/SCCF) through the PRAA project (Spanish acronym of Adaptation to the Impact of Rapid Glacier Retreat in the Tropical Andes). The aim of this project was to better understand the implications of glacier retreat for water provision, irrigation and energy generation in the city region of La Paz – El Alto. In 2011 Bolivia submitted its Strategic Program for Climate Resilience (SPCR) funded by the Climate Investment Fund's (CIF) Pilot Program for Climate Resilience (PPCR). This program matches international climate funds with important public investments in the water sector and integrate adaptation in national policy instruments including the PNC.

The pilot activities of the SPCR both contributed to the integration of climate change adaptation concepts at the level of watershed planning efforts in priority watersheds such as the Katari, Mizque, Rocha and Arque Tapacari watersheds and enabled pilot interventions the water provision systems of, for example, La Paz – El Alto. These activities were intended to serve as testing measures for mainstreaming climate change adaptation into the water sector (SPCR pp. 56).

5.3.2 Data collection

Data has been collected from policy documents and semi-structured interviews. The selection of policy documents (see Table 5.2 and Table S5.1 in the Supplementary materials) for the analysis was undertaken via 'snowball' and 'opportunistic' sampling methods (Kemper et al., 2003). This involves selecting documents because of their relevance to the research but also being open to new leads that may emerge. The document analysis was complemented by 21 face-to-face semi-structured interviews with key stakeholders of the water sector in Bolivia conducted between 2014 and 2018. Interviewees (see Table 5.1) were identified considering PNC activities at different levels of governance. The governance levels were defined in the following way: global (e.g. multilateral processes including UNFCCC); international (e.g. international cooperation and bilateral agreements in Bolivia); regional (involving different countries of the same geographic region e.g. the Andean region); national (e.g. national policy processes in Bolivia); provincial or ´district´ (in the case of Bolivia including two levels *gobernación* and *municipio*); and the local level including local communities. The initial set of interviews were carried out between 2014 and 2017 and served to gain understanding about Bolivia's water sector context and for refining the set of questions for the second round of semi-structured interviews. In these interviews

only notes were made. A second round of 15 semi-structured interviews were conducted in 2018, these were recorded and transcribed.

Table 5.1 List of interviews – Bolivia case

No.	Code	Type of stakeholder	Governance level	Date
1	C01-14	Consultant	National	30/09/2014
2	C02-18	Consultant	National	04/06/2018
3	C03-18	Consultant	National / Regional / Local	14/06/2018
4	C04-18	Consultant	Regional	11/07/2018
5	CO01-18	Civi society	Local	13/06/2018
6	CO02-18	Civil society	Local	15/06/2018
7	G01-15	Government	National	22/09/2015
8	G02-16	Government	National	22/09/2016
9	G03-17	Government	Regional	18/10/2017
10	G04-18	Government	National	05/06/2018
11	G05-18	Government	National	11/06/2018
12	G06-18	Government	National	14/06/2018
13	G07-18	Government	Regional	2/07/2018
14	IC01-15	International cooperation	International	02/10/2015
15	IC02-17	International cooperation	International	25/04/2017
16	IC03-18	Government / International Cooperation	International	05/09/2018
17	IC04-18	Government / International Cooperation	International	09/08/2018
18	IC05-18	International Cooperation	International	17/08/2018
19	R01-18	Researcher	National / Regional	05/06/2018
20	R02-18	Research	National / Regional	25/06/2018
21	U01-18	Utility	Local	27/06/2018

Table 5.2 Policy documents - Bolivia case

Type of document	Short reference (code)	
	Law 300	Mother Earth Framework Law / October 2015
	ENI	National UNFCCC Implementation Strategy 1998 – 2008
	NDC1	Bolivias´ Nationally Determined Contribution
	NC1	Bolivias´ First National Communication
Policy documents	NC2	Bolivias´ Second National Communication
	PNC I	National Watershed Plan (2006-2012)
	PNC II	National Watershed Plan (2013-2017)
	PNC III	National Watershed Plan (2017-2020)
	PDC - Mizque	River Mizque Watershed Plan
	ADA	Water Agenda Cochabamba 2015 – 2025
Programs and projects	SPCR	Strategic Program for Climate Resilience (2011)
	PRAA	World Bank PRAA Report
	PNC I_Eval	Final Evaluation of PNC I
	PNC II_Eval	Final Evaluation of PNC II
Evaluation Reports / Reviews	PNC I_Lessons	Lessons from technical assistance to PNC I
	ACC – PNC	Mainstreaming climate change by PNC II_Consultancy work
	ACC – PNC (2)	Mainstreaming climate change by PNC II_Consultancy work (2)
Workshop minutes	PPCR T 2015	PPCR indicators evaluation workshop (2015)
	Perc. Sajama	Local adaptation perceptions in the National Park Sajama

5.3.3 Data analysis

The documents and interview transcripts/notes were analyzed with qualitative methods, using a set of codes identified through an hybrid process of inductive and deductive thematic analysis integrating data-driven codes with theory-driven ones (Fereday et al., 2006). An inductive process of grouping the codes resulted in a final set of codes that was reorganized according to the theory and research questions (see Table 5.3).

Table 5.3 List and structure of codes - Bolivia case

Major categories	Code group	Codes
Outcomes:	(G1) resilience of:	(1) infrastructure and investments (2) services and functions (3) communities (4) socio-ecological systems
	(G2) adaptive capacity of:	(5) the governance system (6) key stakeholders
Multi-level learning nodes (MLN):	(G3) policy nodes	(7) climate change policy (8) sector policy (9) summary reports (10) policy instruments
	(G5) knowledge nodes	(11) information service (12) analysis unit (13) training module (14) expert group
	(G4) platforms:	(15) planning platform (16) working group
	(G6) pilot interventions	(17) pilot watersheds (18) watershed management units (19) adaptation measures (20) testing measures
Learning domains	(G7) cognitive	(21) strengthening of scientific capacities (22) technical skills and knowledge (23) local, traditional and indigenous knowledge (24) evolution of the conceptual framework
	(G8) normative	(25) policy integration (26) priority setting (27) monitoring, reporting and verification (28) evaluation frameworks and tools standardization tool adoption (29) project guidelines
	(G9) relational	(30) stakeholder involvement (31) multi-level coordination (32) science – policy dialogue (33) knowledge dialogue

Guided by the three research questions, in a first stage, the focus was on identifying MLNs where adaptation related learning is taking place. In a second stage the analysis focused on obtaining the evidence that change in the *cognitive, normative and relational* domains of multi-level learning occurred in relation to these nodes. The following reading, analysis and discussion focused on gaining a better understanding of the implications of such learning for the governance of adaptation and its outcome in the form of enhanced capacity to address climate change challenges.

5.4 Presentation of the results

Multi-level learning about climate change adaptation in Bolivia's water sector is taking place across different governance levels, involving a variety of stakeholders, motivated by different policy processes including UNFCCC provisions, an evolving legal framework, national policy measures, academic research programs, social consultation and planning efforts, and on the ground implementation. The analysis revealed eight institutional arrangements that serve as nodes where multi-level learning for the governance of adaptation can be tracked along their cognitive, normative and relational dimensions. The identified multi-level learning nodes were grouped according to their functional characteristics into four different types: *policy nodes, knowledge hubs, planning platforms, and pilot interventions*. Each of these types are described in the text below and details are also provided in Table 5.4 and a summary in Figure 5.2 (See Table S5.2 for a more comprehensive summary of the findings).

Table 5.4 List of identified multi-level learning nodes in Bolivia´s water sector

	Policy nodes
PN1	The national UNFCCC focal point within the Mother Earth Authority (Autoridad Plurinacional de la Madre Tierra or APMT).
PN2	Two government bodies in charge of water resource planning: the Viceministry of Water Resources and Irrigation (Viceministerio de Recursos Hídricos y Riego or VRHR) and the Viceministry of Water and Sanitation (Viceministerio de Agua y Saneamiento Básico or VASB).

	Knowledge hubs:
KH1	National Information System on Climate and Water (SNICA) headed by the MMAyA to conduct nationwide technical studies needed for water resource planning.
KH2	The expert groups on infrastructure resilience headed by the National Director of Irrigation (Dirección Nacional de Riego) and supported by international cooperation bodies including research institutes and companies.
KH3	Two water research institutes: Institute of Hydraulics and Hydrology (IHH-UMSA) and Centro Agua – UMSS, both have played a relevant role conducting research about the impacts of climate change on water resources.

	Planning platform:
PP1	The River Mizque - Strategic Watershed Plan and Planning Platform has been selected by the SPCR as an established example of active adaptation governance promoted by the PNC and PPCR.

	Pilot interventions:
PI1	Activities promoted by the National Program of Educational Watersheds (cuencas pedagógicas) whereby adaptation measures will be tested on the ground and coordinated with local community actors to come up with a typology of potential interventions.
PI2	Pilot intervention models resulting from testing different project design concepts, the extraction of lessons and the exploration of means for scaling up e.g. the La Paz – El Alto water provision system.

The nodes are organized within the water sector and involve public institutions and policy mechanisms, the academic sector and multi-stakeholder processes.

5.4.1 Cognitive, normative and relational learning

The following elements have been identified by looking into the cognitive, normative and relational dimensions of multi-level learning in each of the selected institutional arrangements that serve as nodes for multi-level learning:

Policy nodes

Policy nodes P1 and P2 together are in charge of mainstreaming climate adaptation policy in the water sector. PN1 represents the work around the national focal point to operationalize existing policy instruments from the UNFCCC and translate them into a coherent climate change policy process in the country. The focal point periodically reports about progress in policy implementation such as the national communications and Nationally Determined Contributions (NDCs). It thus relates with other stakeholders such as the academic sector, the private sector and local communities. They have a central role in identifying knowledge gaps and building capacities for testing and implementing adaptation measures and policies. The scope of Law 300 includes provisions to restructure the institutional setting for addressing climate change, which in the period of analysis were not completely put in place (Interview G05-18).

PN2 represents the policy and normative work of two ministerial departments in charge of water policy and planning for watershed protection and irrigation in the case of VRHR and drinking water purposes in the case of VASB. The aim is that climate change adaptation considerations will be integrated through this. Water uses will be planned in a bottom-up way according to watershed features and the needs of different users and stakeholders involved in watershed management. Due to the lack of an authoritative legal framework that regulates water uses the PNC has been adopted and maintained along the period of analysis (see PNC I; PNC II; PNC III), as a main instrument for water resource planning and achieving stakeholder consensus.

Policy nodes (PN1 and PN2) play a role in the definition and implementation of climate change policies in the water sector, in particular PN1 has a broad overview of all climate related research and adaptation activities being implemented. Changes in the *cognitive domain* are prompted by the need to better understand the effects of climate change on water

resources (e.g. interview IC01-15; IC02-17; R02-18), and to develop and implement effective adaptation measures. Such measures include, in particular, learning about the technical and economic feasibility, social acceptance and institutional aspects of adaptation (interviews G03-17; IC04-18; U01-18).

Changes in the *normative domain* are linked with the operationalization of key adaptation concepts. For example, the operationalization of ´*Mother Earth Rights*´ (e.g. Law 300) at the level of policy instruments requires an immense normative effort to clarify the concept and make it applicable. The incorporation of Mother Earth Rights in territorial planning tools has required the characterization of critical ecosystem functions and the application of adequate metrics that reflect those values on national adaptation monitoring and reporting (interview G05-18, IC05-18).

Another emerging concept with important normative implications is ´*resilience*´ which expands the conceptualization of adaptation and links it to the methodological experience of disaster risk reduction (e.g. Begum et al. 2014). Climate adaptation mainstreaming efforts in the water sector, such as the ones promoted by international climate funding instruments e.g. PPCR, have been driven by the concept of resilience. They have called for a better integration of climate change adaptation and resilience at the level of sector planning and implementation interventions (e.g. SPCR pp.7; interviews G04-18; IC04-18). Changes in *relational domains* are triggered by the need to strengthen links between different concerned stakeholders, including cross level coordination mechanisms between different actors of the water sector, thus producing the institutional and social structure for multi-level learning. There is an expected level of formal coordination between PN1 and PN2, however this relationship was very often constrained due to political dynamics, which hampered the implementation of capacity building and information components of the SPCR (interviews G04-18 and C02-18).

Knowledge dialogue between different stakeholders, but also science – policy interactions at national and subnational levels, are particularly important for relational learning according to government officials and researchers (e.g. interviews G04-18; R02-18). For example, PN2 has interactions with research bodies (KH3) though institutionalized knowledge interfaces (KH1 and KH2), promoting science-policy dialogues. The node PN2 also incorporates views and interest of other concerned stakeholders through planning platforms (e.g. PP1) and educational watersheds on the ground (PI1) benefiting the incorporation of local and traditional knowledge.

Knowledge hubs

Knowledge hubs are organized to fulfill roles of generation, maintenance and transference of relevant knowledge and information. In the case of KH1 and KH2 these are oriented to produce concrete knowledge products to support planning processes and projects on the ground. In the case of KH3 there is a direct involvement in the generation of scientific knowledge.

Changes in the *cognitive domain a*re linked with the need to better understand the implications of climate change for water resources and how to better respond: "The initial `pure research` attempts of Bolivian scientists to better understand the adverse effects of climate change on water resources has combined with the need to apply research findings at the level of sector planning and infrastructure design" (interviews R01-18; R02-18). This creates multi-level learning through collaboration among researchers and practitioners on the ground (interviews G04-18; R01-18). Cross-level (vertical) integration is recognized as key to enhance the capacity of research centers and permit adequate capacity building in particular including the international level: "with funds of the PPCR we received the support of international research centers to carry out climate change modelling, however, due to the lack of research infrastructure and human resources, we only have restricted access to the information base and its potential for climate change studies" (interview C03-18).

Changes in the *normative domain* are linked to the need to standardize data gathering efforts and develop methodologies and tools for different purposes. This is particularly important for KH1 that has the function to translate best available data and research findings for decision making and investments in the sector (interviews C02-18; R02-18). Standardization happens at different levels. In KH3 scientists are encouraged to apply the same tools and methods to make studies from different contexts comparable (R01-18; R02-18). In KH2 project guidelines, tools and methods are used for infrastructure project design and for extensive training of practitioners in the field. The normative value of tools and methods is well captured in the following quotation of one of the experts interviewed: "International cooperation bodies want to get their tools and methods implemented and there is a lot of competition" (interview IC04-18).

Changes in the *relational domain* are linked to collaboration efforts and coordination happening among different stakeholders across levels of governance. The emerging networks resulting from multi-level collaboration within knowledge hubs (in particular KH3) spawn from collaborative research programs that involve national and international

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scientists (R01-18; R02-18) to science policy interfaces (KH1 and KH2) that translate scientific knowledge for the purpose of water planning efforts and decision making on the ground. Particularly relevant are the collaborative efforts between scientists and policy makers at different levels of governance to fill critical data and information gaps (interviews C02-18; G04-18; G06-18). Another example is the science – practice interface that aims to better incorporate local knowledge and practice about the implications of climate change for livelihood systems and to enable local adaptation decision making on the ground, retrofitting learning processes at the level of policy decision making (interviews R02-18; CO02-18; G01-15).

Planning platforms

Planning platforms, such as PP1 that serves as an institutionalized stakeholder consultation space, are expected to serve as instruments for the governance of water resources. Multi-level learning results from the interaction of different types of stakeholders including, for example, ministry officials, municipal government authorities, and different types of water users, water experts and civil society groups. In PP1 active adaptation governance is promoted by the PNC and PPCR (see SPCR; PNC II; PDC-Mizque).

Changes in the *cognitive domain* are related the the learning obtained by testing the applicability of adaptation planning instruments in selected watersheds of different scales in coordination with relevant stakeholders at different levels of governance (e.g. PNC II pp. 36-37; PNC I_Eval; PNC II_Eval). The node KH1 integrates climate change scenarios in watershed planning platforms in order to inform different stakeholders about the future of water resources (e.g. ACC – PNC; ACC – PNC (2); interviews C02-18; G07-18; R02-18). There was strong support from respondents across governance levels, both government officials and consultants, that climate scenarios are critical to increase the level of understanding and confidence about potential impacts of climate change (interviews G03-17; G06-18; C02-18; C03-18).

Changes in the *normative domain* are related to the approaches to and experiences of integrating adaptation to climate change and resilience as a main outcome of watershed planning efforts (see PDC–Mizque). Enhanced PNC policy instruments such as KH2, PP1 and PI1, are intended to make public infrastructure investments and local livelihoods ´more resilient´, and take into consideration climate related variables for the governance of water resources such as the availability and priority setting about the distribution of water resources among different users under climate change scenarios (KH1). An illustration of the

difficulties to apply data and climate models outcomes is this statement by a government official involved in watershed planning "we have achieved very little progress in integrating climate models for decision making purposes at the level of watershed planning" (interview G07-18).

Changes in the *relational domain* are triggered by stakeholder engagement. A respondent argued that "key to the success of planning efforts is to ensure transparent means of representative participation" (interview C0418). Relational learning result from multi-stakeholder dialogue and negotiations initiating social learning, at the level of watersheds, about the implications of both climate change for the future of water resources but also about the adoption of possible measures to reduce potential risk (interviews; G07-18; C04-18; CO02-18). The involvement of the academic sector, NGO´s and local communities in advocacy campaigns and training enhance the opportunities for social learning. One of the practitioners interviewed combine knowledge generated in the labs with the knowledge, real needs and interest of water users "in terms of droughts, we know who has water and who does not, but we do not know how much it will worsen in some sectors due to climate change, because the modeling is so diverse in its results, but calculating for the worst, there will be more shortages, mainly in the high valley." (Interview C04-18).

Pilot interventions

Pilot interventions such as PI1 and PI2 happen with strong support and guidance from the government in the case of PI1, and without direct supervision from government departments, but guided by regulations and the participation of interested stakeholders in a particular sector, like PI2.

Changes in the *cognitive domain* are for this category of multilevel learning nodes related to the knowledge gained in PI1 and PI2 by testing and putting in place adaptation project intervention models. The expectation is to use to models and lessons learnt from interventions to influence national programs or sector regulations to promote enhanced resilience. Learning from practice is an adopted mechanism by educational watersheds "[p]ilot interventions in educational watersheds, serve to gain experience and refine how to integrate climate resilience by different planning instruments" (interview G01-15).

In PI1 the involvement of indigenous and traditional knowledge is key with important *cognitive*, *normative* and *relational* learning implications in the way adaptation related knowledge is structured and applied in local decision making. The value of indigenous

knowledge for the design and application of adaptation models and therefore the active involvement of local actors is well recognized (e.g. interview IC01-15). For example, local communities are aware about the potential impacts of climate change and the priorities to guide the design of adaptation measures as exemplified by this quote from a local community member: "This problem (climate change) is causing a lack of water, …the water in the lake dropped by more than a meter,…this is a fact that is not only appreciated by the information (e.g. climate data), but visible to the entire population" (interview CO02-18). Lessons are extracted to evaluate and consolidate successful interventions models that can be scaled up through policy advocacy and training (interview C01-14). In contrast PI2 intervention models are developed with strong support from science and scientific information, and therefore with the involvement of experts and researchers. In this case cognitive learning is the result of incremental changes resulting from the integration of climate change adaptation at the level of intervention projects. Changes in the normative domain at this level are related to the design of intervention project guidelines, catalogues, and project typology for integrating climate change adaptation considerations. The effectiveness of such interventions will be assessed regularly together with involved stakeholders (e.g. PNC_I_Lesson; interviews G01-15; IC03-18). Changes in the *relational domain* are prompted by the interactions of different types of stakeholders at the project level where different types of knowledge combine to produce an intervention model. In PI1 the formal involvement of local community representatives is key to influence decision making at the provincial/district level (Perc. Sajama; CO01-18). In the case of PI2 the involvement of, for example, `expert` consultants and operators such as the water utility operator requires concrete measures that respond to sector regulation standards, risk analysis and economic feasibility: "Our main concern is to ensure the reliance of the system in drought situations" (interview U01-18).

Looking at the linkages and relationships between multi-level learning nodes, the analysis reveals (as shown in Figure 2) strong interactions between climate change policy operationalization (PN1) and water sector policy (PN2). Vertical integration in the water sector coordinated by water sector bodies (PN2) has the potential to learn from the implementation of different institutional arrangements organized across levels of governance such as KH1, KH2, PI1 and PI2. The interactions of nodes provide interfaces between different ´knowledge domains´ including clear linkages between science and policy in the case of KH1, but also between practitioners in the field and the private sector as in KH2.

The incorporation of different stakeholders' views in planning platforms (PP1) enables pilot interventions, such as PI1 and PI2, to incorporate the view of sector experts and indigenous and traditional knowledge. This provides the opportunity for multi-level learning about the technical, regulatory and socio-economic implications of adaptation measures.
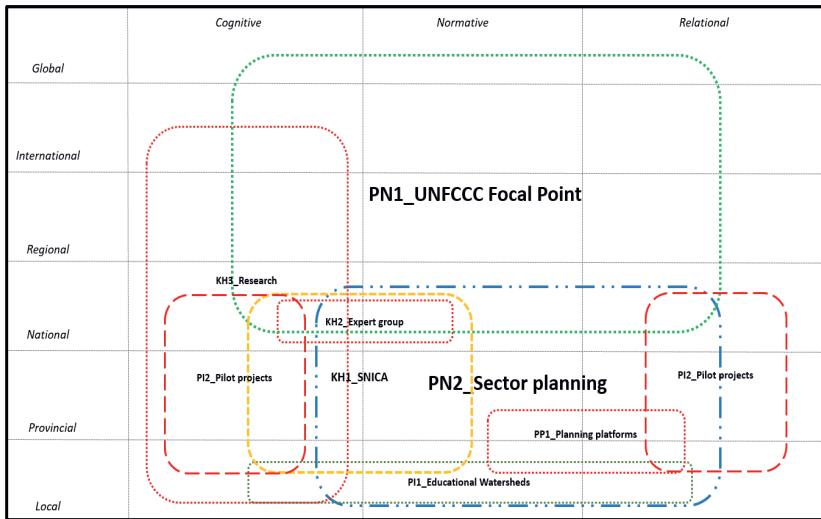
Figure 5.2 Linkages between different multi-level learning nodes in Bolivia´s water sector

Each node in the figure is represented by its cognitive, normative and relational dimensions across different levels of governance. The overlap does not necessarily show formal relations.

Analyzing the multi-level learning processes in the water sector illustrated in Figure 5.2 shows inter-linkages among the different institutional arrangements across levels and learning dimensions. *Cognitive learning* within the sector is basically prompted by the need to better understand the adverse effects of climate change on water resources. This has given a dominant role to climate scientists and research collaborations at different governance levels ranging from local to international research programs in the case of KH3, and testing adaptation measures on the ground in the case of PI2 with the assistance of climate and water `experts`. The accumulated knowledge, resulting from this interactions serves also to respond to questions related to the integration of adaptation and resilience on water resource planning articulated and coordinated by PN2 throughout different policy measures and institutional arrangements (e.g. KH1, KH2, PP1, PI1).

The value of the contribution of climate change funding instruments such as PRAA and PPCR for adaptation capacity building and learning is stressed by different respondents (R02-18; G04-18; G06-18; IC04-18). For example researchers involved in those activities

recognize the enhanced role of providing climate related knowledge products to planning processes in the water sector: "We initiated our work by running hydrological and climate models, now we are called to provide services to water infrastructure projects and participate in planning efforts like the Water Master Plan in the city of La Paz" (interview R02-18). These projects have put in place and strengthened research capacities (*cognitive*), for example to better understand the potential impacts of glacier retreat in the city region of La Paz – El Alto (R02-18). The projects also served to adjust a set of guidelines and regulations to integrate that knowledge by planning of critical infrastructure and water provision operations (U01-18). There has also been enhanced collaboration among different stakeholders to fulfill new and additional tasks like incorporating the results of climate scenarios in decision making, resulting in multi-level learning at different levels of governance and enhanced capacity to deal with climate related challenges.

In the *normative domain* of learning, changes are reflected in the evolution of definitions integrated in policy and planning instruments by PN1 and PN2. Changes are also reflected in the design and formal adoption of tools and standards to approach solutions such as guidelines for incorporating climate change adaptation by interventions projects carried out by KH2 and PI2. Changes in the *normative* domain also reveal the existence of reflexive functions to evaluate success and reevaluate approaches, for example in the interface of PN1-PN2-PI2. The following quote from a climate change expert reveal the perceived need for more reflexive approaches: "We enhanced the storage capacity of the dam, but despite the fact that now the farmers are going to have much more water, they do not want to share it with the municipality to provide to hospitals and schools benefiting their own families and children" (interview IC04-18).

With regards to changes in the *relational domain*, the cross-level network of water sector stakeholders concerned with climate change adaptation has increased its complexity year by year. The review of the emerging network highlights links and gaps in the relations between principal stakeholders, for example the role of climate scientists in the design and implementation of policy and planning measures. However the role of nodes with bridging functions such as KH1 and PP1, to combine different knowledge domains is stressed.

5.4.2 Multi-level learning outcomes and implications

There is a considerable level of consensus among respondents that with the implementation of the UNFCCC and internationally funded projects in Bolivia, key stakeholders such as policy makers, scholars, civil society groups, the press and the private sector have increased their level of knowledge and understanding about the need of climate change adaptation. This increase in the knowledge and understanding of the relevance of adaptation has occurred at and across levels of governance through multilateral processes, international cooperation, national policy making, watershed planning involving provincial and local levels and more (e.g. interviews G03-18; IC05-18; CO01-18). An interview with a climate expert (IC04-18) highlights the role of multi-level learning for building the capacity needed to respond to climate change: "There are different levels at which we have to work, and those need to be articulated…capacity development is a continuous process with continuous experience sharing and learning at the same time".

