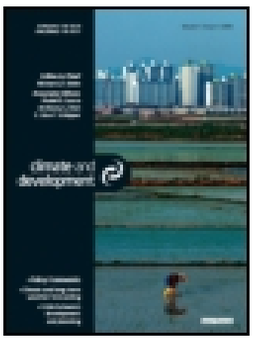

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Multi-level learning in the governance of adaptation to climate change: the case of Bolivia's water sector

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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.

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Bolivia; climate change; multi-level learning; governance of adaptation; water sector planning

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 (PA). 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 PA 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 (e.g. Tompkins & Adger, 2005; Tschakert & Dietrich, 2010). Learning has been perceived as a mechanism to scale and speed up the impact of global adaptation interventions (e.g. Berkhout et al., 2006; Fünfgeld, 2015; Kern & Bulkeley, 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 (e.g. Adger et al., 2013; 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 (e.g. Leys & Vanclay, 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.

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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 2 and 3 we describe the theory, objectives and methods applied for carrying out this case study. In Section 4 we analyse the data and present findings. In Section 5 we discuss the findings and contribution of this study to multi-level learning and the governance of adaptation research and draw conclusions.

2. Theoretical framework

Learning is considered a key mechanism for the governance of adaptation (e.g Crona & Parker, 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. Schout, 2009; Armitage et al., 2010). Thus, it is reasonable to expect that effective adaptation requires policy processes that support learning across levels of governance (e.g. 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 (e.g. 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 and 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 & Howlett, 1992; Hall, 1993; Sabatier, 1988) and *social learning* (e.g. 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 and Fritsch (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 (e.g. Pahl-Wostl et al., 2007; Reed et al., 2010). 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 (e.g. 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 conclusion, 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 (e.g. Benson et al., 2012; Getimis, 2003; Gerlak & Heikkila, 2011; 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. Baird et al., 2014; Haug et al., 2011). 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 (Haug et al., 2011; Huitema et al., 2010).

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 (e.g. 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 Bolivia's 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?

3. Methodology

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 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.

3.1. The case

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). PNC is one of the main water sector policy 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 the year 2000 (e.g. Bustamante, 2004; Driessen, 2008).

During our study period, Bolivia also lead 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 programmes 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 Calzadilla and Kotzé (2018), Aguirre and Cooper (2010) and Hirsch (2017). Linked to the new framework law was the ratification of the PA with the submission of Bolivia's NDC in 2016 and providing additional guidance to the sectors and territorial bodies to consider Mother Earth Rights. Such rights include the regeneration capacity of ecosystems and water bodies including the maintenance of critical environmental functions of the water cycle.

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 1 and Appendix 2 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 the year 2002. In particular, glacier melting attracted the interest of scholars, policy makers and the media. Early research

