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Converging threats: assessing socio-economic and climate impacts on water governance

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Abstract

Purpose – It is increasingly recognised that water will be the prime medium through which climate change impacts will be felt. But water governance issues are already deemed to be a prime cause of a global water issues. Not only will climate change affect the function and operation of existing water infrastructure and institutions but additionally, current frameworks may not be robust enough to cope with climate change impacts. Effective water governance is seen as essential to building adaptive capacity in communities to manage future climatic uncertainty and stress. The purpose of this paper is to assess socio-economic and climate impacts on water governance.

Design/methodology/approach – As a first step in assessing adaptive capacity of two river basins, this paper explores current vulnerabilities in a Swiss water governance arrangement, and then proposes the subsequent implications for water resource management within a climate change context. It presents results from a governance assessment in the specific context of integrated water resource management and suggests a means to develop the assessment to address the issue of climate change and extreme events.

Findings – A low level of integration and highly segregated approach to water resources management suggests that the potential ramifications of climate change and expanding water uses may not be adequately reflected in their current governance framework.

Originality/value – The paper explores the current governance context in order to improve the understanding of how regulatory and institutional regimes may facilitate the development of adaptive capacity. It then proposes additional methodological steps to improve on such an assessment to take into better account the dynamic interplay between the human, hydrological and climate components of the system.

Keywords Water, Governance, Global warming, Switzerland

Paper type Research paper

1. Introduction

Growing freshwater stress around the world is raising significant awareness for the need to better manage systems now, as well as in a future dominated by climatic change. Since the climate cycle is essentially the hydrological cycle (Gleick, 2009), climate change will alter the hydrological system in a number of ways and thus the basic properties of the water systems upon which water governance is currently built (Zinnbauer and Dobson, 2008). According to the Intergovernmental panel on climate change (Bates *et al.*, 2008, p. 168) climate change will not only affect the "function and operation of existing water infrastructure [...] and water management practices", but these very practices are "likely to be inadequate to reduce the negative impacts of climate change".

In response to these issues, water managers and scientists are progressively looking to integrated water resources management (IWRM) and adaptive management

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(discussed below) (Ingram, forthcoming). The multi-faceted, complex and growing issues encompassing water warrant a comprehensive and in depth assessment of water governance frameworks within a context of IWRM (Rieu-Clarke *et al.*, 2008). To this end, an initial indicator-based legal analysis of the water governance framework has been carried out in the Canton Valais, Switzerland, which forms part of the Rhône River Basin. This is an initial step in research to assess the vulnerabilities of the water governance system under a climate of change, which aims to develop the current indicator approach to better identify unknown weaknesses in the face of climate change.

2. Water governance and climate change

Governance, though widely debated, is a more inclusive concept than "government" since it reflects the negotiation between society and government in effectively implementing socially acceptable allocation and regulation by mediating behaviour through values, norms and laws (Rogers and Hall, 2003). The concept of good governance, coined by the World Bank in the 1980s, has become popular in the preceding few decades, in response to the notion that "more effective governance regimes or systems need to be designed/created to overcome government failure, market failure and system failure or a combination of these" (Rogers and Hall, 2003, p. 24). A number of studies and institutes have defined diverse key components central to achieving good governance, which tend to encompass a range of normative values and public policy objectives which are seen as socially desirable (e.g. accountability, transparency, participation, justice, efficiency, rule of law and absence of corruption).

The concept of governance has more recently been adopted by academics and policy makers working in the water sector, with the water crisis broadly recognised as a crisis of governance (UNESCO, 2006; Gleick, 2009; WEF, 2009). Water, due to its transboundary nature and vital significance in all aspects of society and economy, provides an interesting context within which to observe governance issues. Amongst the many definitions of water governance, the UNDP (2009) determines it to address:

> [. . .] formulation, establishment and implementation of water policies, legislation and institutions [. . .] clarification of the roles of government, civil society and the private sector and their responsibilities regarding ownership, management and administration of water resources and service.

Political power and competing priorities are seen to define the relationships between different organisations and stakeholders (Hurlbert *et al.*, 2008).

In recent years, the intensity of debate in both academic and practitioner's fields has led to internationally agreed standards such as the Dublin Principles being adopted by the water community, as a means to set a common bar for water governance. In the context of such principles, concepts such as IWRM have taken on significant currency, as a means of ensuring "equitable, economically sound and environmentally sustainable management of water resources and provision of water services" (Rogers and Hall, 2003, p. 4). The Global Water Partnership (GWP) described IWRM as:

> [. . .] a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (Rogers and Hall, 2003, p. 4).

Greater emphasis is placed on collaborative governance of the multiple values of water, and is seen as one means of increasing the capacity of water management in the face of climate change.

External influences, such as climate change, also act on governance. Accelerating rates of change are a major challenge, since society is increasingly unable to apply previous lessons to today's problems (Ostrom *et al.*, 1999). Flexibility in governance systems is one key criterion in building adaptive capacity to react to the unanticipated conditions that may result from climate impacts (Hurlbert *et al.*, 2008a). There is also an increasing focus on the "need to find transitional governance approaches to help society move [. . .] to future more sustainable governance paradigms" (Pahl-Wostl *et al.*, 2008, p. 420) in the discourse around adaptive governance, which is seen to meet the call for dealing with increased uncertainty and change, arising from the current management failures and rising vulnerabilities in social-ecological systems (Olssen *et al.*, 2006). Within the context of river basins, Pahl-Wostl *et al.* (2007, p. 49) noted that more attention needs to be devoted to understanding and managing the transition to more adaptive regimes that "take into account environmental, technological, economic, institutional and cultural characteristics of the basin".

