Successful Institutional Adaptation to Climate Change Impacts Posed on Water Resources

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1. Introduction

Purpose of this paper

The purpose of this paper is to contribute to the project by **(1)** providing a discussion of the ways that success can be defined when talking about successful institutional adaptation to climate change impacts posed on water resources; **(2)** providing a review of specific "successful" institutional adaptive measures and principles; **(3)** providing suggestions about some *general* principles that can aid successful institutional adaptation (institutional design, process, environment, and principles). This paper is based upon both a review of literature and the views of the authors.

Specifically, in this paper it is argued that the central conceptual and methodological task faced by researchers on institutional adaptations to climate change is the identification –from a vast repertoire of scholarly and experiential literature narrating the stories of communities and their organizations, government, business, NGOs and international fora — of a set of clear, easy-to-communicate, realistic, yet visionary principles on what **constitutes "successful institutional adaptation**" to climate change-induced or heightened vulnerabilities (social, physical/ecological, or environmental).

At the same time, the open dialogue with the communities directly at risk, particularly with the most vulnerable sectors, requires an *open-mind* and *receptive* attitude from the part of the researchers to understand how people, their communities and institutions make sense of the climate change-induced risks and develop ways of responding to these risks. The accomplishment of such a task is a *value-driven* exercise which does not preclude but rather requires the *convergence* of a scientific knowledge (subject to empirical verification by communities of peers) and a social constructivist approach which accounts for people's experience, perception and enacting of their lives, that is, their realities.

This perspective is applied to the conceptualization and methodological design of investigations on climate change-induced water scarcities (drought) in two study regions of Chile (Elqui River Basin in the 4th Region) and Canada (South Saskatchewan River Basin in the provinces of Saskatchewan and Alberta). Based on well established and credible scenarios that forecast increasing climate change–induced droughts in the two study regions, the Major Collaborative Research Initiative on institutional adaptations to climate change of which this paper is a component, has chosen water as a terrain of investigation or microcosm that can contribute to the understanding of the wider problem of adaptations to climate change (Diaz, et all, 2003/4).

The study aims at identifying both, empirical realities and desirable changes that can increase people and their communities' and institutions', ability to respond to impacts posed on water resources, particularly drought. It is a study located in the "realm of the potential", the

intersection between reality as "it is" and reality as it 'ought to be", an approach named elsewhere as "pragmatic idealism" (Rojas. 2002) resulting from the dialogue between scholarly knowledge and local, experiential knowledge. This convergence of *knowledge*s can generate ideas about adaptation that can assist institutions in their process of capacity building and adaptation.

This paper is divided into four sections as described below:

- **Section 2: Exploring the meanings of "successful" institutional adaptation** provides an account of how meanings of success can vary within the climate change community and how this can affect how adaptive measures are developed and operationalised.
- **Section 3: A review of specific "successful" institutional adaptive measures and principles** provides a detailed listing of specific institutional adaptive measures and principles that have been deemed successful in literature to either: **(1)** increase water supplies; **(2)** manage water demands; and/or **(3)** increase institutional flexibility in dealing with water issues.
- **Section 4: Do *general* principles exist that can be the foundation of successful institutional adaptation across different local, regional, national and political contexts?** provides suggestions about some *general* principles that can *aid* successful institutional adaptation (institutional design, process, environment, and principles) to climate change impacts posed on water resources, based upon a literature review and the views of the authors.

2. Exploring the meanings of "successful" institutional adaptation

In the section below, we will further explore how meanings of success can vary, which we believe is very important to acknowledge and understand in order to come up with desirable principles for successful adaptation to climate change impacts posed upon water resources.

As explored in "Institutions and Adaptive Capacity to Climate Change" (Diaz, H. Rojas, A. Richer, L. and S. Jeanne's: April 11, 2005) what is considered "successful" in institutional adaptation greatly depends upon the main discourses articulated by the various stakeholders in the broad climate change community, which ultimately informs how adaptive measures are formed and operationalised.