Multi-level learning should enable behavioral changes in the population. This is recognized as more difficult. For example a water utility operator recognizes that after a climate related disaster happens: "[L]earning is not always happening in broad segments of society, the memory is short, and people repeat the same behavior that increases risk" (interview U01-18).

Multi-level learning is embedded in policy and social processes that sustain desired outcomes of adaptation in the water sector. The desired outcomes include: enhanced institutional capacities to deal with climate change (interview G05-18; G04-18; IC04-18; IC05-18); better understanding and knowledge (interviews R02-18; IC05-18); better operationalization of policy measures (interviews G01-15; G06-18); and enhanced dialogue between different knowledge domains (e.g. interviews G01-15; G04-18; R02-18; IC04-18). Furthermore, these desired outcomes are also expressed in terms of enhanced resilience of infrastructure and investments (interview IC04-18) and the resilience of services and functions (e.g. interview U01-18).

Multi-level learning in Bolivia's water sector for the governance of adaptation has important implications for shaping the general adaptation agenda of the country, for example in the context of its National Adaptation Plan (NAP) because it is an early sector wide mainstreaming adaptation experience of the country (interviews G04-18; R01-18; IC01-18). Some of the interviews highlight that this experience enables the Bolivian government to

5

scale up and possibly leverage additional climate investments for similar transformations in other sectors (interviews G05-18; IC05-18). In particular, coordinated efforts to climate proof public investments in different sectors, is emphasized as an opportunity for this (PPCR T 2015; interviews G06-18 and IC04-18).

In addition to the policy driven process of multi-level learning that dominates the spectrum of multi-level learning for the governance of adaptation in the water sector of Bolivia, there are also some who consider that enhanced stakeholder engagement on adaptation has led to social driven processes of multi-level learning (interview IC02-15; IC05-18). Such social driven multi-level learning processes present in public debates would have a broad range of implications for adaptation governance, ranging from concerns about the impacts of water pollution in water bodies (Interview CO02-18; ADA); the environmental and social impacts of maladaptation in infrastructure projects (Interviews CO01-18; IC04-18; U01-18) and the reinforcement of land use regulations, including riverbank protection to reduce the risk of floods and reforestation projects to recover water tables and protect watersheds (Interviews CO01-18; CO02-18; IC05-18).

5.5 Discussion and conclusions

The objective for this paper was to assess the institutional arrangements that enable multi-level learning for the governance of adaptation in the case of Bolivia´s efforts to mainstream climate change adaptation in the water sector. We assessed multi-level learning processes in eight institutional arrangements organized across levels of governance during a period of ten years in their cognitive, normative and relational dimensions. The study served to better understand the role of those institutional arrangements. Helpful for this purpose was our typology of multi-level learning nodes organized across different levels of governance that performed different functions in the context of the governance of adaptation. Such functions included, among others, the pursuing of incremental changes in knowledge generation capacities; bridging science – policy interfaces that support the operationalization of adaptation policies, vertical integration by testing implementation measures on the ground and providing an enabling environment for social learning through participation of relevant stakeholders in open debates. All these functions contribute to multi-level learning; learning across levels of governance.

The multi-level learning lens permitted the analysis of *policy learning* processes, organized across different levels of governance, producing important changes at the level of

institutions. But it also permitted obtaining evidence of emerging forms of *social learning* processes about the implications of water policies in the context of future climate change scenarios in public debates.

The analysis highlights possible entry points and methods for the operationalization of multi-level learning in the governance of adaptation. The methods applied in this study, look into the functions and inter-linkages of multi-level learning nodes, suggesting that a network perspective is valuable to assess multi-level learning, in particular the types of learning that contribute to transformational change (Huntjens et al., 2011; Pahl-Wostl et al., 2013). On the other hand, the study also served to better understand the role of multi-level learning for facilitating the process and outcomes of adaptation governance (see e.g. Armitage 2008; Pahl-Wostl et al. 2013). In particular, it served to better understand possible approaches to tackle other central questions in the governance of adaptation research, for example about the factors that promote transformational change needed at the level of institutions for effective adaptation where multi-level learning is a key variable (e.g. Tschakert and Dietrich 2010; Termeer et al. 2017).

Multi-level learning processes supported by specific institutional arrangements organized across levels of governance are central for sector-wide transformations. The water sector case highlights potential avenues for policy integration of adaptation in other sector, considering similar multi-level learning and governance challenges to operationalize policy, in the Bolivian context and beyond (Burton et al., 2007; Persson, 2008). Moreover, the study highlights possible entry points for policy transfer of multi-level learning capacities between countries (e.g. Kerber and Eckardt 2007). For example, applying the same approach to understand the role of multi-level learning for the effective exchange of experiences between countries about policy integration which is highly relevant for operational UNFCCC policy instruments.

This case study is circumscribed by unusual conditions of continuity in public sector policies, providing fertile ground for UNFCCC policy driven processes and international climate finance to produce enhanced institutional capacities across levels of governance. This situation, strongly determined by the continuity of the government administration during the study period, is not common in developing countries where multi-level learning processes are likely to be much more challenged by situations of policy discontinuity or disruption.

Nevertheless, this research piece has mainly focused on analyzing the institutional arrangements that enable multi-level learning processes and rather than the quality of the

outcomes of such learning. This means we have only scratched the surface in relation to assessing the effectiveness of multi-level learning in producing transformational change for enhanced resilience and adaptive capacity which is still one of the central questions in adaptation governance research.

5

CHAPTER

6

Synthesis

6.1. Chapter outline

This dissertation's objective is to better understand the role of multi-level learning in the governance of adaptation and how it could be enhanced. In this sense, this dissertation seeks to contribute to the discussion on the governance of adaptation in general and on multi-level learning in governance processes across different levels of governance in particular.

The synthesis chapter is organized according to the four research questions that have guided this research work.

- RQ1. How to conceptualize multi-level learning in the governance of adaptation based on the social learning and policy learning literature?
- RQ2. What are the factors that encourage multi-level learning in the governance of adaptation?
- RQ. Where and how does multi-level learning occur in the governance of adaptation in the Latin American context?
- RQ4. How can multi-level learning be enhanced and what are the implications for the governance of adaptation?

In section 6.2. an overview of the main findings and contributions of this dissertation is presented. In section 6.3. the answers to the four research questions are summarized, highlighting the contribution of this dissertation to the discussion presented in academic literature. In section 6.4. a reflection on research design, limitations and orientations for further research is summarized. And in 6.5. the policy implications of this dissertation are analyzed and recommendations for the climate change adaptation regime outlined.

6.2. Summary of main findings and contributions

In alignment with the objective of this thesis, which aims to understand the role of multi-level learning in adaptation governance and explore strategies for its enhancement, this research came up with following findings and contributions:

Initially, this dissertation contributes to the conceptualization of multi-level learning through a review of the most promising theoretical approaches that have important implications for how multi-level learning in the governance of adaptation can be assessed.

A literature review served to build a definition of multi-level learning based on social learning and policy learning approaches. The definition was expanded into a framework that

conceptualize multilevel learning as the interplay of social learning and policy learning processes assessed in its cognitive, normative, and/or relational dimensions, as the result of interactions between individuals and institutions from different governance levels on policy-relevant aspects of adaptation to climate change.

Analyzing various case studies across different multi-level settings confirms that three pivotal factors significantly shape multi-level learning in adaptation governance. These factors include the international adaptation regime, the configuration and connectivity of nodes that facilitate multi-level learning – defined as multi-level learning nodes, pinpointing the governance levels involved within this framework, as well as the learning culture expressed through the state and trends in the cognitive, normative, and relational dimensions of multi-level learning, alongside the direction of multi-level interactions.

The analysis results differentiate factors enabling multi-level learning from the desires, aspirations and motivations that drive it. Cases illustrate how the imperative to understand climate change implications propels learning across governance levels. Similarly, policymakers' expectations for coherence, effectiveness, and efficiency drive continual adjustments, fostering multi-level learning. Additionally, innovation emerges as both a key outcome and driver of multi-level learning in the case studies.

Multi-level learning analyzed trough different cases of adaptation governance in Latin America, encompassing different multi-level governance settings, evidence shifts in the structures of social networks and incremental adjustments in the functions of multi-level learning nodes. The examination of cognitive, normative, and relational dimensions of multi-level learning reveals their intricate connection to adaptation governance. These changes play a pivotal role in bolstering institutional capacities for adaptation and furthering adaptation objectives.

The case studies demonstrate, in a timeline, an increase in the diversity of actor types involved in the governance of adaptation over time, and enhanced levels of complexity of interactions across various governance levels, spanning from local to global and vice versa. While there is an evident intention to continuously engage actors across these governance levels, notable gaps remain concerning the insufficient roles of national and local actors in advancing adaptation agendas. On the other hand, national actors are assuming increasingly passive roles in adaptation planning processes, as these processes are defined by international cooperation programs and technical assistance.

The multi-level learning nodes analysed play distinct roles within the context of adaptation governance. Some nodes serve to channel necessary multi-level interactions for policy formulation, while others are geared as "knowledge hubs" towards advancing and broadening the level of information and knowledge within the system. Additionally, certain multi-level nodes facilitate interactions among actors in the processes of planning and innovating adaptation measures.

Building upon these findings, multi-level learning can be enhanced by addressing the identified key factors. Multi-level learning nodes are pivotal in shaping the social and institutional structures of adaptation governance, while changes in cognitive, normative, and relational dimensions of multi-level learning influence the learning culture and the capacity of governance systems to instigate adaptation actions. It is acknowledged that besides the cognitive dimension, which has been addressed as a central aspect in all adaptation processes, it is important to see incremental changes in the normative and relational dimensions in adaptation processes, linked to action and enhanced level of collaboration among the actors.

In conclusion, this dissertation enhances the analytical frameworks for evaluating multi-level learning within the governance of adaptation, offering insights into institutional design and adaptive capacity enhancement.

6.3. Responding to the research questions

RQ1. How to conceptualize multi-level learning in the governance of adaptation

Responding to RQ1 about the conceptualization of multi-level learning in the governance of adaptation, this research contributes to the conceptual framework for analysing and understanding multi-level learning in adaptation governance, making a contribution to the discussion about the governance of adaptation and learning (e.g. Huitema et al., 2010; Huntjens et al., 2012; Pahl-Wostl, 2009).

Interplay of social and policy learning – A definition of multi-level learning

The first element in the conceptualization of multi-level learning in the governance of adaptation is the interplay of social and policy learning in policy relevant aspects of adaptation to climate change.

On the one hand, social learning (Ison et al., 2015; Reed et al., 2010; Siebenhüner et al., 2016) generates learning through the interaction of different social actors on a given issue. Those actors generate shared knowledge and views that influence the discourse of a network of actors. Social learning can also serve to broaden the participation of different stakeholders and invite them to share their point of view and to take action favouring changes in behaviour and culture.

The policy learning processes linked to improving the design of public policies allow governments to evaluate the impact of their actions and policies and learn from them. For some scholars, social learning processes occur horizontally, involving different actors without an apparent hierarchy, while policy learning processes occur within an established structure and hierarchy, for example the learning that results from a public policy evaluation (Wenger, 2011). Policy learning processes generate social structures or coalitions that advocate for policy change (Sabatier, 1988) or generate the necessary changes in paradigms that produce changes in policies (Hall, 1993).

The interplay of social learning and policy learning informs the conceptualization of multi-level learning processes in the governance of adaptation. We have conceptualized multi-level learning as the interplay of social learning and policy learning in its cognitive, normative, and/or relational dimensions, as the result of interactions between individuals and institutions from different governance levels on policy-relevant aspects of adaptation to climate change. The assumed goal here is to enhance the capacity of individuals and collectives to respond to the challenges posed by climate change as outlined in Chapters 3, 4 and 5.

Multi-level learning nodes

A second concept that emerges from this dissertation is the concept of multi-level learning nodes defined as institutionalized or informal arrangements of social and policy learning practices and routines occurring across governance levels (Gonzales-Iwanciw et al., 2021).

One of the fundamental notions of multi-level learning in the governance of adaptation is that it occurs through networks organized across different levels of governance. The scholarly literature has suggested different concepts to describe this type of interactions like network governance (e.g. Robins et al., 2011), polycentric governance (e.g. McGinnis, 2011; Ostrom, 2010) and in similar terms multi-level governance (Armitage, 2008; Gupta, 2007).

Through the case studies it becomes evident that the most significant interactions come together in multi-level learning nodes. In turn, those nodes organized spanning different levels of governance establish a complex multi-level architecture that to a large extent defines where and how multi-level learning occurs across levels as shown in Chapter 3, 4 and 5 of this dissertation.

Cognitive, normative and relational dimensions of multi-level learning

Multi-level learning can be assessed from the changes brought about in the governance regime to improve its capacity and performance to face the challenges of adaptation (e.g. Pahl-Wostl 2009; Ison et al. 2015).

The literature has suggested differences between cognitive, normative, and relational learning processes (Baird et al., 2014; Huitema et al., 2010; Munaretto et al., 2012). There is a difference between the changes in the cognitive dimensions like the acquisition of knowledge and the normative dimension of ethical values i.e. how individuals and organizations make judgments about right and wrong. Others have pointed to relational dimensions underscoring issues such as trust building, the ability to collaborate, and ability to understand the views and knowledge of others.

According to the typology of policy learning suggested by Huitema et al. (2010) cognitive learning is linked to the factual learning without changing underlying norms, values, belief systems; normative learning encompass a change in norms, values, and belief systems and relational learning results from enhanced trust, and improved understanding of the mindsets of others.

RQ2. What are the factors that encourage multi-level learning in the governance of adaptation?

Responding to RQ2 about the factors that encourage multi-level learning in the governance of adaptation. This is a central question in the literature of social and policy learning (e.g. Armitage et al., 2018; Gerlak & Heikkila, 2011) and so it has been for this dissertation.

The enabling factors

Three major factors that enable multi-level learning in adaptation governance have been confirmed through this dissertation: i) the international adaptation regime; ii) the structure of multi-level learning nodes and the interactions across levels of governance involved in

that structure; and iii) the learning culture and learning strategies adopted expressed in the cognitive normative and relational dimensions of multi-level learning and the direction of such learning.

First, the case studies provide relevant evidence about multi-level learning encouraged through legal and normative instruments across different levels of governance. A set of UNFCCC decisions like the LDC Work Program, the Nairobi work programme on impacts, vulnerability and adaptation (NWP), the Cancun Adaptation Framework (CAF) and the Paris Agreement basically build the legal-technical framework for adaptation across levels of governance and enable multi-level learning in various ways. For example, as presented in Chapter 3 and further analyzed through the cases in Chapters 4 and 5, the NAP process is the central axis of adaptation governance conceived in the CAF (See Figure 6.1). Through the NAP, global bodies such as the Adaptation Committee or the NAP Task Force analyze the global experience of various NAPs being implemented in the world and develop guides and training processes to conduct and adjust them to the emerging needs. The same NAP processes serve to establish governance mechanisms at the national level, involving different actors in carrying out concrete adaptation measures, evaluating the results and adjusting public policies as well as reporting progress and needs to the global level of the UNFCCC. The NAP process thus enables multi-level learning between the global and the national level.

Second, responding to those legal and institutional requirements an emerging structure or network of multi-level learning nodes across different levels of governance build over time. Figure 6.1 shows, schematically represented, the multi-level learning nodes influencing the NAP process in the governance of adaptation.
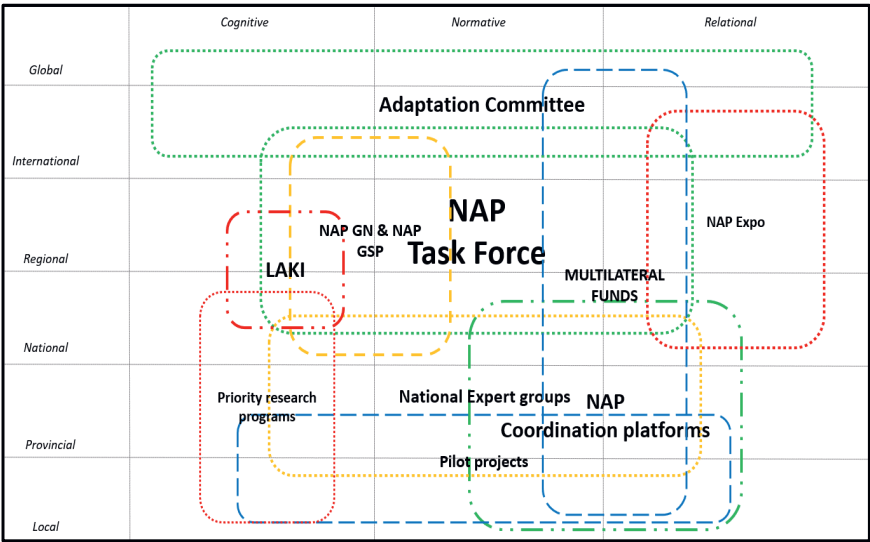
Figure 6.1 Key multi-level learning nodes in the governance of adaptation

The figure generically shows the most representative multi-level learning nodes present in adaptation governance. In green are those aimed at defining and guiding public policies, in red are the nodes that play a role as knowledge hubs, in yellow are the nodes aimed at providing technical assistance and adaptation planning and in blue are the nodes aimed at the implementation of adaptation measures.

Figure 6.1 displays the main nodes of multi-level learning identified in the planning processes of a National Adaptation Plan (NAP) across various governance levels, addressing different dimensions of multi-level learning. As seen in the figure, some nodes are located in the cognitive quadrant, while others pertain to normative and relational dimensions.

Analyzing the structure of the social network (See as an example Figure S4.1 in the Supplementary materials) provide the elements to better understand areas of multi-level collaboration or multi-level learning nodes, but also potential asymmetries and gaps among the actors, the lack of collaboration in certain areas exposing the social dynamic and potential means to bridge the gaps and enhance multi-level learning. The cases illustrate that adaptation agendas remain heavily influenced by public policy priorities and international funding, resulting in overlooked sectors or underserved regions and communities. Additionally, they highlight disparities in the influence of various actors in shaping adaptation priorities, underscoring the imperative to amplify the voices of marginalized stakeholders.

Third, the case studies also highlight the features of the predominant learning culture; whether learning is strongly linked to public policy processes and therefore more linked to

'top-down' policy learning approaches or rather these are 'bottom up' social transformation processes.

Looking into adaptation, the cases studied show that cognitive dimensions of multi-level learning are emphasized at the beginning of a process, since the actors have the need to review factual information and understand potential implications of climate change. The data also signal that to unlock collective processes of appropriation and agency, it is crucial that the normative and relational dimensions of multi-level learning are disseminated across various levels of governance.

These findings relevant for the governance of adaptation overlap with those found in in the literature that basically presents that in governance settings learning is encouraged by different factors (Armitage et al., 2018; Gerlak et al., 2011) such as: structural conditions including legal structures, the communication gaps in a social network and physical conditions for example distance and barriers; the actual dynamic of social interaction including the frequency of gatherings, the affinity among participants and the resulting culture of social interactions; other factors that are in the technological field such as the application of communications and information technologies; and exogenous factors, external to the governance system such as the unexpected impacts of climate change or the economic and social crisis that trigger learning.

How do adaptation goals drive multi-level learning?

The framework utilized for analyzing the data differentiates between the factors that enable multi-level learning and those aspirations, desires or objectives that motivate and drive learning .

For example, one important notion for assessing learning in governance systems is change and performance (e.g. Hamilton & Lubell, 2019; Wood et al., 1990). However, in order for change to be considered as learning, it must occur in a desired direction. The main desired contribution of multi-level learning in the governance of adaptation would be to enhance the adaptive capacity of societies and reduce climate risk (Diduck, 2010; Pelling et al., 2005). To examine this, the research has assessed multi-level learning processes in two distinct scenarios: The first set of case studies (Chapter 4) investigates the multi-level learning outcomes stemming from the enhancement of institutional capacities for adaptation planning within National Adaptation Plan (NAP) contexts. The second case study (Chapter 5)

documents multi-level learning dynamics within a process of integrating adaptation into sector policies.

Within organizations, the refinement of routines and improvement in performance occurs in loops (Argyris, 1976). This is also relevant in the case of governance systems, considering that learning will also produce changes in the structure and dynamic of the governance system itself (Pahl-Wostl, 2009), influencing its resilience and adaptive capacity (e.g. Diduck, 2010; Löf, 2010; Pelling & High, 2005). The cases exhibit relevant examples of how the need to 'gain a better understanding' about potential implications of climate change have driven learning across governance levels (Gonzales-Iwanciw et al., 2021, 2023). The various cases, present substantial evidence of collaboration among research programs spanning different levels. A particularly compelling example is found in a long-term research collaboration aimed at studying the rate and pace of glacier melting in the Andes (Chapter 5). Following the same logic, there is an expectation among policy makers that adaptation planning processes are 'coherent', 'effective' and 'efficient' in achieving desired goals, which requires a series of permanent adjustments in policies and institutional functions, encouraging multi-level learning. In Chapter 3, an interview with a senior official from the Adaptation Committee emphasizes the necessity for coherence among various efforts, ensuring they are not diverging or conflicting.

'Innovation' or the 'capacity to innovate' is also one of those desired outcomes and drivers of multi-level learning identified in the case studies conducted. Innovation requires collaboration of different types of actors including the academia, government and business across levels of governance (e.g. Aranguren & Larrea, 2011; Carayannis & Campbell, 2011; Fuchs, 2014) and thus encouraging forms of relational learning. For example, the case studies highlight the need for innovative institutional arrangements, so that enhanced resilience across sectors and governance levels is enhanced as presented in Chapters 3 and 4.

RQ3. Where and how does multi-level learning occur in the governance of adaptation in the Latin American context?

Responding to RQ3, about where and how multi-level learning occurs in the governance of adaptation in the Latin American context, Chapters 3, 4 and 5 provide a relevant body of empirical evidence to analyze multi-level learning in the governance of adaptation across different multi-level settings.

Multi-level learning observed

The analysis of multi-level learning in the governance of adaptation was carried out through different entry points at different levels of governance. Each of the case studies involves two or more levels of governance to explore relationships across levels.

Chapter 3 explores how the UNFCCC enables multi-level learning between the global, international and national levels in the governance of adaptation. In this case multi-level learning occurs from the top down, involving the global and international levels and from the bottom up, involving all levels of governance including national and local adaptation processes. In between the UNFCCC adaptation regime has also contributed to the emergence of a network of international and regional adaptation processes and multi-level leaning nodes.

The two additional studies conducted under this dissertation (Chapter 4 and 5) were organized in such a way to exhibit multi-level learning processes across international, regional, national and local levels of governance, a regional setting for the first one comparing cases in Bolivia, Ecuador and Honduras and a national setting for the second one focusing on the water sector in Bolivia.

Examining the selected case studies in Latin America over time reveals ongoing multi-level learning processes intricately interwoven within complex institutional frameworks and social networks. These processes are manifested through discernible shifts in the structure and functions of multi-level learning nodes, encompassing various governance levels. Moreover, changes in the cognitive, normative, and relational dimensions of multi-level learning are apparent, illustrating the dynamic evolution of adaptation governance.

Who is learning?

Following the same logic raised by academics in terms of social and policy learning (e.g. Bennett & Howlett, 1992), the case studies were oriented to understand the configuration and relationships among the participating actors, the learning processes in terms of topics and learning needs that arise from the same adaptation agenda and the outcomes of those learning processes.

Although the types of actors have not been characterized throughout this research, there are several actors who have played a leading role in multi-level learning in the governance of adaptation. The number of actors involved in adaptation across levels of governance has been increasing since the inception of the UNFCCC. The UNFCCC itself has encouraged

stakeholder engagement across levels of governance though different established mechanisms.

In all the cases of climate change adaptation governance studied we observe the interaction of multiple actors and a growing diversity of actors involved as the climate change agenda unfolds.

One notable observation is the prevalence of certain actor groups in adaptation governance within specific contexts. For instance, during the inception of the UNFCCC, governments and academics assumed significant roles due to the urgent need for understanding the implications of climate change. However, as the imperative to catalyze adaptation efforts across various levels intensified, there emerged a compelling need to engage other types of stakeholders, including the private and financial sectors. A similar pattern is discernible at the national level, where UNFCCC focal points initially exerted influence over national agendas. But, with the increasing necessity for broader sectoral involvement, this dominance began to shift (Pardoe et al., 2020).

The cases also underscore the critical role of multi-level learning, as they reveal not only the prevalence of competition over collaboration but also the conspicuous absence of learning. Despite the imperative for cooperation, stakeholders often vie for resources and power, resulting in structural voids and a dearth of connections among key actors. This lack of learning exacerbates the challenges faced, hindering the development of effective strategies and impeding progress toward shared adaptation goals.

Chapter 4 highlight relevant structural gaps that can be observed across levels of governance as well, for example, technical assistance and funding are mayor enablers of multi-level learning, and still concentrating know how and learning in the hands of very few international agencies and funding programs, fostering nonreciprocal forms of multi-level learning. This trend accentuates the predominance of international experts in assimilating new experiences, relegating national and local stakeholders to passive learning, rather than active contributors to the decision-making process. To level the playing field, this would imply that officials at the national and local levels may be on par in terms of knowledge and capabilities to follow up and guide adaptation processes, but a significant gap is evident here, as opportunities for officials from developing countries to acquire such knowledge are limited.

Characterizing multi-level learning nodes

As explained in various parts of this dissertation, multi-level learning nodes support the idea of policy networks adopted by governance literature (e.g. Di Gregorio et al., 2019). The idea of a social network concerned with a particular issue, in the selected cases with climate change adaptation, was an important entry point to unpack multi-level learning.

Multi-level learning is observed through *multi-level learning nodes,* which are organized across levels of governance and build a network of interactions with the adaptation agenda and build the structure for the governance of adaptation.

One important observation is that multi-level learning can also involve learning processes that take place in a single level of governance if that process is connected to other processes that involve other levels of governance, supporting the idea of a multi-level network.

