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How to Deal with Climate Change?

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To Mamma*,* Papà *and* Nonna Tilde: *For making me the woman I am today with your enduring love and constant support.*
Thank you.
To Felix: *For always being there for me.*
I love you.

Preface

As the evidence for human-induced climate change becomes more obvious, so too does the realisation that it will harshly impact the natural environment as well as socio-economic systems. Addressing the unpredictability of multiple sources of global change makes the capacity of governance systems to deal with uncertainty and surprise essential. However, how all these complex processes act in concert and under which conditions they lead to the sustainable governance of environmental resources are questions that have remained, so far, relatively unanswered. This book aims at addressing this fundamental gap, by investigating the factors that increase the adaptive capacity of water governance systems to deal with climate-related uncertainty. It is based on high-quality research on a sensitive and timely topic, with important political implications, and it focuses on two cases on which, despite the (diverse) development challenges they face, the existing literature has had little to say to date.

To do all this, the political science literature and methodology have been dynamically combined with those of other disciplines, such as international relations and geography, building on the relevant literature on prospects of conflict and/or cooperation over the management of common resources, institutional and multilevel governance theories, and the more recent studies on climate change adaptation. The final goal of this book is to shed light on how the different institutional determinants of water systems (organised in the categories of finances and risk; government and governance; human and social resources; information management; and infrastructure) interact at different levels to produce more or less adaptive governance arrangements for the management of water resources.

The two river basins that were chosen to perform this kind of analysis are of the Po River, situated in Northern Italy, and the Syr Darya River – a transboundary river flowing in the Central Asian region but here considered only in its Kyrgyz part. Their water governance systems are first studied in isolation and then compared to explain the observed adaptive outcomes on the basis of the distinctive conditions displayed by the two cases. In fact, despite sharing similar geographical and climatic characteristics, these river basins present obvious diversities in socio-economic,

political and cultural terms. This way, it becomes possible to make inferences on the institutional capabilities of adaptation that are context-specific, while remaining endowed with some generality.

To investigate the proposed research question, a number of expert interviews in both Italy and Kyrgyzstan were conducted, aimed at assessing the degree to which the hypothesised determinants of institutional adaptive capacity are present and interact with each other to produce different types of governance arrangements. From here, four ideal models of water governance are derived, defined according to the degree of adaptive capacity of their components (i.e., on the basis of the specific nature of the measures that institutions are adopting – or not – to respond to the prospected impacts of climatic and socio-economic changes): the Syr Darya case is classified as reactive-incremental, while the Po River basin, characterised by a higher presence of proactive and preventive measures, fits more the proactive-incremental type. The comparison between the two case studies also allows identifying a number of specific determinants that are supposedly more favourable to adaptation ('bridges') and others that act as 'barriers' to it when interacting with each other across multiple and connected governance levels.

In conclusion, this book presents a number of policy recommendations for transforming resistant or incremental water governance systems into adaptive ones. This is a fundamental step to adequately respond to the prospected impacts of climate change on water systems: not because climate change is the only or the gravest problem they face, but because it acts as an accelerator of already existing tensions. Therefore, transformative governance systems capable of responding to and incorporating uncertainty and of reducing vulnerabilities will be a key requirement to prevent conflicts over water resources from arising and threatening the livelihoods and survival of individuals, human communities and societies.

London, UK Beatrice Mosello

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Four years are a long time even if, looking back now, they seem to have passed by incredibly fast. Needless to say, an incredible number of people have crossed my life path during this period, helping me grow both professionally and personally. Without each one of them, my doctoral research and hence this book would not have been possible to begin with.

The first 'thank you' goes to **my family**: their encouragement and support, from near and far, throughout this busy and challenging period of my life has been greatly cherished (even if it did not always seem like it). I thank my father in particular for his generous and meticulous reading of the manuscript (throughout all its different phases) and my mother and grandmother for their empathy in all these years of study and research. Their reassurance, inspiration, appreciation and love were crucial for making me the person I am today – I will never be able to thank them enough for this.

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The interviews that I conducted with water experts and stakeholders in the Po and Syr Darya River basins clearly constituted the very core of my research. Therefore, credit must be given to all the professionals that have kindly devoted their time to answer my questions, illustrating their work and discussing problems and potential solutions. In both contexts, my presence as a researcher was always welcomed with enthusiasm, interest and appreciation, and for this I am extremely grateful. Feeling that my topic of investigation was high on the political and technical agenda of farmers, ministers, owners of restaurants in mountain areas, mayors, representatives of international organisations and environmental activists alike was undoubtedly a great push towards completing this study and communicating its results as efficiently and professionally as possible.

Contents

Abbreviations

a.s.l.	Above sea level
ACCRA	Africa Climate Change Resilience Alliance
ACQWA	Assessment of Climatic Change and Impacts on the Quantity and Quality of Water
ACTED	Agency for Technical Cooperation and Development
ADB	Asian Development Bank
AdbPo	Autorità di Bacino del Fiume Po [Po River Basin Authority]
AIWM	Adaptive and Integrated Water Resources Management
ARPAs	Agenzie Regionali per la Protezione Ambientale [Regional Agencies for Environmental Protection]
AUCA	American University of Central Asia
AWM	Adaptive water management
BVOs	Basin Valley Organisations
CAAW	Central Asian Alliance for Water
CAHMP	Central Asia Hydrometeorology Modernisation Project
CAQDAS	Computer-Assisted Qualitative Data Analysis Software
CAREC	Central Asia Regional Economic Cooperation
CCD	Climate compatible development
CDKN	Climate Development Knowledge Network
CDS	Country Development Strategy
CIPRA	Commission Internationale pour la Protection des Alpes [International Commission for the Protection of the Alps]
COP15	15th Conference of the Parties
COVIRI	Comitato di Vigilanza sulle Risorse Idriche [Committee for the Control and Use of Water Resources]
CPI	Consumer price index
CPR	Common pool resource
DFID	Department for International Development (UK)
DPC	Dipartimento della Protezione Civile [Italian Civil Protection Department]
DRCU	Disaster Response Coordination Unit

DRM	Disaster risk management
DRR	Disaster risk reduction
EEA	European Environmental Agency
EU	European Union
EUR	Euros
FP7	Framework Programme 7 (EU)
GDP	Gross domestic product
GEF	Global Environmental Facility (UNDP)
GFDRR	Global Facility for Disaster Risk Reduction
GHG	Greenhouse gas
GIS	Geographic information system
GoKR	Government of the Kyrgyz Republic
GRI	Grantham Research Institute on Climate Change and the Environment
GWP	Global Water Partnership
HEID	Graduate Institute of International and Development Studies
Hydromet	(Kyrgyz) Hydrometeorology Agency
IAD	Institutional Analysis and Development (framework)
IBRD	International Bank for Reconstruction and Development
ICG	International Crisis Group
ICWC	Interstate Commission for Water Coordination
ICWE	International Conference on Water and the Environment
IISD	International Institute for Sustainable Development
IMELS	Italian Ministry for the Environment, Land and Sea
IMF	International Monetary Fund
IO	International Organisation
IPCC	Intergovernmental Panel on Climate Change
IR	International relations
IRBM	Integrated river basin management
IWRM	Integrated water resources management
IWSM	Integrated water service management
JCSS	Joint Country Support Strategy
KGS	Kyrgyz Soms
LCD	Low carbon development
M&E	Monitoring and evaluation
MoES	(Kyrgyz) Ministry of Emergency Situations
MoH	(Kyrgyz) Ministry of Health
MoNR	(Kyrgyz) Ministry of Natural Resources
MTF	Management and Transition Framework
NAS	National Adaptation Strategy
NGO	Non-governmental organisation
O&M	Operation and maintenance
OBMD	Oblast basin management departments
OECD	Organisation for Economic Co-operation and Development
OSCE	Organisation for Security and Co-operation in Europe
OTAs	Optimal territorial areas

PAI	Piano stralcio per l'Assetto Idrogeologico [Draft Hydrogeological Risk Exposure Plan]
PBI	Piano di Bilancio Idrico del distretto idrografico del fiume Po [Plan for the Water Balance for the Po River Basin]
PD	Prisoner's dilemma
RBA	River Basin Authority
REACTs	Rapid Emergency Assessment and Coordination Teams
RSWR	Renewable surface water resources
SAEPF	(Kyrgyz) State Agency for Environmental Protection and Forestry
SCWEM	State Committee on Water Economy and Melioration
SESs	Socio-ecological systems
SHARE	Sustainable Hydropower in Alpine Rivers Ecosystems
SSRs	Soviet Socialist Republics
UN	United Nations
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNISDR	United Nations International Strategy for Disaster Reduction
USAID	United States Agency for International Development
USD	US dollars
USSR	Union of Soviet Socialist Republics
WB	The World Bank
WFD	Water Framework Directive
WMO	World Meteorological Organization
WSS	Water supply and sanitation services
WUA	Water User Association
WWF	World Wildlife Fund

Chapter 1
Governing Water in Times of Climate (and Other) Changes

> *Nothing is more useful than water: but it will purchase scarce any thing: scarce anything can be had in exchange for it. A diamond, on the contrary, has scarce any value in use: but a very great quantity of other goods may frequently be had in exchange for it.*
>
> (Adam Smith, "The Wealth of the Nations" (1776))

Abstract Water is a natural resource that like others has the potential to trigger conflicts over its availability and use; unlike others, however, it is also indispensable for human and other life. Current and future climate and socio-economic changes have and will have an impact on water and its management. In the past, the focus was put on the 'good governance' of water resources, and in particular on the derived framework of Integrated Water Resources Management (IWRM). But traditional water governance, assuming the replication of stable conditions in the past, may not be able to address the challenges posed by climate and other changes to the allocation and regulation of water resources for different economic and human uses. Increasingly, scholars have focused on the adaptive and integrative nature of governance systems, which has led to an abundant body of research investigating the adaptive capacity of water regimes. While it is acknowledged that institutional adaptive capacity will enable to arrive at a governance system that integrates uncertainty, and copes with and responds to changes, it remains unclear how this process will unfold in practical cases. Introducing the aspiration of the present book to address such critical research question, this chapter recalls the historical importance of water for human populations, and how institutions have traditionally served to address the resource-related challenges of scarcity, allocation and use in the past. On these bases, it then makes the case for the need of achieving a better understanding of the processes and conditions that lead to institutional adaptive capacity in the water sector.

Keywords Water governance • Water resources management • Institutions • Climate change • Socio-economic changes • Adaptive capacity

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1.1 The Mission: Addressing the Water Governance Challenge

Water is a fugitive resource, one that crosses political boundaries without a passport in the form of rivers, lakes, aquifers and clouds, linking users across national frontiers, societies and communities in a unique, shared system. Like other natural resources, water has the potential to trigger conflicts over its availability and use. Unlike other natural resources, however, water is also indispensable for the survival of human populations, animals and plants. To put it simply, water is indispensable for life. For this reason, in recent years, the prospect of future "water wars" amongst states and communities has raised particularly alarmist responses, and has fed a lively debate amongst politicians and academics alike on the probability for such inauspicious threats to become reality.