The scientific models used to develop and implement institutional adaptations to climate change impacts posed on water resources affects how successful adaptive measures end up being defined and implemented. For example, from a positivistic approach adaptive measures to climate change impacts are likely to be determined by scientists and understood mainly by scientists and other post-secondary educated citizens. Thus, adaptive approaches here are likely to be implemented in a top-down process. Conversely, from a social constructionist approach, adaptive measures to climate change impacts are likely to be initially facilitated by scientists, but ultimately determined by the community in which the climate change vulnerabilities/impacts are being experienced. Thus, adaptive measures here are likely to be implemented in a bottom-up collaborative process.

Some stakeholders may consider successful adaptation in anthropocentric terms, where success is measured in accordance to the degree that measures benefit human systems. This anthropocentric perception of success can be constructed from either the perspective of individualistic-orientated ideologies or socially-orientated ones. Others may consider successful

adaptation in bio-centric terms, where success is measured in accordance to the degree that measures represent human's ethical responsibility towards the natural world in which we are embedded, by protecting *and* enhancing the diversity and the integrity of natural ecosystems, so they can function according to their natural rhythms and function indefinitely.

Definitions of success vary significantly depending upon whether successful institutional adaptations are developed towards sustainability processes *at all*, and if so, toward *what kind* of sustainability processes. For example, a stakeholder may consider a sustainable successful institutional adaptation to water scarcity if it fulfills human needs, either now or in the future. Thus, sustainability here can be either perceived as now or future based (Grimm, 2005). Or it may be perceived as meeting human needs of some or all. Another stakeholder may consider sustainable successful institutional adaptation to water scarcity if it meets human needs *and* non-human needs. For instance, measures that not only take care of providing adequate supplies and access to clean water to human systems, but also to plant, insect, and animal species. Thus, sustainability here can be perceived as the ability of humans to protect *and* enhance the diversity and the integrity of the natural ecosystems which we belong to.

Thus, successful institutional adaptations to climate change impacts posed upon water resources greatly depend upon how sustainability is perceived. When dealing with institutional adaptations to impacts posed upon water resources, these perceptions of sustainability are formed in relation to how water is valued. For example, based upon a bio-centric perspective and a socially orientated ideology, an Andean common vision of water has been established by many within the indigenous and campesino cultures as described below:

1. **Water as a living being** that provides life to animate the universe;
2. **Water as a divine being** that comes from the creator god of the universe, Wirakocha, to fertilize mother earth, Pachamama, thus permitting the reproduction of life;
3. **Water as the basis of reciprocity** that unifies all living things, connecting nature and human society, creating ties within the family, family groups, and Andean communities;
4. **Water as a universal and communal right** that is distributed equitably according to needs, customs and community norms, and water cycles;
5. **Water as an expression of flexibility that** adapts to ecosystems, circumstances, and opportunities without following rigid norms;
6. **Water as a transformative being** that obeys natural laws, according to seasonal cycles and the condition of the landscape;
7. **Water as a cohesive force** that enables the self-determination of people and their communities based on a respect for nature;
8. **Water as a common patrimony** that belongs to the earth and all living beings; and
9. **Water as a public good** that is governed through local customary rights (IDRC, 2004).

Conversely, based upon an anthropocentric perspective and individual-orientated ideology, water is valued in accordance to its uses value for human needs and wants, as an economic good to be distributed, bought and sold. Contingent valuation approaches are typical examples where water is valued in accordance to its economic use value to humans.

The ways in which adaptive measures are developed and are operationalised depends upon the discourses which inform how water is valued, and whether sustainability is a goal of successful adaptation to water issues at all. But even if sustainability is a goal of successful institutional adaptation measures it is important we ask what kind of sustainability? Is it an end or a means?

Is it now or future-centered? Is it based upon economic and/or social betterment of human systems, or social and ecological betterment of *all* human and non-human systems?

3. A review of specific "successful" institutional adaptive measures and principles

An array of adaptive measures can be found in a literature review. Each adaptive measure was considered successful by the stakeholder in accordance with the discourse which informed them. This section will outline those adaptive measures that we believe are considered successful from the perspective of a weak anthropocentric or biocentric perspective.