3. Empirical methodology

The governance assessment represents a systematic methodology to measure governance in the specific context of IWRM. The methodology has already been applied in a number of basins within the STRIVER (www.striver.no) and Brahmatwinn project (www.brahmatwinn.uni-jena.de/) (Allan *et al.*, 2007). Its application in the basins of the Rhône in the Valais, Switzerland and the Aconcagua, in Chile in the context of the ACQWA project (www.acqwa.ch) will aim to further refine and build on the methodology. While there have been many attempts to assess the quality of governance, most relate to "vague aspects of the broad context of governance but do not specifically address water and governance issues per se" (Rieu-Clarke *et al.*, 2008, p. 3). The indicator approach to water governance is based on three core elements of good governance:

(1) *Accountability*. Holding governments responsible for their actions; Contestability of political power.

(2) *Transparency*. Right to information; availability and clarity of information.

(3) *Participation*. Involvement of citizens in decision making.

A comprehensive set of indicators was developed in the style of a questionnaire comprising 18 key questions, and 60 sub-questions testing both commitment (degree to which the governance context adheres to accepted standards of good governance) and process (extent to which this governance context is implemented in reality) (Allan and Rieu-Clarke, 2007). The resulting outputs are intended to provide a benchmark for identifying potential gaps and barriers to implementing IWRM (Rieu-Clarke *et al.*, 2008, p. 2). Such an approach "provides a mechanism not only to assess existing laws, policies and institutions, but also the extent to which such governance arrangements have been implemented in practice".

Research was conducted initially through a desktop study to gather all relevant information on the laws as well as policies and institutions related to governance and IWRM. Interviews then ascertained the degree to which the law has been implemented

in practice. The next step in this doctoral research will be to then combine results from the governance assessment with, not only, further indicators adaptive capacity, but also quantitative analysis on the past extreme events and return period analysis to develop a better understanding of how the governance framework has operated under past extreme events. The focus of this paper, however, will be on research so far conducted in the Swiss case area.

Case area

Switzerland is characterised by a complex decision-making structure in a highly decentralised state where a far greater share of power is still devolved to the cantonal and communal level and there are a number of public administrative units. The "Principle of Subsidiarity" is vital to Switzerland's decentralised system, allowing each administrative task to be carried out at the lowest level possible. Political affairs have become increasingly consolidated at the federal level, but the implementation of public policy (including environmental laws) has mainly remained within the cantons, often with considerable room for manoeuvre, known as the federalism of implementation "*Vollzugsföderalismus*" (Mauch *et al.*, 2000). The Canton Valais is a bilingual canton in the south-western part of Switzerland (Figure 1), and the third largest of the country's 26 cantons. Within Valais there are 153 communes, organised into a legislative council, an orientation body, and a political/administrative council for a population of just under 300,000 (Valais, 2009a). The canton contains a number of different economic sectors (hydropower, tourism, agriculture and industry), which requires a coordination of water allocation for the different uses. It is one of the poorer cantons in Switzerland, and is therefore reliant on federal subsidies for the implementation of projects.

Note: Canton Valais is highlighted in green

Figure 1.
Switzerland, by cantonal divisions

Climatic influences on mountain water resources are also taking place in "the context of rapid and widespread socio-economic transformation" (Wiegandt, 2008, p. 4). Switzerland is becoming increasingly urbanised and agriculture as well as mobility is intensifying, resulting in growing pressures on the environment (Federal Office of the Environment (FOEN), 2007). Tourism has also had a major effect on the Alpine environment, contributing to increased water usage (increased population, energy and artificial snow) and impacting water quality and related ecosystems. Furthermore, hydroelectric production has affected river quantity, quality and riparian ecosystems through decreased river flows and through hydropeaking (von Arx, 2009; Bonzi, 2009b). The Swiss Alps will experience some of the most pronounced effects of global warming, notably in winter time (Bürki *et al.*, 2005). Higher temperatures are projected to result in more intense winter precipitation, but much reduced in summer precipitation (Häberli and Beniston, 1998). The retreat of Alpine glaciers is projected to have significant consequences for the energy system of the Swiss Alps (Horton *et al.*, 2005) as well as for natural hazard (Organe consultatif sur les changements climatiques (OcCC), 2008). Furthermore, temperature increases at Alpine elevations may raise demand for water uses such as artificial snow and summer cooling/drinking water leading to complex management shifts.

4. Governance assessment

Governance arrangements need to be able to cope with the aforementioned uncertainties. Assessment results presented below indicate the performance of the Swiss/Valais water governance regime in both commitment and practice according to the indicators of good governance. These results will be discussed in the context of their potential to contribute to the reduction of vulnerabilities.

Legal groundings

There are a number of laws with water elements at both the federal and cantonal level in Switzerland as shown in Table AI (Appendix). The main federal provisions for property rights concerning water are set out in the Swiss Civil Code (CC) 664, 704 and 705. If a deed holder wishes to use these waters, they are required to follow federal law governing use and protection. Public property is deemed as rivers, streams, lakes, glaciers, as well as springs arising from uncultivable land. However, in Switzerland, federal provisions refer or imply additional cantonal legislation, which differs across the cantons, and in some cases have not passed additional regulation at all (Expert 1). In Valais, a more decentralised canton, while the lateral rivers of the Rhône are property of the communes, the Rhône itself is the property of the canton.

Accountability

Switzerland represents a direct democratic system and high level of decentralisation for decision making and planning. The primary system to challenge laws is through its citizens' constitutional rights to petition (FC Art. 33), initiative and referendum (FC 138, 139, 140). A number of provisions are present in the Swiss federal constitution (FC) which guarantee access to legal proceedings and the courts (Arts. 29-33 and 64FC). Switzerland's judiciary is independent of the executive and the legislature, with the Federal Court (*Bundesgericht*) being generally viewed as being an effective and independent institution. Rights in legal and judicial proceedings for civil society as well

as organisations are embedded in the FC as well as in a number of Federal Acts, namely, the Federal Judiciary Act (FJA), Federal Administrative Act, Environmental Protection Act (EPA) and the Federal Law on the Principle of Administrative Transparency (LTrans).

