

# Chapter 26

## Canadian, Argentinean, and Colombian Programs Building Resiliency to Extreme Events

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**Abstract** An important determinant of adaptive capacity to climate change and extreme events of drought and flood is institutional capital, or the assistance provided by government, civil society and private companies through programs and policy. A strong institutional capital provides adaptive strategies for agricultural producers and rural communities that not only assist in prevention of disaster, but recovery and rebuilding from disaster. But what are the components of strong institutional capital?

This paper reports research studies drawing on comparative institutional governance studies of agricultural producers in river basins in Canada, Argentina, and Colombia, in relation to climate change and extreme events of drought and flood. An assessment is made comparing and contrasting the different suites of institutional capital (organizations, policy, and programs) in relation to drought and flood and their impact on different types, sizes, and sensitivities of agricultural producers. This comparative analysis provides useful insights into what specific policies and programs build resilience and how this institutional capital is distributed amongst agricultural producers. Recommendations for improving institutional capital and its equitable distribution are made. This paper will be informative for policy makers, civil society organizations, and government.

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## Introduction

In the future increasing climate variability and frequency and duration of weather events such as drought and flood are anticipated in many areas of the world. The study areas of Canada, Argentina, and Colombia are anticipated to face such a future (IPCC 2014). Impacts of drought and flood events are already occurring (ibid.). It is necessary to prepare for these events, but questions remain outstanding on how best to do this. The area of governance or societal decision-making is an important area of focus in this regard.

This paper explores studies of institutional governance in relation to extreme events in three case study areas in Argentina, Canada, and Colombia. In each, an institutional governance assessment was conducted through review of secondary sources and semi-structured qualitative interviews exploring dimensions of adaptive governance. This paper reports on these findings and makes recommendations for a framework for improved resilient governance based on the findings.

## Institutional Capital

An important determinant of the ability of a community to adapt to future climate change impacts and current climate variability is its institutional setting and the degree to which this setting facilitates or hinders the community's adaptive capacity (Willems and Baumert 2003). As the IPCC argues, nations with "well developed institutional systems are considered to have greater adaptive capacity," and accordingly, developed countries have a better "institutional capacity to help deal with risks associated with future climate change" (2001: 896, 897). Institutions contribute to the management of a community's assets, the community members' inter-relationships, and their relationships with natural resources. Formal institutions, like government, non-profit and civil society organizations, and informal institutions such as social norms, values and contexts all contribute to the relationships of people to each other and to natural resources (Hurlbert and Diaz 2013; Moser and Satterthwaite 2008).

Studying the institutional context of adaptive capacity can be done by examining the institutions involved in governance. Governance encompasses laws, regulations, and organizations, as well as governmental policies and actions, domestic activities and networks of influence, including international market forces, the private sector and civil society (Demetropoulou et al. 2010: 341). It entails the

interactions among structures, processes, rules, and traditions that determine how people in societies make decisions and share power, exercise responsibility and ensure accountability (Lebel et al. 2006; Raik and Decker 2007; Cundhill and Fabricius 2010: 14). Thus, governance involves institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their legal obligations and mediate their differences (Armitage et al. 2009; Kiparsky et al. 2012).

A rich literature has developed regarding adaptive governance and specifically how the wider institutional context of governance can facilitate adaptation and improve adaptive capacity of communities. This adaptive capacity is especially important in responding to extreme weather events, drought, and flood events. The governance framework surrounding extreme events (constituted by such things as water allocation laws, programs and policies allowing preparation for drought, and income stabilization in the event of drought) plays an important role. How do we recognize a system of governance as adaptive? Within the adaptive capacity literature, several dimensions have been identified as important characteristics called institutional design principles, or features of governance systems that define an institutional system as adaptive. These include such things as “availability of information,” “openness for experimentation,” “flexibility,” “learning,” and others. The discussion in some cases is generic and applies to institutions in general (Gupta et al. 2010; Folke et al. 2005; Gunderson and Holling 2002; Olsson et al. 2006). The literature refers to a proper understanding of the complexities of the phenomenon of climate change, which include the requirements imposed by different sectors, various levels of government, and diverse stakeholders, as well as the uncertainties surrounding the long-term time-frame of climate change (Gupta et al. 2010, Frohlich and Knieling 2013; Cook et al. 2011). Table 26.1 below outlines these various dimensions.