Before we list these specific measures, we feel that it is important to be explicit about what we believe specific adaptive measures to climate change impacts posed upon water resources should be directed towards, because this has informed our selection here of these measures. Specifically we believe that successful adaptation is about creating adaptations towards sustainability. We refer to sustainability here as a "sustainable earth system" which is based upon a bio-centric and weak anthropocentric perspective. Eight principles are listed below that we believe will help us create and use already existing adaptive measures to construct and walk the evolving path towards a sustainable earth system:

A Sustainable Earth System: 8 Guiding Principles/Goals

1. Must protect *and* enhance the diversity and the integrity of the natural ecosystem that supports it. It must preserve the resources needed that can make it function indefinitely.

2. Relies on local inputs when possible, that come from socially and ecologically conscious producers who receive fair prices for their products, and where inputs and waste are recycled and/or composted back into the system in which it originated.

3. Is a secure system that provides basic resources (food, water, shelter) for basic human needs that are affordable, available, accessible, culturally, ethically and nutritionally appropriate, socially just, safe and resilient.

4. Provides for healthy and safe diets that do not compromise the ability of people to feed themselves or others in the present or in the future

5. Contains an economic system where prices reflect true costs, people have access to earn a decent standard of living, and is based on long-term financial viability.

6. Enhances feelings of community belonging within the non-built environment, and commensality within and between our "places", which requires a heightened awareness of every component, and relationship from the point of production to end disposal.

7. The human animal species, and its representative institutions acknowledges, understands, and appreciates the existence, of natural laws (carrying capacity, finite material and non-material resources) and acts in ways to obey these laws and further understand them.

8. About finding ways to transform the dominant human-centered paradigm which rules predominantly in the "developed world" to one which is life centered, through an effective form of consensus-building and conflict resolution.

Below is a review of specific "successful" institutional adaptive measures to climate change impacts in general, and more specifically to those posed on water. We have chosen the following adaptive measures to be successful or largely successful based upon our belief that

successful adaptation is about creating adaptations towards a sustainable earth system as outlined above. This section is divided into the following categories (1) successful measures to increase supply; (2) successful measures to manage demand; (3) successful ways to increase institutional flexibility. These 3 categories are chosen because according to the IPCC (1995) these constitute the 3 main options to adapt to the impacts that climate change poses on water resources (in Mote et al., 2003). Please note that overlap does exist between these categories and the corresponding specific adaptive measures.

1. Successful measures to *increase water supplies*:

General Strategy	Specific adaptive measures
Rainwater harvesting	• "**Local earthen dams** to collect and store rainwater would help satisfy the need for water, both for residential use and for irrigation". • Using water saving devices such as barrels and plastic covers. • "Construction of **ridge terraces** on hillsides to trap rainfall near where it falls, letting it soak into the soil rather than run off". • "**Reforestation,** particularly in the upper reaches of a watershed, not only helps recharge aquifers but also conserves soil that if washed away might end behind the dams downstream, reducing the storage capacity of reservoirs". • "Land covered with **vegetation** retains rainfall, reducing runoff and enabling water to percolate downward and recharge aquifers" (Brown, 2003).
Switching to mainstream water supply	• "For a single water supply system, the option of switching to mainstream water is worth considering because the potential exists to supply 100% of current and future water demands, a potential that does not usually exist with other supply or demand side options" (Shepherd, P., McNeil, R., and T. Neale in Cohen and Neale 2003).
Increasing upstream storage	• Raising the height of current dams or development of small sites can enhance storage capacity (Shepherd, P., McNeil, R., and T. Neale in Cohen and Neale 2003).
Wetland conservation	• Policy-makers need to establish policies which **protect wetlands**. Wetlands are very "beneficial under extreme drought or flood conditions for their ability to retain water, reduce run-off, filter sediments, and provide water purification" (Hartig, Grozev & Rosenzweig, 1997). • **Buffer zones** should be created along riverbanks and streams to absorb floodwaters, as a precautionary management practice to protect the impacts on wetlands from changes in hydrologic regimes from climate changes (Hartig, Grozev & Rosenzweig, 1997).