The right of appeal for interested civil society/environmental organisations (Verbandsbeschwerderecht) to challenge decision in court, which may affect their members' interest, was initially introduced in 1983 in the referendum on the EPA (Art. 55). The complex governing process, while it ensures a consensus is built, does mean that laws can be difficult to implement, and the process of change or implementation is very slow (Expert 2) and potentially difficult (Uhlmann Brögli and Wehrli, 2008). In enforcing the law, the federal government tends to utilise a hands off approach, but can wield some form of soft enforcement power in terms of financial incentives and subsidies for the implementation of certain principles in projects at the canton and commune level. Under the terms of the "Neuefinanzausgleich" (NFA, 2008), communes can receive greater subsidies for projects from the cantons and federal funds if they meet certain criteria (participative planning, integrated risk management, ecological aspects and technical aspects) (Expert 3).

Transparency

Transparency indicators generally score well in the assessment, though issues were raised in terms of quality, quantity and coherence of certain hydrologic data set across regions, particularly in the Alpine areas. Despite Switzerland's reputation as the nation of banking secrecy, legal provisions for access to environmental information preceded those in the rest of Europe. In general, access to environmental information is perceived to work effectively in Switzerland (Expert 1), although concerns were raised with aspects of implementation in some of the more remote Alpine areas (Experts 2 and 4). The 30-day notification period was seen to be limiting when dealing with some communes that may be far away in the mountains, and/or adverse to environmental organisations, and therefore do not want to give them the report, no matter what rights are provided in the law to the Environmental Impact Assessment (EIA). Additionally, EIAs are outsourced to private bureaus, which can undermine the objectivity of the report (Expert 4). Instances where such bureaus simply do not thoroughly know the detail of the Water Protection Act (WPA), and mistakes are made in how the law should be interpreted and implemented, have also transpired. However, in the time period 1997-2007, there were no court cases or judicial proceedings relating to provisions for environmental information (Kölz and Brunner, 2007).

Participation

Swiss citizens maintain extended political rights through the specific constitutional rights for referendum (Art. 140 FC), petition (Art. 33 FC) and initiation of a referendum (Arts138 and 139 FC). These rights of participation are a fundamental part of the Swiss Constitution not only in law, but also in practice. Therefore, a large number of legislative acts in most policy fields are subject to referendum, requiring ratification by a majority of the electorate and the cantons. This also applies to water policy issues, allowing NGOs, trade unions and professional associations to exert a "considerable influence on political decision-making processes" (Mauch and Reynard, 2002). The right to referendum and the resulting people's initiatives concerning water policy

(1991 "Save our Waterways" (*Volksinitiative: Zur Rettung unsere Gewässer*) and 2007; SFV, 2006) show that public participation has been key in moving forward the ecological agenda in water governance in Switzerland (Experts 1, 2 and 4). However, it has been well documented that since the 70s, voter turnout has started to decline (IDEA, 2009). In the practice of water management, participation takes place at the different institutional rather than individual levels (Expert 2).

Within the Valais, the implementation phase of the major flood protection project "The Third Rhône Correction" (TRC) (Valais, 2009b) is highly participative, with the different segments of each project having its own local planning commission (Commission régionale de pilotage) that includes the different interested parties. However, the level of participation is highly dependent on local factors with inclusion and collaboration in some areas functioning very well, but not in other communes (Expert 4). Further difficulties have been detailed in the problems that arise from the participative process, namely in the slow progress of the project (Experts 2, 4 and 5) as well as in attempting to align conflicting interests (Experts 4 and 5), specifically agricultural stakeholders, who have set up a lobbying group to force the project to follow a more technical approach (Arborino, 2009), and the environmental considerations bound by law (WPA) into the project. Other than the TRC, there are not that many other opportunities for participation or where participation is demanded (Expert 4).

IWRM

This section will look at a number of sub-categories of the IWRM indicator which show that while law and policy is certainly more integrated today and legal provisions for different element of IWRM are generally strong, they are also complex since they are found in a number of separate federal and cantonal acts and ordinances.

Basin approach. Notably there is no framework agreement, convention nor cooperative institution for the Rhône basin as a whole. The River Rhône is the border between the cantons of Valais and Vaud, and is therefore shared 50:50 by each canton. There are federal and cantonal legislative clarifications for managing cross-cantonal waters (Ordinance on the Hydraulic Engineering, 2007), and generally, the Federal State is responsible for those water courses that flow across multiple cantons. However, the responsibility of implementation lies at the cantonal or commune level. International Commission for the Protection of Lake (CIPEL) Geneva: www.cipel.org) does provide a coordinating role for environmental protection across different cantons (Geneva, Vaud and Valais) as well as countries (Switzerland and France) affecting the quality of the Lake of Geneva (Expert 6).

In practice, issues of coordination amongst different communes over one basin are particularly problematic in Valais (Clivaz and Reynard, 2008), since the communes have a large degree of autonomy, while the canton has low financial capacity. This decreases the canton's ability to implement federal legislation or a common hydropower policy (Staatsrat, 2008) across different communes (Clivaz and Reynard, 2008). Since all lateral rivers are under the sovereignty of the communes "it doesn't really matter what the canton says – they have the end decision about how the water is used, and which projects are implemented" (Expert 7). However, others commented that it is in their interests to comply to avoid litigation or losing out financially (Experts 3 and 7). Art. 7(3) WPA states that "the cantons provide a communal and where necessary

a regional drainage plan ('regionale Entwässerungsplanung' (REP))", a provision only binding for built-up areas, but other aspects have to be included in spatial planning tools ("Sachplan" and "Richtplan") (Heller, 2009). However, very few cantons have completed an REP.