The case studies provided relevant data for characterizing these multi-level learning nodes according to different roles and functions in adaptation governance: *Policy nodes* play an important role in the definition and implementation of public policy, for example in the case of adaptation planning presented in Chapter 4 the NAP process encourage the conformation of coordination mechanisms to highlight priorities and define adaptation policies. *Knowledge nodes or 'hubs'* are spaces for the exchange and collaboration around science and knowledge, the cases in Chapter 4 show that national research institutes or research programs play a significant role addressing the knowledge needs resulting from adaptation agendas.

Other nodes play a role as '*planning platforms*' or where different actors participate in order to plan, guide and evaluate adaptation, in Chapter 5 the Bolivia case highlights the integration of climate change adaptation at the level of watershed planning platforms. Finally, there exist multi-level learning nodes where both public and private actors, alongside funding organizations, engage in implementing or innovating adaptation measures or solutions. These nodes, termed *implementation or innovation nodes*, serve as platforms for collaboration. An illustrative example is the establishment of water funds in Bolivia and Ecuador, conceived as multi-stakeholder platforms aimed at refining, putting in place and scaling up rural adaptation models.

6

Cognitive, normative, and relational learning observed.

The case studies provide a body of empirical evidence about the changes in the cognitive, normative and relational dimensions of multi-level learning.

The cognitive dimension is strongly connected with the need to obtain more factual information about climate change and its impacts on a diversity of sectors, regions and populations. The observations gathered through this research is that the cognitive dimension is strongly related to the need to enhance understanding about climate change among the actors. For these purposes, the actors place an emphasis on the acquisition of data and information, highlighting the role of science and academics.

While the literature on learning has described normative learning linked to ethical considerations and value judgments (Haug et al., 2011), the case study evidence suggests, in a pragmatic sense, that many normative processes in climate change adaptation are intricately tied to the delineation of methodological frameworks that regulate or guide adaptation processes.

The normative and relational dimensions play crucial roles in the translation of knowledge into actionable outcomes. The normative dimension serves to establish guiding principles that inform actions and facilitate the evaluation of their outcomes. Meanwhile, the relational dimension emphasizes the importance of interpersonal connections and networks in implementing these principles and achieving desired results.

There is still a strong top-down culture dominating UNFCCC procedures where ´experts´ and international funding define methodological processes followed by training workshops to disseminate the tools and evaluate the results of implementation. This underscores the pivotal role of experts in directing and shaping the process. Normative dimensions manifest in the design of practitioner training programs, aimed at equipping them to apply tailored tools and methodologies across diverse contexts, thereby fostering communities of practice.

The cases illustrate that a significant portion of adaptation approaches and methodologies originate from international institutes and think tanks, necessitating effective transferal to national and local levels. However, this transfer process also reveals a gap in the realization of the normative dimension crucial for instigating profound learning and behavioral shifts at the levels where these changes are most vital.

Another example of normative learning is evident in Monitoring and Evaluation (M&E) systems. Learning has increasingly become integral to M&E efforts, as noted by researchers

such as Brooks et al., (2013) and Villanueva (2011). Within this framework, learning contributes significantly to the ongoing planning process and facilitates adjustments to ensure the attainment of desired outcomes, as emphasized by Ford et al., (2013) and Villanueva (2011). However, the case studies underscore a lack of meaningful opportunities for stakeholders from developing countries to actively engage in this form of learning, primarily because evaluations are often conducted by funding agencies. Consequently, there remains a dearth of opportunities for deeper normative learning at the national and local levels, as also highlighted by Okereke et al.(2009); Paavola (2005).

Relational learning remains relatively scarce in the data obtained. For instance, in Chapter 4, the cases underscore the importance of fostering 'knowledge dialogues' between local or indigenous knowledge and the academic sector, yet there is limited evidence of such dialogues actually taking place and shaping decision-making processes. Relational learning entails ongoing dialogues across diverse knowledge domains, facilitating the continuous exchange of insights, experiences, and intentions. However, a prevalent "silo mentality" persists, with academic and expert knowledge continuing to dominate as the primary sources of learning.

The lack of stronger forms of relational learning observed in the cases where 'silo mentality' is avoided and trust building processes encourages in backed by the concerned literature (Haas, 1992; Leal-Rodríguez et al., 2013; Pelling et al., 2008).

RQ4. How can multi-level learning be enhanced and what are the implications for the governance of adaptation ?

This section elaborates on the answer to RQ4 about how multi-level learning can be enhanced and what the implications for the governance of adaptation are.

I recognize that multi-level learning is a central capacity of the governance of adaptation to enhance its effectivity and performance (Diduck, 2010). The principal arguments have been presented in the introduction of this dissertation and the case studies conducted have reinforced the idea that the governance of adaptation needs to be able to learn effectively to be able to better respond to the challenges posed by climate change.

As previously noted by the literature (e.g. Armitage, 2008; Huntjens et al., 2012) my findings confirm that the governance system itself is the enabler of multi-level learning. Multi-level learning can be perceived as the process embedded in the governance of adaptation oriented

6

to enhance its adaptive capacity (Pahl-Wostl, 2009; Termeer et al., 2012). Furthermore, the adaptative capacity of the governance system and multi-level learning can be enhanced through institutional design (Huntjens et al., 2012).

Multi-level learning can be strengthened through institutional design by addressing the various factors that facilitate and drive multi-level learning across levels of governance:

- UNFCCC provisions: Efforts should focus on leveraging the set of UNFCCC provisions that integrate and enable multi-level learning across governance levels. Particularly, enhancing the NAP process can serve as a catalyst for multi-level learning by facilitating collaboration and knowledge exchange among stakeholders at local, national, and international levels. Strengthening these provisions can lead to a more cohesive and effective approach to adaptation governance.

- Structure and roles of learning nodes: Improving the structure and roles of multi-level learning nodes organized across governance levels is essential. By enhancing their reciprocal interaction, the capacity of the governance system to address climate change challenges can be significantly bolstered. This entails ensuring that these nodes fulfill distinct functions within adaptation governance while promoting seamless communication and coordination among them.

- Learning culture: Addressing the prevailing learning culture is crucial. This involves examining and refining the cognitive, normative, and relational dimensions of multi-level learning to foster a more conducive environment for knowledge sharing and utilization among stakeholders. By promoting a culture of continuous learning and adaptation, stakeholders can better navigate the complexities of climate change and enhance their collective capacity to respond effectively.

Multi-level learning can be seen as a framework for examining adaptation processes. The arrangement of multi-level learning nodes and the governance levels involved in these nodes furnish valuable insights into the efficacy and performance of adaptation within the governance framework. This includes comprehending the specific roles and interrelations among actors, thereby evaluating their capacity to establish priorities and influence adaptation agendas. Moreover, it illuminates the overall coherence and effectiveness of distinct multi-level learning nodes and strategies collaborating for adaptation purposes.

For instance, rectifying significant asymmetries and bridging gaps to enhance collaboration among the Parties to the UNFCCC and the Paris Agreement holds significant implications

for the governance of adaptation. This endeavour aligns seamlessly with observations made by several authors regarding the fragmentation of climate governance and the persistent gaps within the institutional architecture of climate change. These gaps encompass disparities between various issues, multilateral agreements, and regions, which are similarly reflected in global adaptation efforts (e.g. Bauer et al., 2012; Kaiser, 2022; Zelli, 2011).

In Chapter 4 and 5, the case studies provided empirical evidence on how multi-level learning can be strengthened by supporting key institutional functions within the governance system. For instance, consider the case of a national adaptation planning process (NAP) in a developing country. Through multi-level learning nodes operating at local, national, and international levels, stakeholders engage in collaborative decision-making processes to identify adaptation priorities, share knowledge, and innovate solutions. By examining the cognitive dimension, stakeholders can improve their understanding of climate risks and adaptation strategies. Normative dimensions ensure alignment with national and international policies, while relational dimensions foster trust and cooperation among stakeholders. This comprehensive approach to multi-level learning enhances the adaptive capacity of the governance system, enabling more effective responses to climate change challenges.

In the same Chapters 4 and 5, the learning strategies adopted by stakeholders across various cases unveil both common methodologies and notable disparities in the engagement of national and local governance levels, as well as the orientation of multi-level learning. These observations delineate trends and discrepancies regarding the predominant level of learning and the primary beneficiaries thereof. Addressing these disparities provides a gateway to bolster multi-level learning in adaptation planning, particularly by reassessing stakeholders' contributions at these levels and their ramifications for nurturing stakeholder ownership and fostering deeper learning.

Furthermore, while coherence and efficiency are crucial aspects of governance systems fulfilling specific functions, it is essential for the sake of adaptation that these systems ultimately lead to tangible improvements indicative of an ongoing adaptation process. This effectiveness can be gauged by considering factors such as the well-being of vulnerable populations, the prevalence of damages, and related indicators.

6

6.4. Reflections on research design, limitations and orientations for further research

Research design

The research has been structured in such a way as to follow a review of multi-level learning processes across levels of governance.

Initially a systematic review of the literature on multi-level governance, adaptation to climate change and learning was carried out to understand the different approaches present in the literature on multi-level learning and adaptation governance. This review also served to build a definition of multi-level learning that could be applied throughout the dissertation and the review of the theoretical approaches and methods that allow building an analytical framework for the empirical work.

The empirical studies served to acquire an empirical information base on multi-level learning in adaptation processes and governance. These studies were structured in such a way that it was possible to have a comprehensive understanding of multi-level learning processes across the global, international, national and local levels.

One of the main methods applied has been the compilation of relevant policy documentation for the content and thematic analysis (Fereday & Muir-Cochrane, 2006), these documents integrate, legal and technical documents, policy documents and evaluations reports, dissemination materials, workshops and other processes that encourage exchange and learning. The thematic analysis was complemented with interviews conducted with stakeholders across different levels of governance, including e.g. international experts, members of the Adaptation Committee under the UNFCCC, multi-lateral development banks officials, international NGOs, international observers, government officials, national NGOs and civil society members, community-based organizations and academics. This added to the personal involvement in the preparation of adaptation planning tools and direct observations of UNFCCC negotiations.

This dissertation has been instrumental in crafting an analytical framework, which has been refined through an extensive review of scientific literature on adaptation governance and its practical application in selected case studies.

The developed analytical framework for multi-level learning in adaptation governance significantly enhances the methodological repertoire of tools aimed at fostering adaptation

across various governance levels, such as National Adaptation Plans. It supports the consistent integration of multi-level learning aspects into these plans, fostering collective action for adaptation through social learning. Moreover, it facilitates the refinement and efficacy of adaptation policy design through policy learning.

Although the applied analytical tools are innovative in their conception, they align with existing research and echo fundamental questions posed in the literature concerning multi-level learning and adaptation governance (Armitage et al., 2018; Baird et al., 2014). The selected cases addressed in a multi-level governance setting provide relevant insight to adaptation as a multi-level governance process.

Limitations

The research presented in this dissertation has methodological limitations due to different reasons.

As recognized by the concerned literature, despite increased interest in the nexus between environmental governance and learning, the academic discussion remains quite open (Derek Armitage, 2008; Crona et al., 2012; Diduck, 2010), with different approaches and lack of consensus about how to define and measure learning, limited understanding about the factors that encourage or limit learning, and very limited understanding about how the social dynamic of power relations and the challenges of the environment trigger and influence learning.

Another challenge is the difficulty to observe adaptation processes over a period of time, the governance of adaptation is dynamic, continuously changing its structure and inner dynamic. Due to the complexity of the governance system it is very difficult to fully grasp the entire structure and dynamics of the social network that determine multi-level learning, so the evaluation of multi-level learning processes has to occur through partial images and reconstruct the process with the information available in policy documents.

Having to choose an operational definition of multi-level learning implies a level of abstraction and therefore leaves out other types of approaches that may be promising. As presented before, a systematic literature review has served to mitigate this limitation, analyzing different options for a comprehensive definition of multi-level learning and applicable methods.

This research adopted the concept of 'change,' particularly 'change in a desired direction,' as the primary indicator of learning. However, effectively addressing this notion proves challenging without multi-temporal assessments encompassing both pre- and post-interventions, which provide the necessary evidence of change. The study primarily relied on analyzing data collected from documentation within a designated timeline. To corroborate these changes, pertinent and semi-structured interviews were conducted, gathering stakeholder perceptions regarding the process.

According to the methodological design, my interest was to decipher the changes in the cognitive, normative and relational dimensions of multi-level learning. Nevertheless obtaining credibly evidence about those 'changes' is another challenge, since it is necessary to investigate in detail in the cases to decipher forms of deeper learning like normative or relational learning. Given that there was a larger background and a higher degree of a personal involvement with the case in Bolivia (Chapter 5), this has been the space where cognitive, normative and relational changes were more clearly perceived. The codes resulting from this analysis served to have some indication about the three dimensions.

The case studies, provide relevant information about the incremental changes in the cognitive, normative and relational dimensions of multi-level learning, but only some hints about the transformational potential of these processes in relation to adaptive capacity. More observations of more cases over longer periods of time would have been needed to observe transformational processes and also obtain relevant evidence about the impact on the adaptive capacity of the governance system.

Orientations for further research

The concept of multi-level learning in the governance of adaptation is relatively new and requires much more theoretical discussion as well as empirical evidence to consolidate and signal promising research directions. Research will need to be continue to feed on empirical evidence of adaptation governance processes through different levels of governance. For example, in the context of intergovernmental settings, an important gap in academic work about multi-level governance of adaptation, is the scant empirical evidence about the role of the global, international and even transboundary settings where different national jurisdictions make adaptation difficult or conflictive (Campbell et al., 2015; Green et al., 2013). But there is also a recognized need in the literature (e.g. Armitage et al., 2018; Baird et al., 2014; McFadgen & Huitema, 2017) to achieve greater clarity in evidencing learning

processes and how they contribute to adaptation objectives in terms of adaptive capacity, greater resilience or less vulnerability to climate change as a result of multi-level interactions like technical assistance and transfer of knowledge and technology.

Further empirical research should aspire to better highlight the factors that enable and drive multi-level learning and how it could be enhanced, obtaining the necessary evidence and understanding about institutional design and multi-level learning in climate change adaptation processes. But it should also obtain more convincing evidence about the contribution of multi-level learning to institutional design, the performance of selected institutional functions and the adaptive capacity of the governance system.

Another challenge of future research is that multi-level learning linked to adaptation governance is not formally integrated into the adaptation regime, so its evaluation depends on analytical frameworks and indicators suggested by academic research and a critical mass of studies in this direction is required for entering a promising path.

Building upon this research, future endeavours could explore the implementation of these analytical frameworks in real-world settings to assess multi-level learning dynamics within adaptation governance structures. Additionally, further investigation into the practical application of the recommended institutional design enhancements could provide valuable insights for policymakers and practitioners seeking to strengthen adaptive capacity at various governance levels.

6.5. Policy implications and recommendations

Looking ahead to the policy implications of this research for the evolution of adaptation governance across various levels, the following recommendations emerged.

At the level of the international adaptation regime, the CAF and the Paris Agreement provide the institutional platform for enhanced action on adaptation and the governance of adaptation has acquired a new impulse to be perceived as a multi-level governance issue (Dzebo et al., 2015; Persson, 2019).

The conceptualization of adaptation as a multi-level governance issue (e.g. Armitage, 2008; Di Gregorio et al., 2019; Lidskog & Elander, 2010) has important policy implications. With NDCs and NAPs countries are encouraged to put in place national institutional structures for adaptation and new possibilities emerge for studying and enhancing multi-level learning.

The Enhanced Transparency Framework (ETF) of the Paris Agreement can by itself be considered a multi-level learning mechanism that encourage the definition of country owned indicators to assess NDC targets and report them periodically, encouraging the continuous review of NDC targets and policy adjustments to achieve them. According to the Paris Agreement pledges countries are expected to have enough financial resources to guide their adaptation processes in a continuous and incremental manner and multi-level learning has important implications responding to the challenges of adaptation, making the adjustments needed and improving the effectiveness of adaptation in the longer run.

Given that the experiences establishing national adaptation plans are recent and there are very few reported evaluations and studies (Morgan et al., 2019; Woodruff et al., 2019), perspectives on multi-level learning in the scientific literature are almost non-existent. Assessing the impact of international funding on the governance of adaptation and multi-level learning, through an agreed set of indicators is very important to assess if countries are actually developing in the desired direction.

Within the current adaptation framework under the UNFCCC, there are options to further encourage multi-level learning:

- Multi-level learning and adaptation governance mutually reinforce each other. Effective governance fosters multi-level collaboration and mutual learning, while maintaining power asymmetries and competitive dynamics can hinder progress. Multi-level learning serves as a key indicator of the degree and quality of collaboration among stakeholders across governance levels. It also plays a crucial role in assessing the effectiveness of the emerging adaptation regime in addressing global challenges and achieving tangible results.

- Through this research, three central factors guiding adjustments in multi-level learning to enhance adaptation have been identified. These include the international adaptation regime, the network and configuration of multi-level learning nodes across governance levels, and the learning culture expressed in the state and trends of the cognitive, normative, and relational dimensions of multi-level learning, alongside its direction.

- There is a need for greater delegation of power and responsibility from global institutions to national levels, coupled with capacity strengthening to establish effective governance systems for adaptation. This would facilitate knowledge exchange, allowing global institutions to learn from local and national experiences.

Regional processes should also be encouraged to promote experience sharing and multi-level learning among countries.

- National adaptation planning processes such as those promoted through the NAPs should be aimed at strengthening governance processes. The studies highlight arenas of collaboration among different stakeholders like the NAP process conceived as muti-stakeholder platforms and coordination mechanism that encourage exchange and collaboration. But the studies also highlight areas where, despite a strong potential and big need for collaboration, the actors do not collaborate but compete for international resources becoming available, thus limiting the possibilities for enhanced multi-level learning and enhanced adaptation governance.

- The necessity for international financial resources to support adaptation processes in countries is not explicitly discussed in this thesis. However, the potential repercussions of lack of resources arise when these resources are channeled through existing institutional arrangements without challenging prevailing structures. This prevailing approach risks reinforcing both the positive and negative aspects of adaptation governance. Therefore, while greater stakeholder participation is imperative, it is equally crucial to equip national and local actors with advocacy tools to influence both national and international agendas. Multi-level learning intertwined with National Adaptation Plan (NAP) processes should foster not only improved governance but also enhanced agency among stakeholders.

- Last but not least, enhancing multi-level learning in the governance of adaptation involves addressing its cognitive, normative, and relational dimensions across governance levels while responding to the concrete adaptation needs of countries. Going beyond the predominant focus on cognitive aspects, reinforcing the normative and relational dimensions of multi-level learning is essential for fostering deeper understanding among stakeholders and building greater capacity to autonomously respond to emerging challenges.Throughout this dissertation, the prevalent focus on cognitive dimensions in adaptation agendas across governance levels has been highlighted. This has shaped the development of climate change adaptation programs, aimed at broadening the understanding of climate change implications. Enhanced comprehension of the conceptual frameworks guiding adaptation and their normative dimensions among stakeholders in developing countries can promote increased autonomy in adaptation planning. This understanding also facilitates better alignment with national needs and priorities rooted in value systems, fostering the

6

sustainability of adaptation processes over time. Increased stakeholder participation in reflective processes and ongoing evaluation can cultivate relational dimensions, igniting heightened action and ambition. Despite adaptation being deemed a public good, the private sector's engagement in adaptation agendas remains insufficient, constraining opportunities for scalable innovative solutions in emerging markets. Relational dimensions of multi-level learning, rooted in increased trust and understanding of diverse mindsets, are less prominent in the examined cases. Specifically, integrating relational dimensions into adaptation governance can catalyze action, bolster flexibility, and inspire innovative solutions.

Multi-level learning, beyond being one of the predominant features of a governance system, can be seen as a way of understanding adaptation itself. The ability to assess and enhance multi-level learning processes and their outcomes is a way of assessing and enhancing adaptation processes themselves.

References

Adger, W. N. (2003a). Social aspects of adaptive capacity. *Climate Change, Adaptive Capacity and Development*, 29–49. doi: 10.1142/9781860945816_0003

Adger, W. N. (2003b). *Social Capital , Collective Action , and Adaptation to Climate Change*.

Adger, W. N., Arnell, N. W., & Tompkins, E. L. (2005). Successful adaptation to climate change across scales. *Global Environmental Change*, *15*(2), 77–86. doi: 10.1016/j.gloenvcha.2004.12.005

Adger, W. N., Barnett, J., Brown, K., Marshall, N., & O'Brien, K. (2012). Cultural dimensions of climate change impacts and adaptation. *Nature Climate Change 2012 3:2*, *3*(2), 112–117. doi: 10.1038/nclimate1666

Aguirre, J. C., & Cooper, E. S. (2010). Commentary Evo Morales, Climate Change, and the Paradoxes of a Social-Movement Presidency. *LATIN AMERICAN PERSPECTIVES*, *173*(4), 238–244. doi: 10.1177/0094582X10376362

Amundsen, H., Berglund, F., & Westskog, H. (2010). Overcoming barriers to climate change adaptationöa question of multilevel governance? *Environment and Planning C: Government and Policy*, *28*(2), 276–289. doi: 10.1068/c0941

Andonova, L. B., Betsill, M. M., & Bulkeley, H. (2009). Transnational Climate Governance. *Global Environmental Politics*, *9*(2), 52–73. doi: 10.1162/glep.2009.9.2.52

Appelbaum, S. H., & Goransson, L. (1997). Transformational and adaptive learning within the learning organization: A framework for research and application. *The Learning Organization*, *4*(3), 115–128. doi: 10.1108/09696479710182803

Aranguren, M J, Larrea, M., & Wilson, J. (2010). Learning from the local: Governance of networks for innovation in the Basque country. *European Planning Studies*, *18*(1), 47–65. doi: 10.1080/09654310903343526

Aranguren, Mari Jose, & Larrea, M. (2011). Regional Innovation Policy Processes: Linking Learning to Action. *Journal of the Knowledge Economy*, *2*(4), 569–585. doi: 10.1007/s13132-011-0068-1

Argyris, C. (1976). Single-Loop and Double-Loop Models in Research on Decision Making. *Administrative Science Quarterly*, *21*(3), 363. doi: 10.2307/2391848

Armitage, D, Berkes, F., & Doubleday, N. (2010). *Adaptive co-management: collaboration, learning, and multi-level governance* (D Armitage, F. Berkes, & N. Doubleday, Eds.). UBC Press. Retrieved from https://books.google.com/books?hl=es&lr=&id=AA6IfQRKwIYC&oi=fnd&pg=PR5&dq=Armitage+2010+Adaptive+co-management&ots=6TZbIq7Uli&sig=OKP0r9ClOofKCtGpOSoEg90MBBM

Armitage, Derek. (2005). Adaptive capacity and community-based natural resource management. In Environmental Management (Vol. 35, Issue 6, pp. 703–715). Springer. doi: 10.1007/s00267-004-0076-z

Armitage, Derek. (2008). Governance and the commons in a multi-level world. *International Journal of the Commons*, *2*(1), 7–32. Retrieved from http://www.thecommonsjournal.org

Armitage, Derek, Berkes, F., Dale, A., Kocho-Schellenberg, E., & Patton, E. (2011). Co-management and the co-production of knowledge: Learning to adapt in Canada's Arctic. *Global Environmental Change*, *21*(3), 995–1004. doi: 10.1016/j.gloenvcha.2011.04.006

Armitage, Derek, Dzyundzyak, A., Baird, J., Plummer, R., & Schultz, L. (2018). *An Approach to Assess Learning Conditions, Effects and Outcomes in Environmental Governance*. *14*(October 2017), 3–14. doi: 10.1002/eet.1781

Axelsson, R., Angelstam, P., Myhrman, L., Sädbom, S., Ivarsson, M., Elbakidze, M., Andersson, K., Cupa, P., Diry, C., Doyon, F., Drotz, M. K., Hjorth, A., Hermansson, J. O., Kullberg, T., Lickers, F. H., McTaggart, J., Olsson, A., Pautov, Y., Svensson, L., & Törnblom, J. (2013). Evaluation of multi-level social learning for sustainable landscapes: Perspective of a development initiative in Bergslagen, Sweden. *Ambio*, *42*(2), 241–253. doi: 10.1007/s13280-012-0378-y

Baird, J., Plummer, R., Haug, C., & Huitema, D. (2014). Learning effects of interactive decision-making processes for climate change adaptation. *Global Environmental Change*, *27*(1), 51–63. doi: 10.1016/j.gloenvcha.2014.04.019

Bandura, A., & Adams, N. E. (1977). Analysis of self-efficacy theory of behavioral change. *Cognitive Therapy and Research*, *1*(4), 287–310. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-34250296911&partnerID=40&md5=7f2d77f1befba7bfdd2f4153ed2590c8

Bauer, A., Feichtinger, J., & Steurer, R. (2012). The Governance of Climate Change Adaptation in 10 OECD Countries: Challenges and Approaches. *Http://Dx.Doi.Org/10.1080/1523908X.2012.707406*, *14*(3), 279–304. doi: 10.1080/1523908X.2012.707406

Baum, D., Yagüe-Blanco, J. L., & Escobar, J. (2021). Capacity development strategy empowering the decentralized governments of Ecuador towards local climate action. *Journal of Cleaner Production*, *285*, 125320. Retrieved from https://www.sciencedirect.com/science/article/pii/S0959652620353658

Bennett, C. J., & Howlett, M. (1992). The Lessons of Learning : Reconciling Theories of Policy Learning and Policy Change The lessons of leaming : Reconciling theories of policy leaming and policy change. *Policy Sciences*, *25*, 275–294. doi: 10.1007/BF00138786

Benson, D., Jordan, A., & Huitema, D. (2012). Involving the Public in Catchment Management: An Analysis of the Scope for Learning Lessons from Abroad. *Environmental Policy and Governance*, *22*(1), 42–54. doi: 10.1002/eet.593