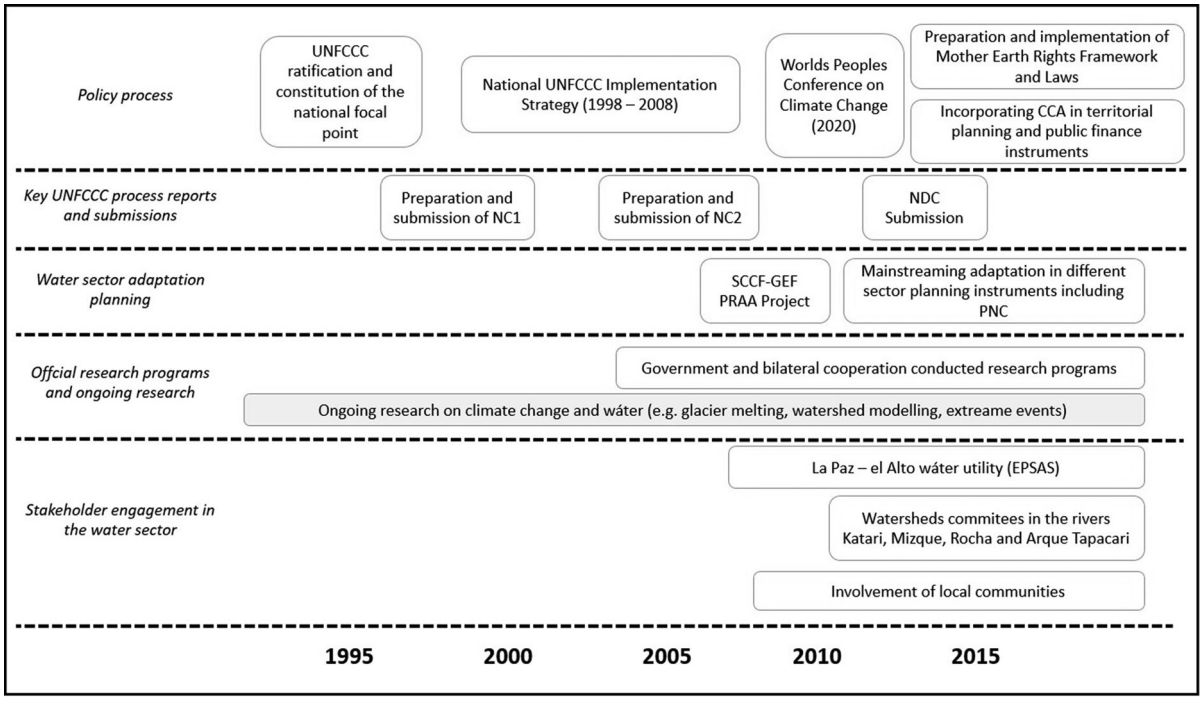

Figure 1. Timeline of climate change policy implementation in Bolivia's water sector. The rows represent the formal efforts of the Bolivian government in relation to climate change policy and mainstreaming efforts of the water sector.

Table 1. List of policy documents.

Type of document	Short reference (code)	
Policy documents	Law 300	Mother Earth Framework Law / October 2015
	ENI	National UNFCCC Implementation Strategy 1998–2008
	NDC1	Bolivia's Nationally Determined Contribution
	NC1	Bolivia's First National Communication
	NC2	Bolivia's 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
Evaluation Reports/Reviews	PNC I_Eval	Final Evaluation of PNC I
	PNC II_Eval	Final Evaluation of PNC II
	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

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 programme matches international climate funds with important public investments in the water sector and integrates 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).

3.2. Data collection

Data have been collected from policy documents and semi-structured interviews. The selection of policy documents (see Table in Appendix 2) 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 2) 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 was 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. The second round of 15 semi-structured interviews was conducted in 2018, these were recorded and transcribed.

3.3. Data analysis

The documents and interview transcripts/notes were analysed with qualitative methods, using a set of codes identified through a hybrid process of inductive and deductive thematic analysis integrating data-driven codes with theory-driven ones (e.g. Fereday & Muir-Cochrane, 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 3).

Guided by the three research questions, in the first stage, the focus was on identifying multi-level learning nodes 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

Table 2. List of interviews.

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 3. List and structure of codes.

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

governance of adaptation and its outcome in the form of enhanced capacity to address climate change challenges.

4. 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 programmes, 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 is described in the text below and details are also provided in Table 4 and a summary in Figure 2 (See Appendix 3 for a more comprehensive summary of the findings).

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

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:

4.1.1. Policy nodes

Policy nodes P1 and P2 together are in change 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 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

Table 4. List of identified multi-level learning nodes on climate adaptation 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.