Adaptive governance entails a more flexible, participatory, experimental, collaborative and learning-based design and approach to policy making to increase the adaptive capacity of institutions and sustainability of natural resources (Pahl-Wostl 2010). Adaptive governance shifts focus from rule-based, fixed organizations to a view of institutions as dynamic, flexible, pluralistic, and adaptive in order to cope with present and future uncertain climatic conditions and the limits of predictability (Carpenter and Gunderson 2001). Adaptive governance is then a means to the achievement of adaptive capacity (Cook et al. 2011). Within this comparative study, the items in bold print in Table 26.1 focus on: responsiveness, flexibility, participation and learning, capacity building, and equity. Each of these themes will be discussed in relation to the case studies.

**Table 26.1** Institutional design principles of adaptive governance

	Institutional design principle of adaptive governance	Related principles/Sub-principles	Explanation
1	<b>Responsiveness</b>		The ability of governance networks, organizations and actors to respond appropriately and in a timely manner to climate variability, hazards and extreme events in a manner that accounts for ecosystem dynamics
		<b>Robust and Flexible Process</b>	Institutions and policy processes that continue to work satisfactorily when confronted with social and physical challenges but which at the same time are capable of changing
2	Learning and institutional memory		Past experiences must be remembered, learned from, and routines improved.
		<b>Participation</b>	Participation by non-state actors
		Collective choice arrangements	To enhance participation of those involved in making decisions about the system in how to adapt
		Monitor and evaluate	Institutional evaluation processes must monitor and evaluate policy experiences
3	Trust		Institutional patterns must exist to promote mutual respect and trust such that participants continue involvement in the process of governance.
4	<b>Capacity Building</b>	Information Leadership Resources	Rigorous up to date information, sufficient and reliable Leadership must exist to act as a catalyst to change; and Appropriate resources (financial, political, human) must be available for this change
5	<b>Equity</b>	Legitimate Accountable Fair	The governance regime must be perceived as legitimate and accountable, as well as fair in its process and impact such that there is an equal and fair (re distribution of risks, benefits and costs)
6	Political support		Responding to climate change is a long-term policy challenge which requires solid political support for plans longer than election cycles

Based on Hurlbert and Diaz (2013)

## Methodology

In three case study areas (Southern Alberta and Saskatchewan, Canada; Mendoza, Argentina; and Manizales, Colombia) a multi-level institutional analysis was conducted exploring the institutions of governance relating to climate change and extreme weather events. In all three of the study areas future climate change of

increasing variability and more frequent and extreme weather events are anticipated (IPCC 2014). In Argentina and Canada drought was explored; in Canada flood as well; and in Colombia, excessive moisture resulting in landslides and flood. First an inventory of organizations was prepared. Organizations were selected that are involved in assisting rural agricultural producers and their communities respond to climate change and extreme weather events of drought and flood. Semi-structured interviews with producers and people involved in governance were then conducted. These interviews explored the dimensions of adaptive governance outlined in Table 26.1. This paper provides the results of this research.

## **Institutional Governance in Canada, Argentina, and Colombia**

### *Canada*

In the Canadian case, national strategies have not been renewed surrounding climate change and adaptation. However, in relation to disaster and events of drought and flood, a host of institutions respond to these extreme weather events and (although not framed specifically in relation to climate adaptation) assist rural agricultural producers adapt to drought and flood (see Hurlbert 2016; Hurlbert et al. 2015; Hurlbert 2013). At the national level, Canada has established a Hyogo Platform for Disaster Risk Reduction that helps coordinate efforts in relation to disaster planning and response, knowledge exchange and dissemination. A federal Disaster Assistance program provides funds to provinces in times of disaster and the province will manage the payment of the disaster funds to impacted individuals. Although flood insurance is not available, these funds assist homeowners in rebuilding. Agricultural producers must rely on business continuity insurance or crop insurance (if they have purchased it) to cover their farm losses.

A certain amount of flexibility exists in the governance regimes of the case study areas (Alberta and Saskatchewan) in relation to water management and droughts and floods. Both systems are predominantly government administered licensing systems, with licenses containing certain restrictions and qualifications. Alberta provides for a limited water transfer system (or water market) which has been utilized in times of drought to facilitate adaptive responses via water transfers to allow some agricultural producers to produce a crop while those transferring their interests receive payment for their foregone water (Hurlbert 2009).