Benz, A. (2012). Yardstick Competition and Policy Learning in Multi-level Systems. *Regional and Federal Studies*, *22*(3), 251–267. doi: 10.1080/13597566.2012.688270

Benz, Arthur, & Eberlein, B. (2011). The Europeanization of regional policies: patterns of multi-level governance. *Http://Dx.Doi.Org/10.1080/135017699343748*, *6*(2), 329–348. doi: 10.1080/135017699343748

Berkes, F. (2006). From Community-Based Resource Management to Complex Systems: The Scale Issue and Marine Commons. *Ecology and Society, Published Online: Jun 21, 2006 | Doi:10.5751/ES-01431-110145*, *11*(1). doi: 10.5751/ES-01431-110145

Berkhout, F., Hertin, J., & Gann, D. M. (2006). Learning to Adapt: Organisational Adaptation to Climate Change Impacts. *Climatic Change 2006 78:1*, *78*(1), 135–156. doi: 10.1007/S10584-006-9089-3

Betsill, M. M., & Bulkeley, H. (2006). Cities and the Multilevel Governance of Global Climate Change. *Global Governance*, *12*. Retrieved from https://heinonline.org/HOL/Page?handle=hein.journals/glogo12&id=151&div=&collection=

Blackmore, C. (2014). Learning to change farming and water management practices in response to the challenges of climate change and sustainability. *Outlook on Agriculture*, *43*(3), 173–178. doi: 10.5367/oa.2014.0169

Blackmore, C., van Bommel, S., de Bruin, A., de Vries, J., Westberg, L., Powell, N., Foster, N., Collins, K., Roggero, P. P., & Seddaiu, G. (2016). Learning for transformation of water governance: reflections on design from the climate change adaptation and water governance (CADWAGO) project. *Water (Switzerland)*, *8*(11). doi: 10.3390/w8110510

Böhmelt, T., Koubi, V., & Bernauer, T. (2014). Civil society participation in global governance: Insights from climate politics. *European Journal of Political Research*, *53*(1), 18–36. doi: 10.1111/1475-6765.12016

Borowski, I., le Bourhis, J.-P., Pahl-Wostl, C., & Barraqué, B. (2008). Spatial misfit in participatory river basin management: Effects on social learning, a comparative analysis of German and French case studies. *Ecology and Society*, *13*(1). Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-50149110635&partnerID=40&md5=80398f6b2fdd30d0c6b68a19d6607516

Bouroncle, C., Imbach, P., Rodríguez-Sánchez, B., Medellín, C., Martinez-Valle, A., & Läderach, P. (2017). Mapping climate change adaptive capacity and vulnerability of smallholder agricultural livelihoods in Central America: ranking and descriptive approaches to support adaptation strategies. *Climatic Change*, *141*(1), 123–137. doi: 10.1007/S10584-016-1792-0/FIGURES/3

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal*, *9*(2), 27–40. doi: 10.3316/QRJ0902027/FULL/XML

Boyd, E., & Osbahr, H. (2010). Responses to climate change: exploring organisational learning across internationally networked organisations for development. *Environmental Education Research*, *16*(5–6), 629–643. doi: 10.1080/13504622.2010.505444

Bradford, N., & Wolfe, D. A. (2013). Governing regional economic development: Innovation challenges and policy learning in Canada. *Cambridge Journal of Regions, Economy and Society*, *6*(2), 331–347. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84879284418&partnerID=40&md5=b628b5538e489d9e48b395fb5f5d6262

Bulkeley, H. (2001). Governing climate change: the politics of risk society? *Transactions of the Institute of British Geographers*, *26*(4), 430–447. doi: 10.1111/1475-5661.00033

Burton, I., Bizikova, L., Dickinson, T., & Howard, Y. (2007). Integrating adaptation into policy: Upscaling evidence from local to global. *Climate Policy*, *7*(4), 371–376. doi: 10.1080/14693062.2007.9685662

Bustamante, R. (2004). The water war: resistance against privatization of water in Cochabamba, Bolivia. *Revista de Gestão de Água Da América Latina, 1(1), 37–46.*, *1*(1), 37–46. doi: 10.21168/rega.v1n1.p37-46

Button, C., Mias-Mamonong, M. A. A., Barth, B., & Rigg, J. (2013). Vulnerability and resilience to climate change in Sorsogon City, the Philippines: Learning from an ordinary city? *Local Environment*, *18*(6), 705–722. doi: 10.1080/13549839.2013.798632

Campbell, B., & Hanich, Q. (2015). Principles and practice for the equitable governance of transboundary natural resources: cross-cutting lessons for marine fisheries management. *Maritime Studies*, *14*(1), 1–20. doi: 10.1186/S40152-015-0028-7/FIGURES/3

Capello, R., & Faggian, A. (2005). Collective Learning and Relational Capital in Local Innovation Processes. *Regional Studies*, *39*(1), 75–87. doi: 10.1080/0034340052000320851

Carayannis, E. G., & Campbell, D. F. J. (2011). Open Innovation Diplomacy and a 21st Century Fractal Research, Education and Innovation (FREIE) Ecosystem: Building on the Quadruple and Quintuple Helix Innovation Concepts and the "Mode 3" Knowledge Production System. *Journal of the Knowledge Economy*, *2*(3), 327–372. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84873253251&partnerID=40&md5=31244b967a1bdb47d4de7a38813ad0eb

Cash, D. W., Neil Adger, W., Berkes, F., Garden, P., Lebel, L., Olsson, P., Pritchard, L., & Young, O. (2006). *Scale and Cross-Scale Dynamics: Governance and Information in a Multilevel World*. *11*(2). Retrieved from https://about.jstor.org/terms

Charles, A. (2012). People, oceans and scale: governance, livelihoods and climate change adaptation in marine social–ecological systems. *Current Opinion in Environmental Sustainability*, *4*(3), 351–357. doi: 10.1016/j.cosust.2012.05.011

Clar, G., & Sautter, B. (2014). Research Driven Clusters at the Heart of (Trans-)Regional Learning and Priority-Setting Processes: The Case of a Smart Specialisation Strategy of a German "Spitzen" Cluster. *Journal of the Knowledge Economy*, *5*(1), 156–180. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84894680068&partnerID=40&md5=c2d59d2aa08e91c6dcb80fb67852b6dc

Coghlan, A. T., Preskill, H., & Tzavaras Catsambas, T. (2003). An overview of appreciative inquiry in evaluation. *New Directions for Evaluation*, *2003*(100), 5–22. doi: 10.1002/EV.96

Collins, K., & Ison, R. (2009). Jumping off Arnstein's ladder: social learning as a new policy paradigm for climate change adaptation. *Environmental Policy and Governance*, *19*(6), 358–373. doi: 10.1002/eet.523

Connor, R., & Dovers, S. (2004). *Institutional Change for Sustainable Development*. ix, 251. Retrieved from https://books.google.es/books?hl=es&lr=&id=CtDSAgAAQBAJ&oi=fnd&pg=PR1&dq=new+institutionalism+e.g.+Connor+and+Dovers+(2004)+&ots=5T3jrcc-AV&sig=VH5uqXa074PjkFmYqtVg6JydoBk#v=onepage&q&f=false

Conzelmann, T. (1998). "Europeanisation" of Regional Development Policies? Linking the Multi-Level Governance Approach with Theories of Policy Learning and Policy Change. *European Integration Online*, *2*(4). doi: 10.2139/ssrn.302723

Crona, B. I., & Parker, J. N. (2012). Learning in support of governance: Theories, methods, and a framework to assess how bridging organizations contribute to adaptive resource governance. *Ecology and Society*, *17*(1). doi: 10.5751/ES-04534-170132

de Coninck, H., Revi, A., Babiker, M., & Bertoldi, P. (2018). Strengthening and implementing the global response. In Global Warming of 1.5 C an IPCC special report on the impacts of global warming of 1.5 C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change. Intergovernmental Panel on Climate Change. Retrieved from http://pure.iiasa.ac.at/id/eprint/15516/

de Kraker, J. (2017). Social learning for resilience in social–ecological systems. *Current Opinion in Environmental Sustainability*, *28*, 100–107. doi: 10.1016/J.COSUST.2017.09.002

Depledge, J. (2006). The opposite of learning: Ossification in the climate change regime. In Global Environmental Politics (Vol. 6, Issue 1, pp. 1–22). MIT Press Journals. doi: 10.1162/glep.2006.6.1.1

Dewulf, A., Meijerink, S., & Runhaar, H. (2015). Editorial: The governance of adaptation to climate change as a multi-level, multi-sector and multi-actor challenge: a European comparative perspective. *Journal of Water and Climate Change*, *6*(1), 1–8. doi: 10.2166/WCC.2014.000

di Gregorio, M., Fatorelli, L., Paavola, J., Locatelli, B., Pramova, E., Nurrochmat, D. R., May, P. H., Brockhaus, M., Sari, I. M., & Kusumadewi, S. D. (2019). Multi-level governance and power in climate change policy networks. *Global Environmental Change*, *54*, 64–77. doi: 10.1016/j.gloenvcha.2018.10.003

Diduck, A. (2010). *The Learning Dimension of Adaptive Capacity: Untangling the Multi-level Connections*. 199–221. doi: 10.1007/978-3-642-12194-4_10

Dieleman, H. (2013). Organizational learning for resilient cities, through realizing eco-cultural innovations. *Journal of Cleaner Production*, *50*, 171–180. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84879958755&partnerID=40&md5=836aba3e8456f289acaa40038a7214ca

Dixit, A., Mcgray, H., Gonzales Iwanciw, J., & Desmond, M. (2012). Ready or not: Assessing National Institutional Capacity for Climate Change Adaptation. *World Resources Institute*, 1–56.

Dodman, D., & Mitlin, D. (2013). CHALLENGES FOR COMMUNITY-BASED ADAPTATION: DISCOVERING THE POTENTIAL FOR TRANSFORMATION. *Journal of International Development*, *25*(5), 640–659. doi: 10.1002/JID.1772

Donatti, C. I., Harvey, C. A., Martinez-Rodriguez, M. R., Vignola, R., & Rodriguez, C. M. (2019). Vulnerability of smallholder farmers to climate change in Central America and Mexico: current knowledge and research gaps. *Climate and Development*, *11*(3), 264–286. doi: 10.1080/17565529.2018.1442796/SUPPL_FILE/TCLD_A_1442796_SM1457.DOCX

Dovers, S. R., & Hezri, A. A. (2010). Institutions and policy processes: the means to the ends of adaptation. *Wiley Interdisciplinary Reviews: Climate Change*, *1*(2), 212–231. doi: 10.1002/wcc.29

Driessen, T. (2008). Collective Management Strategies and Elite Resistance in Cochabamba, Bolivia. *Development 2008 51:1*, *51*(1), 89–95. doi: 10.1057/PALGRAVE.DEVELOPMENT.1100453

Dupuits, E., Llambí, L. D., & Peralvo, M. (2022). Implementing Climate Change Adaptation Policies Across Scales: Challenges for Knowledge Coproduction in Andean Mountain Socio-ecosystems. *Https://Doi.Org/10.1659/MRD-JOURNAL-D-21-00040.1*, *42*(2), A1–A11. doi: 10.1659/MRD-JOURNAL-D-21-00040.1

Dzebo, A., & Stripple, J. (2015). Transnational adaptation governance: An emerging fourth era of adaptation. *Global Environmental Change*, *35*, 423–435. doi: 10.1016/J.GLOENVCHA.2015.10.006

Engle, N. L. (2011). Adaptive capacity and its assessment. *Global Environmental Change*, *21*(2), 647–656. doi: 10.1016/j.gloenvcha.2011.01.019

Ensor, J., & Harvey, B. (2015). Social learning and climate change adaptation: evidence for international development practice. *WILEY INTERDISCIPLINARY REVIEWS-CLIMATE CHANGE*, *6*(5), 509–522. doi: 10.1002/wcc.348

Faguet, J. P. (2014). Decentralization and Governance. *World Development*, *53*, 2–13. doi: 10.1016/J.WORLDDEV.2013.01.002

Fazey, I., Fazey, J. A., Fischer, J., Sherren, K., Warren, J., Noss, R. F., & Dovers, S. R. (2007). Adaptive capacity and learning to learn as leverage for social-ecological resilience. *Frontiers in Ecology and the Environment*, *5*(7), 375–380. doi: 10.1890/1540-9295(2007)5[375:ACALTL]2.0.CO;2

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. *International Journal of Qualitative Methods*, *5*(1), 80–92. doi: 10.1177/160940690600500107

Field, C. B., Barros, V., Stocker, T. F., Qin, D., Dokken, D. J., Ebi, K. L., Mastrandrea, M. D., Mach, K. J., Plattner, G.-K., Allen, S. K., Tignor, M., & Midgley, P. M. (Eds.). (2012). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*. Cambridge, New York: Cambridge University Press.

Filatotchev, I., & Wright, M. (2017). Methodological issues in governance research: An editor's perspective. *Corporate Governance: An International Review*, *25*(6), 454–460. doi: 10.1111/CORG.12211

Foden, W., Mace, G. M., Vié, J., Angulo, A., Butchart, S. H., DeVantier, L., & Turak, E. (2009). Species susceptibility to climate change impacts. In Wildlife in a changing world–an analysis of the 2008 IUCN Red List of threatened species (Vol. 77).

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). ADAPTIVE GOVERNANCE OF SOCIAL-ECOLOGICAL SYSTEMS. *Annual Review of Environment and Resources*, *30*(1), 441–473. doi: 10.1146/annurev.energy.30.050504.144511

Forsyth, T. (2013). Community-based adaptation: a review of past and future challenges. *Wiley Interdisciplinary Reviews: Climate Change*, *4*(5), 439–446. doi: 10.1002/WCC.231

Francou, B., Ribstein, P., Saravia, R., & Tiriau, E. (1995). Monthly balance and water discharge of an inter-tropical glacier: Zongo Glacier, Cordillera Real, Bolivia, 16° S. In J ournal of Glaciology (Vol. 41, Issue 137).

Francou, B., Vuille, M., Wagnon, P., Mendoza, J., & Sicart, J. E. (2003). Tropical climate change recorded by a glacier in the central Andes during the last decades of the twentieth century: Chacaltaya, Bolivia, 16°S. *Journal of Geophysical Research: Atmospheres*, *108*(D5). doi: 10.1029/2002JD002959

Freestone, D. (2010). From Copenhagen to Cancun: Train Wreck or Paradigm Shift? *Environmental Law Review*, *12*(2), 87–93. doi: 10.1350/enlr.2010.12.2.081

Fry, R., & Kolb, D. (1979). Experiential Learning Theory and Learning Experiences in Liberal Arts Education. *New Directions for Experiential Learning*, *6*, 79. Retrieved from http://digitalcommons.unomaha.edu/slceslgen/109

Fuchs, G. (2014). The governance of innovations in the energy sector: Between adaptation and exploration. *Science and Technology Studies*, *27*(1), 34–53. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84899436754&partnerID=tZOtx3y1

Fünfgeld, H. (2015). Facilitating local climate change adaptation through transnational municipal networks. In Current Opinion in Environmental Sustainability (Vol. 12, pp. 67–73). Elsevier. doi: 10.1016/j.cosust.2014.10.011

Füssel, H. M. (2007). Adaptation planning for climate change: concepts, assessment approaches, and key lessons. *Sustainability Science 2007 2:2*, *2*(2), 265–275. doi: 10.1007/S11625-007-0032-Y

Gerlak, A K, & Heikkila, T. (2011). Building a theory of learning in collaboratives: Evidence from the everglades restoration program. *Journal of Public Administration Research and Theory*, *21*(4), 619–644. doi: 10.1093/jopart/muq089

Gerlak, Andrea K., & Heikkila, T. (2019). Tackling key challenges around learning in environmental governance. In Journal of Environmental Policy and Planning (Vol. 21, Issue 3, pp. 205–212). Routledge. doi: 10.1080/1523908X.2019.1633031

Getimis, P. (2003). Improving European Union regional policy by learning from the past in view of enlargement. *European Planning Studies*, *11*(1), 77–88. doi: 10.1080/09654310303662

Gleeson, B. (2003). Learning about regionalism from Europe: "Economic normalisation" and beyond. *Australian Geographical Studies*, *41*(3), 221–236. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-0442312973&partnerID=40&md5=eace770d00f5eee2fcb84fd3b15e9017

Gleeson, B., Van Ewijk, E., Baud, I., Bontenbal, M., Hordijk, M., Van Lindert, P., Nijenhuis, G., Van Westen, G., Löf, A., Hogl, K., van der Wal, M., De Kraker, J., Offermans, A., Kroeze, C., Kirschner, P. A., van Ittersum, M., van Wijk, M., van Bueren, E., te Brömmelstroet, M., … Leonardi, R. (2014). Learning from cross-border arrangements to support climate change adaptation in Australia. *Journal of European Public Policy*, *18*(3), 529–543. doi: 10.1111/1745-5871.12115

Gonzales-Iwanciw, J., Dewulf, A., & Karlsson-Vinkhuyzen, S. (2020). Learning in multi-level governance of adaptation to climate change–a literature review. *Journal of Environmental Planning and Management*, *63*(5), 779–797. doi: 10.1080/09640568.2019.1594725

Gonzales-Iwanciw, J., Karlsson-Vinkhuyzen, S., & Dewulf, A. (2021). Multi-level learning in the governance of adaptation to climate change - the case of Bolivia´s water sector. *Climate and Development*, 1–15. doi: 10.1080/17565529.2020.1785830

Gonzales-Iwanciw, J., Karlsson-Vinkhuyzen, S., & Dewulf, A. (2023). How does the UNFCCC enable multi-level learning for the governance of adaptation. *International Environmental Agreements: Politics, Law and Economics*.

Green, O. O., Cosens, B. A., & Garmestani, A. S. (2013). *Resilience in Transboundary Water Governance: the Okavango River Basin*. *18*(2). doi: 10.5751/ES-05453-180223

Grothmann, T., Grecksch, K., Winges, M., & Siebenhüner, B. (2013). Assessing institutional capacities to adapt to climate change: integrating psychological dimensions in the Adaptive Capacity Wheel. *Natural Hazards and Earth System Science*, *13*(12), 3369–3384. doi: 10.5194/nhess-13-3369-2013

Gupta, J. (2007). The multi-level governance challenge of climate change. *Environmental Sciences*, *4*(3), 131–137. doi: 10.1080/15693430701742669

Gupta, J. (2016). Climate change governance: history, future, and triple-loop learning? *Wiley Interdisciplinary Reviews: Climate Change*, *7*(2), 192–210. doi: 10.1002/wcc.388

Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., Nooteboom, S., & Bergsma, E. (2010). The Adaptive Capacity Wheel: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. *Environmental Science & Policy*, *13*(6), 459–471. doi: 10.1016/j.envsci.2010.05.006

Gupta, J., Termeer, K., Klostermann, J., Meijerink, S., Van Den Brink, M., Jong, P., Nooteboom, S., Gupta, J., Termeer, K., Klostermann, J., Meijerink, S., Van Den Brink, M., Jong, P., Nooteboom, S., Bergsma, E., & Bergsma, E. J. (2008). *Institutions for Climate Change A Method to assess the Inherent Characteristics of Institutions to enable the Adaptive Capacity of Society*. doi: 10.1016/j.envsci.2010.05.006

Haas, P. M. (1992). Introduction: epistemic communities and international policy coordination. *International Organization*, *46*(1), 1–35. doi: 10.1017/S0020818300001442

Hackmann, B. (2016). Regime learning in global environmental governance. *Environmental Values*, *25*(6), 663–686. doi: 10.3197/096327116X14736981715625

Hall, N., & Persson, Å. (2018). Global climate adaptation governance: Why is it not legally binding? *European Journal of International Relations*, *24*(3), 540–566. doi: 10.1177/1354066117725157

Hall, P. A. (1993). Policy Paradigms, Social Learning, and the State: The Case of Economic Policymaking in Britain. *Comparative Politics*, *25*(3), 275–296. doi: 10.2307/422246

Hamilton, M. L., & Lubell, M. (2019). Climate change adaptation, social capital, and the performance of polycentric governance institutions. *Climatic Change 2019 152:3*, *152*(3), 307–326. doi: 10.1007/S10584-019-02380-2

Hanssen, G. S., Mydske, P. K., & Dahle, E. (2013). Multi-level coordination of climate change adaptation: by national hierarchical steering or by regional network governance? *Local Environment*, *18*(8), 869–887. doi: 10.1080/13549839.2012.738657

Haug, C., Huitema, D., & Wenzler, I. (2011). Learning through games? Evaluating the learning effect of a policy exercise on European climate policy. *Technological Forecasting and Social Change*, *78*(6), 968–981. doi: 10.1016/j.techfore.2010.12.001

Henderson, G. M. (2002). Transformative Learning as a Condition for Transformational Change in Organizations. *Human Resource Development Review*, *1*(2), 186–214. doi: 10.1177/15384302001002004

High, C., & Pelling, M. (2005). Social learning and adaptation to climate change. In Benfield Hazard Research Centre, Disaster Studies Working Paper, 11, 1-19. Retrieved from http://www.swan.ac.uk/cds/research/ESRC.htm

Hirsch, C. (2017). Makers and shapers of environmental policy making: Power and participation in forest legislation in Bolivia. *Journal of Rural Studies*, *50*, 148–158. doi: 10.1016/J.JRURSTUD.2016.11.013

Hogl, K. (2002). Patterns of multi-level co-ordination for NFP-processes: Learning from problems and success stories of European policy-making. *Forest Policy and Economics*, *4*(4), 301–312. doi: 10.1016/S1389-9341(02)00072-2

Hooghe, L., & Marks, G. N. (2010). Types of Multi-Level Governance. In H. Enderlein, S. Wälti, & M. Zürn (Eds.), Handbook on multi-level governance (Issue 11). Edward Elgar Publishing. Retrieved from https://doi.org/10.4337/9781849809047.00007

Hourcade, J. C., Shukla, P. R., & Cassen, C. (2015). Climate policy architecture for the Cancun paradigm shift: building on the lessons from history. *International Environmental Agreements: Politics, Law and Economics*, *15*(4), 353–367. doi: 10.1007/s10784-015-9301-x

Huitema, D.a, Cornelisse, C. a, & Ottow, B. b (2010). Is the jury still out? toward greater insight in policy learning in participatory decision processes-the case of dutch citizens' juries on water management in the rhine basin. *Ecology and Society*, *15*(1). Retrieved from http://www.ecologyandsociety.org/vol15/iss1/art16/

Huitema, Dave, Adger, W. N., Berkhout, F., Massey, E., Mazmanian, D., Munaretto, S., Plummer, R., & Termeer, C. C. J. A. M. (2016). The governance of adaptation: Choices, reasons, and effects. Introduction to the special feature. *Ecology and Society*, *21*(3). doi: 10.5751/ES-08797-210337

Huntjens, P. i P., Pahl-Wostl, C., Rihoux, B. b B., Schlüter, M. M. c, Flachner, Z. Z. d, Neto, S. e S., Koskova, R. f R., Dickens, C. C. g, Kiti, I. N. h, & Nabide Kiti, I. (2011). Adaptive Water Management and Policy Learning in a Changing Climate: a Formal Comparative Analysis of Eight Water Management Regimes in Europe, Africa and Asia. *Environmental Policy and Governance*, *21*(3), 145–163. doi: 10.1002/eet.571

Huntjens, P., Lebel, L., Pahl-Wostl, C., Camkin, J., Schulze, R., & Kranz, N. (2012). Institutional design propositions for the governance of adaptation to climate change in the water sector. *Global Environmental Change*, *22*(1), 67–81. doi: 10.1016/j.gloenvcha.2011.09.015

Ison, R. L., Collins, K. B., & Wallis, P. J. (2015). Institutionalising social learning: Towards systemic and adaptive governance. *Environmental Science and Policy*, *53*, 105–117. doi: 10.1016/j.envsci.2014.11.002

Jabeen, H., Johnson, C., & Allen, A. (2010). Built-in resilience: Learning from grassroots coping strategies for climate variability. *Environment and Urbanization*, *22*(2), 415–431. doi: 10.1177/0956247810379937

Janjua, S., Thomas, I., & McEvoy, D. (2010). Framing climate change adaptation learning and action: The case of Lahore, Pakistan. *International Journal of Climate Change Strategies and Management*, *2*(3), 281–296. doi: 10.1108/17568691011063051

Johannessen, Å., & Hahn, T. (2013). Social learning towards a more adaptive paradigm? Reducing flood risk in Kristianstad municipality, Sweden. *Global Environmental Change*, *23*(1), 372–381. doi: 10.1016/j.gloenvcha.2012.07.009

Juhola, S. (2010). Developing Adaptation Policy and Practice in Europe: Multi-level Governance of Climate Change. In E. C. H. Keskitalo (Ed.), Developing Adaptation Policy and Practice in Europe: Multi-level Governance of Climate Change. Dordrecht: Springer Netherlands. doi: 10.1007/978-90-481-9325-7

Kaiser, C. (2022). Rethinking polycentricity: on the North–South imbalances in transnational climate change governance. *International Environmental Agreements: Politics, Law and Economics*, *22*(4), 693–713. doi: 10.1007/s10784-022-09579-2

Kashyap, A. (2004). Water governance: Learning by developing adaptive capacity to incorporate climate variability and change. *Water Science and Technology*, *49*(7), 141–146. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-3042555352&partnerID=tZOtx3y1

Kemper, E. A., Stringfield, S., & Teddlie, C. (2003). *Mixed methods sampling strategies in social science research. Handbook of mixed methods in social and behavioral research*.