Water allocation and prioritisation measures. There are currently no overarching principles on how to manage user conflicts in periods of water stress that address international, national and local actors all together. Provisions for allocation and prioritisation measures can be categorised into two groups: concessions and residual flows. Concessions are administrative agreements allowing exploitation of natural resources. For the exploitation of water power and irrigation, they are subject to the general provisions of the Use of Water Power Act (UWPA). The act provides regulations and guidelines for instances where watercourses run through more than one canton (Arts. 6, 7, 61 and 68). IN Valais, most concessions were granted by the communal administration for an 80-year time period and. Residual Flows (Mindestrestwassermenge) are provisions in both WPA (Arts. 31, 33, 34 and 36) and the Federal Fishing Act (FA), which require that sufficient quantities of water should be either left or returned to watercourses, whatever the water use.

While Swiss legal provisions recognise both economic and ecological water uses, implementation of these provisions has been difficult (Petitpierre, 1999), as a 2006 Eidgenössische Anstalt für Wasserversorgung, Abwasserreinigung und Gewässerschutz (EAWAG) study on the implementation of Art. 80 WPA shows (Uhlmann Brögli and Wehrli, 2008). Interviews also suggested that it has led to increased conflict amongst how to best manage the different user groups (Interviews: Experts 2, 4, 5, 6 and 9), with the key issue being the development of the growing micro-hydro sector (Experts 2-4 and 10). There are very few provisions in the law that concern the management of scarcity situations and no overarching principles on how to manage user conflicts in periods of water stress that address international, national and local actors all together.

Protection of aquatic ecosystems. Aquatic ecosystems are protected in both qualitative and quantitative terms under Swiss law (see above), through provisions in the WPA (Appendix Tables AI and AII) as well as Protection of Nature and Landscape/Cultural Heritage Act (PNLA) and Federal Forest Act (FFA) (preservation of natural diversity of riparian species). Within the legislation of the Canton Valais Law, the Law on Hydraulic Engineering (LHE) (Arts. 5g and 39, 15 March 2007) provides protection of aquatic ecosystems, as does a 1999 law protecting the floodplain of the Rhône. In practice, a number of water courses and aquatic ecosystems have been severely impaired and federal targets are not being met (e.g. nitrate concentrations) (FOEN, 2009a). Hydro-peaking regularly impacts rivers, while some periodically dry up from over extraction. Environmental lobby groups have expressed concern with the fact that the legally binding provisions for residual flows are too weak for effective nature protection (Bonzi, 2009b), raising questions as to whether an effective and efficient instrument exists for coordinating water's protection and use (Bonzi, 2009a). Enforcement of protection provisions are seen to be hampered by resource limitations in staff numbers at the canton level (Expert 6).

Flood risk management and response systems. Since the 70s there has been a shift from technical building and hard canalisation approach to a more integrated and eco-system based flood management philosophy (Zaugg, 2002), which has meant that implementing flood protection projects (such as the TRC) requires a more complex

negotiating process (Experts 3 and 5). While federal and cantonal law (WBG.Valais) state that the natural condition of the river must be improved, other stakeholder groups, such as agriculture, have rallied against impacts this would have for their own resources. However, financing mechanisms are perceived to effectively assist the federal government in implementing current philosophy of the law (Expert 2). Recurring issues of sovereignty and human resources were raised in interviews across the cantonal departments. Hazard maps are a key requirement of the flood protection concept due for completion by the end of 2011. Progress is recorded in the ShowMe maps (FOEN, 2009b). It was noted that better coordination across different departments was required to reduce duplification of effort (Figure 2) (Experts 3, 6 and 8).

Institutional arrangements and challenges related to IWRM. Swiss water management is driven from the local level up, thereby reducing the impact of IWRM policies proposed by FOEN at the cantonal and communal level. Organisations such as Wasser Agenda 21 (WA21) are more focused on the theory of IWRM, so have very little impact in practice. Despite policy briefs from FOEN (SAEFL, 2002, 2003), so far there is no cooperative institution at the basin level in the Canton Valais or the Rhône basin in general, instead a complex and segregated approach (Figure 2) makes coordination across the different actors difficult (Expert 6). There are many institutions that focus on the different elements of water, spread across the federal, canton and communal level, leading to weak internal policy coherence within the federal administration (Varone *et al.*, 2002) and in the country as a whole.

Many interviewees raised the issue of professionalism and lack of capacity at the commune and canton level. Those responsible for a water management component often do not have the time, the training or both (Experts 2, 4, 6, 8 and 11). The autonomy from federal control (provided by Art. 50 FC) is another facet of the principle of subsidiarity and one that has significant consequences in water management (Aschwanden *et al.*, 2008). It makes it particularly difficult to establish appropriate geographical units for water management, since their areas are too small to represent either natural or technical territorial units of water courses. Over the years each canton has developed their own brand of water management, along with their own institutions, leading to a lack of overall vision for Switzerland (Chaix, 2008). Some question whether

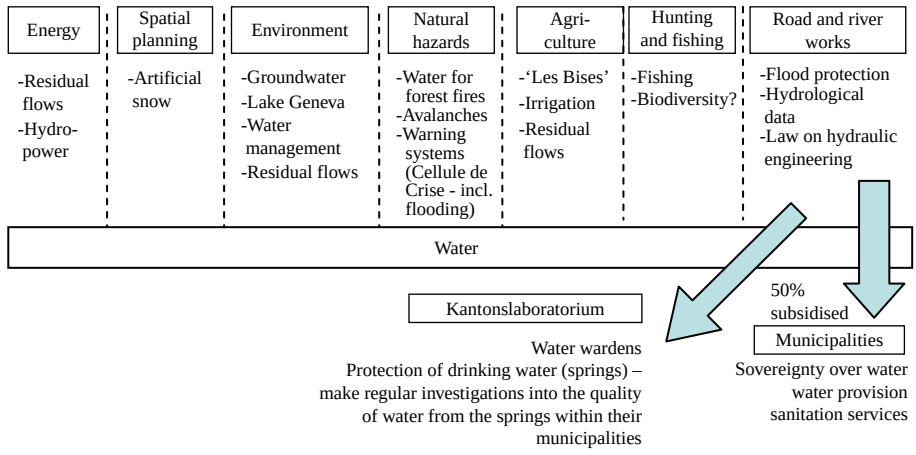

Figure 2.
Organigram of water resource management across Canton Valais

this decentralised approach to water management is compatible with the goals of IWRM (Chaix, 2008). While limited and independent examples of integrated watershed management have been documented across different cantons (WA21, 2007), the ability for IWRM to move more comprehensively from theory to practise is yet to be seen.