Local watershed planning has existed in Saskatchewan and Alberta for some time engaging in source water protection planning and education of communities about water. These groups have facilitated climate change and drought planning with rural agricultural producers using scenarios and discussion groups to build strategies at a local level (East et al. 2012; Alberta Government 2013). Province-

wide consultations contributed to the development of long term water strategies in both Alberta (Alberta Environment 2003, 2008) and Saskatchewan (SWSA 2012).

Local watershed groups also contribute to capacity building in their local communities through their activities of source water protection planning and drought planning. Saskatchewan groups also facilitate a federal government program aimed at encouraging environmental farm practices through “best management practices” that can be done with groups of agricultural producers, or single producers (GS 2011). Although local drought plans exist in Saskatchewan, a provincial plan does not; a provincial drought plan exists in Alberta, but often local plans do not.

In Canada, local communities are tasked with responding to emergencies (which include flood). This study found in Canada that rural communities studied did have various emergency plans and services in place, but that these plans didn’t include climate change per se considerations within their plans or planning processes (Hurlbert et al. 2015), but did have climate variability events in the short term. The federal government has withdrawn its support through funding the education of local community members in emergency planning in the last decade.

Considerations of equity in relation to the impacts of the institutions of governance were noted in the study. Agricultural producers demographics are changing. Producers are getting older, farm sizes are increasing, and debt levels are rising. Small agricultural producers are decreasing in number with many supporting the farm with off farm income in the oil and gas industry. Indigenous people were absent from local watershed groups; studies have concluded these groups are marginalized and especially vulnerable to the impacts of climate change (Corkal et al. 2016).

## *Argentina*

Argentinian created the Argentinean Carbon Fund by National Decree 1070/05 in order to maximize Clean Development Mechanism projects (Pochat et al. 2006). Further, a National Program for Rational Use of Energy and Energy Efficiency was created in 2005 that encourages the use of bio-ethanol and biodiesel (Pochat et al. 2006; United Nations 2011). These programs do not relate to climate change adaptation. A Climate Change Agency at the provincial level (Mendoza) has had a minimal involvement in adaptation and no role in mitigation (Hurlbert et al. 2015). For the past four years Mendoza has had a Declaration of Drought by the Governor; a process of “turno” or water rationing has been implemented by inspectors charged with managing the irrigation canals. This process is highly responsive in managing the reduction in stream flow, but not highly responsive or flexible in meeting differing crop needs of agricultural producers. Water delivery is completely dependent on supply.

Water rights are based on the principle of inherence, or ownership of property. Water can’t be transferred or sold separately from the land to which it pertains. This

system results in a rigid allocation system incapable of adapting quickly to changing agricultural practices.

In Mendoza, Argentina, flood is unheard of; any additional water coming down the river is thought of favourably. Extreme events of hail figure more highly into the risk psyche of residents. Response to weather-related disasters centers more on drought. After four years of drought declarations, practices have changed and adapted. Some agricultural producers have diversified into producing olive oil; large producers have expanded at the headwaters and if they have enough financial capital, access groundwater. The regulatory regime does not have pricing or quantity restrictions relating to groundwater.

A very deep institutional structure of participation in water governance exists, for those with water rights. The riverbed inspectors and canal associations and general users assembly are only open to water rights holders for participation. Those without water, dry land farmers and ranchers, do not have a voice as they don't participate.

A Master Plan for Mendoza River Basin was developed in 2010 to 2012. However, this plan was developed in respect of five river basins after only one focus group meeting. Departamento General de Irrigacion (DGI) developed a water plan "H2020" which sets out its plans surrounding water infrastructure upgrades, legal and institutional changes; no mention is made of climate change and adaptation (DGI 2015). In the spring of 2014 the government of Mendoza was embarking on integrated land use planning (Planning Law 8051) through public consultations. There is potential to address issues of climate change, decreasing water supply, increasing aridity. However, the plan would be subject to the inflexible water laws of Mendoza.