Kerber, W., & Eckardt, M. (2007). Policy learning in Europe: The open method of co-ordination and laboratory federalism. *Journal of European Public Policy*, *14*(2), 227–247. doi: 10.1080/13501760601122480

Kern, K., & Bulkeley, H. (2009). Cities, Europeanization and Multi-level Governance: Governing Climate Change through Transnational Municipal Networks*. *JCMS: Journal of Common Market Studies*, *47*(2), 309–332. doi: 10.1111/J.1468-5965.2009.00806.X

Klein, I. (2010). Political Leadership as Participation Process by a Supranational Actor - The European Commission's Leadership Features Demonstrated by Conceptualizing Lifelong Learning on European Level. *OSTERREICHISCHE ZEITSCHRIFT FUR POLITIKWISSENSCHAFT*, *39*(3), 337+.

Koerber, A., & McMichael, L. (2008). Qualitative Sampling Methods. *Journal of Business and Technical Communication*, *22*(4), 454–473. doi: 10.1177/1050651908320362

LDC Expert Group (LEG). (2012). *National Adaptation Plans: Technical guidelines for national adaptation plan process*.

Leal-Rodríguez, A. L., Roldán, J. L., Leal, A. G., & Ortega-Gutiérrez, J. (2013). Knowledge management, relational learning, and the effectiveness of innovation outcomes. *Service Industries Journal*, *33*(13–14), 1294–1311. doi: 10.1080/02642069.2013.815735

Lesnikowski, A., Ford, J., Biesbroek, R., Berrang-Ford, L., Maillet, M., Araos, M., & Austin, S. E. (2017). What does the Paris Agreement mean for adaptation? *Climate Policy*, *17*(7), 825–831. doi: 10.1080/14693062.2016.1248889

Leys, A. J., & Vanclay, J. K. (2011). Social learning: A knowledge and capacity building approach for adaptive co-management of contested landscapes. *Land Use Policy*, *28*(3), 574–584. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-78751625428&partnerID=40&md5=bd342a03cec65255e793a96ccf46a1d0

Lidskog, R., & Elander, I. (2010). Addressing climate change democratically. Multi-level governance, transnational networks and governmental structures. *Sustainable Development*, *18*(1), 32–41. doi: 10.1002/sd.395

Lima-Quispe, N., Coleoni, C., Rincón, W., Gutierrez, Z., Zubieta, F., Nuñez, S., Iriarte, J., Saldías, C., Purkey, D., Escobar, M., & Angarita, H. (2021). Delving into the Divisive Waters of River Basin Planning in Bolivia: A Case Study in the Cochabamba Valley. *Water 2021, Vol. 13, Page 190*, *13*(2), 190. doi: 10.3390/W13020190

Löf, A. (2010). Exploring adaptability through learning layers and learning loops. *Environmental Education Research*, *16*(5–6), 529–543. doi: 10.1080/13504622.2010.505429

Lynch, A. H., & Brunner, R. D. (2010). Learning from Climate Variability: Adaptive Governance and the Pacific ENSO Applications Center. *Weather, Climate, and Society*, *2*(4), 311–319. doi: 10.1175/2010WCAS1049.1

Mah, D. N., & Hills, P. R. (2014). Policy Learning and Central-Local Relations: A Case Study of the Pricing Policies for Wind Energy in China (from 1994 to 2009). *ENVIRONMENTAL POLICY AND GOVERNANCE*, *24*(3, SI), 216–232. doi: 10.1002/eet.1639

Marks, G. (2007). An actor-centred approach to multi-level governance. *Https://Doi.Org/10.1080/13597569608420966*, *6*(2), 20–38. doi: 10.1080/13597569608420966

Mattes, J., Huber, A., & Koehrsen, J. (2015). Energy transitions in small-scale regions - What we can learn from a regional innovation systems perspective. *ENERGY POLICY*, *78*, 255–264. doi: 10.1016/j.enpol.2014.12.011

Maurel, M.-C. (2008). Local development stakeholders and the european model: learning the leader approach in the new member states. *Sociologicky Casopis*, *44*(3), 511–529. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-52149091398&partnerID=40&md5=f1c138310cdf6d909986ff340ea246c4

McCarthy, J. J., Canziani, O. F., Leary, N. A., Dokken, D. J., & White, K. S. (Eds.). (2001). *Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

McCrum, G., Blackstock, K., Matthews, K., Rivington, M., Miller, D., & Buchan, K. (2009). Adapting to climate change in land management: The role of deliberative workshops in enhancing social learning. *Environmental Policy and Governance*, *19*(6), 413–426. doi: 10.1002/eet.525

McFadgen, B., & Huitema, D. (2017). Stimulating learning through policy experimentation: A multi-case analysis of how design influences policy learning outcomes in experiments for climate adaptation. *Water (Switzerland)*, *9*(9). doi: 10.3390/w9090648

McGinnis, M. D. (2011). Networks of Adjacent Action Situations in Polycentric Governance. *Policy Studies Journal*, *39*(1), 51–78. doi: 10.1111/J.1541-0072.2010.00396.X

Metz, F., & Ingold, K. (2014). Sustainable Wastewater Management: Is it Possible to Regulate Micropollution in the Future by Learning from the Past? A Policy Analysis. *SUSTAINABILITY*, *6*(4), 1992–2012. doi: 10.3390/su6041992

Mimura, N., Pulwarty, R. S., Duc, D. M., Elshinnawy, I., Redsteer, M. H., Huang, H.-Q., Nkem, J. N., Rodriguez, R. A. S., Moss, R., Vergara, W., Darby, L. S., & Kato, S. (2015). Adaptation planning and implementation. In Climate Change 2014 Impacts, Adaptation and Vulnerability: Part A: Global and Sectoral Aspects (pp. 869–898). doi: 10.1017/CBO9781107415379.020

Minx, J. C., Callaghan, M., Lamb, W. F., Garard, J., & Edenhofer, O. (2017). Learning about climate change solutions in the IPCC and beyond. *Environmental Science and Policy*, *77*, 252–259. doi: 10.1016/j.envsci.2017.05.014

Morgan, E. A., Nalau, J., & Mackey, B. (2019). Assessing the alignment of national-level adaptation plans to the Paris Agreement. *Environmental Science & Policy*, *93*, 208–220. doi: 10.1016/J.ENVSCI.2018.10.012

Morse, J. M. (2015). Critical Analysis of Strategies for Determining Rigor in Qualitative Inquiry. *Http://Dx.Doi.Org/10.1177/1049732315588501*, *25*(9), 1212–1222. doi: 10.1177/1049732315588501

Munaretto, S., & Huitema, D. (2012). Adaptive comanagement in the Venice lagoon? An analysis of current water and environmental management practices and prospects for change. *Ecology and Society*, *17*(2). doi: 10.5751/ES-04772-170219

Naess, L. O. (2013). The role of local knowledge in adaptation to climate change. *Wiley Interdisciplinary Reviews: Climate Change*, *4*(2), 99–106. doi: 10.1002/wcc.204

Newig, J., & Fritsch, O. (2009). Environmental governance: participatory, multi-level – and effective? *Environmental Policy and Governance*, *19*(3), 197–214. doi: 10.1002/EET.509

Newig, J., Günther, D., & Pahl-Wostl, C. (2010). Synapses in the network: Learning in governance networks in the context of environmental management. *Ecology and Society*, *15*(4), 24. doi: 10.5751/ES-03713-150424

Nieuwaal, K. van, Driessen, P. P. J., Spit, T. J. M., & Termeer, C. J. A. M. (2009). *A State of the Art of Governance Literature on adaptation to climate change. Towards a research agenda*.

Nuorteva, P., Keskinen, M., & Varis, O. (2010). Water, livelihoods and climate change adaptation in the tonle sap lake area, Cambodia: Learning from the past to understand the future. *Journal of Water and Climate Change*, *1*(1), 87–101. doi: 10.2166/wcc.2010.010

Okereke, C., Bulkeley, H., & Schroeder, H. (2009). Conceptualizing climate governance beyond the international regime. *Global Environmental Politics*, *9*(1). doi: 10.1162/glep.2009.9.1.58

Ostrom, E. (2010). Beyond Markets and States: Polycentric Governance of Complex Economic Systems. *American Economic Review*, *100*(3), 641–672. doi: 10.1257/AER.100.3.641

Paavola, J. (2005). Seeking justice: International environmental governance and climate change. *Globalizations*, *2*(3), 309–322. doi: 10.1080/14747730500367850

Paavola, J. (2007). Institutions and environmental governance: A reconceptualization. *Ecological Economics*, *63*(1), 93–103. doi: 10.1016/J.ECOLECON.2006.09.026

Pahl-Wostl, C. (2009). A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change*, *19*(3), 354–365. Retrieved from https://doi.org/10.1016/j.gloenvcha.2009.06.001

Pahl-Wostl, C. a, Craps, M. b, Dewulf, A. b, Mostert, E. c, Tabara, D. d, & Taillieu, T. b. (2007). Social learning and water resources management. *Ecology and Society*, *12*(2). Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-34447323232&partnerID=40&md5=791b90ce0b0196d4c92eae751b03f5ae

Pahl-Wostl, C., Becker, G., Knieper, C., & Sendzimir, J. (2013). How multilevel societal learning processes facilitate transformative change: A comparative case study analysis on flood management. *Ecology and Society*, *18*(4). Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84891870126&partnerID=40&md5=7d7058af9cbc23ecdce8cb94c2561c74

Paquet, G. (1999). *Governance Through Social Learning*. University of Ottawa Press.

Paraskevopoulos, C. J., & Leonardi, R. (2004). Introduction: Adaptational pressures and social learning in European regional policy - Cohesion (Greece, Ireland and Portugal) vs. CEE (Hungary, Poland) countries. *Regional and Federal Studies*, *14*(3), 315–354. doi: 10.1080/1359756042000261342

Pardoe, J., Vincent, K., Conway, D., Archer, E., Dougill, A. J., Mkwambisi, D., & Tembo-Nhlema, D. (2020). Evolution of national climate adaptation agendas in Malawi, Tanzania and Zambia: the role of national leadership and international donors. *Regional Environmental Change*, *20*(4), 1–16. doi: 10.1007/S10113-020-01693-8/FIGURES/2

Parry, M. L., Canziani, O., Palutikof, J., van der Linden, P., & Hanson, C. (Eds.). (2007). *Climate change 2007-impacts, adaptation and vulnerability: Working group II contribution to the fourth assessment report of the IPCC (Vol. 4).* Cambridge University Press.

Pauw, W. P., & Klein, R. J. T. (2020). Beyond ambition: increasing the transparency, coherence and implementability of Nationally Determined Contributions. *Climate Policy*, *20*(4), 405–414. doi: 10.1080/14693062.2020.1722607

Pelling, M., & High, C. (2005). Understanding adaptation: What can social capital offer assessments of adaptive capacity? *Global Environmental Change*, *15*(4), 308–319. doi: 10.1016/J.GLOENVCHA.2005.02.001

Pelling, M., High, C., Dearing, J., & Smith, D. (2008). Shadow spaces for social learning: A relational understanding of adaptive capacity to climate change within organisations. *Environment and Planning A*, *40*(4), 867–884. doi: 10.1068/a39148

Perrier, B., & Levrat, N. (2015). Melting law: Learning from practice in transboundary mountain regions. *Environmental Science and Policy*, *49*, 32–44. doi: 10.1016/j.envsci.2014.12.023

Persson, Å. (2008). Mainstreaming Climate Change Adaptation into Official Development Assistance: A Case of International Policy Integration. *EPIGOV Papers No. 36. Ecologic –*

Institute for International and European Environmental Policy. Retrieved from
http://www.ecologic.de/projekte/epigov/

Persson, Å. (2019). Global adaptation governance: An emerging but contested domain. *Wiley Interdisciplinary Reviews: Climate Change*, *10*(6), e618. doi: 10.1002/WCC.618

Petticrew, M., & McCartney, G. (2011). Using systematic reviews to separate scientific from policy debate relevant to climate change. *American Journal of Preventive Medicine*, *40*(5), 576–578. doi: 10.1016/j.amepre.2010.12.022

Plummer, R., & Armitage, D. (2010). *Integrating Perspectives on Adaptive Capacity and Environmental Governance* (pp. 1–19). Springer, Berlin, Heidelberg. doi: 10.1007/978-3-642-12194-4_1

Pörtner, H.-O., Roberts, D. C., Tignor, M., Poloczanska, E. S., Mintenbeck, K., Alegría, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., Okem, A., & Rama, B. (Eds.). (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK and New York, USA: Cambridge University Press. doi: 10.1017/CBO9781139177245.003

Raadgever, G. T., Mostert, E., & van de Giesen, N. C. (2008). Identification of stakeholder perspectives on future flood management in the Rhine basin using Q methodology. *Hydrology and Earth System Sciences*, *12*(4), 1097–1109. doi: 10.5194/HESS-12-1097-2008

Ramírez, E., Francou, B., Ribstein, P., Descloitres, M., Guérin, R., Mendoza, J., Gallaire, R., Pouyaud, B., & Jordan, E. (2001). Small glaciers disappearing in the tropical Andes: a case-study in Bolivia: Glaciar Chacaltaya (16^3 S). *Journal of Glaciology*, *47*(157), 187–194.

Rantala, S., Hajjar, R., & Skutsch, M. (2014). Multilevel governance for forests and climate change: Learning from Southern Mexico. *Forests*, *5*(12), 3147–3168. doi: 10.3390/f5123147

Reed, M. G., Godmaire, H., Abernethy, P., & Guertin, M.-A. (2014). Building a community of practice for sustainability: Strengthening learning and collective action of Canadian biosphere reserves through a national partnership. *Journal of Environmental Management*, *145*, 230–239. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84904907331&partnerID=40&md5=6b25b0be4897239c44e7790ecc13404c

Reed, M. M. S., Evely, A. A. C., Cundill, G., Fazey, I., Glass, J., Laing, A., Newig, J., Parrish, B., Prell, C., Raymond, C., & Stringer, L. L. C. (2010). What is Social Learning? *Ecology and Society*, *15*(4), r1. doi: Article

Reid, H. (2016). Ecosystem- and community-based adaptation: learning from community-based natural resource management. *Climate and Development*, *8*(1), 4–9. doi: 10.1080/17565529.2015.1034233

Rietig, K. (2014). Reinforcement of multilevel governance dynamics: creating momentum for increasing ambitions in international climate negotiations. In International Environmental Agreements: Politics, Law and Economics. Department of Geography and Environment, Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy, London School of Economics and Political Science, Houghton Street, London, WC2A 2AE, UK. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84897118050&partnerID=40&md5=c7ff3a3b19bee339f3133386c4bc846b

Rietig, Katharina. (2019). *Leveraging the power of learning to overcome negotiation deadlocks in global climate governance and low carbon transitions global climate governance and low carbon transitions*. *7200*. doi: 10.1080/1523908X.2019.1632698

Robins, G., Bates, L., & Pattison, P. (2011). NETWORK GOVERNANCE AND ENVIRONMENTAL MANAGEMENT: CONFLICT AND COOPERATION. *Public Administration*, *89*(4), 1293–1313. doi: 10.1111/J.1467-9299.2010.01884.X

Robinson, O. C. (2013). Sampling in Interview-Based Qualitative Research: A Theoretical and Practical Guide. *Https://Doi.Org/10.1080/14780887.2013.801543*, *11*(1), 25–41. doi: 10.1080/14780887.2013.801543

Rodela, R. (2011). Social Learning and Natural Resource Management: The Emergence of Three Research Perspectives. *Ecology and Society*, *16*(4), art30. doi: 10.5751/ES-04554-160430

Rodela, R., Cundill, G., & Wals, A. E. J. (2012). An analysis of the methodological underpinnings of social learning research in natural resource management. *Ecological Economics*, *77*, 16–26. doi: 10.1016/j.ecolecon.2012.02.032

Rojas, A., Magzul, L., Marchildon, G. P., & Reyes, B. (2009). The oldman river dam conflict: Adaptation and institutional learning. *Prairie Forum*, *34*(1), 235–260. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-70350158718&partnerID=40&md5=57cb137a95e34daeac6a8b13a8d362db

Rowley, J. (2007). The wisdom hierarchy: representations of the DIKW hierarchy. *Journal of Information Science*, *33*(2), 163–180. doi: 10.1177/0165551506070706

Sabatier, P. A. (1988). An advocacy coalition framework of policy change and the role of policy-oriented learning therein. *Policy Sciences*, *21*(2–3), 129–168.

Sabel, C. F., & Zeitlin, J. (2008). Learning from difference: The new architecture of experimentalist governance in the EU. *European Law Journal*, *14*(3), 271–327. doi: 10.1111/j.1468-0386.2008.00415.x

Sanderson, I. (2002). Evaluation, Policy Learning and Evidence-based Policy Making. *Public Administration*, *80*(1), 1–22. doi: 10.1111/1467-9299.00292

Sandström, A., Söderberg, C., & Nilsson, J. (2020). Adaptive capacity in different multi-level governance models: a comparative analysis of Swedish water and large carnivore management. *Journal of Environmental Management*, *270*, 110890. doi: 10.1016/J.JENVMAN.2020.110890

Schipper, E. L. F. (2006). Conceptual history of adaptation in the UNFCCC process. *Review of European Community and International Environmental Law*, *15*(1), 82–92. doi: 10.1111/J.1467-9388.2006.00501.X

Schout, A. (2009). Organizational learning in the EU's multi-level governance system. *Journal of European Public Policy*, *16*(8), 1124–1144. doi: 10.1080/13501760903332613

Serrat, O. (2017). Social Network Analysis. *Knowledge Solutions*, 39–43. doi: 10.1007/978-981-10-0983-9_9

Shaw, A., & Kristjanson, P. (2014). A Catalyst toward Sustainability? Exploring Social Learning and Social Differentiation Approaches with the Agricultural Poor. *SUSTAINABILITY*, *6*(5), 2685–2717. doi: 10.3390/su6052685

Siebenhüner, B, Rodela, R., & Ecker, F. (2016). Social learning research in ecological economics: A survey. *Environmental Science and Policy*, *55*, 116–126. doi: 10.1016/j.envsci.2015.09.010

Siebenhüner, Bernd. (2008). *Learning in International Organizations in Global Environmental Governance*. Global Environmental Politics. Retrieved from file:///C:/Users/Javier/Downloads/Siebenhubner.pdf

Silver, J., McEwan, C., Petrella, L., & Baguian, H. (2013). Climate change, urban vulnerability and development in Saint-Louis and Bobo-Dioulasso: Learning from across two West African cities. *Local Environment*, *18*(6), 663–677. doi: 10.1080/13549839.2013.807787

Soruco, A., Vincent, C., Rabatel, A., Francou, B., Thibert, E., Sicart, J. E., & Condom, T. (2015). Contribution of glacier runoff to water resources of La Paz city, Bolivia (16° S). *Annals of Glaciology*, *56*(70), 147–154. doi: 10.3189/2015AOG70A001

Steele, W., Sporne, I., Dale, P., Shearer, S., Singh-Peterson, L., Serrao-Neumann, S., Crick, F., Choy, D. L., & Eslami-Andargoli, L. (2014). Learning from cross-border arrangements to support climate change adaptation in Australia. *Journal of Environmental Planning and Management*, *57*(5), 682–703. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84896842419&partnerID=40&md5=92df48dbf080332d3c69aaa58ffb4cff

Taylor, B. M., Harman, B. P., Heyenga, S., & McAllister, R. R. J. (2012). Property Developers and Urban Adaptation: Conceptual and Empirical Perspectives on Governance. *Urban Policy and Research*, *30*(1), 5–24. doi: 10.1080/08111146.2011.639178

Termeer, C, Biesbroek, R., & Van Den Brink, M. (2012). Institutions for adaptation to climate change: Comparing National Adaptation strategies in Europe. *European Political Science*, *11*(1), 41–53. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84856875538&partnerID=40&md5=8fa7a3711a4fea89ac2ea8d5b80ecaf2

Termeer, C. J. A. M., Dewulf, A., & Biesbroek, G. R. (2017). Transformational change: governance interventions for climate change adaptation from a continuous change perspective. *Journal of Environmental Planning and Management*, *60*(4), 558–576. doi: 10.1080/09640568.2016.1168288

Termeer, Catrien, Dewulf, A., Rijswick, H. van, Buuren, A. van, Huitema, D., Meijerink, S., Rayner, T., & Wiering, M. (2011). The regional governance of climate adaptation: A framework for developing legitimate, effective, and resilient governance arrangements. *Climate Law*, *2*(2), 159–179. doi: 10.1163/CL-2011-032

Thapa, B., Scott, C., Wester, P., & Varady, R. (2016). Towards characterizing the adaptive capacity of farmer-managed irrigation systems: learnings from Nepal. *Current Opinion in Environmental Sustainability*, *21*, 37–44. doi: 10.1016/j.cosust.2016.10.005

Thompson, D. (2016). Community adaptations to environmental challenges under decentralized governance in southwestern Uruguay. *Journal of Rural Studies*, *43*, 71–82. doi: 10.1016/j.jrurstud.2015.11.008

Thompson, G. (1991). *Markets, hierarchies and networks: the coordination of social life*. Retrieved from
https://books.google.com/books?hl=es&lr=&id=UEPRgGmmv4IC&oi=fnd&pg=PP7&dq=Mark
ets,+Hierarchies+and+Networks&ots=WONKsShwxr&sig=3SKImJ9eLvWEsKO4FZOLYEoa_Fc

Thompson, M., Ellis, R., & Wildavsky, A. (1990). *Cultural theory.* Westview Press. Retrieved from
http://psycnet.apa.org/psycinfo/1990-98188-000

Tompkins, E., & Adger, N.-E. S. &. (2005). Defining response capacity to enhance climate change
policy. *Environmental Science & Policy*, *8*(6), 562–571. Retrieved from
https://doi.org/10.1016/j.envsci.2005.06.012

Tschakert, P., & Dietrich, K. A. (2010). Anticipatory Learning for Climate Change Adaptation and
Resilience. *Ecology and Society*, *15*(2), art11. doi: 10.5751/ES-03335-150211

van Bommel, S., Blackmore, C., Foster, N., & de Vries, J. (2016). Performing and orchestrating
governance learning for systemic transformation in practice for climate change adaptation.
Outlook on Agriculture, *45*(4), 231–237. doi: 10.1177/0030727016675692

van der Wal, M., de Kraker, J., Offermans, A., Kroeze, C., Kirschner, P. A., & van Ittersum, M.
(2014). Measuring social learning in participatory approaches to natural resource
Management. *Environmental Policy and Governance*, *24*(1), 1–15. doi: 10.1002/eet.1627

van Ewijk, E., Baud, I., Bontenbal, M., Hordijk, M., van Lindert, P., Nijenhuis, G., & van Westen, G.
(2015). Capacity development or new learning spaces through municipal international
cooperation: Policy mobility at work? *Urban Studies*, *52*(4), 756–774. doi:
10.1177/0042098014528057

van Gerven, M., Vanhercke, B., & Gürocak, S. (2014). Policy learning, aid conditionality or
domestic politics? The Europeanization of Dutch and Spanish activation policies through the
European Social Fund. *Journal of European Public Policy*, *21*(4), 509–527. Retrieved from
http://www.scopus.com/inward/record.url?eid=2-s2.0-
84897028059&partnerID=40&md5=d5653ddee45aea348de346193b33fd67

van Wijk, M., van Bueren, E., & te Brömmelstroet, M. (2014). Governing structures for airport
regions: Learning from the rise and fall of the "Bestuursforum" in the Schiphol airport
region. *Transport Policy*, *36*, 139–150. doi: 10.1016/j.tranpol.2014.08.006

Vella, K., Sipe, N., Dale, A., & Taylor, B. (2015). Not Learning from the Past: Adaptive Governance
Challenges for Australian Natural Resource Management. *Geographical Research*, *53*(4),
379–392. doi: 10.1111/1745-5871.12115

Villavicencio-Calzadilla, P., & Kotzé, L. J. (2018). Living in Harmony with Nature? A Critical
Appraisal of the Rights of Mother Earth in Bolivia. *Transnational Environmental Law*, *7*(3),
397–424. doi: 10.1017/S2047102518000201

Vink, M. J., Dewulf, A., & Termeer, C. (2013). The role of knowledge and power in climate change
adaptation governance: a systematic literature review. *Ecology and Society*, *18*(4), art46. doi:
10.5751/ES-05897-180446

Vinke-de Kruijf, J., & Pahl-Wostl, C. (2016). A multi-level perspective on learning about climate
change adaptation through international cooperation. *Environmental Science and Policy*, *66*,
242–249. doi: 10.1016/j.envsci.2016.07.004

Wagnon, P., Ribstein, P., Kaser Georg, & Berton, P. (1999). Energy balance and runoff seasonality of a Bolivian glacier. *Global and Planetary Change* , *22*, 49–58. Retrieved from ftp://ftp.bpcrc.osu.edu/downloads/outreach/2011_Plagos_Review/Wagnon-etal_1999.pdf

Wenger, E. (2011). Social Learning Capacity. *Re-Shaping Learning: A Critical Reader*, 193–210. doi: 10.1007/978-94-6091-609-0_15

Widerberg, O., & Pattberg, P. (2015). International Cooperative Initiatives in Global Climate Governance: Raising the Ambition Level or Delegitimizing the UNFCCC? *Global Policy*, *6*(1), 45–56. doi: 10.1111/1758-5899.12184

Wood, R., Bandura, A., & Bailey, T. (1990). Mechanisms governing organizational performance in complex decision-making environments. *Organizational Behavior and Human Decision Processes*, *46*(2), 181–201. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-38249019725&partnerID=40&md5=efc7aa5efeb9d624f4c4f750cc64b74e

Woodruff, S. C., & Regan, P. (2019). Quality of national adaptation plans and opportunities for improvement. *Mitigation and Adaptation Strategies for Global Change*, *24*(1), 53–71. doi: 10.1007/S11027-018-9794-Z/METRICS