2. Successful measures to *manage water demands*:

General Strategy	Specific adaptive measures
Adopting realistic water prices	• Water prices should be adopted that actually reflect its real value to decrease water demand. • i.e. "South Africa introduced lifeline rates, whereby each household receives a fixed amount of water for basic needs at low price. When water exceeds this level, the price escalates. This helps to ensure basic needs are being met, while discouraging the wasteful use of water". • "The effect of price rises on water use varies widely, but as a general matter a 10% rise in the price of irrigation water reduces water use by 1-2%. For residential and industrial use, the drop is usually higher- ranging from 3-7%". • "Surface water usually belongs to the state and groundwater to the person who owns the land under which it is located. Even though individual farmers drill wells on their land, the pumps can be metered and farmers can be charged for the water. Local acceptance of this approach depends on convincing farmers to work together to stabilize the aquifer for everyone's long-term benefits".

	• Basic principle should be applied to managing both ground and surface water: "Provide economic incentives to use water efficiently and involve local water users' associations in the allocation of water". • Moving water from low to high use values (common in Western US): "Some countries have introduced tradable water rights so that individuals who have rights to surface water or who owns the well can sell their water" (Brown, 2003). • **Domestic Water Metering: "**Based on the experience with larger communities, such as Kelowna, BC a **reduction of 20 to 30% in domestic water use** is reasonable with the implementation of meters and a usage based price. The cost of metering will be less for communities with over a 1000 connections because of bulk purchasing and installation" (Shepherd, P., McNeil, R., and T. Neale in Cohen and Neale 2003). • Creating pricing measures to reallocate water to uses deemed higher value (Stakiv, E. and Major, D., 1997). • "When users bear the full costs and have opportunities to voluntarily transfer supplies, water is used more efficiently, there are increased incentives to develop and adopt water conserving technologies, the highest-value uses are assured of an adequate supply, and society derives greater net benefits from its water (Frederick, 1995 in Frederick, 1997).
Raising irrigation water productivity & general farm water productivity	• Use of **efficient technology**, such as irrigation systems: • Use of **low-pressure** sprinklers, "which release water at a lower level, close to the soil surface, loses less water through evaporation and drift". • Use of **drip irrigation** (*gold* standard), is a "method that supplies water directly to the root zone of plants,…in addition to cutting water use by half, it also raises yields because it offers a constant carefully controlled water supply" (Brown, 2003). • According to an Earthtech report, a "trickle irrigation system should result in a **savings of 30% of the water** used by a conventional sprinkler system. In areas of high crop water demand the actual water saved will be higher on a per acre basis giving a lower cost per acre-foot of water conserved. As rough examples the analysis considers annual water demands of 2 feet, 3 feet and 4 feet with per acre foot costs of water saved at $2500, $1667 and $1250 respectively" (Shepherd, P., McNeil, R., and T. Neale in Cohen and Neale 2003). • **Laser leveling of the land** "a precise leveling that can reduce water use by 20% and increase crop yields by up to 30%, boosting water efficiency by half". • **"Raising crop yields** is an often overlooked way of raising water productivity" (i.e. where farmers have to share with urban and industrial users they in turn lower water use and increase yields). • **Shifting to more water-efficient grains**, such as from rice to wheat**.** • **A shift to higher-yielding crops** can increase the economic efficiency of water use. • **"Institutional shifts,** specifically moving the responsibility for managing irrigation systems **from government agencies to local water users' associations**, can facilitate the more efficient use of water" (Brown, 2003). • **Irrigation Scheduling "**involves metering of individual agricultural operations without per unit pricing. The objective is to provide each grower with an accurate figure of how much water he is using compared to how much is actually required based on soil and weather conditions. This option has proved to be very cost effective in the South East Kelowna Irrigation district which achieved a 10% water saving. For irrigation districts with large holdings, fewer meters are required on a per acre basis resulting in a low cost of $500 per acre-foot of water saved. For an irrigation district with smaller holdings the costs would go up to $835 per acre-foot". • **Leak Detection:** "The amount of water that can be saved by leak detection and repair depends upon the age and maintenance of the system. Several older systems in the area