At the same time, evidence for anthropogenic climate change has become more and more obvious, together with the realisation that it will harshly impact on natural environments as well as socio-economic systems worldwide. According to some scientists, we are witnessing the advent of a new geological period, called the 'anthropocene', which is demarcated by the predominance of human actions that are capable of significantly moulding the ecological world (Crutzen and Stoermer 2000). Thus, humans are no longer mere observers of bio-physical or bio-chemical processes, but have become major contributors to them, and assumed a special role in *managing* them, too. The Fifth Assessment Report, the most recent assessment by the Intergovernmental Panel on Climate Change (IPCC), very clearly delineated the crucial linkage between climate change and related resource management issues, including water. The report also highlighted that climate and water cannot be treated independently from one another, especially since water is the primary medium through which climate change impacts will be experienced (IPCC 2014).

Indeed, the significance of the climate and water nexus emerges as fundamental to economic development globally. Modifications of the hydrological cycle will impact on both rich and poor (although significantly more on poor), whether through too much, or too little water (IPCC 2014). In addition, by increasing the variability and unpredictability of water supply, climate change will strongly affect the linkages between water, land use and energy. For example, intensive groundwater extraction for electricity generation, subsidised by the government in order to reduce dependency on fossil fuels, has already bankrupted the electricity economy in India. This, in turn, resulted in more and more power cuts in urban areas. In other cases, biofuel production is demanding prime agricultural land and water, contributing to food price spikes and competition for land and water rights, as sovereign and commercial investors begin to acquire tracts of farmland in developing countries (Allan et al. 2012).

Governance regimes for natural resource management, particularly in the water sector, have been indicated by the research community as a fundamental entry point to address the climate change challenge – a challenge that will consist not only of reduced amounts of water resources (water scarcity), but that will also, and

importantly, have to do with *how* water is managed to guarantee its fair and sustainable allocation and use (GWP 2000; UNESCO 2006; UNDP 2006). In fact, while the improvement of engineering and technology has allowed human societies to access increasing water supplies, it has simultaneously encouraged them to take water resources for granted. Current institutions for water management are based on the assumption that demand can righteously exceed supply. However, facing growing populations, as well as the effects of climate change, the same institutions will need to learn how to operate in a completely new scenario. This means that there may no longer be enough water for everything and everyone – what some authors have termed as "*the end of abundance*" (Zetland 2011). To cut a long story short, it is not a problem of scarcity *per se*, but of how a given stock of water (which is a *finite* resource) is allocated in a changing environment to satisfy all economic and social demands without giving rise to conflicts between uses and users.

Many studies exist on the topic, recognising the essential functions of governance regimes in managing variability (seasonal and local) in water supply and delivery, through the construction and management of regulating infrastructure, but also the establishment of rules (permits, ownership rights, laws, regulations) (UNDP 1997, 2006). The question, however, is whether governance regimes will be able to continue to work along the same lines, i.e., whether they will have the required capacity to adapt to climate-related changes, inherently combined with and exacerbated by socio-economic processes. In fact, while the challenges that climate change poses to water resources at the global, regional, national and local levels are increasingly better understood by the scientific community, research on how to cope with them remains scattered (e.g. IPCC 2014). One of the main difficulties in this sense derives from the uncertainty that continues surrounding the climate change discourse, and stems not only from the unknown intensity and danger of risks and hazards brought about by a potentially warmer world, but also from the very nature of the knowledge system that is used to map climate impacts (Carter et al. 2007).

In addition, most social systems typically embed rules or tools to cope with *normal* ranges of uncertainty, or moderate deviations from the norm (Yohe and Tol 2002; Smit and Wandel 2006). However, climate change brings about a more unpredictable and indeterminate form of uncertainty. Also, it will lead to irreversible changes in the state of the water system (e.g. reduced run-off contribution from glacier and snow melt, shifts in seasonality, and increasingly consecutive dry years) that may lie outside or beyond the boundaries of the past and present coping ranges of water governance regimes (Yohe and Tol 2002; Smit and Wandel 2006; IPCC 2014). Some scientists described climate change impacts in terms of a move from stationarity to non-stationarity, or from a pattern that is predictable to no pattern at all (e.g. Kiang et al. 2011). For instance, 100-year floods will happen more frequently than once per century; temperatures will vary in a greater range; droughts will get longer, and so forth. In other words, climate change implies that water governance regimes cannot approach the future based on the assumption that the relatively stable conditions of the past will be simply replicated: the move to a "*new normal*" makes it difficult to apply traditional knowledge systems to reduce the consequences of novel disruptions (Zetland 2011). Therefore, fundamental shifts in

how water governance regimes operate, and how they interact across local, regional, national and transboundary scales are required; and this makes the capacity of governance systems to deal with uncertainty and surprise essential (Pahl-Wostl 2007; Pahl-Wostl et al. 2010).

Analysing the dynamics of multi-level resource governance systems is a fascinating, and yet underdeveloped area of research (Pahl-Wostl 2007). Relevant conceptual frameworks in social science (e.g., regime theory, game theory, new institutional economy) remain relatively weak in their ability to make sense of the complex, context-dependent dynamics of such governance regimes (Harrison 2006; Ostrom 2007). Notwithstanding, they constitute a useful starting point from which to investigate the conditions that help build the capacity of water governance systems to cope with and respond to climate change and variability. This book situates itself within this research niche by proposing a multi-factor analysis of the interplay between climate change and climate variability, water and socio-economic and institutional factors to understand the means and gaps in the adaptive capacity of water governance systems. It does so by drawing on insights from institutional theories, including the analysis of social learning and regime transition, combined with the more recent literature on multi-level governance and adaptive management. Two river basins are then compared to illustrate how shared/diverse conditions combine with each other and across scales to produce different adaptive outcomes in the management of water resources. In what way is this work then different from previous studies, one may ask? The answer simply rests with the fact that it addresses the role of institutions and socio-economic dynamics, which has so far been given considerably less attention than the interplay between climatic change and hydrological resources (on which significant advances have been made in recent years, see: IPCC 2014).

Institutions have always played, and continue to play, a fundamental role in the management of natural resources within human communities. However, what are the conditions that determine the evolution and learning of institutions towards responding to uncertain change? What needs to be modified in the current practices of water governance to make them adaptive to climate change? What is the most appropriate governance level for climate change adaptation to occur? Which actors should participate in decision-making on water resources management? Finally, what is the 'magic formula' to ensure that human societies can efficiently and sustainably govern their water resources? It is hoped that this book, if not able to definitely answer all of the above questions, will at least add to the research efforts that generations of scholars have devoted (and are still devoting) to shed light on how to cope with the climate change challenge.

1.2 Water Is Essential for Life, and We Have Always Known It

Being a crucial resource for life, water has been at the centre of human concerns since the first communities started to form. Individuals and societies have struggled throughout time and space to understand how to guarantee the availability and quality of water for human survival, and how to distribute water resources in an equitable and transparent manner so as to avoid or at least reduce social conflict. The management of rivers, lakes, streams, underground and over ground reservoirs has oftentimes been the activity around which states and governments arose and consolidated. For example, in the Ancient Mesopotamia, where the Tigris and Euphrates rivers flowed, valleys were rendered fertile by centuries-old deposits of soil, thus consenting, for the first time in history, the growing of surplus food. At the same time, however, the unpredictability of the Tigris and Euphrates' waters called for collective action to protect the marshy, low-lying land from flooding. As surplus production increased and as water resources management became more and more advanced, a process of urbanisation was also initiated, leading to the development of one of the most illustrious civilisations in history: the Sumerians. Similarly, public works were organised in the Ancient Egypt to clean clogged irrigation canals. Later, this simple but vital task became the basis upon which the power structure of the Egyptian society was built.

Initially, therefore, human beings and communities matched their activities to the nature of water resources; civilisations developed along rivers where the soil was more fertile, and around natural harbours where the trade of goods and knowledge was facilitated. At a certain point in history, however, engineers learned how to do the reverse, i.e., how to match the nature to their needs, for example by bringing freshwater to cities by means of wells and aqueducts, or by building dams and ditches for storage and irrigation purposes. Clearly, these interventions were limited by the amount of energy that was required to pump water over hills, and by the availability of materials necessary to store large quantities of water. These restrictions, in turn, meant that most water management decisions remained local (Ostrom 1990; Wiegandt 2008), and so did conflicts and tensions over water resources (Wolf 2007; Trawick 2008).

In economics, there are two characteristics that fundamentally determine the best way to manage a particular good (in this case, water): use and access, or rivalry and excludability (see discussion in Chap. 2). Nevertheless, this type of classification could easily change, for example, if resources were privatised by modifying the degree of excludability and hence the possibility of accessing the good, or by altering the balance between supply and demand, which leads to more or less scarcity (or abundance). Methods to manage natural resources, of course, could also fail; in turn, mismanagement bears the potential to result in conflicts over allocations. Conflict, though, does not have to be the obvious final outcome; it can be prevented through long-term solutions that impede scarcity from turning into persistent shortage. In this sense, political decisions over the parameters of use and

access can substantially change the availability and quality of the resource, together with the evolution of other factors that are nonetheless subject to uncertainty, and hence difficult to estimate. While we cannot predict *with perfect confidence* the extent to which populations will grow in the next decades, or to which climate change will impact the hydrological cycle, we can modify and control the rules and institutions that stand at the basis of water extraction, allocation and use.

Institutions, therefore, would seem to be a key factor to prevent "*the end of water abundance*" (Zetland 2011) from translating into the much-feared water wars forecasted by some authors (Gleick 1993; Homer-Dixon 1994; Klare 2001; Shiva 2002). Indeed, empirical research has demonstrated that conflicts over water resources merely result from instances in which the political allocation of water resources "*leaves winners with abundance and losers with shortage*: *the problem is not a lack of water as much as a lack of water management*" (Zetland 2011, p 211). Understood as "*systems of rights*, *rules*, *and decision-making procedures*" (Young 2008, p 4), institutions can hence provide a response to the problems of water management. In that, they give rise to social practices, assign tasks to participants in those practices, and govern the interactions among the occupants of the various roles, thereby enhancing cooperation between and within human communities (North 1990; Young 1999). Of course, especially in the environmental field, institutions can be subject to complications. This derives from the fact that the level of socio-political organisation at which a given environmental and/or resource-related issue is addressed is not always the optimal one (Ostrom 1990). This is also because the design of institutions that correctly match the relevant biophysical system is complicated by the impact of anthropogenic forces (Young 2008; Rockstrom et al. 2009; Gunderson and Holling 2002).

If the goal is to explain institutional behaviour in terms of uncertain climatic and socio-economic changes, it is fundamental to analyse the complex interactions between institutions for water resources management across multiple scales. This way, the spatial and dynamic dimensions of water resources management can be understood and adequately taken into account, leading the researcher to look at *processes* rather than static factors. To this end, the concept of governance, described as "*the set of regulatory processes*, *mechanisms and organisations through which political actors directly or indirectly affect the use*, *development and management of water resources and the delivery of water services at different levels of society*" (Rogers and Hall 2003, p 4), allows to explore current instances of water resources management. Importantly, attention needs to be directed to those processes that build and/or enhance the capacity of institutions (considered as constituting parts of governance systems) to affect the use, development and management of water resources even under non-stationarity, or rapidly evolving circumstances (Tompkins and Adger 2004).