Yuthas, K., Dillard, J. F., & Rogers, R. K. (2004). Beyond agency and structure: Triple-loop learning. *Journal of Business Ethics*, *51*(2), 229–243. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-4043130261&partnerID=40&md5=1372b6484e675b10a1e9257b02f3286b

Zanon, B. (2010). Planning small regions in a larger Europe: Spatial planning as a learning process for sustainable local development. *European Planning Studies*, *18*(12), 2049–2072. doi: 10.1080/09654313.2010.515822

Zelli, F. (2011). The fragmentation of the global climate governance architecture. *Wiley Interdisciplinary Reviews: Climate Change*, *2*(2), 255–270. doi: 10.1002/WCC.104

Ziervogel, G., Pasquini, L., & Haiden, S. (2017). Nodes and networks in the governance of ecosystem-based adaptation: the case of the Bergrivier municipality, South Africa. *Climatic Change*, *144*(2), 271–285. doi: 10.1007/s10584-017-2008-y

Supplementary materials

Supplementary materials of Chapter 2

Table S2.1 Sample of the papers reviewed

No.	Autor (s)	Year	E/T[1]	Definition	Methods	Process	Factors
	Governance of adaptation AND learning						
1	Baird, J., Plummer, R., Haug, C., & Huitema, D.	2014	E	X	X	X	
2	Blackmore, C.	2014	E		X	X	
3	Boyd, E., Osbahr, H.	2010	E	X	X	X	
4	Button, C., Mias-Mamonong, M. A. A., Barth, B., & Rigg, J.	2013	E			X	
5	Huntjens, P., Pahl-Wostl, C., Rihoux, B., Schlüter, M., Flachner, Z., Neto, S., … Nabide Kiti, I.	2011	E	X	X	X	X
6	Ison, R. L., Collins, K. B., & Wallis, P. J.	2015	T	X			
7	Jabeen, H., Johnson, C., & Allen, A.	2010	E			X	
8	Janjua, S., Thomas, I., & McEvoy, D.	2010	E				
9	Kashyap, A.	2004	E			X	
10	Lynch, A. H., & Brunner, R. D.	2010	E	X			
11	McCrum, G., Blackstock, K., Matthews, K., Rivington, M., Miller, D., & Buchan, K.	2009	E	X		X	X
12	Nuorteva, P., Keskinen, M., & Varis, O.	2010	E	X		X	
13	Reid, H.	2016	T			X	
14	Rojas, A., Magzul, L., Marchildon, G. P., & Reyes, B.	2009	E	X		X	
15	Shaw A., Kristjanson, P.	2014		X	X		X
16	Siebenhüner, B., Rodela, R., & Ecker, F.	2016	T	X		X	
17	Silver, J., McEwan, C., Petrella, L., & Baguian, H.	2013	E			X	
18	Steele, W., Sporne, I., Dale, P., Shearer, S., Singh-Peterson, L., Serrao-Neumann, S., … Eslami-Andargoli, L.	2014	E	X	X	X	X
19	Thapa, B., Scott, C., Wester, P., & Varady, R.	2016	E	X		X	X
20	van Bommel, S., Blackmore, C., Foster, N., & de Vries, J.	2016	E			X	
21	van der Wal, M., De Kraker, J., Offermans, A., Kroeze, C., Kirschner, P. A., & van Ittersum, M.	2014	E	X	X		
	Multi-level governance AND learning						
22	Aranguren, M. J., Larrea, M., & Wilson, J.	2010	E	X	X	X	
23	Axelsson, R., Angelstam, P., Myhrman, L., Sädbom, S., Ivarsson, M., Elbakidze, M., … Törnblom, J.	2013	E	X	X	X	
24	Benson, D., Jordan, A., & Huitema, D.	2012	E	X		X	X
25	Benz, A.	2012	E	X			X
26	Borowski, I., Le Bourhis, J.-P., Pahl-Wostl, C., & Barraqué, B.	2008	E	X			X
27	Bradford, N., & Wolfe, D. A.	2013	E	X		X	
28	Clar, G., & Sautter, B.	2014	E	X		X	X
29	Gerlak, A. K., & Heikkila, T.	2011	E	X	X		X
30	Getimis, P.	2003	E			X	
31	Gleeson, B.	2003	E			X	
32	Hogl, K.	2002	E			X	
33	Johannessen, Å., & Hahn, T.	2013	E	X	X	X	X
34	Kerber, W., & Eckardt, M.	2007	E	X		X	X
35	Klein, I.	2010	E			X	
36	Löf, A.	2010	T	X			
37	Mah, D.N., Hills, P.R.	2014	E			X	
38	Mattes, J., Huber, A., Koehrsen, J.	2015	E			X	
39	Maurel, M.-C.	2008	E			X	
40	Metz, F., Ingold, K.	2014				X	
41	Pahl-Wostl, C., Becker, G., Knieper, C., & Sendzimir, J.	2013	E	X	X	X	X
42	Paraskevopoulos, C. J., & Leonardi, R.	2004	E	X		X	
43	Perrier, B., & Levrat, N.	2015	E				
44	Rantala, S., Hajjar, R. Skutsch, M.	2014					
45	Reed, M. G., Godmaire, H., Abernethy, P., & Guertin, M.-A.	2014	E	X	X	X	X
46	Sabel, C. F., & Zeitlin, J.	2008	E			X	
47	Schout, A.	2009	E		X		
48	Van Ewijk, E., Baud, I., Bontenbal, M., Hordijk, M., Van Lindert, P., Nijenhuis, G., & Van Westen, G.	2015	E			X	
49	van Gerven, M., Vanhercke, B., & Gürocak, S.	2014	E			X	
50	van Wijk, M., van Bueren, E., & te Brömmelstroet, M.	2014	E			X	
51	Vella, K., Sipe, N., Dale, A., & Taylor, B.	2015	E			X	
52	Yuthas, K., Dillard, J. F., & Rogers, R. K.	2004	T	X			
53	Zanon, B.	2010	E				
	Climate adaptation AND Multi-level governance AND learning						

[1] Empirical / Theoretical

54	Blackmore, C., van Bommel, S., de Bruin, A., de Vries, J., Westberg, L., Powell, N., … Seddaiu, G.	2016	E			X	
55	Dieleman, H.	2013	E	X		X	X
56	Leys, A. J., & Vanclay, J. K.	2011	E	X		X	X
57	Pahl-Wostl, C.	2009	T	X	X	X	X
58	Pelling, M., High, C., Dearing, J., & Smith, D.	2008	E	X			X

Table S2.2 Summary table of the literature review

Governance of adaptation AND learning

No.	Author (s)	T/E[2]	Country / Region	Explicit definition	Describe a methodology to assess learning	Describe learning processes and strategies	Factors that foster or inhibit learning described
1	Baird, J., Plummer, R., Haug, C., & Huitema, D.	E	Niagara region / Canada		Typology of cognitive / normative /relational	Adaptive co-management /learning by doing	
2	Blackmore, C.	E	UK	Learning system perspectives	Changes in practices / innovations	Learning systems	
3	Boyd, E., Osbahr, H.	E	UK	Organizational learning / Reflexive learning	Interviews	Organizational learning strategies	
4	Button, C., Mias-Mamonong, M. A. A., Barth, B., & Rigg, J.	E	UK/ The Philipines/ Kenya			Communities of practice	
5	Huntjens, P., Pahl-Wostl, C., Rihoux, B., Schlüter, M., Flachner, Z., Neto, S., … Nabide Kiti, I.	E	Czech Republic, Portugal, Hungary, Ukraine, South Africa, Uganda, Tanzania, Rwanda, Uzbekistan and The Netherlands.	Policy learning	Triple loop learning to assess different levels of policy learning	Adaptive water management	Cooperation structures / Information management
6	Ison, R. L., Collins, K. B., & Wallis, P. J.	T		Social learning and adaptive governance			
7	Jabeen, H., Johnson, C., & Allen, A.	E	Bangladesh			Extract lessons	
8	Janjua, S., Thomas, I., & McEvoy, D.	E	Pakistan	Organizational and policy learning			
9	Kashyap, A.	E	LDC's SIDC's			Extract lessons / Peer learning	
10	Lynch, A. H., & Brunner, R. D.	E	Pacific Islands	Adaptive governance			
11	McCrum, G., Blackstock, K..	E	UK	Social learning		Deliverative workshops	learning platforms

[2] Theoretical / Empirical approaches

No.	Autor (s)	T/E[2]	Country / Region	Explicit definition	Describe a methodology to assess learning	Describe learning processes and strategies	Factors that foster or inhibit learning described
	Matthews, K., Rivington, M., Miller, D., & Buchan, K.						
12	Nuorteva, P., Keskinen, M., & Varis, O.	E	Cambodia	Learning as a factor of resilience		Learning from the past	
13	Reid, H.	T	Worldwide			Research	
14	Rojas, A., Magzul, L., Marchildon, G. P., & Reyes, B.	E	Canada	Institutional learning		Extract lessons	
15	Shaw A., Kristjanson, P.	E	Global	Social learning	Processes and outcomes of learning		(5) Factors assessed context assessment, inclusive design and management, facilitating learning, mobilizing knowledge and assessing outcomes
16	Siebenhüner, B., Rodela, R., & Ecker, F.	T		social learning within ecological economics		Process and agents of social learning	
17	Silver, J., McEwan, C., Petrella, L., & Baguian, H.	E	Kenya / Burkina Faso			Peer learning	
18	Steele, W., Sporne, I., Dale, P., Shearer, S., Singh-Peterson, L., Serrao-Neumann, S., … Eslami-Andargoli, L.	E	Australia	Institutional learning framework / 4 different types based on Connor and Dovers 2004	different levels of institutional analysis	Institutional learning described	Political and institutional factors
19	Thapa, B., Scott, C., Wester, P., & Varady, R.	E	Nepal	Institutional level learning		adaptive capacity of farmer-managed irrigation systems	interaction and interlinkages with formal and informal institutions.
20	van Bommel, S., Blackmore, C., Foster, N., & de Vries, J.	E	CADWGO Project Europe, Australia, N. America			co-learning for systemic governance trans-formations	

No.	Autor (s)	T/E²	Country / Region	Explicit definition	Describe a methodology to assess learning	Describe learning processes and strategies	Factors that foster or inhibit learning described
21	van der Wal, M., De Kraker, J., Offermans, A., Kroeze, C., Kirschner, P. A., & van Ittersum, M.	E	The Netherlands	Social learning	Describing perspectives with cultural theory		

Multi-level governance AND learning

No.	Autor (s)	T/E²	Country / Region	Explicit definition	Describe a methodology to assess learning	Describe learning processes and strategies	Factors that foster or inhibit learning described
22	Aranguren, M. J., Larrea, M., & Wilson, J.	E	Basque Country	National and regional innovation systems	Learning from Success	Innovation networks	Effective coordination of knowledge flows; Local and regional networking
23	Axelsson, R., Angelstam, P., Myhrman, L., Sädbom, S., Ivarsson, M., Elbakidze, M., ... Törnblom, J.	E	Sweden	Social learning	An analytical method suggested	Multi-level social learning	
24	Benson, D., Jordan, A., & Huitema, D.	E	European Union	Lesson drawing for policy transfer		cross-national learning	Factors for policy transer described
25	Benz, A.	E	Germany	Policy learning / loop learning			Yardstick competition as an incentive
26	Borowski, I., Le Bourhis, J.-P., Pahl-Wostl, C., & Barraqué, B.	E	Germany and France	Social learning			Factors that encourage or impede learning described
27	Bradford, N., & Wolfe, D. A.	E	Canada	Policy learning / loop learning		Policy learning in regional policy development	
28	Clar, G., & Sautter, B.	E	Germany	Regional learning / Innovation systems / loop learning		Multi-level innovation networks / Strategic learning cycle	Spatial clustering
29	Gerlak, A. K., & Heikkila, T.	E	Florida – USA	Individual and collective learning	Learning process and learning products		Types of stracutral, social and technological factors

No.	Autor (s)	T/E[2]	Country / Region	Explicit definition	Describe a methodology to assess learning	Describe learning processes and strategies	Factors that foster or inhibit learning described
30	Getimis, P.	E	European Union			Institutional learning / Regional policy	
31	Gleeson, B.	E	Europe			Extract lessons	
32	Hogl, K.	E	Europe			Learning form cases	
33	Johannessen, Å., & Hahn, T.	E	Sweden	Social learning / Loop learning	Empirical case study	Social learning	Factors described that foster social learning
34	Kerber, W., & Eckardt, M.	E	Europe	Policy learning in the context of Open Method of Coordination (OMC)		Policy transfer	Describe factors for policy transfer
35	Klein, I.						
36	Löf, A.	T	Sweden	Learning loops / Learning layers in relation to adaptability and resilience			
37	Mah, D. N., Hills, P.R.	E	China	Policy learning		A case study of the pricing policies for wind energy in China.	
38	Mattes, J., Huber, A., Koehrsen, J.	E	Germany			Innovation systems	
39	Maurel, M.-C.	E	Europe / Hungary, Poland and Czech Republic			Policy transfer	
40	Metz, F., Ingold, K.					Learning from the past	
41	Pahl-Wostl, C., Becker, G., Knieper, C., & Sendzimir, J.	E	Europe (Hungary, Germany, The Netherlands)	A conceptual framework to analyze multi-level and multiloop learning in resource governance systems.	Conceptual and methodological framework to analyze transformative change / Management and transition framework (MTF)	Case studies: Tisza Hungary, Dutch Rhine, German Rhine	Informal learning and actor networks and; Degree of centralization; Vertical coordination.
42	Paraskevopoulos, C. J., & Leonardi, R.	E	Europe (Greece, Ireland and Portugal, Hungary, Poland)	Learning and regional policy / Social learning loop learning		patterns of learning in the cohesion and CEE countries	
43	Perrier, B., & Levrat, N.	E	Europe				

No.	Autor (s)	T/E[2]	Country / Region	Explicit definition	Describe a methodology to assess learning	Describe learning processes and strategies	Factors that foster or inhibit learning described
44	Reed, M. G., Godmaire, H., Abernethy, P., & Guertin, M.-A.	E	Canada	Social learning / Communities of practice	building a community of practice for collective learning and action	Building the community of practice is described	Factors are described
45	Sabel, C. F., & Zeitlin, J.	E	Europe			Learning through local experimentation / sharing experiences / mutual learning	
46	Schout, A.	E	European Union		Typology of: governance learning, instrument learning and organizational learning		
47	Van Ewijk, E., Baud, I., Bontenbal, M., Hordijk, M., Van Lindert, P., Nijenhuis, G., & Van Westen, G.	E	Municipal International Cooperation (MIC) Benin, Indonesia, Nicaragua, South Africa and the Netherlands			peer-to-peer learning / mutual learning, resulting in both policy transfer and mobility	
48	van Gerven, M., Vanhercke, B., & Gürocak, S.	E	Europe (Spain, The Netherlands)			/ Mutual learning	
49	van Wijk, M., van Bueren, E., & te Brömmelstroet, M.	E	The Netherlands			Draw lessons for airport regions	
50	Vella, K., Sipe, N., Dale, A., & Taylor, B.	E	Australia			Learning in relation to adaptive governance	
51	Wyborn, C., van Kerkhoff, L., Dunlop, M., Dudley, N., & Guevara, O.	T				Learning in relation to adaptive governance	
52	Yuthas, K., Dillard, J. F., & Rogers, R. K.	T		Loop learning Typology of learning: first level learning, second level learning and deuteron learning			

No.	Autor (s)	T/E[2]	Country / Region	Explicit definition	Describe a methodology to assess learning	Describe learning processes and strategies	Factors that foster or inhibit learning described
53	Zanon, B.	E	Europe			mutual learning and cooperation	
Climate adaptation AND Multi-level governance AND learning							
54	Blackmore, C., van Bommel, S., de Bruin, A., de Vries, J., Westberg, L., Powell, N., ... Seddaiu, G.	E	CADWAGO Project / Europe, Australasia and North America			Design for governance learning	
55	Dieleman, H.	E	Mexico City	Organizational learning / Experiential learning		Kolb learning cycle	Reflective action
56	Leys, A. J., & Vanclay, J. K.	E	Australia	Social learning as an approach to adaptive co-management		Social learning process	Facilitation of bridging organizations
57	Pahl-Wostl, C.	T		A conceptual framework to analyze multi-level and multiloop learning in resource governance systems.	Operational indicators for loop learning	Policy learning process	Informal networks
58	Pelling, M., High, C., Dearing, J., & Smith, D.	E		Interplay of institutions and social learning			Informal institutions / Sahdow system

Supplementary materials of Chapter 3

Table S3.1: List of document references

	Short ID	Reference	Document
1	D5/CP.7	Decision 5/CP.7	Implementation of Article 4, paragraphs 8 and 9, of the Convention (decision 3/CP.3 and Article 2, paragraph 3, and Article 3, paragraph 14, of the Kyoto Protocol)
2	D28/CP.7	Decision 28/CP.7	Guidelines for the preparation of National Adaptation Programmes of Action
3	D29/CP.7	Decision 29/CP.7	Establishment of a least developed countries expert group
4	D2/CP.11	Decision 2/CP.11	Five-year programme of work of the Subsidiary Body for Scientific and Technological Advice on impacts, vulnerability and adaptation to climate change
5	D1/CP.16	Decision 1/CP.16	The Cancun Agreements: Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention
6	D2/CP.17	Decision 2/CP.17	Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention
7	D1/CP.21	Decision 1/CP.21	Adoption of the Paris Agreement
8	D16/CP.24	Decision 16/CP.24	Least developed countries work programme
9	CMA.1	FCCC/PA/CMA/2018/3/Add.1	Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on the third part of its first session, held in Katowice from 2 to 15 December 2018 Addendum Part two: Action taken by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
10	SBSTA 25	FCCC/SBSTA/2006/11	Report of the Subsidiary Body for Scientific and Technological Advice on its twenty-fifth session, held at Nairobi from 6 to 14 November 2006
11	SBSTA 28	FCCC/SBSTA/2008/6	Report of the Subsidiary Body for Scientific and Technological Advice on its twenty-eighth session, held in Bonn from 4 to 13 June 2008
12	SBSTA 29	FCCC/SBSTA/2008/13	Report of the Subsidiary Body for Scientific and Technological Advice on its twenty-ninth session, held in Poznan from 1 to 10 December 2008
13	SBSTA 30	FCCC/SBSTA/2009/3	Report of the Subsidiary Body for Scientific and Technological Advice on its thirtieth session, held in Bonn from 1 to 10 June 2009
14	SBSTA 33	FCCC/SBSTA/2010/13	Report of the Subsidiary Body for Scientific and Technological Advice on its thirty-three session, held in Cancun from 30 November to 4 December 2010
15	SBSTA 37	FCCC/SBSTA/2012/5	Report of the Subsidiary Body for Scientific and Technological Advice on its thirty-seventh session, held in Doha from 26 November to 2 December 2012
16	SBSTA 39	FCCC/SBSTA/2013/5	Report of the Subsidiary Body for Scientific and Technological Advice on its thirty-ninth session, held in Warsaw from 11 to 17 November 2013
17	SBSTA 41	FCCC/SBSTA/2014/5	Report of the Subsidiary Body for Scientific and Technological Advice on its forty-first session, held in Lima from 1 to 6 December 2014
18	SBSTA 44	FCCC/SBSTA/2016/2	Report of the Subsidiary Body for Scientific and Technological Advice on its forty-fourth session, held in Bonn from 16 to 26 May 2016
19	SBSTA 46	FCCC/SBSTA/2017/4	Report of the Subsidiary Body for Scientific and Technological Advice on its forty-sixth session, held in Bonn from 8 to 18 May 2017

20	SBSTA 48	FCCC/SBSTA/2018/4*	Report of the Subsidiary Body for Scientific and Technological Advice on the first part of its forty-eighth session, held in Bonn from 30 April to 10 May 2018
21	SBI 16	FCCC/SBI/2002/6	Report of the Subsidiary Body for Implementation on its sixteenth session, held at Bonn, from 10 to 14 June 2002
22	SBI 33	FCCC/SBI/2010/27	Report of the Subsidiary Body for Implementation on its thirty-third session, held in Cancun from 30 November to 4 December 2010
23	SBI 38	FCCC/SBI/2013/10	Report of the Subsidiary Body for Implementation on its thirty-eighth session, held in Bonn from 3 to 14 June 2013
24	SBI 46	FCCC/SBI/2017/7	Report of the Subsidiary Body for Implementation on its forty-sixth session, held in Bonn from 8 to 18 May 2017
25	SBI 51	FCCC/SBI/2019/20	Report of the Subsidiary Body for Implementation on its fifty-first session, held in Madrid from 2 to 9 December 2019
26	LEG 30	Report FCCC/SBI/2016/18	The 30th meeting of the Least Developed Countries Expert Group. Report by the secretariat.
27	LEG 35	FCCC/SBI/2019/5	The 35th meeting of the Least Developed Countries Expert Group. Report by the Secretariat
28	AC-SB 37	FCCC/SB/2012/3	Report of the Adaptation Committee at the thirty-seventh session of the Subsidiary Body for Scientific and Technological Advice and Subsidiary Body for Implementation, held in Doha from 26 November to 1 December 2012
29	AC-SB 39	FCCC/SB/2013/2	Report of the Adaptation Committee at the thirty-ninth session of the Subsidiary Body for Scientific and Technological Advice and Subsidiary Body for Implementation, held in Warsaw, 11–16 November 2013
30	AC-SB 41	FCCC/SB/2014/2	Report of the Adaptation Committee at the forty-one session of the Subsidiary Body for Scientific and Technological Advice and Subsidiary Body for Implementation, held Lima, 1–6 December 2014
31	AC-SB 47	FCCC/SB/2017/2	Report of the Adaptation Committee at the forty-seventh session of the Subsidiary Body for Scientific and Technological Advice and Subsidiary Body for Implementation, held in Bonn, 6–15 November 2017
32	AC-SB 49	FCCC/SB/2018/3	Report of the Adaptation Committee at the forty-ninth session of the Subsidiary Body for Scientific and Technological Advice and Subsidiary Body for Implementation, held in Katowice, 2–8 December 2018
33	AC-SB 51	FCCC/SB/2019/3	Report of the Adaptation Committee at the fifty-first session of the Subsidiary Body for Scientific and Technological Advice and Subsidiary Body for Implementation, held in Santiago, 2–9 December 2019
34	NWP Report 2008	FCCC/SBSTA/2008/5	Report on the meeting of representatives from Parties on the outcomes of the activities completed under the Nairobi work programme on impacts, vulnerability and adaptation to climate change
35	AC-TP2014		Institutional arrangements for national adaptation planning and implementation
36	AC-TP2017	FCCC/TP/2017/3	Opportunities and options for integrating climate change adaptation with the Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction 2015–2030. Technical paper by the secretariat
37	Report LEG 2020	Report FCCC/SBI/2020/7	Stocktaking meeting of the Least Developed Countries Expert Group. Report by the Secretariat
38	FPF 2		Second Focal Point Forum of the Nairobi Work Programme, Poznan, 6 December 2008

39	FPF 10	10th Focal Point Forum of the Nairobi Work Programme, Marrakech, 9 Nov 2016
40	FPF 11	11th Focal Point Forum of the Nairobi Work Programme, Bonn, 8 Nov 2017
41	FPF 12	Proceeding from the 12th Focal Point Forum of the Nairobi work programme, Diversifying economic activity as an adaption strategy, Katowice, 5 December 2018
42	NAP Expo 2017	Regional NAP Expo, 28 June 2017 DRAFT PROGRAMME
43	AF 2018_1	Session 164 – Evaluating social learning and its impacts in participatory adaptation planning, Tuesday 19 June 2018
44	AF 2018_2	Session 36: Solutions for a Healthy Planet - learning from each other's successes on ecosystem-based adaptation, Wednesday 20 June 2018
45	AF 2018_3	Session 6: the role of faith-based organizations in adaptation, Adaptation Futures 2018, 7 August 2018

Table S3.2: Interviews

I1	International NGO (Observer)	25/10/2021
I2	Multi-lateral fund	10/11/2021
I3	Multi-lateral development bank	16/11/2021
I4	International NGO (Observer)	01/07/2022
I5	International NGO (Observer)	21/07/2022
I6	Multi-lateral fund and former AC member	19/08/2022

Table S3.3: Personal notes and participation in observer reports

P1	AC 18RINGO Report	RINGO Report of the observer group to the 18th meeting of the Adaptation Committee.
P2	CAS 2021	Climate Adaptation Summit hosted by the Netherlands 25-26 January 20021, Personal Notes

Table S3.4: code structure

Elements of the analytical framework	Code group	Codes
A. Enabling Factors		
(11) Institutional framework	(111) mandate to UNFCCC bodies	e.g. mandate to the COP, mandate to SBSTA, NWP, CAF, AC, LEG,…
	(112) institutional arrangements	e.g. Activities of Parties, NWP Partner organizations, expert groups, regional centres, platforms, national focal points, vulnearble local communities,
(12) working modalities	(121) Stablished procedures	e.g. Stakeholder engagement, nomination procedures, reporting, submissions, meetings and workshops

	(122) Adaptation working modalities	e.g. climate data and observations, climate models and scenarios, impact and vulnearbility assesments, adaptaiton actions, methods and tools
	(123) Adaptation policy instruments	e.g. NAPA's, NAP's, action pledges, National Communications, global stocktake,

B. Learning strategies		
(21) Learning strategies	(211) Aggregated learning strategies	e.g. data and information collection, data and information sharing, knowledge dialogues
	(212) explicit learning strategies	e.g. data collection, information sharing, collection of traditional and indigenous knowledge, sharing experiences, extraction and dissemination of lessons learned, peer learning
(22) dimensions of learning	(221) cognitive learning	e.g. new knowledge, increase the basis of scientific knowledge,
	(222) normative learning	e.g. shifts in viewpoints, building of consensus, shifts in values and paradigms,
	(223) relational learning:	e.g. building of relationships, enhanced trust; enhanced ability to cooperate
A. Outcomes		
(31) Expected outcomes	(311) Increased understanding	e.g. about the impacts, means of implementation, gaps and needs of different stakeholders
	(312) Enhanced action on adaptation	e.g. multi-level collaboration, catalyse action, scaling up of interventions
	(313) Increased ffectiveness of adaptation policies	e.g. effective policy integration, mainstreaming adaptation, tracking adaptation, coherence
	(314) Enhanced capacity for innovation	e.g. interface science-policy-practice, innovation platforms

Table S3.5: Summary of adaptation under the Convention mandates

UNFCCC Decision	*Adaptation mandate*
The Least Developed Countries work programme (D5/CP.7);	In response to Article 4.9 of the Convention "Parties shall take full account of the specific needs and special situations of the least developed countries (LDC's) in their actions with regard to funding and transfer of technology". updated in the 2018 (D16/CP.24), to continue assisting LDC's in their adaptation efforts.
Nairobi work programme on impacts, vulnerability, and adaptation to climate change	The NWP is outlined in ANNEX of D2/CP.11 This decision defines de objective, outcomes, scope of work and modalities of the NWP. - The objective is twofold to enhance understanding about the implications of climate change and make informed decisions on practical adaptation actions. - The NWP expected outcomes include enhanced capacity, enhanced information and knowledge management, integration of adaptation and international cooperation to manage climate risk. - The programme of work comprises two thematic areas a) impacts and vulnerability and b) Adaptation planning, measures and actions, each with several action-oriented sub-themes.