5. Discussion: meaning for climate change

Climate change has significant ramifications for water law and governance (Tarlock, 2009). However, the current academic consensus on the need for more adaptive and flexible institutions to meet the challenges posed by climatic and socio-economic forcings (Ingram, forthcoming; Pahl-Wostl *et al.*, 2007; Tarlock, 2008) is juxtaposed by the search for stability within legal frameworks. Table I sets out an initial attempt to identify vulnerabilities, to present socio-economic and climate change threats on the Valais water governance system and the degree to which the governance system is prepared to meet these challenges.

The highly distributed governance system does yield positive results in accountability, participative and transparency categories. However, Table I highlights potential areas of vulnerability with respect to future uncertainty. With regards to participation, Margot Hurlbert comments that the "development of adaptive capacity requires the participation of all members of a community in a manner balancing social, economic and natural interests" (Hurlbert, 2008b, p. 5). While the "Verbandsbeschwerderecht" is a key provision in Swiss Law (FOEN, 2009c), the contentions between different stakeholders in the Valais support the suggestion that "participation is no panacea for water conflicts" (Bloomquist and Schlager (2005) in Ingram, forthcoming, p. 8).

Even within water rich Switzerland, conflicts of interest and challenges do arise, as seen during the 2003 heat wave as well as less extreme reference periods (Experts 8 and 10). Additionally, there are two areas of water use, which are currently under the legal radar: rainwater and artificial snow production (Experts 1, 2 and 8). Artificial snow is seen as a complicated area, which currently is under-regulated (Expert 2). The Department of Spatial Planning has issued guidelines on where snow making facilities can and cannot be built, the question of what to do, once it is too warm for artificial snow making is not being addressed. The situation today is seen to mirror the situation prior to the 1916 Law on Hydropower, when a large amount of development was taking place virtually free of any regulation.

Concerning concessions, Clivaz and Reynard (2008, p. 111) touch upon the issues associated with the 80-year time period for agreed concessions in the Valais resort of Crans-Montana (2008), which pose significant questions on whether such a rigid and long-term agreement is still suitable in the face of future uncertainty of supply and demand. Hurlbert (2008b) noted that flexible institutions are vital for facilitating adaptive practice in water governance in response to climate impacts and Tarlock (2009) comments that "any kind of fixed allocation agreement is not suitable under climate change scenarios, since there is a more urgent need to make real time decisions". Hence, the 80-year fixed concessions may be unsuitable for a future impacted by climate change.

The development of Swiss water law reflects the conflicts between the earlier granted "Rights of Use" and the younger laws provisioning for the protection of water. Exploitation rights have been layered over with protection laws, and the two have continued to be in conflict since (Expert 9), with no overlying framework. This is a clash

Table I.
Main threats from socio-economic and climate change criteria to the water governance system, and key areas of vulnerability (italics) or preparedness (non-italics) per assessment indicator

Threats	Accountability	Transparency	Participation	IWRM
Growing competition over water and growing environmental awareness	Verbands-beschwerderecht Consensus building *Fierce independence from federal control* *Complicated governing process*	Well-established legal provisions for access to environmental info Verbands-beschwerderecht *Problems in implementation of EIA and access to info*	Verbands-beschwerderecht Rights to participation and initiative *Slow progress of projects*	Residual flows Ecological objectives in the law *Sectoral organisation of institutions and legal provisions* *Fixed and long-term allocations in UWPA* *Absence of legal provisions for some uses* *Separation/layering of exploitation rights over water protection provisions* *Lack of resources and professionalism at the commune level*
Demographic changes	*Complicated governing process*		Participative decision-making process *Slow progress of projects*	Ecological objectives in the law *Lack of resources and professionalism at the commune level*
Rising energy demand	Verbands-beschwerderecht Consensus building *Fierce independence from federal control* *Complicated governing process*	Well-established legal provisions for access to environmental info *Problems in implementation of EIA and access to info*	Verbands-beschwerderecht Rights to participation and initiative *Slow progress of projects*	Residual flows Ecological objectives in the law *Fixed and long-term allocations in UWPA* *Separation/layering of exploitation rights over water protection provisions* *Lack of resources and professionalism at the commune level*
Increase in micro-hydropower	Verbands-beschwerderecht Consensus building *Fierce independence from federal control* *Complicated governing process* *Soft enforcement power of federal government*	Well-established legal provisions for access to environmental info *Problems in implementation of EIA and access to info*	Verbands-beschwerderecht Rights to participation and initiative	Residual flows Ecological objectives in the law *Fixed and long-term allocations in UWPA* *Separation/layering of exploitation rights over water protection provisions* *Lack of resources and professionalism at the commune level*

(*continued*)