In the past two decades, studies of different governance regimes and outcomes in the water sector have sought to identify the conditions that produce effective results in terms of "*good governance*" (UNDP 1997), or the broadening of the participation base to ensure the durability of solutions evolving from negotiation and consultation (UNDP 1997, 2006). From these studies, a number of frameworks for water

resources management have surfaced, such as the one of Integrated Water Resources Management (IWRM) (e.g. GWP 2000; Allan 2003; Hassing et al. 2009). The focus on good governance and IWRM has been undoubtedly useful for drafting a theoretical and normative basis upon which water managers could construct practical solutions for the day-to-day management of water resources (UNECE 2009). However, a better understanding of the ways in which these frameworks address the challenges posed by climate change is still missing.

It is only recently that scholars and practitioners have started talking about adaptive and integrative governance systems. By criticising traditional command and control approaches (Meinzen-Dick 2007), the new focus tries to be more suitable for managing uncertainty (Engle et al. 2011). An abundant literature on adaptive processes has flourished as a consequence, looking at how systems have handled either past variability, or shocks outside past and present coping ranges (Pahl-Wostl and Sendzimir 2005; Pahl-Wostl 2007; Engle 2010; Huntjens et al. 2011). Moreover, an increasing number of studies have been devoted towards improving the understanding of adaptation and adaptive capacity in water governance systems. On these lines, adaptive governance and the importance of learning mechanisms have been identified as essential tools for managing socio-ecological systems during periods of gradual as well as abrupt change (Folke et al. 2005; Pahl-Wostl 2007; Armitage 2008). More generally, the concept of adaptive capacity, indicating the primary human mechanisms for managing system resilience, or the "*ability to recover or adjust to change through learning and flexibility so as to maintain or improve into a desirable state*" (Engle and Lemos 2010, p 4), has gradually entered the climate change adaptation research and practitioner agenda. While it is understood that institutional adaptive capacity should be established in order to facilitate systemic response (and eventual transformation) to change, it still remains unclear *how* this process should occur.

1.3 Why This Book and What Can You Expect?

The main goal of this book is to contribute to an improved understanding of the conditions and processes that build the capacity of institutions in the water sector to adapt to change, risks and uncertainty. Taking inspiration from existing research on the institutional dimensions of adaptive capacity (presented in Chap. 2), we propose a typology of water governance systems based on the degree to which change is incorporated into action. More specifically, we try to answer the question of what conditions define the higher or lower capacity of institutions to respond to climate-induced (affecting water resources availability) and socio-economic (affecting water resources demand) modifications. Chapter 3 outlines the methodology used to this end, thereby describing the expert interviews that were conducted in two river basins, the Po in Northern Italy and the Syr Darya in Kyrgyzstan, in order to understand the barriers and bridges to the capacity of institutions in the water sector to adapt to climate and socio-economic changes.

Chapters 4 and 5 present the findings of the study that was conducted for the Po River and the Syr Darya River, respectively. Accordingly, institutions in the Po River, characterised by a higher presence of proactive and preventive measures, were found to be proactive-incremental in terms of their response to change, while the Syr Darya River ones were more reactive-incremental. In particular, for the Po River basin, we demonstrated that although response and preparation actions tended to prevail, some proactive adaptation was also initiated. This was particularly done under the lead of the Po River Basin Authority, and in order to implement environmental directives and legislation coming from the European Union. Instead, for the Syr Darya River basin, we found that proactive adaptation was almost non-existent. Only some attempts in this sense have been made by international organisations within the framework of pilot projects, especially in terms of disaster risk management (DRM). However, more time will be required in order to be able to measure their effectiveness. Therefore, this second case study fitted the reactive-incremental governance framework category. However, if international organisations and donors were not considered, it would rather fall into the resistant category.

Chapter 7 concludes by reaffirming this book's main message that multi-level dimension is important to define whether a given governance arrangement will be more or less adaptive to respond to climate-related (but also socio-economic) changes. Indeed, it was found that the identified determinants of adaptive capacity combined across multiple governance levels to produce a specific adaptation outcome. This means that adaptive solutions are not only individual initiatives at the community level, or national/international policy and institutional measures, but need to stretch horizontally and vertically to coherently involve a multitude of different actors (e.g. NGOs and the private sector) in order to build bridges to overcome barriers. It was also demonstrated that proactive responses to climatic and socio-economic changes tended to be triggered by top-down processes, whereby external actors at the international and/or regional level intervene directly by means of operational decisions, or indirectly by enacting policies and regulations. In turn, reactive responses occurred in the form of concrete interventions at the local level (within villages, municipalities, or provinces). Therefore, the implementation of operational adaptation decisions followed a bottom-up process, starting from more localised levels to be then scaled up towards higher governance levels.

Interestingly, these two forms of vertical governance (bottom-up and top-down) converged at the national level, thereby indicating the fundamental political and decision-making role that the state retains in the environmental field. It also emphasises the requirement for the national level to ensure coordination between decentralised water management authorities, as well as an integrated approach that takes into account all water-related sectors such as agriculture, energy, and DRM. All in all, it was found that it is the interaction between different determinants that stands at the basis of the occurrence (or not) of adaptation processes in multi-actor settings, eventually leading (or not) to structural change in the governance regime as a whole. At the end of Chap. 7, the results of our analysis are translated into a number of more concrete recommendations aiming to be used in the policy-making process on sustainable water management in times of global change.

References

Allan JA (2003) IWRM/IWRAM: a new sanctioned discourse? SOAS/KCL water issues group occasional paper 50. SOAS/King's College London, London

Allan JA, Keulertz M, Sojamo S, Warner J (eds) (2012) Handbook of land and water grabs in Africa: foreign direct investment and food and water security. Routledge International Handbooks, London

Armitage D (2008) Governance and the commons in a multi-level world. Int J Common 2(1):7–32

Carter TR, Jones RN, Lu X, Bhadwal S, Conde C, Mearns CG, O'Neill BC, Rounsevell MDA, Zurek MB (2007) New assessment methods and the characterisation of future conditions. Climate change 2007: impacts, adaptation and vulnerability. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (eds) Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge

Crutzen PJ, Stoermer EF (2000) The 'anthropocene'. IGBP Newsl 41:17–18

Engle NL (2010) Adaptation to extreme droughts in Arizona, Georgia, and South Carolina: evaluating adaptive capacity and innovative planning and management approaches for states and their community water systems. Dissertation, University of Michigan

Engle NL, Lemos MC (2010) Unpacking governance: building adaptive capacity to climate change of river basins in Brazil. Glob Environ Chang 20(1):4–13

Engle NL, Johns OR, Lemos MC, Nelson DR (2011) Integrated and adaptive management of water resources: tensions, legacies, and the next best thing. Ecol Soc 16(1):19, Retrieved from http://www.ecologyandsociety.org/vol16/iss1/art19/

Folke C, Hahn T, Olsson P, Norberg J (2005) Adaptive governance of social-ecological systems. Annu Rev Environ Resour 30:8.1–8.33

Gleick PH (1993) Water and conflict: fresh water resources and international security. Int Secur 18(1):79–112, Summer

Global Water Partnership (GWP) (2000) Integrated water resources management. TAC background papers no.4. Global Water Partnership – Technical Advisory Committee (GWP-TAC), Stockholm

Gunderson LH, Holling CS (eds) (2002) Panarchy: understanding transformations in human and natural systems. SCOPE/Island Press, Washington, DC

Harrison NE (ed) (2006) Complexity in world politics: concepts and methods of a new paradigm. State University of New York Press, Albany

Hassing J, Ipsen N, Jonch Clausen T, Larsen H, Lindgaard-Jorgensen T (2009) Integrated Water Resources Management (IWRM) in action. The United Nations world water assessment paper, jointly prepared by DHI Water Policy and UNEP-DHI Centre for Water and Environment

Homer-Dixon T (1994) Environmental scarcities and violent conflict: evidence from cases. Int Secur 19(1):5–40

Huntjens P, Pahl-Wostl C, Rihoux B, Schlüter M, Flachner Z, Neto S, Koskova R, Dickens C, Nabide Kiti I (2011) Adaptive water management and policy learning in a changing climate: a formal comparative analysis of eight water management regimes in Europe, Africa and Asia. Environ Policy Gov 21:145–163

Intergovernmental Panel on Climate Change (IPCC) (2014) In: Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (eds) Climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge/New York

Kiang JE, Olsen JR, Waskom RM (2011) Featured collection on "nonstationarity, hydrologic frequency analysis, and water management". J Am Water Resour Assoc 47(3):433–570

Klare M (2001) Resource wars: the new landscape of global conflict. Henry Holt and Company, New York

Meinzen-Dick R (2007) Beyond panaceas in water institutions. Proc Natl Acad Sci U S A 104(39):15200–15205

North DC (1990) Institutions, institutional change and economic performance. Cambridge University Press, Cambridge

Ostrom E (1990) Governing the commons. The evolution of institutions for collective action. Cambridge University Press, Cambridge

Ostrom E (2007) A diagnostic approach for going beyond panaceas. Proc Natl Acad Sci 104:15181–15187

Pahl-Wostl C (2007) Transition towards adaptive management of water facing climate and global change. Water Resour Manag 21(1):46–92

Pahl-Wostl C, Sendzimir J (2005) The relationship between IWRM and adaptive water management. NeWater working paper 3. Available online at: http://www.newater.uni-osnabrueck.de/index.php?pid=1020

Pahl-Wostl C, Holtz G, Kastens B, Knieper C (2010) Analyzing complex water governance regimes: the management and transition framework. Environ Sci Policy 13:571–581

Rockstrom J, Steffen W, Noone K, Persson A, Chapin FS, Lambin E, Lenton TM, Scheffer M, Folke C, Schellnhuber HJ, Nykvist B, de Wit CA, Hughes T, van der Leeuw S, Rodhe H, Sorlin S, Snyder PK, Costanza R, Svedin U, Falkenmark M, Karlberg L, Corell RW, Fabry VJ, Hansen J, Walker B, Liverman D, Richardson K, Crutzen P, Foley J (2009) Planetary boundaries: exploring the safe operating space for humanity. Ecol Soc 14(2):32

Rogers P, Hall A (2003) Effective water governance. Global Water Partnership Technical Committee, Stockholm

Shiva V (2002) Water wars: privatization, pollution, and profit. South End Press, Cambridge, MA

Smit B, Wandel J (2006) Adaptation, adaptive capacity and vulnerability. Glob Environ Chang 16(3):282–292

Tompkins EL, Adger WN (2004) Does adaptive management of natural resources enhance resilience to climate change? Ecol Soc 9(2):10. Retrieved from http://www.ecologyandsociety.org/vol9/iss2/art10

Trawick P (2008) Scarcity, equity and transparency: general principles for successfully governing the water commons. In: Wiegandt E (ed) Mountains: sources of water, sources of knowledge. Springer, Geneva

United Nations Development Programme (UNDP) (1997) Governance for sustainable human development. Retrieved from http://mirror.undp.org/magnet/policy/

United Nations Development Programme (UNDP) (2006) Beyond scarcity: power, poverty and the global water crisis. Human development report 2006, United Nations Development Programme (UNDP). Oxford University Press, New York/Oxford

United Nations Economic Commission for Europe (UNECE) (2009) Guidance on water and adaptation to climate change. United Nations Publications, New York/Geneva

United Nations Educational, Scientific and Cultural Organization (UNESCO) (2006) Water: a shared responsibility. The United Nations World Water Development Report 2. UNESCO, Paris; Berghahn Books, New York