	could benefit by such a program with savings of 10% to 15% of current usage. The costs will depend on the nature of the leaks, as large leaks will have a lower cost per unit of water. An approximate range for the costs of water saved by leak detection is from $1300 to $1900 per acre-foot "(Shepherd, P., McNeil, R., and T. Neale in Cohen and Neale 2003). • Diversifying crops, conserving soil moisture and nutrients, using green cover and buffer zones, protecting wetlands, conservation tillage, improving water uptake, and reducing runoff can raise farm water productivity (Brown, 2003; Downing, 2003; SSCAF, 2003).
Raising non-farm water productivity	• **Composting toilets** are "simple waterless toilets linked to a small compost facility". • Using **water efficient appliances** such as showerheads, flush toilets, dishwashers, and clothes washers. • "For cities, the most effective single step to raise water productivity is to adopt a **comprehensive water treatment/recycling system**, reusing the same water continuously" (Brown, 2003). • Government responses that encourage the public to conserve water include: "(1) advising the public of potential shortages and monitoring use; (2) requesting voluntary use reductions; (3) prohibiting inessential, high-consumption use such as watering lawns and washing cars; (4) rationing" (Mote, P. et al., 2003); and (5) regulations for water reuse and recycling by industrial and commercial users (Miller, K. et al., 1997).
Public Education	• "This option can achieve **a 10% reduction in water use** if a consistent effort is made to reach the public, stressing the importance of reducing consumption and showing how water can be used efficiently. The per unit cost of water saved will vary depending on the size of the system since there are definite economies of scale. For example a large system can afford to hire a full time coordinator in charge of public mail-outs and disseminating information to customers. For medium to large systems the costs of water saved by this option are estimated at $835 per acre foot for a system with 10,000 connections and a full time coordinator" (Shepherd, P., McNeil, R., and T. Neale in Cohen and Neale 2003).
Government regulation	• "State regulations could specify **consumptive use thresholds** at which owners of existing water rights could reasonably be required to modify their diversions and application practices as climatic conditions change. State water authorities should explicitly incorporate such conditions in the specification of any new water rights" (Miller, Rhodes & MacDonnell, 1997). • During periods of water scarcity, water authorities "could announce **firm cut-backs of permit rights during a drought**, but allow permit holders to sell part of their entitlements or purchase additional water through the bank…[this] "could allow water users to improve upon the distribution of entitlements established by the permitting agency and could ease the burden of adjusting to any reductions in permit rights instituted in response to the effects of climate change" (Miller, Rhodes & MacDonnell, 1997). • A water supply **"Safety-Margin"** should be created and preserved to prevent shortages and conflict during periods of low water availability with both appropriated and un-appropriated water. Specifically, a "range of environmentally desirable flow levels could be defined…[whereby] the lower level might serve as a trigger for water authorities to enhance in stream flows by purchasing water or implementing restrictions on existing rights, while the upper level would be used as the target for conditioning new rights" (Miller, Rhodes & MacDonnell, 1997). This would mean that new water permits would be allocated with the condition that users can not exhaust stream flows beyond specified upper flow-level targets (Miller, Rhodes & MacDonnell, 1997). Thus, "if flows increase, water users could fully exercise the new rights; if flows decline the impact would fall first on the conditioned permits, then on the buffer, and finally on current water uses" (Miller, Rhodes & MacDonnell, 1997). In areas where water is already appropriated, water authorities "could create such a buffer by purchasing water rights from willing sellers to reduce existing

	consumptive uses" (Miller, Rhodes & MacDonnell, 1997). Similarly, informal agreements among peasant farmers in Latin America emphasize the collective responsibility over water, and regulate in a cooperative basis access and use of water streams (functioning commons).