	- And the modalities of the programme comprise workshops, working groups, web-based repositories and different types of reports and submissions.
The Cancun Adaptation Framework	The mandate is at (D1/CP.16, Section II). The CAF invites parties to enhance action on adaptation: - by putting in places institutional capacities and enabling environment for adaptation. - It invites parties to formulate NAP and request the SBI to compile modalities and guidelines on NAP's. - Stablishes the Adaptation Committee and its functions and invite parties to submit on modalities and procedures for the Adaptation Committee. - Recognize the need for enhanced collaboration on loss and damage.
D1/CP.21 and The Paris Agreement	The mandate for adaptation is contained in the decision for the adoption of the Paris Agreement (D1/CP.21) and in Article 7 of the Paris Agreement which is also the Annex of D1/CP.21. Within the Paris Agreement (Art. 7) Parties shall: - Adopt a global goal on adaptation. - recognize that adaptation is a global challenge faced by all with local, subnational, national, regional and international dimensions, and that it is a key component of and makes a contribution to the long-term global response to climate change. - Recognize the importance of international cooperation on adaptation recognizing the CAF and the need for systematic responses for enhancing the effectiveness and durability of adaptation actions. Furthermore D1/CP.21: - Parties are invited to communicate NDC's before COP 22, those NDC's might include adaptation components, it also stablishes the procedures for the global stock take. - Provides additional mandates to the Adaptation Committee and the LEG on different aspects of the implementation of Art.7 of the Paris Agreement. - Request the GCF to provide funding for the preparation of NAP's. - Decides on the continuation of the Warsaw International Mechanism for Loss and Damage. - And decides to launch, in the period 2016 2020, a technical examination process on adaptation (TEP-A) under guidance of the Adaptation Committee;

Table S3.6: Summary table of institutional arrangements of adaptation under the UNFCCC

Institutional arrangement	Governance levels involved	Short description of nadate and institutional functions in the context of adaptation under the Convention
Bodies		
SBSTA	Global	SBSTA oversees matters related to methodologies and science. It coordinates IPCC reports and methodological issues under the Convention and the Paris Agreement. In relation to adaptation, under the guidance of its Chair and with the assistance of the secretariat, its mandate is to coordinate the implementation of the NWP, subject to the availability of resources (D2/CP.11 para 5).
SBI	Global	SBI oversees matters related with implementation of the Convention. In relation to adaptation it has guided the work on LDC's (SBI 16 endorsed the LDC work progamme - SBI 16 para 28b), National Communications, the Financial Mecahnism and other means of implementation like NAPA's and NAP's. With the adoption of the Paris Agreement it also guides the implementation of the NDC's.

Adaptation Committee	Global, International Regional, National.	Promotes the implementation of enhanced action on adaptation in a coherent manner under the Convention (D1/CP.16 para. 20); The Adaptation Committee is the overall advisory body to the COP on adaptation (D2/CP.17). The the first three-year workplan of the Adaptation Committee was approved in 2011.
Working groups		
LEG	Global National	The objective of the LEG is to advise on the preparation and implementation strategy for national adaptation programmes of action (NAPA's), considering the urgent and immediate adaptation needs of LDC's (D29/CP.7 Annex).
NAP task force	Global International National	The Adaptation Committee established a task force on NAP's (AC-SB 39 para 33) to facilitate the work of all developing countries on NAP's. Terms of reference of the NAP task force are given in (AC-SB 39 annex I).
TEP-A	Global	COP 21 decided to launch in the period 2016-2020 a technical examination process on adaptation to identify concrete opportunities for strengthening resilience, reducing vulnerabilities and increasing the understanding and implementation of adaptation actions (D1/CP.21 para 124-125). Thi sprocess is jointly guided by the subsidiary bodies and the Adaptation Committee.
Multistakeholder gatherings (Workshops, forums, expo)		
FPF	Global, International, Regional, National, Local	The Focal Point Forun is convened yearly by the Chair of SBSTA to share experiences and guidance among Parties and NWP partner organizations in the context of the NWP implementaion.
AF	Global, International,	The Adaptation Forum is an annual outreach event carried out by the Adaptation Committee to interact and dialogue with broader audiences.
NAP Expo	Global, International, Regional, National, Local	NAP expo is a yearly outreach activity conducted by the LEG to work on the implementation of NAP's. In some occasions the LEG has carried out regional NAP Expos aimed at promoting greater interaction among countries and collaboration with stakeholders at the regional levels.
International partnerships and networks		
LAKI	Regional, National,	The Lima Adaptation Knowledge Innitiative is an action pledge of the NWP initiated/supportedby the UNFCCC secretariat and UN Environment to explore knowledge gaps related to adaptation.
NAP Global Network	International, National,	The NAP Global Network is a bilateral effort of the International Institute of Sustainable Development (IISD) to support learning in relation to NAP implementation.

Supplementary materials of Chapter 4

Table S4.1: Full reference of policy documents reviewed.

1	Alianza Corredor Seco 2017	SCG (2017) Adaptación y mitigación de los efectos del cambio climático en la seguridad alimentaria y nutricional en Honduras
2	AECID 2018	AECID (2018) Lecciones aprendidas sobre agricultura resiliente al cambio climático para contribuir a la seguridad alimentaria y al derecho a la alimentación en América Latina y el Caribe.
3	AFD Bolivia	BOLIVIA, Mejorar la Gobernanza del sector del agua
4	BH Bolivia 2016	Balance Hídrico Superficial de Bolivia. Documento de difusión, La Paz 2016
5	BUR1 Honduras	SERNA (2019). Primer Informe Bienal de Actualización de Honduras
6	CABEI 2021	Ecosystem-based Adaptation to increase climate resilience in the Central American Dry Corridor and the Arid Zones of the Dominican Republic Multiple Countries, Funding Proposal GCF, Central American Bank for Economic Integration (CABEI), 23 November 2021
7	CATIE 2017	Viguera B., Martínez-Rodríguez,M.R., Donatti, C.I., Harvey, C.A., Alpízarr, F. (2017). Impactos del cambio climático en la agricultura de Centroamérica, estrategias de mitigación y adaptación. Proyecto CASCADA, Conservación Internacional (CI) - Centro Agronómico Tropical de Investigación y enseñanza (CATIE), Turrialba, Costa Rica, 2017
8	CGIAR 2014	Bouroncle, C., Imbach, P., Läderach, P., Rodríguez, B., Medellín, C., Fung, E. (2014) La agricultura de Honduras y el cambio climático: ¿Dónde están las prioridades para la adaptación?
9	CIF 2015	CIF (2015) Informe evaluacion - indicadores CIF. Foro taller "resiliencia y adaptación al cambio climático". Programa Piloto para la Resiliencia Climática (PPCR),Julio 2015
10	CIF 2020	Master plan for Investments to Increase Water Availability for Human Consumption and Agriculture in the Dry Corridor. CIF – IADB 2020
11	CIIFEN 2019	Construyendo comunidades costeras resilientes y mitigando emisiones de carbono a través de asociaciones público-privadas en la restauración de manglares y humedales. CIIFEN 2019
12	CONDESAN 2021	Llambí, L.D. & Garcés, A. 2021. Adaptación al cambio climático en los Andes: Vacíos y prioridades para la gestión del conocimiento. CONDESAN. Quito-Ecuador
13	CONGOPE 2019	CONGOPE, 2019. Informe metodológico y guía de interpretación de los diagnósticos provinciales de cambio climático. Proyecto Acción Provincial frente al Cambio Climático. Quito, Ecuador.
14	ENT Honduras	SERNA. Evaluación de Necesidades Tecnológicas. Reporte de Adaptación,
15	GAD CBBA 2015	GAD Cochabamba (2015). Agenda del Agua Cochabamba 2015-2025
16	GEF 2007	GEF (2007) Project Proposals Submitted for LDCF/SCCF Council Approval, June 2007
17	GIZ 2017	Bolivia: Adaptation to Climate Change M&E System for the Departmental Government of Santa Cruz (SMEACC)
18	IAEA 2021	IAEA Supports Study of Bolivian Wetland Water Reserves as Glaciers Melt
19	IADB 2013	ECUADOR: Mitigación y Adaptación al Cambio Climático Marco de la preparación de la Estrategia 2012 - 2017 del BID en Ecuador
20	IADB 2021 Bioeconomy Fund	FP173: The Amazon Bioeconomy Fund: Unlocking private capital by valuing bioeconomy products and services with climate mitigation and adaptation results in the Amazon Multiple Countries	Inter-American Development Bank (IDB), GCF Funding Proposal, 23 November 2021
21	IFAD 2020	Proyecto de Competitividad y Desarrollo Sostenible del Corredor Fronterizo Sur Occidental (FMAM PRO-LENCA)

22	IFPRI 2019	Sanders, A., Thomas, T.S., Rios, A., Dunston, S. (2019) Climate Change, Agriculture, and Adaptation Options for Honduras. IFPRI Discussion Paper 01827
23	IISD 2013	IISD (2013) Gestión de riesgos climáticos para la agricultura de pequeña escala en Honduras
24	INNOVA	Impulsan proyecto de adaptación de la agricultura familiar al cambio climático
25	MA 2012	República del Ecuador. Ministerio del Ambiente. (2012) Estrategia Nacional de Cambio Climático del Ecuador 2012-2025
26	MA 2019	MA (2019) Herramienta para la integración de criterios de Cambio Climático en los Planes de Desarrollo y Ordenamiento Territorial. Quito – Ecuador
27	MAE, UICN & GIZ 2019	MAE, UICN y GIZ. (2019). Nuestra experiencia de Adaptación basada en Ecosistemas en Manabí – Ecuador. Programa Regional "Estrategias de Adaptación al cambio climático basadas en Ecosistemas en Colombia y Ecuador". Quito, 107 pp
28	MMAyA 2013	MMAyA (2013) Programa Intercultural Cuencas Pedagógicas
29	MMAyA 2016	MMAyA (2016) Informe progreso de la política sectorial Gestión 2015
30	NAP-GSP Regional	PNUD-ONU Ambiente-GEF (LATIN AMERICA IN FOCUS: Regional brief on National Adaptation Plans
31	NAP-GSP Ecuador	PNUD-ONU Ambiente-GEF (Planes Nacionales de Adaptación: Lecciones aprendidas del Ecuador
32	NAP-GSP Honduras	NAP-GSP 2022. Supporting Honduras to advance their NAP process
33	SERNA 2018	SERNA (2018) Plan Nacional de Adaptación al Cambio Climático Hoduras
34	NDC Bolivia 2022	Nationally Determined Contribution (NDC) of the Plurinational State of Bolivia: NDCs update for the 2021-2030 period within the framework of The Paris Agreement
35	PBA 2017	Ecosistemas y cambio climático Identificación de vacíos en la aplicación del enfoque ecosistémico para la adaptación al cambio climático en el Ecuador. Propuestas Andinas Jul 17 NÚMERO 16
36	PDC Rocha 2015	GAD Cochabamba (2015) Plan Director de la cuenca del río Rocha: "Estado de Situación y Propuesta de Lineamientos Estratégicos", GAD Cochabamba -SDC – Secretaria Departamental de los Derechos de la Madre Tierra
37	PFA 2013	Proyecto del Fondo de Adaptación (2013) Guía metodología para incorporar la adaptación al cambio climático en la planificación del desarrollo, SERNA – PNUD
38	PNC 2017	MMAyA (2017) Programa Plurianual de Gestión Integrada de Recursos Hídricos y Manejo Integral de Cuencas 2017-2020, La Paz
39	PNC Evaluation 2013	Vuurmans, J., de Vries, P., Gutiérrez, R. (2013) Evaluación final del Plan Nacional De Cuencas 2006–2012
40	PNC Evaluation 2017	Evaluación al Plan Nacional de Cuencas Fase II. Contrato de servicios 2016/380702/1. Informe de evaluación marzo 2017
41	PNUD Guia financiamiento climático	GCF – PNUD (n.d.) Programa de fortalecimiento de capacidades en formulación de propuestas para acceder a financiamiento climático: Módulo 2. Cambio Climático en el Ecuador. GIZ – Futuro Latinoamericano
42	PROAMAZONIA	Buenas prácticas y lecciones aprendidas del Programa Integral Amazónico de Conservación de Bosques y Producción Sostenible (PROAmazonía)
43	ProCambio II	Buenas prácticas y lecciones aprendidas del Programa "Aumento de la resiliencia frente al cambio climático a través de la protección y el uso sostenible de ecosistemas frágiles – ProCamBío II"
44	Programa ABE_Manual de líderes	Programa Regional ABE Ecuador. Estrategias de adaptación basadas en ecosistemas en Colombia y Ecuador. Manual de líderes Modulo 4. MAE – UICN – GIZ

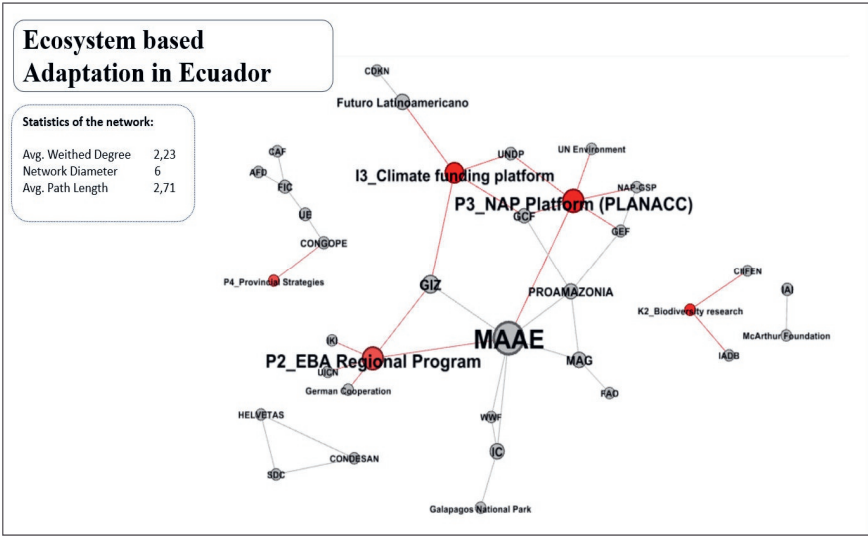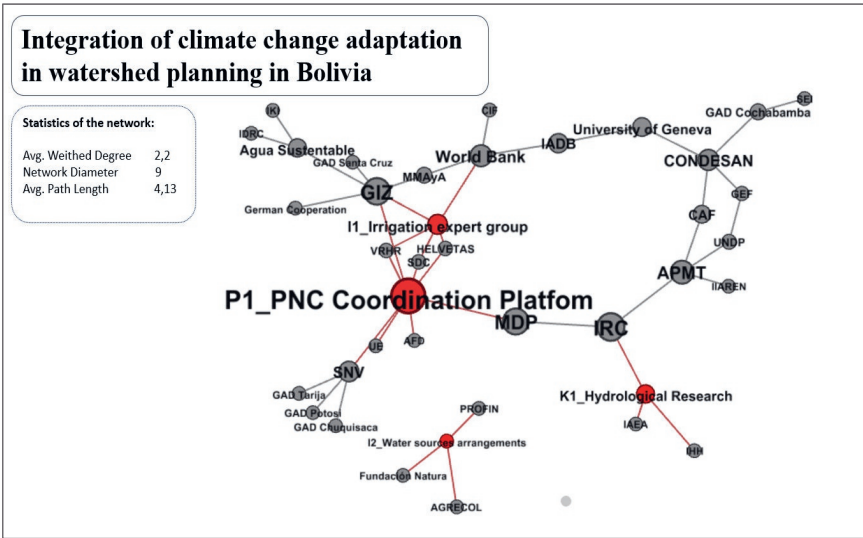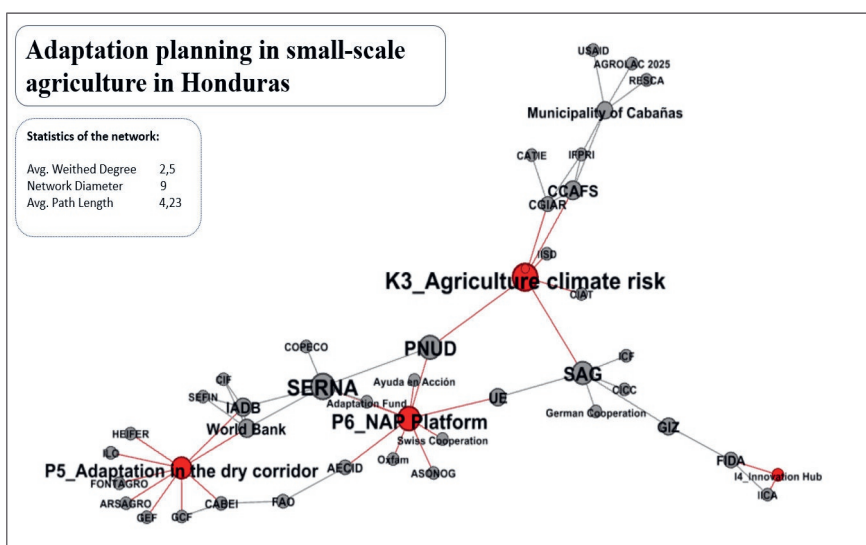| 45	SAG CGIAR	SAG (n.d.) Estatus de la Gestión de Riesgos Climáticos en el Sector Agroalimentario y su Importancia para la Seguridad Alimentaria y Nutricional en Honduras, CGIAR - CCAFS – CAC - CIAT
46	SAG 2015	Estrategia Nacional de Adaptación al Cambio Climático para el Sector Agroalimentario de Honduras (2015-2025)
47	SPCR Bolivia	Plurinational State of Bolivia (2011). Strategic Program for Climate Resilience. La Paz, Bolivia.
48	SPCR Honduras	Gobierno de la República de Honduras (2017). Strategic Program for Climate Resilience.
49	Work GIA 2014	Encuentro de intercambio de experiencias y articulación de políticas en gestión del agua con enfoque de cuencas y adaptación al cambio climático, 2014

Table S4.2: List of interviews

No	Code	Type of stakeholder	Governance level	Case Study	Date
1	G1	Government	National	Bolivia	05/06/2018
2	CS1	Civil society	Local	Bolivia	13/06/2018
3	IC1	International coop	National / Local	Bolivia	09/08/2018
4	FI1	Financial inst.	Internat. / National	Bolivia	05/09/2018
5	G2	Government	National	Ecuador	17/02/2021
6	G3	Government	National	Ecuador	18/02/2021
7	G4	Government	National	Honduras	01/03/2021
8	SC2	Civil society	Local	Honduras	02/03/2021
9	G5	Government	National	Honduras	08/03/2021
10	IC2	International coop	Regional	Ecuador	25/10/2021
11	FI2	Financial inst.	International		10/11/2021
12	IC3	International coop.	National / Local	Ecuador	15/11/2021
13	FI3	Financial inst.	Regional		16/11/2021
14	CS3	Civil society	National	Bolivia	05/01/2022
15	IC4	International coop.	National / Local	Bolivia	11/01/2022
16	IC5	International coop.	Regional	Honduras	21/01/2022
17	CS4	Civil Society	National	Honduras	01/07/2022
18	IC6	International coop	National	Ecuador	21/07/2022
19	IC7	International coop.	Regional	Honduras	28/07/2022
20	FI4	Financial inst.	International		19/08/2022

Table S4.3: Code structure

Framework elements		Code groups	Actual codes
Enabling factors	Structural	Multi-level learning nodes	platform; knowledge hubs; working group; task force
	Functional	Working modalities	e.g. meetings; technical reports; workshops; repositories
		Learning strategies Based on DIKW model (Rowley 2007)	e.g. data collection, experience exchange, peer learning,
Learning assessed	Learning dimensions	Cognitive	e.g. new knowledge, increase the basis of scientific knowledge,
		Normative	e.g. shifts in viewpoints, building of consensus, shifts in values and paradigms,
		Relational	e.g. building of relationships, enhanced trust; enhanced ability to cooperate
Institutional functions		Coordination	Cross sectoral coordination; vertical integration; concertation and conflict management; participation; transparency and accountability; reporting
		Knowledge and prioritization	Climate models; IVA Studies; Risk maps; Cost-benefit analysis; Multi-variable analysis
		Policy integration	NAP and other planning tools; Mainstreaming; policy integration;
		Implementation	Policy measures; Technological measures; Tools and guidelines
		M&E	Indicators; M&E Framework
		Funding	Access: Coverage; Diversity

Figure S4.1: Stakeholder networks and multi-level learning nodes: The number of stakeholders for the analysis has been limited to between 30 and 40. Multi-level learning nodes and respective edges are highlighted in red. Avg. Weighted Degree, Network Diameter, Avg. Path Length are parameters that describe the size of the network, the normalized distance between all pairs of nodes. The size of the nodes refers to the level of centrality of different nodes. The list of acronyms is included bellow.

Adaptation planning in small-scale agriculture in Honduras

Statistics of the network:

Avg. Weithed Degree   2,5
Network Diameter   9
Avg. Path Length   4,23

List of Acronyms

AECID	Agencia Española de Cooperación Internacional	IC	Conservation International
AFD	Agence Française de Développement	ICF	Instituto de Conservación Forestal
AGRECOL	Fundación AGRECOL	IDRC	International Development Research Centre
APMT	Autoridad de la Madre Tierra	IFPRI	International Food Policy Research Institute
ARSAGRO	Asociación regional de servicios agropecuarios de oriente	IHH	Instituto de Hidráulica e Hidrología
ASONOG	Asociación de Organizaciones No Gubernamentales de Honduras	IIAREN	Instituto de Investigaciones Agropecuarias y de Recursos Naturales
		IICA	Instituto Internacional de Cooperación en Agricultura
CABEI	Central American Bank for Economic Integration	IISD	International Institute for Sustainable Development
CAF	Development Bank of Latin America	IKI	Internationale Klimaschutzinitiative
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza	ILO	International Labor Organization
		FAP	Fundación Amazonia Productiva
CDKN	Climate and Development Knowledge Network	FIC	Fundación para la Investigación del Clima
CGIAR	Consultative Group for International Agricultural Research	FIDA (IFAD)	International Fund for Agricultural Development
		FONTAGRO	Fondo Regional de Tecnología Agropecuaria
CIAT	Centro Internacional de Agricultura Tropical	MMAE	Ministerio del Ambiente, Agua y Transición Ecológica
CICC	Comité Interinstitucional de Cambio Climático	MAG	Ministerio de Agricultura y Ganadería (Ecuador)
CIF	Climate Investment Fund	MMAyA	Ministerio de Medio Ambiente y Agua (Bolivia)
CIIFEN	Centro Internacional para la Investigación del Fenómeno de El Niño	NAP-GSP	NAP (National Adaptation Plan) Global Support Programme
CONDESAN	Consorcio para el Desarrollo Sostenible de la Ecorregión Andina	PNUD (UNDP)	United Nations Development Programme
		PROFIN	Fundación PROFIN
CONGOPE	Consorcio De Gobiernos Autónomos Provinciales Del Ecuador	RESCA	Resilience Central America
		SAG	Secretaria de Agricultura y Ganadería (Honduras)
COPECO	Comisión Permanente de Contingencias	SEFIN	Secretaria de Finanzas (Honduras)
FAO	Food and Agriculture Organization	SDC	Swiss Development Cooperation
FIC	Fundación para la Investigación del Clima	SERNA	Secretaria de Recursos Naturales y Ambiente (Honduras)
GAD	Autonomous Departmental Government		
GCF	Green Climate Fund	UE (EU)	European Union
GEF	Global Environmental Facility	UICN (IUCN)	International Union for Conservation of Nature
GIZ	Gesellschaft für Internationale Zuzamenarbeit	UN Environment	United Nations Environment Programme
IADB	Interamerican Development Bank	VRHR	Viceministerio de Recursos Hídricos y Riego (Bolivia)
IAEA	International Atomic Energy Agency	WWF	World Wild Foundation
IAI	Interamerican Institute		

Supplementary materials of Chapter 5

Table S5.1: Full reference of policy documents reviewed

Short reference	Full reference
Mother Earth Framework Law / October 2015	Ley Marco de la Madre Tierra y Desarrollo Integral para Vivir Bien / 15 October 2012
National UNFCCC Implementation Strategy 1998 – 2008	Ministerio de Desarrollo Sostenible y Planificación (2008). Estrategia Nacional de Implementación 1998 – 2008, MDSP – PNCC, La Paz – Bolivia
Bolivias´ Nationally Determined Contribution	Estado Plurinacional de Bolivia. (2011). Contribución Prevista Determinada Nacionalmente del Estado Plurinacional de Bolivia, 1–18.
Bolivias´ First National Communication	Republic of Bolivia (2000), First National Communication to the UNFCCC, La Paz – Bolivia
Bolivias´ Second National Communication	Ministerio de Medio Ambiente y Agua (MMAyA). (2009). Segunda Comunicación Nacional del Estado Plurinacional de Bolivia ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático. La Paz - Bolivia.
National Watershed Plan (2006-2012)	Ministerio del Agua (2007), Plan Nacional de Cuencas, Marco Conceptual y Estratégico, La Paz – Bolivia
National Watershed Plan (2013-2017)	Ministerio de Medio Ambiente y Agua (MMAyA) (2014). Programa Plurianual de Gestión Integrada de Recursos Hídricos y Manejo Integral de Cuencas 2013-2017. La Paz - Bolivia.
National Watershed Plan (2017-2020)	Ministerio de Medio Ambiente y Agua (MMAyA). (2017). Programa Plurianual de Gestión Integrada de Recursos Hídricos y Manejo Integral de Cuencas 2017-2020, La Paz – Bolivia
River Mizque Watershed Plan	Equipo técnico de Planificación PDC-Mizque. (2014). Plan Director de la Cuenca del Río Mizque, Cochabamba
Water Agenda Cochabamba	Gobierno Autónomo Departamental de Cochabamba. (2015). Agenda del Agua Cochabamba (2015-2025). Cochabamba - Bolivia.
Strategic Program for Climate Resilience (2011)	Plurinational State of Bolivia (2011). Strategic Program for Climate Resilience. La Paz, Bolivia.
World Bank PRAA Report	The World Bank. (2014). PRAA - Implementation Completion and Results Report.
Final Evaluation of PNC I	Vuurmans, J., de Vries, P., & Gutiérrez, R. (2013). Evaluación final Plan Nacional de Cuencas 2006 - 2012. La Paz - Bolivia.
Final Evaluation of PNC II	Dockweileer, M., & Alecastre, A. (2017). Evaluación al Plan Nacional de Cuencas Fase II (Versión Preliminar). La Paz, Bolivia.
Lessons from technical assistance to PNC I	Rodríguez Ballesteros, L. P., & Gutierrez Agramont, R. A. (2012). Memorial de las lecciones aprendidas de la asistencia técnica al apoyo sectorial al Plan Nacional de Cuencas: hacia una gestión integral del agua en Bolivia. La Paz- Bolivia.
Mainstreaming climate change by PNC II_Consultancy work	Kowal, M. (2012). Mitigación y Adaptación al Cambio Climático en el Plan Nacional de Cuencas. La Paz - Bolivia.
Mainstreaming climate change by PNC II_Consultancy work (2)	Marengo Orsini, J. A. (2011). Inserción del componente Cambio Climático al PNC. Delegación de la Comisión Europea, La Paz - Bolivia.