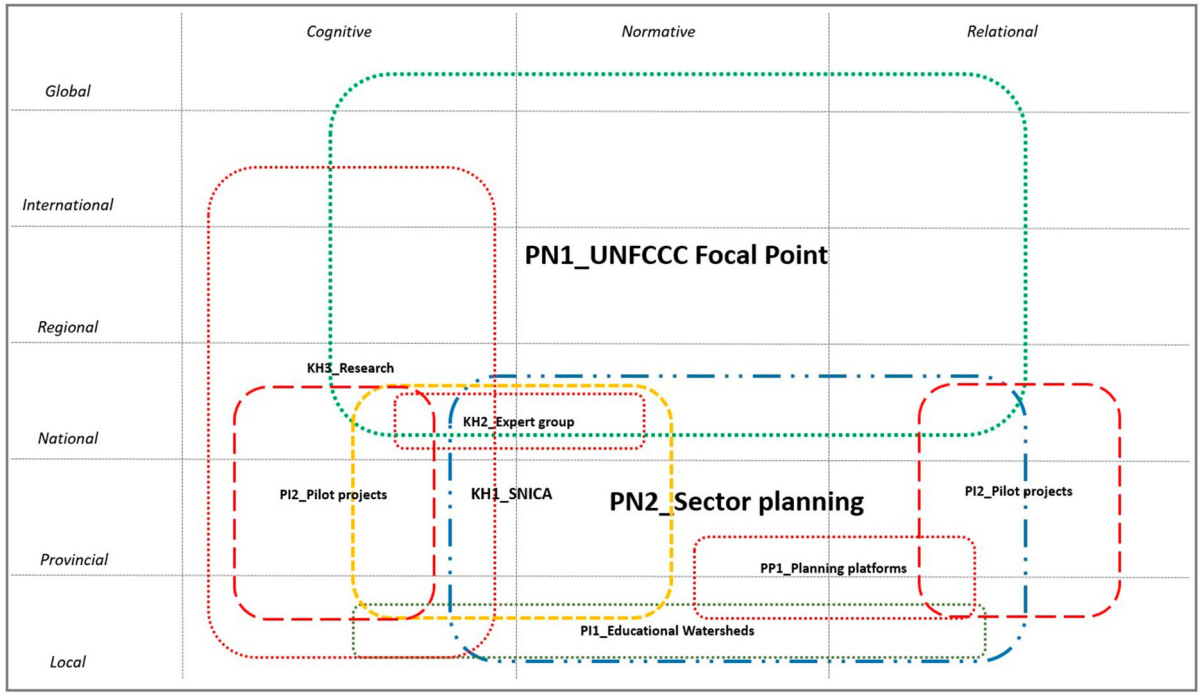

Figure 2. Linkages between different multi-level learning nodes in Bolivia's water sector. Each node in the figure is represented by its cognitive, normative and relational dimensions across different levels of governance. The overlap does not necessarily show formal relations.

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 the 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 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) through institutionalized knowledge interfaces (KH1 and KH2), promoting science-policy dialogues. The node PN2 also incorporates views and interests 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.

4.1.2. Knowledge hubs

Knowledge hubs are organized to fulfil 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 centres and permit adequate capacity building in particular including the international level: 'with funds of the PPCR we received the support of international research centres 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 the 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: '[I]nternational 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 programmes that involve national and international 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).

4.1.3. Planning platforms

Planning platforms, such as PP1 that serve 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 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 the 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 '[k]ey to the success of planning efforts is to ensure transparent means of representative participation' (interview C0418). Relational learning results 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

> [i]n 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)

4.1.4. 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 multi-level 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 the models and lessons learnt from interventions to influence national programmes 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 intervention 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: '[O]ur 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.

Analyzing the multi-level learning processes in the water sector illustrated in Figure 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 programmes 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 these 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 the planning of critical infrastructure and water provision operations (U01-18). There has also been enhanced collaboration among different stakeholders to fulfil 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 re-evaluate approaches, for example in the interface of PN1-PN2-PI2. The following quote from a climate change expert reveals 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.

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 behavioural 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 behaviour 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 (interviews 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 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 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 are 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. Discussion and conclusions

The objective of 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 include, 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 (see e.g. 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. Termeer et al., 2017; Tschakert & Dietrich, 2010).

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 sectors, considering similar multi-level learning and governance challenges to operationalize policy, in the Bolivian context and beyond (e.g. 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 & 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 the transformational change for enhanced resilience and adaptive capacity which is still one of the central questions in adaptation governance research.