3. Successful measures to increase *institutional flexibility* to deal with water issues:

General Strategy	Specific adaptive measures

Planning for uncertainties in management	• **No-regrets policy**, which is a policy, advocated by the IPCC "that will generate net social benefits whether or not there is human induced climate change" (SSCAF, 2003).
	• **Examples of possible components of a no-regrets policy:**
	  • Drought **preparedness**, warning and management
	  • Avoid monoculture, **diversify crops**
	  • **Conserve** soil moisture and nutrients
	  • **Diversify income**, off-farm employment
	  • **Reduce** runoff, **improve** water uptake, reduce wind erosion
	  • Increase irrigation **efficiency**, prevent salinizations
	  • Upgrade food storage and distribution systems
	  • **Liberalize** agricultural trade (market structures often support crops with a high level of risk and fail to support markets for drought-tolerant crops)
	  • Reduce production subsidies (Adapted from Dowing et al. 1997 (2003)).
	• One response is to identify policies to be pursued when conditions become either wetter or drier, where responses are then phased in to adapt appropriately to the effects (Miller, K., et al., 1997).
	• Diversification of crop varieties can help minimize risks to uncertainties on climate change impacts on water availability.
	• Another response is creating and preserving a water safety margin to prevent shortages, which encourages collective responsibility over water, cooperative and integrated basin wide coordination (Frederick, K., 1997; Miller, K., et al., 1997).
	• Water managers should engage in **precautionary adaptation practices** (rather than anticipatory approaches) to changes in water runoff as they occur. Specifically, they should "build new projects given the unfolding climate (rather than some past climate), adjust allocations based on the revealed flows, [and] in places with growing water scarcity, managers can encourage water to be moved from low valued to high valued uses, incorporating an important dynamic adjustment into water management" (Mendelsohn & Bennett, 1997).
	• It may be "valuable to **re-establish interstate or national-level forums** for water resources planning. **Interstate river basin commissions** could facilitate the development of flexible options for responding to the uncertain impacts of climate change" (Miller, Rhodes & MacDonnell, 1997).

4. Do *general* principles exist that can be the foundation of successful adaptation across different local, regional, national and political contexts?

In the section below suggestions are provided about some *general* principles that can aid successful institutional adaptation (institutional process, design, environment and principles) to climate change impacts posed on water resources, based upon a literature review and the views of the authors.

Pragmatic Idealism as Guiding Research Paradigm

Our inquiry is guided by an approach that could be called "*pragmatic idealism":* Pragmatic because it examines the empirical reality of climate-induced water shortages and the practical lessons drawn from previous experiences of drought, and idealism reflecting the value-driven goal of understanding under what conditions it would be possible (if at all) to develop strategies of adaptation that not only reduce the vulnerability to drought but also move the institution and the people it serves, towards proactive solutions that are socially, ecologically and economically sustainable Moreover, the empirical reality of water scarcity, is examined from the perspective of what *should* and *could* be done in terms of successful adaptation. The tension between reality "*as it is"* and reality as *"it should be"* provides a terrain of inquiry where new possibilities emerge as "*potential realities.*"

Guiding Principles for successful institutional adaptation *processes*:

Based upon adaptive conflict resolution principles identified for environmental conflicts in Rojas (2002), 9 principles have been identified that can be used to guide successful institutional adaptation processes:

1. All parties involved have the right and duty to access the most complete information about climate change impacts on water resources, and this information includes the definition of the problem formulated by each stakeholder in the conflict.

2. The accumulated experience of previous adaptations to droughts and other water issues are seriously considered.

3. The design of the process of adaptation involves all stakeholders and it is examined from a perspective other than simply one of mobilizing a maximum of power resources. The desirability of creating multi-stakeholder scenarios and methods of negotiation that allow parties in conflict to achieve some degree of power symmetry to articulate their concerns is emphasized.

4. The dialogue among stakeholders is nurtured by legitimate differences in values and goals: it can burn and destroy, or it can illuminate and fuel social creativity. Conflict resolution which encourages the latter is desirable; ideally, this improves people's well-being.

5. There are provisions to protect the biodiversity of places affected by water scarcity. If the biodiversity is already impoverished, these provisions should ensure restoration or remedial action. These provisions should also ensure that the health of the soil, the quality of the water and the native flora and fauna of the place affected by a given project are enhanced rather than diminished.