Wiegandt E (2008) From principles to action: incentives to enforce common property water management (chapter 5). In: Wiegandt E (ed) Mountains: sources of water, sources of knowledge. Springer, Dordrecht, pp 63–83

Wolf AT (2007) Shared waters: conflict and cooperation. Annu Rev Environ Resour 32(3):421–449

Yohe G, Tol RSJ (2002) Indicators for social and economic coping capacity: moving toward a working definition of adaptive capacity. Glob Environ Chang 12:25–40

Young OR (1999) The effectiveness of international environmental regimes: causal connections and behavioral mechanisms. The MIT Press, Cambridge, MA

Young OR (2008) Institutions and environmental change: the scientific legacy of a decade of IDGEC research. In: Young OR, King LA, Schroeder H (eds) Institutions and environmental change: principal findings, applications, and research frontiers. The MIT Press, Cambridge, MA

Zetland D (2011) The end of abundance: economic solutions to water scarcity. Aguanomics Press, Amsterdam

Chapter 2
Water Governance Throughout History and Science

> *Human progress is neither automatic nor inevitable. We are faced now with the fact that tomorrow is today. We are confronted with the fierce urgency of now. In this unfolding conundrum of life and history there is such a thing as being too late… We may cry out desperately for time to pause in her passage, but time is deaf to every plea and rushes on. Over the bleached bones and jumbled residues of numerous civilizations are written the pathetic words: Too late.*
>
> (Martin Luther King Jr. 1967)

Abstract Far from being pioneering in terms of trying and understanding how water and human beings and societies interconnect, this work starts by presenting an overview of the previous literature that exists in this domain. The analysis, first, draws on the academic debate that portrays water-related problems and scarcities as the result of mismanagement and ineffective policy decisions. Thus, we look in detail at the new paradigms of Integrated Water Resources Management (IWRM) and Adaptive and Integrated Water Resources Management (AIWM). Turning to political science and International Relations (IR) theories, this chapter then equips the reader with a thorough definition and understanding of governance (vertical and horizontal governance, multi-level governance, water governance, and adaptive governance) and institutions (their concept, institutional change, institutions across scales and institutional adaptive capacity). We find there have been relatively few empirical studies on how institutions and governance mechanisms systematically build – or not – their adaptive capacity to respond to the expected impacts of climate change in the water sector. We attempt to move the analysis of institutional adaptation mechanisms away from a mere focus on organisational learning towards looking at the interactions and development process of institutions. Finally, and given the inherent multi-scale nature of water resources management, the perspective of those scholars focusing on how governance stretches across spatial and temporal levels is presented. The chapter concludes by emphasising the need to establish and reinforce institutional adaptive capacity to facilitate system transformation towards the integration of uncertainty and the consequent ability to respond to change.

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However, from the literature it remains unclear how this process does or should occur, thus highlighting the need for a dynamic multi-level analysis of water institutions and how they respond to change.

Keywords Institutional change • Water conflict • IWRM • AWRM • Multi-level governance • Adaptive governance

2.1 Sharing Waters Between Engineers, Hydrologists and Social Scientists

Once a technical topic that exclusively belonged to the fields of engineering and hydraulic, water has gradually developed into an object of interest for the social sciences too, especially after the raising of alarmist prospects of scarcity-induced "water wars" in certain regions of the world. Most studies in this domain have correctly understood that it is not a matter of water scarcity *per se*: water can cause violence between human communities also because of the ways in which it is managed and allocated, i.e. its governance. Concerns over development and sustainability issues, combined with uncertainty related to climate change, have further encouraged studies in this direction, resulting in a rich literature that predominantly focuses on how water resources are and should be managed, by whom, and for which purposes.

2.1.1 Water: A Source of Conflict or Cooperation?

Water is considered a common pool resource (CPR), one that is shared by multiple users, crosses political and administrative boundaries, and is essential for the very survival of human beings. It comes as no surprise, therefore, that issues related to its management have attracted the attention of a considerable number of scholars in different disciplines. In particular, studies about the potential for water to fuel conflicts between individuals, societies and even states have flourished in recent years. The compelling argument made by the Indian physicist and internationally renowned activist Vandana Shiva about the prospect of so-called water wars is a case in point (Shiva 2002).[1] Indeed, the question of natural resources shortages (including water) was already at the centre of the global policy agenda in the early 1990s, largely as a

[1] According to Shiva (2002), the emergence of a corporate culture and the historical erosion of communal water rights are likely to lead to the deprivation of water rights for the world's poor, which, in turn, will trigger water wars within and between human societies.

result of the end of the Cold War and the subsequent decline of traditional security threats.[2]

In this debate, scholars aligned themselves along two main positions. On the one hand, Neo-Malthusian authors (Gleick 1993; Homer-Dixon 1994; Klare 2001) suggested that the growth of the world's population inevitably brings mankind to a disproportionately high rate of resource consumption. In turn, "*scarcities of renewable resources will precipitate violent civil or international conflict*" (Homer-Dixon 1994, p 5).[3] On the other hand, proponents of the Cornucopian approach offered a much more positive view of the relationship between natural resources and conflict. According to them, thanks to new technological innovations, "*an overall abundance of resources will compensate for population growth, so that the threat associated to resource scarcity is minimised*" (Lomborg 2001, p 128). Both the Cornucopian and the Neo-Malthusian perspectives, however, have been extensively challenged. The political scientist Niels Petter Gleditsch, for example, called for a clearer distinction to be made between simple resource scarcity and environmental degradation, and for taking into due account the role of ingenuity, or "*the capacity of human beings and societies to adapt to change*" (Gleditsch 1998, p 387).

As a crucial resource for the survival and development of human societies, water occupies an important position in the debate on natural resources and conflict, to the point that it has come to be associated with security concerns, a phenomenon defined as the "*securitisation of water resource management*" (Phillips et al. 2006, p 20), or "*the association of water issues to national security concerns, taking them out of the normal domain of technical management and placing them in the secret and closed domain of security officials*" (Buzan et al. 1998, p 24). More generally, the spectre of growing competition between states over water resources has produced a specialised literature within IR, which describes water both as a historical and future cause of interstate warfare. A number of articles, dating back to the 1950s, persuasively identified a causal connection between environmental stress and political decision-making (e.g., Wittfogel 1956; Toynbee 1946).[4] Without going into detail, it is important to acknowledge that these studies have contributed to linking the ways in which societies manage water with their social structure and political culture.

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[2] In the 1990s, critical or non-traditional security studies broadened the understanding of national security threats to include not only military and economic threats but also environmental and social ones (e.g. Buzan et al. 1998).

[3] This idea falls under the concept of "environmental security" that describes the increasing risk of conflict as a consequence of resource scarcity. According to Thomas Homer-Dixon (1994), one of the most prominent exponents of this school of thought, resource scarcity generates conflict within a state in two primary ways: (a) by driving elites to "capture" resources, thus marginalising powerless groups in the process; and (b) by having a debilitating effect on economic and social innovations, and determining an "ingenuity gap" which condemns already poor countries to a condition of permanent underdevelopment.

[4] The historian Karl August Wittfogel, for example, observed that the drive to manage water in semiarid environments led to the dawn of institutional civilisations, as well as to particularly autocratic and despotic forms of government (Wittfogel 1956). In contrast, Arnold Toynbee argued that the impetus toward civilisation became stronger with greater environmental stress (Toynbee 1946).

Yet, it must be recognised that the global picture is not as bleak as the authors of water wars have tended to portray it. For example, some scholars have noted that if securitisation triggers conflict over water resources, de-securitisation can be a viable and optimal long-range solution to water management problems (Daoudy 2007). According to the political scientist Marwa Daoudy, the "de-*securitisation of water resources management can open the way to negotiated agreements between and among states, and the consequent sharing of benefits*" (Daoudy 2007, p 25). Similarly, water experts like Aaron Wolf and Jesse Hamner have strongly rejected the conflict-inducing nature of water, claiming instead that historical evidence shows that governments have always found innovative and cooperative solutions to reduce tensions derived from the management of transboundary waters. Their *Transboundary Freshwater Dispute Database* confirmed the "*cooperation-inducing characteristics of transboundary waters*" (Wolf and Hamner 2000), and led to the conclusion that "*violence over water does not seem strategically rational, hydrographically effective, or economically viable. Shared interests along a waterway consistently outweigh water's conflict-inducing characteristics*" (Wolf 2007, p 7).[5]

These studies concentrated mostly on international transboundary water resources, i.e., on sources of freshwater that are shared by multiple states, each with their own values and needs associated with water use. More recently, scholars have also started paying attention to water-related problems occurring between stakeholders within the same national context. This is a welcome shift in emphasis since the history of water-related violence is characterised by "*incidents at the subnational level between tribes, water-use sectors, and states/provinces*" (Wolf 2007, p 253). Some authors have even suggested that as the scale drops, the likelihood and intensity of violence goes up (Giordano et al. 2002). Accordingly, it makes sense to temporarily leave aside concerns regarding the prospects of conflict/cooperation over water resources at the *inter*-national level, and rather investigate problems that may emerge at the national and sub-national levels.

Sandra Postel, director and founder of the Global Water Policy Project, was one of the first authors to focus on water-related issues at the subnational level (Postel 1999). Postel observed that water, unlike other scarce consumable resources, is used to fuel all facets of society, from biologies to economies, aesthetics, and religious practices. Therefore, there is no such thing as managing water for one single purpose: all water management serves multiple objectives and hence, by definition, is based on conflicting interests. Within a state, these interests include domestic use, agriculture, hydropower generation, recreation, and environment – any two of which are regularly at odds. The chance of finding mutually acceptable solutions drops precipitously the more actors are involved in the game. As described in the case studies proposed by Jon Martin Trolldalen, these conflicting interests represent a microcosm of the international setting, while also having a direct influence upon

[5] The "Transboundary Freshwater Dispute Database" is a project of the Oregon State University Department of Geosciences in collaboration with the Northwest Alliance for Computational Science and Engineering. It seeks to compile a data set covering every reported interaction over water going back 50 years.

it (Trolldalen 1992). Trolldalen's work is particularly useful to sidestep the common trap of treating nations as homogeneous, rational entities, and to more explicitly link internal with external interests.

Narrowing down the analysis to the state and community levels, it is worth citing the work of Tony Allan, a laureate of the Stockholm Water Prize in 2008. Allan identified five paradigms of water management (Allan 2003). At first, water use increases as societies experience industrial modernity. During this phase, resource capture is done intensively, whether through dams, irrigation channels, or groundwater pumping schemes; the 'hydraulic mission' is central to the development of a state. In turn, large-scale water capture gives rise to environmental concerns and management practices become reflexive. The reflexive modernity paradigm is driven by the rationality of environmental awareness, which emphasises sustainable water allocation practices. These can progress into valuing water economically and introducing water efficiency measures. Once water management is treated as a political and institutional process, paradigms such as the Integrated Water Resources Management (IWRM) (see Sec. 2.1.2) start playing a central role. Therefore, if a basin state is in the reflexive modernity paradigm, it will almost automatically adapt to the changes that occur in the natural environment. According to Allan (2003), this adaptive capacity is further increased as the water system moves to the fifth paradigm, which is holistic and inclusive of all interested stakeholders.[6]

In parallel to the political science and IR literature on water-related conflict and cooperation, there exists another stream of literature specifically examining the issue of climate change. Here, the focus is on how climate change affects decision-making and international relations, and how it challenges traditional state authority by encouraging the emergence of new transnational actors on the global scene (e.g. Choucri 1995; Luterbacher and Sprinz 2001; Bodansky 2001). In turn, concerns about climate change and its impacts on water resources have laid the basis for the emergence of new management paradigms that prescribe adaptation and responsiveness to change (e.g. Gleick 1992; GWP 2000; Ludwig et al. 2009; Adger et al. 2007). The present book, by investigating the conditions that enable institutions in the water sector to effectively address the impacts of climate change, aligns with these studies. Before getting there, however, it is important to analyse the origins and characteristics of existing water management paradigms in order to adequately frame the research question within the context of current theories and hypotheses, and thus build on, rather than duplicate or try to substitute, other scholars' research efforts.