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References

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

Adger, W. N., Barnett, J., Brown, K., Marshall, N., & O'brien, K. (2013). Cultural dimensions of climate change impacts and adaptation. *Nature Climate Change*, *3*(2), 112–117. https://doi.org/10.1038/nclimate1666

Aguirre, J. C., & Cooper, E. S. (2010). Evo Morales, climate change, and the paradoxes of a social-movement presidency. *Latin American Perspectives*, *37*(4), 238–244. https://doi.org/10.1177/0094582X10376362

Armitage, D. (2008). Governance and the commons in a multi-level world. *International Journal of the Commons*, *2*(1), 7–32. https://doi.org/10.18352/ijc.28

Armitage, D., Berkes, F., & Doubleday, N. (Eds.). (2010). *Adaptive co-management: Collaboration, learning, and multi-level governance*. UBC Press.

Armitage, D., 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. https://doi.org/10.1016/j.gloenvcha.2011.04.006

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

Begum, R. A., Sarkar, M. S. K., Jaafar, A. H., & Pereira, J. J. (2014). Toward conceptual frameworks for linking disaster risk reduction and climate change adaptation. *International Journal of Disaster Risk Reduction*, *10*, 362–373. https://doi.org/10.1016/j.ijdrr.2014.10.011

Bennett, C. J., & Howlett, M. (1992). The lessons of learning: Reconciling theories of policy learning and policy change. *Policy sciences*, *25*(3), 275–294. https://doi.org/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. https://doi.org/10.1002/eet.593

Berkhout, F., Hertin, J., & Gann, D. M. (2006). Learning to adapt: Organisational adaptation to climate change impacts. *Climatic Change*, *78*(1), 135–156. https://doi.org/10.1007/s10584-006-9089-3

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. https://doi.org/10.1080/14693062.2007.9685662

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

Calzadilla, P. V., & 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. https://doi.org/10.1017/S2047102518000201

Crona, B., & Parker, J. (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), https://doi.org/10.5751/ES-04534-170132

Driessen, T. (2008). Collective management strategies and elite resistance in Cochabamba, Bolivia. *Development*, *51*(1), 89–95. https://doi.org/10.1057/palgrave.development.1100453

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. https://doi.org/10.1177/160940690600500107

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. https://doi.org/10.1146/annurev.energy.30.050504.144511

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. *Journal of Glaciology*, *41*(137), 61–67. https://doi.org/10.1017/S0022143000017767

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

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. https://doi.org/10.1093/jopart/muq089

Getimis, P. (2003). Improving European Union regional policy by learning from the past in view of enlargement. *European Planning Studies*, *11*(1), 77–87. https://doi.org/10.1080/09654310303662

Gleeson, B., Van Ewijk, E., Baud, I., Bontenbal, M., Hordijk, M., Van Lindert, P., & Leonardi, R. (2014). Policy learning in Europe: The open method of co-ordination and laboratory federalism. *Journal of European Public Policy*, *18*(3), 529–543. https://doi.org/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. https://doi.org/10.1080/09640568.2019.1594725

Hall, P. A. (1993). Policy paradigms, social learning, and the state: The case of economic policymaking in Britain. *Comparative Politics*, *25*(3), 275–296. https://doi.org/10.2307/422246

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. https://doi.org/10.1016/j.techfore.2010.12.001

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. https://doi.org/10.1016/j.jrurstud.2016.11.013

Hooghe, L., & Marks, G. (2001). *Types of multi-level governance*. European integration online papers (EIoP). 5(11). http://dx.doi.org/10.2139/ssrn.302786

Huitema, D., Cornelisse, C., & Ottow, 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), 16. https://doi.org/10.5751/ES-03260-150116. Retrieved September 19, .2012, from http://www.ecologyandsociety.org/vol15/iss1/art16/

Huntjens, P., Pahl-Wostl, C., Rihoux, B., Schlüter, M., Flachner, Z., Neto, S., Koskova, R., Dickens, C., & 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. https://doi.org/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. https://doi.org/10.1016/j.gloenvcha.2011.09.015

Kemper, E. A., Stringfield, S., & Teddlie, C. (2003). Mixed methods sampling strategies in social science research. In: A. Tashakkori, & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 273–296). Sage.