6. The communities' social capital - their sense of commensality, solidarity, mutual aid and shared knowledge and their network of social support – is protected and enhanced.

7. The ability of institutions to create technological and organizational adaptations towards ecological, economic and social long-term sustainability is enhanced with new learning.

8. The capacity of community-based organizations to advocate, negotiate and propose creative solutions is improved.

9. The authority and legitimacy of state democratic organs are reinforced by a perception of maximization of moral authority and minimization of coercive authority. The collective wisdom of all contributes to better management of the next potential conflict.

Guiding principles for successful institutional *design*:

In Salvador's "Institutions and Sustainability" (2004) he argues that according to Goodin (1996) **five "desirable principles** of institutional design" exist that can help determine the level of success of an institution:

1. **Revisability,** where an institution and those within it can learn through experience, and change trajectories and practices as required;
2. **Robustness,** where an institution is subject to ill-thought change in response to any fleeting imperative, but responds appropriately to more or less significant pressures;
3. **Sensitivity to motivational complexity**, accepting that what constitutes "appropriate" or "significant" will vary, and that institutions must be open to a variety of motivations and values;
4. **Publicity**, where the logic of an institution or institutional change are publicly defensible and can gain political community support; and
5. **Variability**, so institutional learning can be enhanced through encouraging "experiments" in different places and within different structures.

Salvador (2004) further argues that 5 principles exist that can guide adaptive institutions towards successful adaptation:

1. Persistent, where efforts are maintained over time, enabling learning experience, rather than the past pattern of ad hocery. This principle addresses the attributes of temporal scale, pervasive uncertainty, cumulative impacts, systematic causes, and lack of methods and policy property rights.

2. Purposefulness, where efforts are supported by stated principles and goals. This principle addresses the attributes of temporal scale, uncertainty, new moral dimensions and novelty.

3. Information-richness and sensitivity, where the best information is sought and made widely available. This principle addresses the attributes of uncertainty, lack of methods and policy approaches, the need for participation, and systemic causes.

4. Inclusiveness, where the full range of stakeholders are involved in policy formulation and in management. This attends the attributes of demand for participation, spatial scale, uncertainty and lack of policy and property rights responsibilities.

5. Flexibility, where there is a preparedness to experiment, preventing persistence and purposefulness from becoming rigidity. This attribute addresses temporal and spatial scale, uncertainty, and novelty.

Functions and components for successful institutional *environments*:

In the World Bank's "World Development Report 2003", they outline the main functions and sub-components for the development of a successful institutional environment "that could encourage

solutions to the problems of sustainable development, facilitate partnerships, and help to mobilize the necessary resources" as outlined below:

a. **Capacity to identify needs and problems**. This involves:
    1. Being **sensitive to early signs of problems**, especially from the fringes, is important to avoid a costly crisis later. Paying attention to the development of water shortages, for example, could avoid community problems.
    2. Creating **information for constituencies**. There is a need to create a solid system of information and indicators that responds to the information needs of different social groups. Data gaps inhibit understandings of policies and impede the formulation and implementation of strategies.
    3. **Creating constituencies for information**. The development of a need for and use of information simplifies the implementation of strategies and the coordination of efforts.

b. **Capacity to balance interests**. It is important that (a) everybody is fairly represented in the decision making process and (b) negotiations be facilitated in the process. This requires:
    1. **Transparency,** performance reporting, and accountability. Devices for accountability –including transparency— are useful tools for countering the tendency of entrenched interests or to be unresponsive to dispersed or less powerful interests.
    2. The development of **forums and networks** of negotiations. This is an important tool that could help to reduce tensions between different water users and to establish fair systems of distribution.
    3. **Compensation and incentives**. Resource scarcities always produce a loser, so it is important to minimize losses, compensate losers, and provide incentive for the development of new initiatives.

c. **To execute and implement decisions**. Implementing and executing adaptive policies and strategies require appropriate institutional capacity. This institutional capacity involves:
    1. Promoting capacity building and problem solving
    2. Creating of think-and-do tanks.

(World Bank, 2003 in Diaz, 2004).