[6] However, Allan (2003) also pointed out that not all states are in the paradigm of reflexive modernity. While the 'North' or developed states have gradually moved to this stage, states in the 'South' are often still expanding their hydraulic mission.

2.1.2 Old and New Approaches to Water Resources Management: What Is Still Missing?

Framing water challenges as governance challenges has allowed politics to enter the discourse on water resources management. Understanding water-related problems as deriving from a combination of natural (scarcity) and social (mismanagement) causes has also suggested that it might be necessary to fundamentally rethink existing water management paradigms. Historically, water resources management has followed four main modalities (Ciervo 2009). At first, there was only local subsistence, meaning that individual property was not defined, and water resources were managed in a collective way within river-based systems, using simple infrastructures that required little maintenance and monitoring.

With the emergence of national states, community control was gradually eliminated, and a second model of water resources management was introduced: the agrarian/hydraulic state, exemplified by the cases of Ancient Egypt, Mesopotamia, and China. These states were primarily founded on the discipline and management of water resources, which occurred at a higher scale, thereby allowing for significant interventions on the supply side. Furthermore, more human and financial capital was available for investments in the construction and maintenance of water-related infrastructure. As a result, 'ordinary' ventures such as the construction of wells were supplemented with the first grandiose infrastructure projects, characterised by high costs and the capacity to significantly modify the territory.

In the post-Industrial Revolution capitalistic state, the intervention scale remained national, since it was the state that directly participated in the provision of hydraulic services and infrastructure. It is in this period that water started being used for objectives that went beyond irrigation, and extended to all production activities, including the energy sector. This process, occurring primarily in Western Europe in the eighteenth to nineteenth centuries, culminated with the evolution of transportation, the beginning of large-scale agriculture (i.e., agro-business), the modification of human settlements (i.e., urban concentration), and the alteration of the landscape (e.g., with the construction of dams and roads). The capitalistic state invented the use of large hydroelectric projects as instruments of regional politics to favour the economic development of areas that were considered as 'under-developed'.

However, during this phase, the diffusion of the liberal/neoliberal culture also profoundly modified the area of intervention of the state in favour of the market, which began to be considered as a more efficient instrument for the management and allocation of natural resources, including water. Certain countries and regions experienced for the first time a shift from public to private water resources management as a consequence of the institutional reforms that were initiated by the states themselves in the name of economic progress and profit. The fourth model of water resources management is thus characterised by the predominance of the private sector. With multinational enterprises gradually assuming a position in the water sector, the state is generally left with the mere function of controlling and releasing authorisations. While attractive in theory, this governance modality creates asymmetries

between those who enjoy the benefits and those who bear the costs, and this is particularly true when the state is weak and cannot ensure that the existing laws for the protection of the environment and the population are respected (Ciervo 2009).

This brief historical overview effectively illustrates how, in response to changes that occurred within the water sector throughout time and space, new forms of governance were introduced in a way that made water resources management progressively more complex. Today, with the increase of "*privatisation and public and private partnerships, and the decentralisation of water management and services delivery*" (Tropp 2007, p 22), the characteristics of the third and fourth models are evident at the local and national levels and in both developing and developed countries. Water governance is in the hands of a variety of agencies, institutions and systems, which are linked by multifaceted patterns of interaction and marked by problems of coordination. Current trends in the water sector reveal that the traditional role of state governments, which consisted of hierarchical control and the claim of a monopoly of power over water resources, is de-emphasised, while it is "*the private sector, civil society and public-private partnerships that emerge as alternative forms of governance*" (Tropp 2007, p 22).

One of the most debated developments in the water sector has been the decentralisation of public services.[7] On the one hand, it is argued that, by including service receivers as parts of the decision-making process, the service provider – in most cases a central government – will respond better and in a more equitable manner to local needs, thus allowing efficiency gains to be realised from lower transaction costs (e.g. Besley and Coate 1999; Conyers 1984; Shah 1998; Wallis and Oates 1988). On the other hand, a number of authors have observed that a lack of local capacity, diseconomies of scale, and the politics of local interest groups inevitably make the provision of decentralised services inefficient (e.g., Smith 1985; Wandschneider 1984). In the specific case of water resources management, decentralisation to "*the lowest appropriate level*" has become one of the major components of water reforms in the 1990s (GWP 2000; ICWE 1992; World Bank 1993). The lowest appropriate level usually means involving all stakeholders (including water users) in decision-making processes concerning water resources management. For example, the concept of Integrated River Basin Management (IRBM) was formulated in order to take into account the fact that the basin constitutes a single and inter-connected natural system and that, as a consequence, the coordination of collective decisions has to be done at the local level.[8] In turn, this approach has come to represent a particularly suitable model for the Integrated Water Resources Management (IWRM) paradigm.

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[7] Decentralisation is usually defined as the "*redistribution of authority and allocation of resources with more power being shifted away from the central or national level to lower levels of government*." (Dinar et al. 2007, p 852).

[8] Integrated River Basin Management (IRBM) is defined as "*the process of coordinating conservation, management and development of water, land and related resources across sectors within a given river basin, in order to maximise the economic and social benefits derived from water resources in an equitable manner, while preserving and, where necessary, restoring freshwater ecosystems*" (Jones et al. 2003, p 15).

The IWRM paradigm, which embodies a "*multi-objective platform of water resources infrastructure and institutions*" (Turton et al. 2007, p xxxv), is one of the most celebrated ways of thinking about reforming current practices of water resources management. IWRM is not a scientific theory that needs to be proved or disproved, but rather a set of "*common-sense suggestions as to what makes up important management aspects*" (Hassing et al. 2009, p 4). Elaborated during the International Conference on Water and the Environment, which was held in Dublin in January 1992, one of the greatest strengths of the IWRM consists in the provision of a common language to the water community that is applicable to all the levels (local, national and regional), and thus enables the exchange of knowledge and lessons learned. As defined by the Global Water Partnership (GWP), IWRM is a "*process that promotes the co-ordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*" (GWP 2000, p 22).

The pillars upon which the IWRM approach is based (also called the Dublin principles) can be summarised under two main headlines: (a) all the components of the water cycle need to be managed as a single unit, and (b) all the relevant stakeholders should be involved in the decision-making process to ensure that management outcomes have greater acceptance and legitimacy (ICWE 1992). Thus, the IWRM approach offers an inclusive way to conceive the development and management of water resources, comprising of: (a) a *social dimension*, which points to the equitable use of water resources; (b) an *economic dimension*, concentrating on the use of water resources and the role of water in economic growth; (c) a *political empowerment dimension*, focusing on guaranteeing water stakeholders and citizens' equal democratic opportunities to influence and monitor political processes and outcomes; and (d) an *environmental sustainability dimension*, demonstrating that improved governance allows for the sustainable use of water resources and ecosystem integrity (UNDP 2006).

In addition, IWRM relies on a strong governance framework of legislative, policy, institutional and management instruments that addresses the mismatch between ecological and administrative boundaries in the interest of better coordinating the management of land and water (GWP 2004).

While some authors have praised the IWRM approach for its capacity to cope with concerns related to climate vulnerability and climate change (e.g., UNDP 2008), others have identified significant limitations in this sense (Pahl-Wostl and Sendzimir 2005; Galaz 2007). Accordingly, the integrative management goals purported by IWRM would need to be supplemented with adaptive objectives in order to be effective in practice. These, in turn, can be enabled through governance structures and management frameworks that not only address challenges related to transparency, participation and cooperation (as in the case of IWRM), but also tackle complexity, uncertainty, risk and change. This approach is generally referred to as "*adaptive management*" (Pahl-Wostl 2007).

Challenges in the implementation of both IWRM and adaptive management approaches are widely documented in the literature (Meinzen-Dick 2007; Medema

et al. 2008; Engle et al. 2011). As for the IWRM paradigm specifically, the difficulties of concretely defining and operationalising an integrationist agenda i.e., addressing the two main headlines of IWRM, are primarily linked to the timeframes of the policy-planning process, and to the limitations of institutional capacity at different levels of governance (White 1998). As for adaptive management, institutional, organisational and technical barriers have been identified in relation to the resource- and time-intensive processes associated with the development, implementation and monitoring of policy experiments (Medema et al. 2008). In addition, there are evident tensions between the two approaches, most notably in terms of the balance that needs to be struck between the search for flexibility and experimentation in adaptive management on the one hand, and the search for legitimacy in IWRM through deliberative, participatory and pluralistic forums on the other (Engle et al. 2011).

Despite these unresolved questions, however, the increasing tendency has been to combine aspects of IWRM and adaptive management. Such an attempt has resulted, for example, in the elaboration of the Adaptive and Integrated Water Resources Management (AIWM) framework. The AIWM proposes a set of desirable characteristics that join a holistic and participative approach to water management with learning mechanisms that address uncertainty and complexity in socio-ecological systems. As such, it highlights "*polycentric governance with a broadly based constituency*, *cross-sectoral analysis to support holistic understanding of system behaviour*, *transparent approaches to communication and knowledge sharing*, *and diversified funding through private and public sources*" (Pahl-Wostl 2007). It is useful to note that all these approaches emphasise the governance dimension. Therefore, it is also important to better understand the concept of governance, as well as the ways in which it applies to the water sector, especially if one takes into account the impacts of climate change in terms of increased uncertainty and greater variability.

2.2 Understanding (Multi-level) Governance, Water Governance, and Adaptive Governance

The literature on water resources management stresses the need to govern water resources in accordance with the specific socio-economic and climatic characteristics of the human and natural environment in which they are situated. To this end, the governance framework that is in place for the management, distribution and utilisation of water resources develops according to complex processes that stretch across time and space. Water resources management cannot be understood as an isolated act for which one institution or another is in charge, but rather as a dynamic process that 'muddles through' various needs and objectives according to the specificities of a given ecological and social context. The IR literature on governance can offer interesting insights and arguments to inform the analysis of how such dynamic processes occur.

2.2.1 The Concept of Governance

The term *governance*, which comes from the Greek "to steer",[9] has recently been taken by political science and IR as an alternative to *government*, a concept that was allegedly no longer able to account for the increasing interactions of non-state actors on the global scene. In his book "*Change, Complexity and Governance in a Globalizing Space*" (2000), the notorious American political scientist James Rosenau clarified the basic distinction between 'government' and 'governance'. While the former encompasses the world of states, the latter "o*ccurs on a global scale through both the co-ordination of states and the activities of a vast array of rule systems that exercise authority in the pursuit of goals and that function outside normal national jurisdictions*" [167]. Governance has also been defined as related to "*any form of creating or maintaining political order and providing common goods for a given political community on whatever level*" (Risse 2004, p 298). Therefore, the concept of governance tends to be more inclusive than the one of government, in that it incorporates both state and non-state, and public and private actors. According to the United Nations Development Programme (UNDP), governance comprises the "*mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations, and mediate their differences*" (UNDP 1997, p 12).