Threats	Accountability	Transparency	Participation	IWRM
Glacial melting		*Poor data quality, quantity and coherence across certain hydrologic data sets in Alpine region*		*Low priority of climate change on agenda* *Lack of resources and professionalism at the commune level*
Increase in natural hazards	Accountable responsibilities of the different administrative levels *Soft enforcement power of federal government*	Well-established access to environmental info *Poor data quality, quantity and coherence across certain hydrologic data sets in Alpine region*	Participative decision-making process *Slow progress of projects*	TRC project Protection provisions in the law *Lack of resources and professionalism at the commune level*
Change variability seasonality of precipitation and melting patterns	Accountable responsibilities of the different administrative levels *Soft enforcement power of federal government*	Well-established access to environmental info *Poor data quality, quantity and coherence across certain hydrologic data sets in Alpine region*	Participative decision-making process *Slow progress of projects*	Residual flows Protection provisions in the law Ecological objectives in the law *Low priority of climate change on agenda* *Lack of resources and professionalism at the commune level*
Temperature increase/heat waves	Accountable responsibilities of the different administrative levels *Soft enforcement power of federal government*	Well-established access to environmental info *Poor data quality, quantity and coherence across certain hydrologic data sets in Alpine region*	Participative decision-making process *Slow progress of projects*	Residual flows *Fixed and long-term allocations in UWPA* *Absence of legal provisions for some uses* *Separation/layering of exploitation rights over water protection provisions*

Table I.

that continues to this day (as seen in Lebendiges Wasser Initiative; Expert 6) and is likely to continue as the TRC is implemented, the renewal period (from 2015 onwards) for concessions approaches and the Bundesamt für Energie (BFE) sponsored micro-hydro projects (BFE, 2009) are realised. The separation of legislation between water quality and water use has also generated challenges to adequately integrate the water regulation.

Issues of implementation for quantitative environmental provisions (e.g. Art. 76 & 80 WPA) reflect the current challenges faced in such highly decentralised governance, as well as managing varying and growing conflicting interests (Experts 4 and 8). The resource and capacity issues at the different political levels indicate a potential inability in the future to manage more time consuming and complex resource management issues (Experts 2-4). While commune council members are given assistance from the canton (Expert 3), most do not have the time, expert knowledge or long-term mandate that may be necessary to meet the challenges in climate change and other rising uncertainties in the water system. The lack of coordination across the different elements of water law and management also heighten the capacity issues, as there is no oversight direction for water use and protection, let alone planning, within the canton or the basin. However, given the Swiss politico-administrative order, management at the watershed level is unlikely, since the communes remain the logical political boundaries.

Interviewees suggested a lack of consideration of climate issues in water management at the Canton level in the Valais. The only exception was that the TRC did have an integrated a climate component, in that flood protection needed to take into account any impacts from climate change (i.e. increased severity of flood events). However, the projected increase in pressure on rivers and streams arising from conflicting demands coupled with variability and seasonality changes (OcCC, 2008) is not receiving much attention, or being looked at as a holistic issue at the local and cantonal level (Experts 2, 4 and 8). Stakeholders feel that there is more than enough water, assimilating the issue of climate change as one with increased water scarcity (Expert 8), rather than with altered seasonality and increased extreme events.

The issues discussed above raise serious questions as to whether the Swiss governance arrangement could be "able to anticipate problems and to manage risk and challenges in a way that balances social, economic and natural interests" (Hurlbert *et al.*, 2008, p. 7). Although the foundations are in place, issues detailed in practise need to be addressed collaboratively and systematically across cantons that share watershed areas in order to meet the converging challenges of climate change and socio-economic developments. Further work aims to more specifically clarify future challenges and develop the assessment in order to better determine the system's ability to respond to those challenges. It is proposed that adaptive capacity indicators be integrated into the assessment, in order to more accurately measure the ability of the system to cope with increased uncertainty from climate change, perhaps the biggest challenge that already vulnerable systems will face. Literature analysis will serve to identify key components of adaptive capacity to develop a further set of indicator questions for measuring adaptive capacity.

Past examples of extreme climatic events will then be used to explore particular problems experienced under climate extremes. These case events will serve as useful indications of the potential impact of extremes in a future, warmer climate.

Return period analysis will be employed to understand the development of such events and to project the likelihood of such events happening under climate change scenarios. Further stakeholder interviews will then provide deeper investigation into the potential performance of the governance system under climate change impacts. The results from an assessment of these indicators will be referred back to the original assessment to identify particular parts of the methodology that are/are not indicative to adaptive capacity, thereby developing and improving on the existing model.

6. Conclusion

The initial Valais governance assessment shows that while there is much cause for optimism, in that elements of the system show preparedness for future uncertainty (Table I), there is a significant gap between the conceptual strands of good governance which are supported in federal laws and policies, and the translation of IWRM at the regional and local level. It mirrors other studies, which show that "a substantial gap exists between promise and practice" (Ingram, forthcoming, p. 2) in water governance.

Key findings in the assessment can be grouped under the headings listed below:

- human Resources: lack of professionalism and resources at commune level;
- sectoral approach;
- suitability of the "lowest possible level" concept of subsidiarity and "Kantonligeist" syndrome;
- complexity of water sovereignty at different levels of government; and
- conflicts on the Horizon: artificial snow, climate change, long-term hydropower concessions, growth of micro-hydropower.

Swiss water law although wide reaching, still maintains a focus on sectoral and end of pipe regulation, and there is no real integrated water policy or legislation across all water goods and services (Varone *et al.*, 2002). While such a sectoral and politically (rather than geographically) led approach and may have been sufficient, it is unlikely to be efficient in the face of the future challenges or effective in establishing sustainable and equitable resource management. The complex institutional infrastructure, legislative provisions and levels of sovereignty, which govern water resources in the Valais, need to be re-addressed in order to build efficiency and stability in the face of future change.

The assessment of Swiss Valais also highlighted that the ramifications of climate change and expanding water uses are not adequately reflected in their current governance framework. Some have suggested that a lack urgency to address this issue in an integrated manner and vision is due to fact that there has historically been a low level of pressure on water management in the region, and Switzerland in general (Heller, 2009). However, even within the water tower of Europe, the prognosis of rising conflicting demands on a water system facing uncertain changes from climate impacts suggest that it is high time for a change of speed. It suggests that in the Valais, prescriptions may no longer fit the context as competing claims on water mount, and climate impacts become more apparent. The next methodological step details will move the study to assessing the system's "ability to design and implement effective adaptation strategies, or to react to evolving hazards and stresses" (Burton, 2005, in Hurlbert, 2008b, p. 2). This development would expand on other studies concerning

climate change impacts on water governance (Hurlbert, 2008a) through the integration of quantitative data on climatic extremes.