In Argentina there are marked differences among farmers in horticulture and viticulture. Small grape producers with traditional vineyards exist generally downstream. The horticulturalists in some cases are of Bolivian origin and resort to social and family networks to organize their production and successfully develop their agricultural activities. A web of medium and small-sized towns spread over these agricultural lands away from the central Metropolitan Area of the capital city of Mendoza (Montaña and Boninsegna 2016). Campesinos or "guarpes" live in the dry lands raising goats. One interviewee identified that these producers, "never had water, and now have even less." These poorer people (dry land farmers and small irrigator/ horticulturalists) are described as having strong social capital within their local communities, but having no bridging connections with institutions outside their local communities. As a result, these voices would be in the audience of current participatory processes like integrated land planning, not at the table. Infrastructure development (such as the building of the Portrerillos Dam) occurs often at their expense. These small producers can't access financial tools as they generally don't qualify (with all taxes and fees being up to date). Access to services such as sanitation and living assistance occurs with the municipalities.

Twenty years ago, producers were all relatively small or medium sized; now there is a significant group of large producers. Today the DGI (the main water governance institution) and its system of managing water meets the interests of the

most wealthy and powerful regional producers, perpetuating its development model established in 1884 in producing agricultural crops through irrigation systems for virtual water export (the trade of agricultural commodities with embedded water) (Hurlbert et al. 2015). This is implemented through the use of the tool of forfeiture only in two areas where the most expensive lands are (Uco Valley and to the right margin of the Luhan River). In these areas the small farmers' properties were appropriated. However, in other areas forfeiture is unheard of.

## *Colombia*

In the Colombian case, a National Development Plan "Prosperity for All 2010–2014" was developed to promote a cultural change and anticipate and cope with the adverse effects of climate change and variability; one year later a policy to implement this was developed (Departamento Nacional de Planeación 2011). This policy takes an inter-sectorial focus on ensuring development projects account for climate change.

The national government has just moved from a service-oriented emergency response system (The National System of Disaster Prevention and Care created in 1989) to a disaster-response system focusing on risk prevention (National System For Disaster Risk Management) because of the La Nina event of 2010–2011. In the study area, the Chinchiná River basin, a Risk Management Unit coordinates with non-governmental organizations, universities, emergency response groups and private businesses. This model was found to promote flexibility and participation of many different actors in the community of Manizales.

Because Manizales is located near an active volcano on steep slopes, there is a culture of risk in relation to the environment. Mudslides from intense rainfalls (made worse with deforestation and increased livestock production) are the predominant concern. A warning system is in place that monitors rain and issues alerts in the event of excess accumulations. Unfortunately rural areas are not incorporated.

Local communities are starting to plan for climate change and further, some initiatives have been undertaken by the Regional Autonomous Corporation of Caldas. The Colombian Coffee Growers' Federation (CCGF) and the National Coffee Research Centre (NCRC) are important institutions providing research and outreach information (occasionally funding) to rural agricultural coffee farmers in relation to climate change, variability and agricultural practices. The main adaptation strategy to the changing climate of the CCGF is the renovation of coffee plantations with a new variety resistant to coffee rust (*Hemilea vastatrix*).

In Manizales, Colombia, drought is not the issue. The issues experienced by local agricultural producers relate to weather impacting production and falling coffee prices. In the highlands, small coffee farmers can't afford chemical inputs to respond to pests and diseases generated from excess moisture. Issues of equity arise as these small producers must recover the cultural memory of agricultural



practices previous to the Green Revolution (the development of a coffee monoculture) in order to adapt to the changing climate. These farms remain small employing traditional practices to control weeds, properly handle vegetative cover, trench to drain water, and hold plots of coffee at various different stages (some of the traditional practices). In the lowlands coffee farmers are adapting by moving to livestock and fruit crops. As a result, hundreds of workers are unemployed and populating the informal sector in the urban areas, many of them living in precarious areas next to river banks prone to mudslides during torrential rain.

In the study region capacity is an issue. While the professionals and actors involved in the Risk Management Unit are highly educated, the local agricultural producers are not: the average is 5.1 years of schooling (Grajales Quintero 2013). Capacity of these producers is built through the CCGF and NCRC (organizations which are essential in communicating out best agricultural practices).