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. https://doi.org/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. https://doi.org/10.1111/j.1468-5965.2009.00806.x

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. https://doi.org/10.1016/j.landusepol.2010.11.006

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

Pahl-Wostl, C., Craps, M., Dewulf, A., Mostert, E., Tabara, D., & Taillieu, T. (2007). Social learning and water resources management. *Ecology and Society*, *12*, 2. https://www.jstor.org/stable/26267868

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. https://doi.org/10.1016/j.gloenvcha.2009.06.001

Pahl-Wostl, C., Becker, G., Knieper, C., & Sendzimir, J. (2013). How multi-level societal learning processes facilitate transformative change: A comparative case study analysis on flood management. *Ecology and Society*, *18*(4). https://doi.org/10.5751/ES-05779-180458

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: Economy and Space*, *40*(4), 867–884. https://doi.org/10.1068/a39148

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.

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°S). *Journal of Glaciology*, *47*(157), 187–194. https://doi.org/10.3189/172756501781832214

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

Reed, M. S., Evely, A. C., Cundill, G., Fazey, I., Glass, J., Laing, A., Newig, J., Parrish, B., Prell, C., Raymond, C., & Stringer, L. C. (2010). What is social learning? *Ecology and Society*, *15*(4), resp1. https://doi.org/10.5751/ES-03564-1504r01

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

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

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. https://doi.org/10.3189/2015AoG70A001

Termeer, C. J., 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. https://doi.org/10.1080/09640568.2016.1168288

Tompkins, E. L., & Adger, W. N. (2005). Defining response capacity to enhance climate change policy. *Environmental Science & Policy*, *8*(6), 562–571. 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). https://doi.org/10.5751/ES-03335-150211

Wagnon, P., Ribstein, P., Georg, K., & Berton, P. (1999). Energy balance and runoff seasonality of a Bolivian Glacier. *Global and Planetary Change*, *22*(1–4), 49–58. https://doi.org/10.1016/S0921-8181(99)00025-9

Appendices

Appendix 1. List of Acronyms Used in Text

CAF: the Cancun Adaptation Framework
CIF: Climate Investment Fund
GEF/SPCR: Global Environmental Facility – Special Climate Change Fund
NAPs: National Adaptation Plans
NDCs: National Determined Contributions
ENI: Estrategia Nacional de Implementación de la CMNUCC 1998–2008 (National UNFCCC Implementation Strategy 1998-2008)
MMAyA: Ministerio de Medio Ambiente y Agua (Ministry of Environment and Water)
NWP: The Nairobi Work Programme on Impacts, Vulnerability and Adaptation to Climate Change
PA: Paris Agreement
PNC: Plan Nacional de Cuencas (National Watershed Plan)
PPCR: Pilot Project on Climate Resilience
PRAA: Proyecto de Adaptación Andina (Adaptation to the Impact of Rapid Glacier Retreat in the Tropical Andes project)
SNICA: Sistema Nacional de Clima y Agua (National System on Climate and Water)
SPCR: Strategic Program for Climate Resilience
APMT: Autoridad Plurinacional de la Madre Tierra (The Plurinational Mother Earth Authority)
UNFCCC: United National Framework Convention on Climate Change
VASB: Viceministerio de Agua y Saneamiento Básico (Viceministry of Water and Sanitation)
VRHR: Viceministerio de Recursos Hídricos y Riego (Viceministry of Water Resources and Irrigation)

Appendix 2. 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
Bolivia's Nationally Determined Contribution	Estado Plurinacional de Bolivia. (2011). Contribución Prevista Determinada Nacionalmente del Estado Plurinacional de Bolivia, 1–18.
Bolivia's First National Communication	Republic of Bolivia (2000), First National Communication to the UNFCCC, La Paz – Bolivia
Bolivia's 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.

Appendix 3. 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) • 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 • **Multi-level learning processes:** Conducting mainstreaming climate change in water sector planning processes;	• ***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.
• **(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 centres 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;

(*Continued*)

Continued.

MLN (Institutional arrangements and implementation)	Characterization of MLN	Cognitive, normative and relational processes of multi-level learning	Outcomes and implications
• **(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;
• **(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 programmes; • Better incorporation of local and indigenous knowledge and experiences in project definition.