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Appendix

English	German
Section 1: federal level	
FC (see below)	Bundesverfassung der Schweizerischen Eidgenossenschaft (BV), 2000, SR 101 www.admin.ch/ch/d/sr/sr.html
Swiss CC (see below)	Schweizerisches Zivilgesetzbuch (ZGB), 1912, SR 210 www.admin.ch/ch/d/sr/c210.html
FJA	Bundesgerichtsgesetz (BGG), 2007, SR 173.110 www.admin.ch/ch/d/sr/c173_110.html
Federal Administrative Procedure Act	Verwaltungsgerichtsgesetz (VGG), 2007, SR 173.32 www.admin.ch/ch/d/sr/c173_32.html
LTrans	Bundesgesetz über das Öffentlichkeitsprinzip der Verwaltung (BGÖ), 2006, SR 152.3 www.admin.ch/ch/d/sr/c152_3.html
EPA	Bundesgesetz über den Umweltschutz (USG), 1985, SR 814.01 www.admin.ch/ch/d/sr/c814_01.html
PNLA	Bundesgesetz über den Natur– und Heimatschutz (NHG), 1967, SR 451 www.admin.ch/ch/d/sr/c451.html
WPA	Bundesgesetz über den Schutz der Gewässer (GSchG), 1992, SR 814.20 www.admin.ch/ch/d/sr/c814_20.html
EIA	Verordnung über die Umweltverträglichkeitsprüfung (UVPV), 1989, SR 814.011 www.admin.ch/ch/d/sr/c814_011.html
FA	Bundesgesetz über die Fischerei (BGF), 1994, SR 923.0 www.admin.ch/ch/d/sr/c923_0.html
Federal Land Planning Act	Bundesgesetz über die Raumplanung (RPG), 1980, SR 700 www.admin.ch/ch/d/sr/c700.html
FFA	Bundesgesetz über den Wald (Waldgesetz, WaG), 1993, SR 921.0 www.admin.ch/ch/d/sr/c921_0.html

(*continued*)

Table AI. Legal provisions concerning water and environment in Switzerland

English	German
Ordinance on the Cleanup of Contaminated Sites	Verordnung über die Sanierung von belasteten Standorten (Altlasten-Verordunung, AltlV), 1998, SR 814.680, www.admin.ch/ch/d/sr/c814_680.html
UWPA	Bundesgesetz über die Nutzbarmachung der Wasserkräfte (Wasserrechtsgesetz, WRG), 1918, SR 721.80, www.admin.ch/ch/d/sr/c721_80.html
LHE	Bundesgesetz über den Wasserbau, 1991 (WBG), 1993, SR 721.100 www.admin.ch/ch/d/sr/c721_100.html
Ordinance on Environmentally Harmful Substances	Verordnung zur Reduktion von Risiken beim Umgang mit bestimmten besonders gefährlichen Stoffen, Zubereitungen und Gegenständen (Chemikalien-Risikoreduktions-Verordnung, ChemRRV), 2005, SR 814.81, www.admin.ch/ch/d/sr/c814_81.html
Polluter Pays Principle	Bundesverfassung der Schweizerischen Eidgenossenschaft (BV), 2000, SR 101 www.admin.ch/ch/d/sr/sr.html
Precautionary Principle	Schweizerisches Zivilgesetzbuch (ZGB), 1912, SR 210 www.admin.ch/ch/d/sr/c210.html
Principle of Sustainable Development	Bundesgerichtsgesetz (BGG), 2007, SR 173.110 www.admin.ch/ch/d/sr/c173_110.html
Section 2: FC	
Bundesverfassung der Schweizerischen Eidgenossenschaft (2000), SR 101 is available on the website of *Die Bundesbehörden der Schweizerischen Eidgenossenschaft*': www.admin.ch/ch/d/sr/101/index.html An English version of selected parts of the FC is available at: www.servat.unibe.ch/icl/sz00000_.html	
Art. 76	The Federation provides within its competencies for the moderate use and protection of the water resources, and for the defence against harmful effects of water. The Federation establishes principles on the preservation and opening of water resources, on the use of water for the production of energy and for cooling purpose, and on other interventions into the water cycle. The Federation adopts rules on water protection, on securing appropriate residual water, on hydraulic engineering, on the safety of dams and on interventions to influence precipitation. The Cantons dispose of the water resources. They may levy duties for the water use within the limits of federal legislation. The Federation has the right to use waters for its transporting enterprises; for which the Federation pays a duty and compensation. On rights concerning international water resources and therewith connected duties, the Federation decides in consultation with the Cantons concerned. If the Cantons concerned cannot agree upon rights to inter-cantonal water resources, the Federation will decide In the fulfilment of its tasks, the Federation considers the requests of the cantons from which the water originates.
Section 3: Swiss CC (1912)	
SR 210, Schweizerisches Zivilgesetzbuch (ZGB) www.admin.ch/ch/d/sr/c210.html	

Table AI. (*continued*)