Two water-planning activities are currently under way in the study region. A Watershed Council is governed by the environmental authority of the government and developing a Management Plan for the Chinchina River basin. Another initiative is the *Pactos por la Cuenca* (Pacts of the Basin), which is a voluntary initiative for the recovery and conservation of the river bringing together industrial companies, government officials and members of civil society. Although too early to tell, it is questionable if issues of equity and adaptation can be addressed with these two processes.

## Comparative Analysis

There are some interesting differences between the case study areas. First the organization of water governance is markedly different. Both Mendoza and southern Alberta and Saskatchewan have a highly institutionalized system of water allocation and an irrigation industry. In Colombia irrigated agriculture and the highly institutionalized water allocation system doesn't exist. While Canada's systems are predominantly based on government-allocated licenses (albeit Alberta has a small water market (in the South Saskatchewan River Basin), Mendoza's water is governed on the principle of inheritance. Thus far, the government allocation of water has provided some flexibility in Canada (and the water market an added feature, only used sparingly thus far). Interviewees perceived that the inheritance principle had favourable implications for equity as it ensured that water rights stayed with the land to which they were allocated thus preventing an entity purchase of water rights and market dominance. However, an element of inflexibility exists in an inability to adjust water supply based on demand factors.

In the Canadian case more institutional response has occurred in relation to the extreme event of flood. There is disaster assistance for homeowners and agricultural producers have some ability to access insurance. In Colombia, the institutional support in relation to mudslides and floods is predominantly local and regional.

Some initiatives (basin planning and *Pactos por la Cuenca*) hold promises to be successful, but these processes will require comprehensive participation.

These processes in Colombia have similar replications in Canada and Argentina. In Canada local watershed organizations have been active in source water protection and environmental planning. To date, these groups have not had significant involvement in land use planning (which significantly impacts source water protection). Integrated land planning by way of community plans is currently being undertaken in many local communities in Canada. Argentina currently is embarked in integrated land use planning. In all three study areas there is potential to address some of the major challenges of climate change and increasing extreme events within a context of a major driver of vulnerability, development and changes to land use. In Canada issues of building in flood plains and intensive production causing pollution could potentially be discussed; in Argentina the expansion of the oasis in the headwaters at the expense of downstream users; in Colombia the integration of different users along the river, the impacts of pollution, a building in flood and landslides zones.

Another striking similarity in these regions is the growing inequity occurring in relation to agricultural producers. In Argentina and Canada bigger agricultural production units are emerging and smaller units are experiencing increasing vulnerability. In Colombia, changes in agricultural production are resulting in more migration to urban areas (often residing in places of vulnerability to mud slides) and greater food insecurity. Current governance structures in all three countries have not effectively address this dynamic. A new governance framework for inclusive resilience governance is required.

## Recommendations and Proposed Framework

The comparison of governance institutional frameworks doesn't offer simple solutions for improved governance; context and drivers operating within each case study have to be contemplated. Simple recommendations such as creating a government-based licensing framework such as Canada would not bode well in Mendoza, Argentina where the water rights of inheritance have existed for centuries. Further, the limited but favourable experience of Alberta's water market might not be possible in some places depending on the water resource and built infrastructure. In order to trade water the physical reallocation must be possible. In Colombia, these solutions have no application to coffee growers depending on rain and moisture conditions.

The similarities existing within the case studies set the stage for the development of resilient governance for disaster. These similarities are the current forums for consultation and discussion of development, land use, and impacts on water. As water is ubiquitous and interconnected with so many other social processes (community drinking water, agriculture, industrial development) the current initiatives

occurring within each case study offer opportunity to develop a robust resilient governance system.

The blueprint for this robust system rests on the dimensions of adaptive governance outlined in Section “Institutional Capital” and the adoption of several governance practices: continuous information flow, ongoing consultation, and meaningful participation. Each of these will be discussed in turn.

Often the purposes of public participation in governance decision-making are grouped into processes that seek to increase legitimacy of the process of knowledge generation (performing a normative function); those that seek to integrate more sources of knowledge and greater capacity for problem solving (performing a substantive function); and those seeking to build collaborative relationships (an instrumental function) (Jones et al. 2009: 1181). A normative function is fulfilled by increasing the accountability of the knowledge in existence through the scrutiny of stakeholder participants discussing, analyzing and critiquing such knowledge; the substantive function requires a commitment to listening to the knowledge of stakeholders in order to select an appropriate solution; lastly the instrumental function would appear to require a process of consultation specifically aimed at resolving disagreements about knowledge, enhancing individual and social learning, and assisting collective decision making. These purposes have been expressed in different manners by different authors. Table 26.2 organizes these functions of public participation into the normative, substantive, and instrumental functions.