Governance also is described as ordered and intentional, and results from the "*instituted process that serves to guide and constrain future governing behaviour*" (Lowndes 2001, p 1961). The concept further embodies the means of "*authoritatively allocating resources and exercising control and co-ordination*" (Rhodes 1996, p 653), thus incorporating the mechanisms and social relations through which steering occurs, in addition to the actors it involves (e.g., state or non-state actors), and the structures it creates (e.g., regimes and networks). While some authors have reserved the term "governance" solely for non-hierarchical forms of steering, including either private, or both private and public actors (Risse 2004), broader interpretations cover the multiple modes through which governing can be accomplished (Kooiman 2003; Bulkeley et al. 2007).

This evidences an evolution from the top-down, centralised and hierarchical concept of government to the bottom-up, decentralised and diffuse concept of governance. It represents a shift to new, more inclusive and cooperative forms of societal organisation, in which state governments have lost their traditional control over socio-political processes and goals, and networks of private and public actors have emerged to solve collective issues (Mayntz 2006; Grote and Gbikpi 2002). Non-governmental actors are no longer passive 'citizens', but have become active 'stakeholders' (Grote and Gbikpi 2002) through their participation in public-private networks.

[9] From the Greek verb *κυβερνάω* [*kubernáo*] (Rosenau 1995). The notion of steering is prominent in the literature on governance, with many scholars explicitly using the word "steer" in their definitions of (global) governance or implicitly defining governance in a way that suggests it involves efforts to steer society towards the pursuit of collective goals (Pierre 2000; Rosenau 1995, 2000).

This discourse on the different types of governance also helps elucidate how roles (e.g., state and non-state, formal and informal) are negotiated in policy formulation and implementation (Rhodes 2007). In this sense, governance modes can take the form of bureaucratic hierarchies, networks, and/or markets (Thompson et al. 1991). Hierarchical governance refers to the traditional model of top-down political systems with highly centralised governments and institutions. Instead, the network mode is dominated by informal institutional arrangements and the participation of state as well as non-state actors. At the other end of the spectrum, market-based modes are characterised by non-state actors interacting across formal and informal institutions. The concentration of these types of governance in different national settings tends to be influenced by the political regime of the country, or by "*the diverse economic*, *cultural and political norms and the behaviours of the legislature and legislators*" (Rogers and Hall 2003, p 8). In the past few decades, the network and market-based modes have attracted the attention of scholars for their flexibility and ability to provide access to new forms of knowledge (Kooiman 2003). Although seemingly very attractive, these modes of governance have also raised concerns for their non-representative membership, which might threaten the democratic principles of accountability and legitimacy.

Moreover, attention has started to be directed towards multi-level and distributed forms of governance. This initiated with studies comparing federal and centralised systems (Ammon et al. 1996; Pahl-Wostl 2009), and continued then with research on complex multi-level interactions in the European Union (EU) (Hooghe and Marks 2003). Similarly, polycentric governance systems, or "*systems of many centres of decision-making*, *which are formally independent of each other*" (Ostrom et al. 1961), have recently been discussed in relation to complex adaptive systems (Pahl-Wostl 2009). These notions of governance, sharing the capacity to simultaneously take into account different levels of action and interaction, will be discussed in Sect. 2.2.2.

2.2.2 Multi-level Governance

As an extension of the literature mentioned above, and to account for the fact that modern governance is no longer about "command and control" but about the dispersal of authority across multiple centres (Hooghe and Marks 2003, p 233), scholars in mainstream political science have proposed the now-fashionable concept of multi-level governance. The main value of this formulation is that it allows understanding complexity at and between levels. More specifically, the vertical notion of multi-level governance, including the "above" and "below" levels of the state, exists alongside a horizontal dimension, thereby addressing the relationships between state and non-state actors, and new forms of public-private partnerships.

The concept of multi-level governance was initially proposed in the framework of studies on the EU, where it was taken to describe the "*system of continuous negotiation among nested governments at several territorial tiers – supranational*,

national, *regional and local*", which was distinctive of EU policy-making (Marks 1993, p 39). With this concept, Europeanists were able to analyse the diffusion of decision-making to informal and overlapping policy networks (e.g. Ansell 2000). Differences among scholars, however, soon started to emerge: while some conceived multi-level governance as an alternative to hierarchical government, others viewed policy networks as nested within formal government institutions (Peters and Pierre 2000; Rhodes 1996). Furthermore, IR theorists examined the issue of how authority needs to be reconfigured to make sense of contemporary political processes, including multi-level governance. For example, the literature on multilateral cooperation and global governance sought to specify the conditions under which national governments create international regimes (e.g. Keohane 1982). More recently, scholars are examining how globalisation facilitates the diffusion of political authority to subnational and international institutions (Pattberg and Stripple 2008; Andonova et al. 2009), as well as the proliferation of non-governmental actors in international governance (e.g. Keck and Sikkink 1998; Risse-Kappen 1995). A common idea underlying all these studies is that "*we are witnessing a partial hollowing-out of the nation state*, *or institutions closely connected to it*, *as a political authority*" (Eckerberg and Joas 2004, p 405). This does not mean that the state is disappearing from the stage, but rather that its position within the policy-making environment is changing.

Overall, the concept of multi-level governance puts the accent on the multi-scale nature of governance systems, and on how their different levels are connected and interacted. The literature on multi-level governance identifies three key dimensions of particular relevance for the purposes of this book. The first dimension is related to the deregulation of financial markets. It is said to have been the cause of national governments losing their control function to international and individual actors, such as markets and business corporations (Pierre 2000, p 1). Secondly, governance implies a change in the interaction between different political actors, so that policy networks assume their own role in decision-making (Eckerberg and Joas 2004, p 406). This observation suggests the need to shift from understanding decision-making in terms of "*discrete territorial levels*" to "*complex overlapping networks*" (Bache and Flinders 2004, p 197), which also include informal institutions and actors. It recognises the fact that actors at the local and regional levels have taken on more functions, assumed more power, and grown independent of national governments. In fact, sub-national units, local governments, civil society organisations and networks can introduce their own policies, or coordinate efforts to influence policy-making processes at different system levels. In turn, national governments have responded to these changes by elaborating new policy instruments that involve local communities and other actors (Eckerberg and Joas 2004, p 406). Consequently, the third dimension of multi-level governance refers to the way in which the state is moving towards new strategies of coordinating, steering and networking – a practice that becomes particularly salient in transitional countries emerging out of communist regimes (e.g. Stubbs 2005).

In turn, this means that political power is simultaneously moving in two directions: up to transnational levels of governance and down to local communities

(Pierre 2000, p 1). In this "vertical multi-level governance" model, the state retains a leading role, but local governments gain more and more political influence within the state and in the international setting. Therefore, other actors can and will influence the policy process at the local level, through sub-governmental, transnational networks and international organisations. For example, the EU is said to represent a new channel through which the political behaviour of local governments can be changed, something that has become especially visible in the areas of sustainability and development policies (Eckerberg and Joas 2004).

The second type of multi-level governance implies a horizontal shift of responsibilities from governmental to non-governmental actors (Hooghe and Marks 2003). This development can be observed at all levels – local, regional, national and international (Eckerberg and Joas 2004) – and implies that the autonomous position of both national and local governments is constrained by new political actors that were not typically involved in the 'normal' political process. The scope of this process is "*widened, and becomes more open to influences from stakeholders*" (Eckerberg and Joas 2004, p 407). This development follows the definition of governing given by Kooiman (2003), according to whom "*public as well as private actors participate, aimed at solving societal problems or creating societal opportunities*" [4].

Particularly in the environmental policy sector, the move towards transnationalisation has been explained as a consequence of and a response to the recognition that environmental changes are global phenomena that require integration across levels in order to effectively inform policy- and decision-making (e.g. Pattberg and Stripple 2008; Andonova et al. 2009). In their work on global environmental assessments, the environmental scientists David Cash and Susanne Moser usefully identified the management challenges raised by the multi-scale nature of environmental issues (Cash and Moser 2000, p 109). These include: (a) matching the scales of the biogeophysical system and the management system – an "*institutional fit problem*"; (b) matching the scales of the assessment and the management system – a "*scale discordance problem*"; and (c) understanding the linkages between scales, and how they affect decision-making, information flows, and the integration of information into the decision-making process – a "*cross-scale dynamics problem*" (Cash and Moser 2000, p 110).

In environmental governance, issues of scaling, or "*moving up or down from one level to another on a particular scale*" (Gupta 2008, p 225), are strongly linked to the concept of fit, or the study of the "*congruence or compatibility between ecosystems and institutional arrangements*" (Young 2002, p 20). Fundamentally, the main question relates to identifying the adequate administrative and time level at which an environmental problem should be tackled and resolved. In turn, this process changes the nature of the problem itself, the menu of possible solutions, and the ways in which the results are evaluated (Young et al. 2008). To this end, some authors suggested the adoption of a polycentric approach at various levels. This approach comprises an active oversight of local, regional and national stakeholders for tackling natural resources management under conditions of climate-induced changes and increased uncertainty (Ostrom et al. 1961; Ostrom 2008). According to this perspective, polycentric governance would encourage experimental efforts at

multiple levels, thus leading to the development of methods for assessing the benefits and costs of particular strategies adopted in one type of ecosystem, as compared to results obtained in others (Ostrom 2008).

Numerous normative assumptions have been identified regarding the linkages between different forms, modes and types of governance and their legitimacy, as well as their ability to adapt to changing conditions (Pahl-Wostl 2007). At present, however, this discussion is locked in the identification of 'silver bullet' solutions, while the analysis of the issues of fit, interaction and compatibility is being dangerously forgotten (Young 2002; Meinzen-Dick 2007). As a result, there is an urgent need to reconsider governance approaches in light of their multiple conjugations at different administrative and time scales, as well as their capacity to flexibly exert their functions and tasks within the framework of rapidly changing social and environmental contexts.

2.2.3 Water Governance

In the specific case of water resources, the literature has increasingly come to recognise the need to move away from a state-centred analysis to consider the multiplicity of actors and institutions that influence the ways in which water resources are governed. According to the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the development of governance and management systems within the water sector is closely related to the overall trend that has seen the role of the state gradually shifting from being the provider of development and welfare, to becoming a mere enabler, a phenomenon also known as the "*rolling back of the state*" (UNESCO 2006). In turn, this has translated into the diffusion of governance "*away from a concentration in the state's hands and towards both the global and local levels*" (Lipschutz 1997). Nevertheless, the academic debate on water resources management has rather concentrated on scarcity issues and the threat of "water wars", thereby missing the crucial developments that were occurring in the governance and political arenas. It is only in the last decade, after having at least implicitly accepted that water wars are highly unlikely for the time being- although situations of water scarcity will allegedly compel and intensify already existing tensions and conflicts- that scholars and practitioners have begun redirecting their attention to the question of how water is governed (UNESCO 2006; de Stefano et al. 2010).