PPCR indicators evaluation workshop (2015)	Ministerio de Medio Ambiente y Agua (MMAyA). (2015). Resiliencia y adaptación al cambio climático - Sistematización del Foro Taller (p. 37). La Paz - Bolivia: MMAyA - PPCR.
climate change and water resources-local perceptions of communities in the National Park Sajama	Ulloa, D., & Yager, K. (2007). Cambio Climático: Percepción Local y Adaptación en el Parque Nacional Sajama. Sajama - Bolivia.

Table S5.2: Characterization of multi-level learning nodes in Bolivia´s water sector

MLN (Institutional arrangements and implementation)	Characterization of MLN	Cognitive, normative and relational processes of multi-level learning	Outcomes and implications
(PN1) UNFCCC focal point: role assumed by the Mother Earth Authority (APMT) Participation in UNFCCC negotiations, coordination with international bodies (e.g. donors), other sector ministries, and key stakeholders.	**Type of learning node:** Policy node **Main levels of governance:** Global/ international / regional national **Multi-level learning processes:** International UNFCCC process / national climate change policy development;	**Cognitive:** NC reports based on inputs from key sectors and research institutes on climate change impacts, vulnerability and adaptation. Exploring means for involvement of local and indigenous knowledge. **Normative:** National focal point prepare policy recommendations together with sector bodies. **Relational:** Coordination with different sectors for reporting progress Multi-level coordination with subnational bodies Nomination of national experts to the IPCC and other UNFCCC bodies.	Better knowledge and understanding about the impacts, vulnerability and adaptation to climate change; Climate change adaptation policies and plans in place; Public awareness and training of key stakeholders.
(PN2) Water sector normative bodies: Viceministry of Waterresources and Irrigation (VRHR); and Viceministry of Water and Sanitation (VASB) **Multi-level learning processes:** Conducting mainstreaming climate change in water sector planning processes; Coordination with international bodies (e.g. technical assistance), and key stakeholders at different levels of governance.	**Type of learning node:** Policy node **Main levels of governance:** National / provincial / local	**Cognitive:** Integration of climate change scenarios in the water balance at different scales. **Normative:** Preparation of project norms and standards at the level of infrastructure projects Climate change indicators in M&E frameworks to assess policy effectiveness **Relational:** Coordination with key stakeholders of the water sector Enhanced science policy dialogue Multi-level coordination with subnational bodies	Better knowledge and understanding about the implications of climate change on key water infrastructure and services; Experience about how to integrate adaptation and climate resilience in key policy and planning instruments. Procedures in place to integrate climate change adaptation by project design.

MLN (Institutional arrangements and implementation)	Characterization of MLN	Cognitive, normative and relational processes of multi-level learning	Outcomes and implications
(KH1) National Information System on Climate and Water (SNICA) Headed by the Ministry of Environment and Water (MMAyA) Coordination with the meteorology service and research institutes.	**Type of learning node:** knowledge hub **Main levels of governance:** National / provincial **Multi-level learning processes:** Supervising priority studies i.a. the national water balance, and services like early warning systems.	*Cognitive:* Climate science / climate change scenarios / hydrological models / measurements *Normative:* Standardization of methods e.g. the use of Global Circulation Models (GCM) Standardization of research tools and methods in the water sector e.g. climate models / drought forecasting indicators / early warning Training of staff at national and subnational levels. *Relational:* Collaboration networks with the meteorology service and research centers at local/national levels	· Better knowledge and understanding about the adverse effects of climate change on key hydrological variables, like water balances and tables; · Better procedures for generating and sharing data and information;
(KH2) Expert groups on infrastructure resilience Ad hoc group headed by the Director of Irrigation and supported by international cooperation bodies. Individual experts are invited to contribute.	**Type of learning node:** knowledge hub **Main levels of governance:** national **Multi-level learning processes:** Tool and guideline definition	*Cognitive:* Integration of climate change adaptation considerations by project design; *Normative:* Preparation of project guidelines according to different project typologies in the water sector; Training and registry of qualified consultants; *Relational:* Knowledge transfer e.g. tools that work elsewhere;	· Better understanding about the design and climate proofing project interventions; · Dissemination of good practices and training;
(KH3) Water research Institutes i.a. Institute of Hydraulics and Hydrology (IHH-UMSA); Centro Agua – UMSS Institutes are invited to provide services for policy definition and planning efforts.	**Type of learning node:** knowledge hub **Main levels of governance:** International / national **Multi-level learning processes:** Tool and guideline definition	*Cognitive:* Climate science / climate change scenarios / hydrological models / measurements *Normative:* Standardization of methods e.g. the use of Global Circulation Models (GCM) Academic training of professionals and scientists *Relational:* Science – policy dialogue Knowledge dialogue with local communities	· Better knowledge and understanding about the adverse effects of climate change on key hydrological variables, and ecosystems e.g. glacier melting, highland pastures, etc; · Enhanced understanding about adaptation options;

MLN (Institutional arrangements and implementation)	Characterization of MLN	Cognitive, normative and relational processes of multi-level learning	Outcomes and implications
(PP1) River Mizque - Strategic watershed Plan and planning platform Multi-stakeholder platforms formally established for consultations and definition of Watershed Director Plans	**Type of learning node:** Planning platform **Main levels of governance:** Provincial / local **Multi-level learning processes:** Priority watershed planning	*Cognitive:* Integration of climate change scenarios in water planning and management models; Water availability forecast e.g. through hydrologic models; *Normative:* Priority setting; *Relational:* Multi-stakeholder dialogue, negotiations and social learning about climate change adaptation options at different levels; Involvement of the academic sector and local NGO's for advocacy.	Stakeholder negotiations and future expectations consider the potential impacts of climate change; Potential adoption of new approaches , like water resource conservation, green infrastructure and flexibility in the distribution of water uses.
(PI1) Educational watersheds (*cuencas pedagógicas*) Formally established in the National Watershed Plan to test governance and implementation models.	**Type of learning node:** Pilot interventions **Main levels of governance:** National / provincial / local **Multi-level learning processes:** Community participation in the development of project interventions.	*Cognitive:* Revaluation of indigenous and traditional knowledge; Selection and dissemination of best practices; *Normative:* Development and application of communal norms e.g. land use, water rights, etc.; *Relational:* The community interact with the academic sector and the government at different levels for the use of public expenditures in adaptation projects and measures.	Public awareness about the potential impacts of climate change; Adaptation options are tested in collaboration with the communities and stakeholders in the ground.
(PI2) Pilot adaptation projects Projects of different scale and design concepts to test interventions models in the water sector.	**Type of learning node:** Pilot intervention **Main levels of governance:** Local **Multi-level learning processes:** Adaptation intervention models.	*Cognitive:* Development and application of adaptation intervention models; Traditional and indigenous knowledge about natural resource management and governance aspects of watershed management; *Normative:* Models and principles of effective adaptation *Relational:* Participatory processes of knowledge and wisdom dialogue and decision making	Better understanding about the implications of climate change on local livelihoods; Successful interventions models can be scaled up, retrofitting policy definition and public investment programs; Better incorporation of local and indigenous knowledge and experiences in project definition.

Summary

The aim of this thesis is to gain a deeper understanding of the role of multi-level learning in adaptation governance and how it can be enhanced. Four research questions have guided this investigation:

- RQ1. How to conceptualize multi-level learning in the governance of adaptation based on the social learning and policy learning literature?
- RQ2. What are the factors that encourage multi-level learning in the governance of adaptation?
- RQ. Where and how does multi-level learning occur in the governance of adaptation in the Latin American context?
- RQ4. How can multi-level learning be enhanced and what are the implications for the governance of adaptation?

As outlined in the introductory chapter, the overarching methodological approach aims to understand learning about climate change adaptation from a multi-level perspective. Consequently, the proposed chapters are structured to examine adaptation-related learning processes across different levels of governance. Following a systematic literature review presented in Chapter 2, multi-level learning is explored from the global perspective of the UNFCCC in Chapter 3. Chapters 4 and 5 delve into multi-level learning involving international, regional, national, and local levels. Chapter 4 analyzes multi-level learning linked to adaptation planning processes in three Latin American cases, while Chapter 5 evaluates the integration of adaptation policies through a case study in Bolivia's water sector, assessing multi-level interactions at both national and local levels.

Building upon this framework, Chapter 2's literature review aims to comprehend learning approaches within two scientific fields: multi-level governance and climate change adaptation. The chapter addresses this review through four categories: definitions of learning adopted in both fields, methodologies proposed for assessing and measuring learning, strategies adopted to foster learning, and factors considered to promote or hinder learning across different levels of governance.

As a result of this systematic literature review, a definition of multi-level learning is proposed and consistently utilized throughout the thesis. This literature review also identifies key theoretical elements applied across the thesis to develop analytical frameworks and methods for exploring multi-level learning in adaptation governance.

In Chapter 3, the thesis addresses a fundamental question to understand multi-level learning within the context of the international adaptation regime's evolution. Given the significance of the multilateral climate regime defining adaptation, the chapter presents an analysis to better understand how the UNFCCC enables multi-level learning.

Recognition of climate change adaptation as a multi-level governance challenge has increased in both the UNFCCC regime, including the Paris Agreement, and academic literature. This chapter addresses a gap identified in academic literature regarding how multi-level learning has been considered in the UNFCCC regime. The chapter fills this knowledge gap by focusing on how the UNFCCC multilateral process enables multi-level learning for adaptation governance. Three research questions are addressed in this chapter to understand how the institutional design of adaptation under the UNFCCC enables multi-level learning; the learning strategies adopted across governance levels; and how the UNFCCC regime perceives the contribution of multi-level learning to adaptation outcomes.

The analytical framework applied draws on theoretical approaches present in the literature to evaluate learning processes linked to adaptation and has been utilized and refined in the subsequent chapters to analyze multi-level learning in adaptation governance across governance levels.

Chapter 4 delves into adaptation processes at the national level, defined by adaptation planning processes in three case studies: Integration of adaptation into watershed planning in Bolivia; ecosystem-based adaptation in Ecuador; and small-scale agriculture planning processes in Honduras. The selected cases offer empirical insights into the cognitive, normative, and relational dimensions of multi-level learning and their relationship with necessary adjustments and improvements at the institutional level of adaptation planning functions. The study also provides empirical evidence on the role played by stakeholder networks and multi-level learning nodes in establishing and implementing the climate change agenda and identifies structural barriers or gaps that hinder better coordination, thus strengthening multi-level learning processes and collaboration among actors for greater ambition in adaptation goals, as required by the Paris Agreement.

Chapter 5 delves even deeper into the case study of Bolivia's water sector to understand, from a multi-level learning perspective, the processes of adaptation policy integration or mainstreaming adaptation. The case study provides a wealth of empirical information on the roles of national and local actors, as well as institutional arrangements, in the formation of multi-level learning nodes. The study is supported by a significant amount of information on

the depletion of the National Watershed Plan in Bolivia supported by international cooperation.

Chapter 6 presents a synthesis of the thesis. The Chapter is organized to address the research questions of this thesis, analyze the strengths and limitations of the methodological design, and outline prospects for future research. The chapter also analyzes the policy implications and recommendations of this thesis regarding the contribution of multi-level learning to adaptation governance.

Resumen

El objetivo de esta tesis es comprender mejor el papel del aprendizaje multi-nivel en la gobernanza de la adaptación y cómo podría mejorarse.

Cuatro preguntas de investigación han guiado este trabajo de investigación.

- PI1. ¿Cómo conceptualizar el aprendizaje multi-nivel en la gobernanza de la adaptación a partir de la literatura sobre el aprendizaje social y el aprendizaje de políticas?

- PI2. ¿Cuáles son los factores que fomentan el aprendizaje multi-nivel en la gobernanza de la adaptación?

- PI3. ¿Dónde y cómo se da el aprendizaje multi-nivel en la gobernanza de la adaptación en el contexto latinoamericano?

- PI4. ¿Cómo se puede mejorar el aprendizaje multi-nivel y cuáles son las implicaciones para la gobernanza de la adaptación?

Como se indicó en el capítulo introductorio de esta tesis, el enfoque metodológico general tiene como objetivo comprender el aprendizaje sobre la adaptación al cambio climático desde una perspectiva multi-nivel.

Por ello, los diferentes capítulos propuestos se ordenan para estudiar los procesos de aprendizaje vinculados a la adaptación a través de diferentes niveles de gobernanza. Continuando con una revisión sistemática de la literatura, presentada en el Capítulo 2, se explora el aprendizaje multi-nivel desde la perspectiva global de la CMNUCC, lo cual se presenta en el Capítulo 3. El aprendizaje multi-nivel que involucra al nivel internacional, regional, nacional y local se presenta en los Capítulos 4 y 5. En el Capítulo 4 se analiza el aprendizaje multi-nivel, vinculado a los procesos de planificación de la adaptación en 3 casos en América Latina, y en el Capítulo 5 la integración de políticas de adaptación a partir de un estudio de caso en el sector de agua de Bolivia, donde se evalúan las interacciones multi-nivel a nivel nacional y local.

Siguiendo esta secuencia, la revisión bibliográfica presentada en el Capítulo 2 tiene como objetivo comprender los enfoques del aprendizaje en dos campos de la literatura científica: *la gobernanza multi-nivel y* la *adaptación al cambio climático*. El capítulo aborda esta revisión a partir de 4 categorías: las definiciones de aprendizaje adoptadas en ambos campos de la literatura; las metodologías propuestas para la evaluación y medición del aprendizaje; las estrategias adoptadas para fomentar el aprendizaje; y, por último, los factores que alientan o limitan el aprendizaje a través de los diferentes niveles de gobernanza.

Como resultado de esta revisión sistemática de la literatura, se propone una definición de aprendizaje multi-nivel, la cual se ha utilizado a lo largo de la tesis. Esta revisión de la literatura sirvió también para identificar elementos teóricos clave que se han aplicado a lo largo de la tesis para el desarrollo de marcos analíticos y métodos para explorar el aprendizaje multi-nivel en la gobernanza de la adaptación.

En el capítulo 3, la tesis aborda una cuestión fundamental para comprender el aprendizaje multi-nivel a la par de la evolución del régimen internacional de adaptación. Dada la importancia del régimen climático multilateral que define la adaptación, el capítulo presenta un análisis para comprender mejor las formas en que la CMNUCC permite el aprendizaje multi-nivel.

La adaptación al cambio climático se ha reconocido cada vez más como un desafío de gobernanza multi-nivel tanto en el contexto de la CMNUCC y el Acuerdo de París, como en la literatura académica. En este capítulo se aborda un vacío identificado en la literatura académica sobre cómo se ha considerado el aprendizaje multi-nivel en el contexto de la CMNUCC. El capítulo llena este vacío de conocimientos centrándose en las formas en que el proceso multilateral de la CMNUCC permite el aprendizaje multi-nivel para la gobernanza de la adaptación. En este capítulo se abordan tres preguntas de investigación para comprender cómo el diseño institucional de la adaptación en el marco de la CMNUCC permite el aprendizaje multi-nivel; las estrategias de aprendizaje adoptadas en todos los niveles de gobernanza; y la forma en que el régimen de la CMNUCC entiende la contribución del aprendizaje multi-nivel a los resultados de la adaptación.

El marco analítico aplicado se basa en los enfoques teóricos presentes en la literatura para evaluar los procesos de aprendizaje vinculados a la adaptación y ha sido utilizado y perfeccionado en los siguientes capítulos para analizar el aprendizaje multi-nivel en la gobernanza de la adaptación en los diferentes niveles de gobernanza.

En el capítulo 4 se profundiza en los procesos de adaptación a nivel nacional, definidos por los procesos de planificación de la adaptación en tres estudios de caso: Integración de la adaptación en la planificación de cuencas hidrográficas en Bolivia; adaptación basada en ecosistemas en Ecuador; y procesos de planificación de la agricultura a pequeña escala en Honduras. Los casos seleccionados proporcionan una gran cantidad de información empírica sobre las dimensiones cognitivas, normativas y relacionales del aprendizaje multi-nivel, y cómo éstas se relacionan con los ajustes y mejoras necesarios a nivel de las funciones institucionales para la planificación de la adaptación. El estudio también proporciona evidencia empírica sobre el papel desempeñado por las redes de actores y los nodos de

aprendizaje multi-nivel en el establecimiento y la implementación de la agenda de cambio climático y dónde existen barreras o brechas estructurales que impiden una mejor coordinación y, por lo tanto, el fortalecimiento de los procesos de aprendizaje multi-nivel y la colaboración entre los actores para una mayor ambición en los objetivos de adaptación, como lo requiere el Acuerdo de París.

En el capítulo 5, se profundiza aún más en el estudio de caso del sector del agua en Bolivia para comprender desde una perspectiva de aprendizaje multi-nivel, los procesos de integración de políticas de adaptación o transversalización de la adaptación. El estudio de caso proporciona una gran cantidad de información empírica sobre el papel de los actores nacionales y locales, así como los arreglos institucionales en la formación de nodos de aprendizaje multinivel. El estudio se sustenta en una cantidad relevante de información sobre la implementación del Plan Nacional de Cuencas en Bolivia apoyado por la cooperación internacional.

En el capítulo 6 se presenta una síntesis de la tesis. Este capítulo está organizado para responder a las preguntas de investigación de esta tesis, analizar las fortalezas, pero también las limitaciones del diseño metodológico y esbozar las perspectivas para futuras investigaciones. El capítulo también analiza las implicaciones políticas y las recomendaciones de esta tesis sobre la contribución del aprendizaje multi-nivel a la gobernanza de la adaptación.

About the author

Javier P.E. Gonzales-Iwanciw, was born in Buenos Aires, Argentina in 1969. After graduating from high school in La Paz, Bolivia in 1988, he was awarded a fellowship by the German Democratic Republic (GDR) to pursue studies at the Food Technology Faculty of Humboldt University Berlin, where he successfully completed his degree in 1994. During his time at Humboldt University (HUB), he was trained about the economics of peri-urban agriculture and the contribution of non-edible gardening to ecological modification and air pollution abatement in city regions at the Institute of Economic Engineering of the Food Industry of HUB and with short study periods at the Department of Economics and Agrarian Social Sciences of Universidad Politécnica de Madrid and the Fraunhofer Institute of Information and Data Processing in Berlin.

Returning to Bolivia, he was invited at the Institute of Ecology of Universidad Mayor de San Andrés (UMSA) (1995 - 1997) where he had the opportunity to familiarize with remote sensing in ecological research and better learn about the environmental challenges of Bolivia, he also had the opportunity to delved into research activities of the International Human Dimensions of Global Environmental Change Research Program (IHDP) exploring the implications of climate change on food and water security until 2005.

In 2001, he was invited to teach at the Master Course on Sustainable Development at Universidad Nur in Bolivia, initiating a long-standing relationship with the institution. He also served as a member of the Fiduciary Board of Universidad Nur and contributed to the conceptualization and inception of its Institute for Science and Social Research (IICS).

He worked for almost a decade (1998-2008) for the National Climate Change Program of the Vice-ministry of Environment in Bolivia. During this period, he contributed to the formulation of climate change policies, including the drafting of Bolivia's First UNFCCC implementation strategy. He also engaged in adaptation negotiations within the UNFCCC as a member of Bolivian delegation until 2008.

From 2010 to 2013, he had the opportunity to observe and follow up the negotiation of the Cancun Adaptation Framework (CAF) in collaboration with the Stockholm Environment Institute (SEI), the World Resources Institute (WRI) and other international partners. Additionally, between 2010 and 2017, he collaborated with SEI and the Climate and Development Lab at Brown University on the implications of the Transparency Framework of the Paris Agreement on international climate finance for adaptation.

Over the past 15 years, he has been extensively involved in shaping adaptation policies and programs in Bolivia and abroad, collaborating with entities such as the UN System, Helvetas Swiss Intercooperation, and the Interamerican Development Bank (IADB) among others.

In 2015, Javier was accepted as an external PhD researcher at the Public Administration and Policy Group of Wageningen University and Research until his defense in June 2024.

Selected publications:

Gonzales-Iwanciw, J., Karlsson-Vinkhuyzen, S., & Dewulf, A. (2023). How does the UNFCCC enable multi-level learning for the Governance of Adaptation? International Environments Agreements, Politics, Law and Economics

Gonzales-Iwanciw, J., Witkowski, K., & Borda, C. (2022). El acuerdo de Paris y el agro: una mirada a la implementación de las NDC en América Latina. Instituto Interamericano de Cooperación en Agricultura, San Jose de Costa Rica, ISBN: 978-92-9248-974-8

Gonzales-Iwanciw, J., Karlsson-Vinkhuyzen, S., & Dewulf, A. (2021). Multi-level learning in the governance of adaptation to climate change: the case of Bolivia's water sector. Climate and Development, 13(5), 399-413.

Gonzales-Iwanciw, J., Dewulf, A., & Karlsson-Vinkhuyzen, S. (2020). Learning in multi-level governance of adaptation to climate change–a literature review. Journal of Environmental Planning and Management, 63(5), 779-797.

Allen, S., Gonzales-Iwanciw, J., Rodríguez, L., Stoffel, M., Grünwaldt, A., Brusa, F., & Bocco, M. J. (2020). Building Transformative Institutional Adaptive Capacity. Assessing the Potential Contribution of PPCR to Build a Climate Resilient Water Governance Framework in the Plurinational State of Bolivia. Inter-American Development Bank, Washington, DC.

Dixit, A., McGray, H., Gonzales, J., & Desmond, M. (2012). Ready or not: Assessing national institutional capacity for climate change adaptation. World Resources Institute (WRI).

Gonzales-Iwanciw, J., Salamanca-Mazuelo, L.A., Condori, B., Ontiveros, M.A. (compiling authors) (2011). Tras las huellas del cambio climático en Bolivia: Estado del arte del conocimiento sobre adaptación al cambio climático agua y seguridad alimentaria, Programa de las Naciones Unidas para el Desarrollo, 144 pp. ISBN: 978-99954-711-8-7

Gonzales-Iwanciw, J. , Cusicanqui-Giles, J., Aparicio-Effen, M. (2004). Vulnerabilidad y adaptación al cambio climático en las regiones del Lago Titicaca y los Valles Crucenos de Bolivia. Programa Nacional de Cambios Climáticos.

Gonzales-Iwanciw, J. (2004). Promoting social adaptation to climate change and variability through knowledge, experiential and co-learning networks in Bolivia. Programa Nacional de Cambios Climáticos – Universidad Nur - Imperial College of London, La Paz, Bolivia

Gonzales-Iwanciw, J. (2002). Food Systems Vulnerability and Adaptation to Climate Change and Variability in Mountain Semiarid Regions: Sistematization of consulations at different levels of decision-making. Ministry of Sustainable Development and Planning, La Paz – Bolivia https://unfccc.int/resource/docs/natc/boladd5.pdf