**Table 26.2** Functions of public participation

Function	Normative	Substantive	Instrumental
<b>Purpose</b> (Jones et al. 2009: 1181)	To increase legitimacy of the process of knowledge generation	To integrate more sources of knowledge and greater capacity for problem solving	To build collaborative relationships
<b>Uncertainty</b> (Bijlsma et al. 2011: 54)	To manage normative uncertainty (different societal values and goals contributing to the upcoming decision)	To manage informational or substantive uncertainty (improving the information basis of decisions)	To achieve procedural justice or obtain information about local acceptance of the proposal through illustrating how the decision was derived
<b>Goal</b> (Jackson 2001: 140)	Informing or public education, testing reactions to planners’ ideas through consultation,	Seeking ideas and alternative solutions	Collaborative shared decision making
<b>Methods</b> (Lynam et al. 2007)	Diagnostic and informing methods that extract knowledge, values, or preferences from a target group to understand local issues	Co-learning methods in which perspectives of all groups change as a result of the process	Co-management in which actors involved are learning and are included in the decision making process

**Table 26.3** Citizen power and degrees of involvement

Ladder of citizen participation Arnstein (1969)	Spectrum of public involvement Dorcey et al. (1994)	Information flows
Increasing citizen power	Increasing levels of involvement	
Citizen control Delegated power Partnership	Ongoing involvement Seek consensus	Ongoing, iterative information flow
Placation Consultation	Test ideas Seek advice Define Issues Consult on relationships	Two way information flow
Informing Therapy Manipulation	Gather information and perspectives Educate Inform	One way information flow

The direction of information flow correlates with the purpose of involving public in decision-making. Information flows can be one way (where government provides information to people or people engage in an activity like a demonstration and provide information to government), two way (where an exchange of information takes place), or iterative (wherein a process of ongoing dialogue occurs between government and people) (Barreteau et al. 2010). As the information flows increase, so does the degree of citizen participation in decision-making processes. Dorcey et al. (1994) built a ladder of participation from bottom rungs of lowest participation (where manipulation and placation of the public occurs) to the highest (where citizens are engaged in actual decision making). Congruence can be seen between the idea of citizen participation or power and levels of participation in Table 26.3.

In order for the higher rungs of the ladder to be engaged, there must be high levels of trust and expertise. At the bottom end of the ladder there would be lower levels of trust and expertise. Shared trust among stakeholders is key in reducing conflict in public participation processes and studies have found early public involvement in decision making processes decreases the conflict between people (Mackenzie and Krogman 2005). Figure 26.1 combines the concepts of function (normative, substantive, and instrumental), expertise, trust, levels of participation, and communication flows.

We argue that at the top end of the matrix, social learning can occur. Social learning is learning in and with social groups through interaction (Argyris and Schön 1978; Siebenhuner 2008). This is a process of iterative reflection that occurs when we share our experiences, ideas and environments with others. Pahl-Wost (2006) defines social learning as the process of model development where actors develop “their” system and their own behaviour as group model building or scenario development. By merging resilience thinking and action research/learning, a new form of learning, anticipatory learning has emerged in the literature (Tschakert and Dietrich 2010). In resilience literature, learning includes

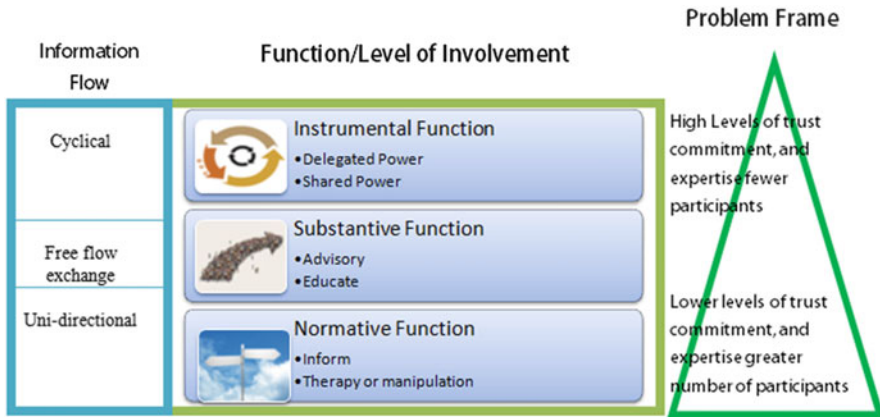


Fig. 26.1 Policy participation matrix (Hurlbert 2014)