<u>Principles to guide the creation, selection and use of successful institutional adaptive measures</u>:

- The IPCC has advocated a **"no regrets policy"** – a policy that will generate net social benefits whether or not there is human-induced climate change (SSCAF, 2003).The range of possible climate change impacts on water resources should be incorporated in water resource planning and management practices with this **no-regrets policy** (Stakiv & Major, 1997).

- "The **precautionary principle**, a phrase coined circa 1988, is the ethical principle that if the consequences of an action, especially the use of technology, are unknown but are judged by some scientists to have a high risk of being negative from an ethical point of view, it is better not to carry out the action rather than risk the uncertain, but possibly very negative consequences" (Wikipedia, 2004).

- **Institutional flexibility** in water planning and management (Frederick, Major & Stakhiv, 1997; Miller, Rhodes & MacDonnell, 1997).

- Using "local **multi-stakeholder fora** offer opportunities for institutional innovation" For example, the multi-stakeholder format of the 1994 Carchi Consortium has led to the creation of a watershed analysis that involves viewing the entire watershed as an **interconnected system**, creating diverse sustainable water management strategies, and provided a forum for diverse stakeholders to resolve and prevent water conflicts (IRDC, 2004).

- Providing adaptation assistance requires: "Addressing **real local vulnerabilities**, so that stakeholders buy into the issue and are interested in reducing vulnerabilities of which they are all aware; involve **real stakeholders** early and substantively, so that any assistance is directed at known local vulnerabilities, and adaptation initiatives are **realistic** and designed to be **consistent** with existing institutions and decision processes; **connect** with local decision-making processes, so that adaptation initiatives are developed relative to other conditions, are "mainstreamed" to the extent possible, and have the best possible chance of actually being implemented" (Smit & Pilifosova, 2003).

- **Governance of water issues** should be guided by:
    - *Both* perspectives of **water as a public *and* private good** should inform management to be effective;
    - **Locally focused** decision making processes (with and as close to water users as possible) and should build upon local institutions; **sharing the costs and benefits** of water use equitably;
    - Consideration of hydrological watershed processes as well as other biophysical and socioeconomic processes that influence the water supply and demand;
    - Provision of **open spaces f**or the participation of **multiple** stakeholders;
    - **Allocation of water use equitably** among mutually dependent users within watersheds.
    - **Adopting a watershed perspective** or other locally constructed concept regarding how social territory is perceived that can assist water users and authorities to better understand the impacts of their actions and their mutual dependencies across those boundaries. Developing a *shared* sense of social territory can lead to changes in motivation and behavior.
    - Taking into account **transboundary geopolitical issues** regarding water resources, such as by addressing water issues **jointly** with neighboring regions and countries (adapted from IRDC, 2004).

- Successful institutional adaptation to climate change impacts posed on water resources should be guided by **"AAAASS"**: **Availability** (must be a sufficient supply of water); **Accessibility** (water must be readily accessible and shared equitably); **Acceptability** (water stewardship must be locally culturally suitable); **Appropriateness** (true costs and benefits of water must be shared using locally appropriate means, while respecting ecosystems); **Safety** (quality of water must be safe for species consumption); and **Sustainability** (water must be treated and extracted in a manner which respects

environmental limits and well-being, as well as, meet the needs of the present generation and does not exploit and jeopardize the needs of future generations).

Concluding remarks

The proposed successful adaptive strategies and guiding principles outlined in this paper are intended to guide our steps to answer those questions in dialogue with the stakeholders affected by the climate change impacts on water resources, and not as a-priory answers to realities waiting to be discovered and documented. This exercise, important as it is, has definite limitations and, if not pursued with great flexibility, it risks bringing to the communities and institutions agendas that do not match their lives and realities. Ultimately, creating, selecting and implanting adaptation strategies need to be tailored to specific local environments, cultures, conditions and settings, and thus will likely need to vary from place to place.

Needless to say, these examples of successful adaptive measures, guiding principles and processes constitute promising avenues for establishing criteria for successful adaptation within the great diversity and variation of regional and local situations.

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