Processes and practices of water resources management are anchored in governance systems that span across three fundamental levels: the government, civil society, and the private sector. Therefore, water governance can be said to refer to "*the range of political, social, economic and administrative systems that are in place to develop and manage water resources and the delivery of water services at all the different levels of society*" (GWP 2000). In other words, governance systems determine who gets water, when and how, and lay the ground for protecting water resources from pollution through the implementation of socially-acceptable

allocation and regulation frameworks (Rogers and Hall 2003). The analysis of water governance arrangements becomes particularly important in light of the fact that the way in which societies govern their water resources bears profound impacts on settlements, livelihoods and environmental sustainability, and hence has spillover effects on other crucial economic and social sectors.

In this sense, property and use rights are central elements of water governance regimes due to the political role that different forms of ownership can play in the internalisation of externalities and the realisation of efficiencies (Demsetz 1967).[10] Rights can be land-based (riparian), or use-based (including market-based or based on historical use), and are categorised into different forms of ownership such as communal, private, state, open access (Demsetz 1967). Owning the right to use water resources means that an actor has control and power over them, as well as the authorisation to take part in collective decision-making about the management and operation of water systems. Therefore, the issue of water rights is closely linked to the concept of property: well-defined and coherent water rights and responsibilities are essential to deal with increased competition between water users in order to avoid situations of the 'tragedy-of-the-commons' type (UNESCO 2006). These observations emphasise once again the fundamental role that formal and informal institutions play in enforcing, monitoring and protecting the relevant property or use rights, and thus ensuring sustainable and effective water resources management (Thobani 1995).

Still, there remain a number of unresolved questions concerning the appropriate definition, evaluation and measurement of water rights in the quest for efficiency, effectiveness, and the reduction of social and environmental externalities. These issues are further complicated by the fact that hydrological realities are not fixed, regular or constant, as is the case for land and other commodities. Previous studies have relied on empirical examples of water governance, suggesting that there exist certain specific combinations of institutional arrangements that allow for the effective management of water resources (Maas and Anderson 1978; Keohane and Ostrom 1995; Trawick 2008). Of course, there is no single model of effective governance, since systems should fit the social, political, cultural, economic and environmental contexts within which they operate. "One size-fits-all" solutions are neither possible, nor desirable. However, there are certain principles and criteria that can be considered as essential components of water governance frameworks, and which have become the object of investigation for organisations such as the UNDP, the World Bank (WB), the Asian Development Bank (ADB), and the Global Water Partnership (GWP). Their studies in this area have informed the reform of water institutions, for example through the elaboration of principles of good governance

[10] The concept of externalities embraces all the external costs and benefits of a given activity, both pecuniary and non-pecuniary. External effects are felt differently by different categories of users and stakeholders. Therefore, internalising externalities, a process that usually happens through a change in property rights, means "bringing these effects back into the system so that all interacting actors can pay their costs and/or enjoy their benefits." (Demsetz 1967, p 348).

"*to assist in the fair, effective and environmentally-sensitive management of water*" (Hurlbert 2009).[11]

Today, much of the debate on water governance has moved towards the identification of the administrative and geographic levels at which water should be managed, as well as towards the understanding of the governance problems of public or private water utilities, the issue of private sector participation, the context-specific nature of water governance, and the ways of reducing water demand. The gradual shift of these discussions from the national to the international arena, through global conferences and events such as the World Water Forums,[12] has also led to the elaboration of internationally-agreed standards, of which the Dublin Principles and the consequent IWRM approach are prominent examples.

2.2.4 Adaptive Governance

As discussed in the previous sections, good governance and IWRM prescriptions have been specifically formulated to provide solutions to mounting internal and external pressures on water resources. More particularly, it is external influences, including physical climate factors that pose new risks to societies, and which, therefore, need to be taken into account by governance systems. Climate change has been defined as a "*great accelerator*", or a "*threat multiplier*" (Downing 2009), since it pushes systems past environmental thresholds in terms of droughts, glacial retreat and heat waves. Some scholars have argued that the speed at which these changes happen today is leaving governance systems unable to apply prior lessons to current problems (Ostrom et al. 1999), especially when risks fall outside the range of both human and ecological frames of reference (Parry et al. 2007).

While researchers were working to identify what defines "good" governance, the need also emerged to move towards considering what makes governance systems able to adapt to more intense and frequent extremes. In some sense, it could be said that climate variability and change are modifying the frame of analysis for evaluating the ability of water governance arrangements to manage resources efficiently

[11] The concept of good governance was developed in the 1980s, but it was only in the 1990s that it became used in the social sciences as a means to analytically assess public policy arrangements in empirical research (Kooiman 1993). Since then, good governance has become very popular as a solution to government/market/system failure. Good governance is said to encompass "*a range of normative values and public policy objectives which are seen as socially desirable, such as accountability, transparency, participation, justice, efficiency, rule of law, and absence of corruption*" (UNDP 1997). Since good governance does not play a significant role in the analysis presented here, the debate is only briefly mentioned. Nevertheless, it should be noted that many other definitions of this concept exist (e.g. Brugnach et al. 2008).

[12] The World Water Forum is an international conference organised every 3 years since 1997 by the World Water Council, which is an international multi-stakeholder platform created in 1996 on the initiative of water specialists and international organisations in response to growing concerns about world water issues.

and effectively. In fact, as climatological and hydrological patterns shift from one set of parameters to a wider range of uncertainty and risks, the theoretical paradigms that inform water management need to change accordingly.

Water governance and management systems tend to have specific rules or tools to cope with normal ranges of uncertainty, or moderate deviations from the norm (Yohe and Tol 2002). However, climate change will bring about more unpredictable and irreversible changes in state (e.g., reduced run off contribution from glacier and snow melting, shifts in seasonality and distribution of precipitations, etc.) that may lie outside the actual coping ranges of water management and governance regimes (Yohe and Tol 2002). Traditional governance approaches have been criticised for being rooted in a command and control paradigm, and in fragmented regulatory and institutional landscapes (Gleick 2003; Pahl-Wostl 2009) that do not take into account the complex linkages between social and ecological systems. In addition, at the biophysical level, management approaches have favoured the control of the hydrological system with measures such as the construction of dams or the enforcement of dykes. Such methods, however, reduce the natural range of variation, affect riparian ecosystems and their services, and thus diminish the overall resilience of the system (Pahl-Wostl 2009).

In recent years, scholars and practitioners, using evidence from the experience of developing countries, have increasingly argued that the promises of successful water management through the IWRM approach did not fully materialise (Medema et al. 2008; Engle et al. 2011). As a result, theoretical attention has gradually shifted towards trying to better understand adaptive processes in water governance systems as a way to manage uncertainty in future climatic conditions. An adaptive approach to water resources management was said to touch on the principles of broad stakeholder and public participation, cross-sectoral analysis and policy integration, polycentric and decentralised governance, and a focus on multiple scales of decision-making. Most importantly, it explicitly acknowledges and embraces uncertainty by recognising the complexity of the systems to be managed and the limits that subsist in predicting and controlling them (Mysiak et al. 2010).[13]

If applied to the water sector, adaptive water management (AWM) allows for the recognition that water management strategies and goals have to respond to circumstances that emerge and change over time through a process of *social learning*. In turn, social learning requires different authorities, experts, interest groups and the public to develop the capacity to manage their river basins in a collective way (Pahl-Wostl 2007). Nonetheless, as observed by the ecologist Eric Gunderson, three major factors hamper the successful implementation of AWM: (1) social systems tend to be inflexible; (2) ecological systems can be characterised by little resilience; and (3) there may be technical challenges associated with experimental design (Gunderson 1999). More generally, one of the major problems posed by AWM is that it

[13] It should be noted that the AWM approach does not substitute the IWRM one, but can rather "*be considered an important adjunct to it, enhancing its relevance when operating under uncertain and complex conditions with respect to, for example, climate change and socio-economic changes*" (Mysiak et al. 2010, p 7).

necessitates learning to occur specifically at those spatial and temporal scales that are relevant for a given management task, which brings back the difficult question of how to appropriately match 'science' and 'management' in order to formulate sound policies and improve practices and methods at both the biophysical and governance level (Mysiak et al. 2010).

Over a decade of applied research has greatly improved the scientific community's understanding of sustainable resource governance, and has identified adaptive governance and learning mechanisms as essential tools for managing socio-ecological systems during periods of abrupt change (Folke et al. 2005; Armitage 2008). For example, in one of her latest works called "*The Challenge of Common-Pool Resources*" (2008), Elinor Ostrom suggested that adaptive governance could be a suitable method for the management of common pool resources because of its specific capacity to deal with problems that are complex, uncertain and fragmented. Ostrom (2008) outlined five basic requirements for achieving adaptive governance, including: (a) the production of accurate and relevant information by creating and using timely scientific knowledge; (b) the discovery, prevention and resolution of conflict in a timely manner; (c) the fostering of compliance with institutional rules and regulations through the creation of a monitoring system; (d) the provision of infrastructures that are flexible over time; and (e) the response to errors and new changes and developments.

According to the political scientists John Scholz and Bruce Stiftel, adaptive governance represents "*a new generation of governance institutions for resolving collective action problems that occur between different types of resource users*" (Scholz and Stiftel 2005, p 1). For Scholz and Stiftel, this type of collective action problems, called "*second-order collective action conflicts*", typically emerge when decisions by one authority impact other authorities and the users they govern. In this sense, adaptive governance can be conceptualised as a tool to resolve conflicts among competing users. It does so in a manner that enhances joint gains while minimising negotiation costs and leading to the sustainable use of the natural system (Scholz and Stiftel 2005). These authors also pointed to the fact that second-order collective action conflicts arise under conditions of stress, and require the affected agencies to deal with unfamiliar issues beyond their established expertise. As a consequence, the creation of successful second-order institutions capable of adaptive governance depends on the capacity of a given political system to achieve effective representation, a deliberative process design, scientific learning, public learning, and problem responsiveness (Scholz and Stiftel 2005).

To date, there have been relatively few empirical studies on how institutions and governance mechanisms systematically build – or not – their adaptive capacity to respond to the expected impacts of climate change in the water sector. This gap is particularly problematic since the capacity of communities to adapt to long-term change and uncertain conditions is a critical aspect of the transition to sustainable development. A comprehensive conceptual framework "*that allows for the analysis of the properties and dynamics of complex water management and governance systems to develop appropriate strategies for their management*" (Pahl-Wostl et al. 2010, p 572) is still missing, with two significant exceptions.

The first one is the Institutional Analysis and Development (IAD) framework, elaborated by Elinor Ostrom and her colleagues (2005). The IAD framework aims at analysing the role of institutions in collective choice processes to avoid common pool resource dilemmas, using assumptions from game theory and rational choice concepts. More specifically, this analytical tool is a "*meta-theoretical conceptual map that identifies an action situation*, *patterns of interactions and outcomes*, *and an evaluation of these outcomes*" (Poteete et al. 2010, p 40).[14] As such, it offers researchers a structured way to study complex processes of resources management, based on two analytical steps. First, the factors that affect the structure of an action situation are identified. From this vantage point, the action situation is viewed as a set of variables dependent upon other contextual variables, including: (a) the structure of the resource system involved (size, complexity, predictability); (b) the rules used by participants to order their relationships; and (c) the structure of the more general community within which any particular arena is placed. Then, the researcher moves beyond the action situation to consider methods for explaining complex structures that link sequential and simultaneous action situations to one another (Poteete et al. 2010, p 41).