incremental front – loop learning, spasmodic or profound back-loop learning, and transformational learning that can lead to innovative processes with high potential for transformability (Tschakert and Dietrich 2010). This learning occurs in small and fast cycles and larger and slower cycles over time. Action learning is a field of inquiry that has emerged with action research and future studies (Ramos 2006) that is a collaborative, democratic, and heuristic-reflexive process that links iterative questioning, anticipation, learning and creation with the ultimate purpose of crafting a different world (Stevenson 2002). As a critique of positivist research, it has emerged as a critical theory grounded in participatory worldview and is a particularly applicable to poor and vulnerable communities (Tschakert and Dietrich 2010).

Increasingly, iterative information flows and inclusive governance is recognized as necessary for both resilient planning for risk (Renn 2008) and engagement with uncertain science such as climate change (Weible et al. 2010; Darier et al. 1999). Including the public in the process of dialogue between and with policymakers and scientists is occurring (Carolan 2006) and the idea has emerged that formal science no longer speaks uniquely to determine policy, but that a plurality of knowledge claims exist (Lovebrand and Oberg 2005: 196). Learning is seen as an important part of this process and an integration of expert and non-expert or local knowledge (Weible et al. 2010, 522; Darier et al. 1999, 104) in a manner that co-produces knowledge at the front end of science (determining what is studied, how it is defined, and in what manner) and also the back end of science (determining how evidence is evaluated) (Morehouse et al. 2008: 280; Carolan 2006: 236). Buizer et al. (2011) sees this interface happening in relation to issues of scale such as where current events have long-term global consequences or the time-space compression issues. Others term this public ecology (Robertson and Hull 2003: 399). The reciprocating result is that the participation of the public facilitates the changes in values institutions and behaviours required to move people to recognition that variability and change, not stability is the more usual condition of life (Morehouse et al. 2008: 281).

## Conclusions

An important determinant of adaptive capacity to climate change and extreme events of drought and flood is institutional capital, or the assistance provided by government, civil society and private companies through programs and policy. This paper reported research drawing on comparative institutional governance studies of agricultural producers in river basins in Canada, Argentina, and Colombia, in relation to climate change and extreme events of drought and flood. An assessment was made comparing and contrasting the different suites of institutional capital (organizations, policy, and programs) in relation to drought and flood and their impact on different types, sizes, and sensitivities of agricultural producers.

The comparison of governance institutional frameworks doesn't offer simple solutions for improved governance; context and drivers operating within each case study have to be contemplated. Simple recommendations such as creating a government-based licensing framework such as Canada would not bode well in Mendoza, Argentina where the water rights of inheritance have existed for centuries. Further, the limited but favourable experience of Alberta's water market might not be possible in some places depending on the water resource and built infrastructure. In order to trade water the physical reallocation must be possible. In Colombia, these solutions have no application to coffee growers depending on rain and moisture conditions.

The review of these three case studies offered interesting insight into mechanisms for strengthening institutional capital and equity. These findings were contemplated within the literature describing what practices build a strong institutional capital. The practices of information flow, consultation, and meaningful participation are necessary.

This comparative analysis provided useful insights into what specific policies and programs build resilience and how this institutional capital is distributed amongst agricultural producers. In order to build more equitable distribution of institutional governance capital, it is first of all necessary to build iterative communication flows between the government, scientists and people. Within these iterative communication flows, consultation, and increased participation of people need and can occur. This participation must be meaningful. It must involve all people and allow for all opinions and ideas to be voiced. Through iterative communication flows issues and disagreements can be resolved.

Recommendations for improving institutional capital and its equitable distribution include the adoption of adaptive governance principles and these practices of iterative information flow, consultation, and meaningful participation. In order to establish this framework of resilient governance, government, policy makers, people, stakeholders and civil society groups must all engage in these practices.

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