English	German
Art. 664 Public	Abandoned sites and the property of the public domain are subject to state policing on the territory on which they are located In the absence of evidence to the contrary, public water bodies, as well as regions unsuitable for cultivation, boulders, masses of fallen rocks, névés (firns), glaciers and their springs shall not be considered private property Cantonal legislation regulates those things which are free, such as the exploitation of common use public properties, such as roads, open spaces, water courses and river beds
Art. 704 Private	Springs are components of the property and can only be owned in conjunction with the ground from which they arise The law of spring waters from external property is to be established as subservience through registration in the land register Groundwater is on equal terms with spring waters
Art. 709	Cantonal legislation can reconcile use laws between neighbours or other persons, notably for the extraction of water, the watering of livestock, water sources, springs and streams which are private property
Art. 711	The title bearer of sources, springs or streams which are not useful for him, or which have an unreported use with their worth, is required to divest against full indemnity (with compensation?) for the drinking water services, hydrants or other public good services in general
Art. 712	Title bearers of drinking water can demand the relinquishing of the surrounding ground, in the instance of expropriation, so far as the protection of their water sources against contamination is necessary
Section 4: Legal Provisions at the Canton Level in the Valais A full listing of cantonal acts, ordinances and decision is available at: www.vs.ch/Navig/navig.asp?MenuID=4609&RefMenuID=0&RefServiceID=0	
LHE	Gesetz über den Wasserbau, 2007, 721.1 www.vs.ch/Navig/navig.asp?MenuID=4628&Language=de&RefMenuID=0&RefServiceID=0&link=
Law on the Utilisation of Hydropower	Gesetz über die Nutzbarmachung der Wasserkräfte, 1990, 721.8 www.vs.ch/Navig/navig.asp?MenuID=4628&Language=de&RefMenuID=0&RefServiceID=0&link=
Law on the Protection of Nature and Landscape/Cultural Heritage	Gesetz über den Natur- und Heimatschutz, 1998, 451.1 www.vs.ch/Navig/navig.asp?MenuID=4610&RefMenuID=0&RefServiceID=0
Canton Fishing Act	Kantonales Fischereigesetz, 1996, 923.1 www.vs.ch/Navig/navig.asp?MenuID=4610&RefMenuID=0&RefServiceID=0
Law on Official Surveys and Geo-information	Gesetz über die amtliche Vermessung und Geoinformation, 2006, 211.6 www.vs.ch/Navig/navig.asp?MenuID=4610&RefMenuID=0&RefServiceID=0

(*continued*)

Table AI.

English	German
Law on Agriculture and the Development of Rural Land	Gesetz über die Landwirtschaft und die Entwicklung des ländlichen Raumes (Landwirtschaftsgesetz), 2007, 910.1 www.vs.ch/Navig/navig.asp?MenuID=4610&RefMenuID=0&RefServiceID=0
Regulation concerning leisure cruising on motorboats on Valaisanne waterways	Reglement betreffend die motorisierte Vergnügungs- Schiffahrt auf den Walliser Wasserläufen, 1990, 747.201 www.vs.ch/Navig/navig.asp?MenuID=4610&RefMenuID = 0&RefServiceID=0
Ruling concerning Drinking Water Installations/Facilities	Beschluss betreffend die Trinkwasseranlagen, 1969, 817.101 www.vs.ch/Navig/navig.asp?MenuID=4610&RefMenuID=0&RefServiceID=0
Ruling concerning the Use of Groundwater, Lakes or Waterways for Thermal Energy	Beschluss betreffend die Nutzung des Grundwassers, der Seen oder Wasserläufe zur Gewinnung thermischer Energie, 1982, 730.102 www.vs.ch/Navig/navig.asp?MenuID=4610&RefMenuID=0&RefServiceID=0
Ruling on the Draining of Dams and Reservoirs and the Purification of Waterways	Beschluss über die Spülungen, die Entleerungen von Stauanlagen und Speicherstollen und die Reinigung der Wasserläufe, 2002, 721.805 www.vs.ch/Navig/navig.asp?MenuID=4610&RefMenuID=0&RefServiceID=0
Further provisions on water also exist in the laws and decisions concerning land protection: e.g. Entscheid betreffend den Schutz des Auengebietes Gletschboden sowie des Gletschervorfeldes des Rhonegletschers in Oberwald (from 10 March 1999). 'Decision concerning the protection of glacial floodplains such as the glacial forefield of the Rhône Glacier in Oberwald'	

Table AI.

Expert	Interview/correspondence date	Affiliation
Expert 1	24 February 2009	Umweltrecht in der Praxis, Zürich, Switzerland
Expert 2	19 May 2009	University of Lausanne, Lausanne, Switzerland
Expert 3	25 June 2009	Dienstelle für Strass und Flussbau, Oberwallis, Brig, Switzerland
Expert 4	3 June 2009	WWF, Zürich, Switzerland
Expert 5	9 July 2009	Dienstelle für Strass und Flussbau/Service des cours et des cours d'eau (Projet Rhône), Sion, Switzerland
Expert 6	29 June 2009	Dienstelle für Umwelt; Sektion Abfälle und Grundwasser, Sion, Switzerland
Expert 7	9 July 2009	Dienstelle für Wasserkraft und Energie, Sion, Switzerland
Expert 8	2 June 2009	Service des forêts et du paysage (section dangers naturels), Sion, Switzerland
Expert 9	26 March 2009	Ecosens, Zürich, Switzerland
Expert 10	5 August 2008	Amt für Strukturverbesserungen, Dienstelle für Landwirtschaft, Sion, Switzerland
Expert 11	29 May 2009	EAWAG/WA21, Dubendorf, Switzerland

Table AII.
Detail of expert interviews and correspondence

About the author
Margot Hill started her PhD in the Research Group on Climate Change and Climate Impacts at the University of Geneva in 2008. Her research is part of an EU funded project (ACQWA) and focuses on assessing the vulnerabilities in the water governance systems of Switzerland and Chile with regards to the converging threats from climate and socio-economic factors. Previous to her PhD she worked in the commercial sector for three years, on secondment in Frankfurt, before studying for an MSc in Environmental Technology at Imperial College, London. She has continued to work in part time in the finance field, but moving into CSR and SRI issues. She completed her BA Hons Classics at the University of Cambridge, England. Margot Hill can be contacted at: margot.hill@unige.ch