The second important contribution to the development of a framework for the analysis of complex systems for water resources management was proposed by Claudia Pahl-Wostl and her colleagues. Partly built on the IAD, the Management and Transition Framework (MTF) (Pahl-Wostl et al. 2010) is "*an interdisciplinary conceptual and methodological framework supporting the analysis of water systems*, *management processes and multi-level governance regimes*, *developed in a process involving a wide range of researchers from different disciplines*" (Pahl-Wostl et al. 2010, p 574). The MTF integrates a range of different concepts to develop a more coherent understanding of the complexity of water management regimes, with specific emphasis on adaptive capacity and learning processes. Such analytical framework is not linked to one specific theory, but provides a language that can be tailored to specific research questions and different theoretical approaches (Pahl-Wostl et al. 2010). The present book partially builds on these last two analytical frameworks, especially in their consideration of multi-level governance as a cross-case concept that underlies and explains interactions between institutional actors and groups towards different adaptation outcomes.

[14] An action situation occurs when individuals interact, exchange goods and services, solve problems or develop new rules. It is structured by seven broad attributes, which, in turn, are the core micro-variables that affect the preferences, information, strategies and actions of participants. Each action situation "*includes a set of actors*, *which acquire*, *process*, *retain and use information*, *have preferences related to outcomes*, *consciously or unconsciously select one course of action over another*, *and have resources that they bring to the situation*" (Ostrom 2005, p 15).

2.3 Defining and Understanding Institutions

Water presents all the typical characteristics of common pool resources: it is *subtractable* (i.e., once water is extracted, its total available amount decreases and this eventually causes rivalry between users), and it is *non-excludable* (i.e., access to and the exploitation of water resources are open to all interested individuals, and can be impeded only at great costs) (Wiegandt 2008). As such, water resources run the risk of experiencing what the ecologist Garrett Hardin famously defined as "*the tragedy of the commons*" (Hardin 1968). Fundamentally, Hardin's idea was that overexploitation occurs when resource use is unlimited, multiple rational users are present, and when there is excessive demand (Hardin 1968).[15] Of course, and as Hardin's critics have argued over the years, a more careful distinction needs to be drawn between common property and open access resources (e.g. Runge 1981). Accordingly, a tragedy of the commons does not result from an inherent malfunctioning of common property management *per se*, but rather from an institutional failure to control access to resources, and to make and enforce internal decisions for collective use.[16]

Since it is the institutional failure to govern resources that causes eventual conflict over their allocation and use, scholars have increasingly looked at the arrangements that could prevent such a disastrous outcome to occur in the first place. Their insights can be regrouped into three main schools of thought. The first one, the property rights school, proposes that the problem of the overexploitation and degradation of CPRs is best addressed through the creation and enforcement of private property rights. These rights then can effectively incorporate the externalities that arise when access to natural resources is unregulated (e.g. Demsetz 1967). A second school of thought instead, calls for granting full regulatory authority over the commons to an external agency, such as the state, in order to control and reduce instances of overexploitation (e.g., Hardin 1968; Ehrenfeld 1972). Finally, a third school of

[15] Central to Hardin's argument is the example of land tenure in medieval Europe, where herders shared a common parcel of land, and each of them was entitled to put cows on it, even if that meant damaging the quality of the common through overgrazing. The herder obviously received all the benefits from any additional cow she/he invested in, while the costs brought about by the degradation of the common were shared by the entire group. In the final instance, if all the herders made this individually rational (but collectively deplorable) economic decision, the common would be depleted or even destroyed. Hardin concluded that overexploitation leads to situations of scarcity both because the resource availability decreases exponentially and because its quality is altered. This, in turn, is likely to cause tensions and conflicts between users (Hardin 1968).

[16] On the basis of the time scale of the relevant adjustment process, natural resources can be classified as expendable, renewable, or depletable. Depletable resources are those whose adjustment speed is so slow that they can be considered as being made available by nature only once, such as natural gas and oil, endangered species, most minerals, and the ozone layer. Renewable resources, like water, forest products, and fish, adjust more rapidly, so that they self-renew in a time scale that is relevant for economic decision-making. Finally, expendable resources are those whose adjustment speed is so fast the use of the resource in one period has little or no effect on its availability in subsequent periods; this is the case of most agricultural products, for example (Kneese and Sweeney 1993).

thought proposes collective action at the local level (i.e., within communities and groups of users) as an alternative to market and state-controlled institutional arrangements (e.g. Ostrom et al. 1988). In addition to these three schools, a later approach invoked the decentralised collective management of CPRs (e.g. Berkes 1989), as a consequence of the fact that every society has its own means (in terms of its cultural capital) to deal with the natural environment and common pool resources (Berkes and Folke 1994).

Common to all these authors is a focus on institutional arrangements to favour cooperation within communities for the achievement of an equitable and sustainable use of common pool resources. Therefore, it is useful to also explore the literature on the role of institutions for promoting cooperation, and avoiding and/or resolving conflicts. In so doing, the functions and roles of institutions in effectively governing natural resources will be explained, as well as their mechanisms for learning and thus adapting to changing internal and external conditions.

2.3.1 The Concept of Institutions

It is sufficient to look back to the past 8,000 years of civilisation to see that human beings have been successful in creating institutions for collective action. In different cultures all over the world, individuals and groups have proved creative enough (most of the time at least) to bring forth effective strategies to overcome the obstacles of living together, for example by establishing contracts, agreements, incentives, constitutions, signals and media (Ostrom 1990). It is unsurprising, therefore, that institutions are such a fascinating and important topic for political scientists.

Institutional theories aim to explain why institutions exist, what roles and functions they perform, how they evolve, and how decision-making happens within them. In principle, institutionalism takes institutions as *the* explanatory concept that makes sense of political behaviour. As a result, it stands in stark contrast with rationalist approaches, according to which political processes are the mere result of individual decisions that are determined by some form of rational calculation expressed in terms of expected utility (Schrodt 1985). Rationalists consider institutions as "*arrangements of rules and incentives* [*that make*] *the members of institutions behave in response to those basic components of institutional structure*" (Peters 2000, p 3). This is not to say that institutions modify the preferences of their members according to the latter's objectives and values, rather the contrary: individuals who interact within institutions have their own well-ordered sets of preferences that remain largely unchanged, and institutions are only vehicles to convey them.

Against rational choice theories, a second approach to institutional analysis is the normative one, advocated by political scientists James March and Johan Olsen (1984). March and Olsen (1984) suggest that political behaviour (both individual and collective) can be best understood through the "*logic of appropriateness*" that

individuals acquire as a consequence of their belonging to institutions.[17] Institutional membership thus modifies the preferences of actors and encourages them to behave according to certain pre-set values and objectives (March and Olsen 1984).

A third approach to the study of institutions in political science is historical institutionalism, which argues that the structural choices made and the policies established at the origin of an institution will have a persistent influence over its behaviour – a concept that has been called "path dependency" (Steinmo et al. 1992). Although some scholars are also interested in the ideas that shape and sustain the directions of policy (Hall and Taylor 1996), historical institutionalism generally fails to explain changes in policies and structures and, as such, is not particularly useful for the purposes of this book.

Fourth and finally, empirical institutionalism investigates whether institutions, described as formal structures of government, can make a difference in policy choices (Weaver and Rockman 1993). In this field, some authors have focused, for example, on analysing the differences between presidential and parliamentary elections (Von Mettenheim 1996). Others, such as the American political scientist Samuel Huntington, rather examined the creation of structures that mediate between the demands that are generated within societies and the governments that address them (Huntington 1965). In some ways, this conceptualisation is similar to the rational choice one in that it treats institutions as exogenous to the values of the individuals functioning within them.

Despite the theoretical dissimilarities that distinguish these approaches to institutional theory, it is undeniable that they also present some noteworthy common features. First of all, it appears that institutional structures – independently from the way in which they are defined – *do* matter. In empirical institutionalism, the structure is the formal government, defined as presidential or parliamentary. Institutional structures become more complex for historical institutionalists, who, nevertheless, maintain a rigid approach by claiming that they persist unchanged over time. For March and Olsen (1984), structures represent both a formalised organisational apparatus and the pattern of values embedded within it and taught to new members. Lastly, for rational choice theorists, structures are the incentives offered to and the constraints imposed upon individual and group behaviour. All in all, the shared argument between these four approaches is that structures persist across space and time, thereby constituting the underlying institutional framework that creates greater regularity in human behaviour.

Although some advancements have been made in recent years, institutional theory continues to suffer from theoretical problems, which arise most notably from the co-existence of multiple understandings of what institutions are, and what factors shape behaviour within them (Peters 2000, p 5). As a consequence, some important questions remain unanswered. For example and first, the modalities through which individuals and institutions interact to make decisions are unclear, as

[17] This view contrasts with the so-called "logic of appropriateness" in rational choice theories, according to which individuals behave as they do because of their desire to maximise individual utilities (March and Olsen 1984).

are the criteria used to select the preferences to be addressed. Secondly, institutional approaches disagree on the extent to which institutions are malleable, or how and at which speed change occurs. While the rational choice approach tends to see change as an easily-attainable objective (it is necessary to only modify the incentives), historical institutionalists argue that change is difficult, if not impossible, to plan, design, and address. The other two approaches fall somewhere in between these two extremes: normative institutionalism considers change to be a challenging task, especially when it involves the modification of institutional values; the empirical approach does not consider it as an issue to start with. Overall, none of these theoretical traditions has yet been able to provide a definite answer to illuminate the extent to which institutions are malleable, let alone investigate the concrete conditions that allow institutional change to happen.

2.3.2 Moving Across Time and Space: Recognising and Understanding Institutional Change

Of course, institutions are nothing fixed in time and space, but act and interact with each other at different levels, learning, evolving, at times even transforming. Learning – and how the institutional system incorporates it into its operational modes – is a paramount concept to take into account, to analyse, and to understand if one is to make sense of institutional change. First of all, it is important to clarify what institutions *are*. There exist two schools of thought in this sense: one that considers institutions as synonymous with organisations, and one that makes the difference between institutions and organisations.

Let us start with this second standpoint, described in the work of Herbert Simon on administrative behaviour (Simon 1997), for example. For Simon, the main distinction between institutions and organisations is that the former act in a hierarchical way, while the latter tend to be non-hierarchical (Simon 1997). Other scholars classify organisations as those material entities that possess personnel, offices, budgets, and a legal personality (Young 1989; North 1990; Scott 1995). Similarly, studies of small-scale traditional societies pose that the establishment of organisations is not a necessary condition for the creation and operation of effective institutions (Ostrom et al. 2002; Berkes 2007). Adopting a more pragmatic approach, the World Bank classifies institutions as "*the rules*, *organisations and social norms that facilitate coordination of human action*" (World Bank 2003, p 203). The advantage of this evidently less abstract description is that, by including organisations, it facilitates the operationalisation of the definition of institutions. An argument can thus be made that institutions and organisations exist at different levels of reality; simply put, organisations are the more concrete representation of institutions. For the purposes of this study, organisations are considered as the changeable manifestation of institutions, which are, in turn, underlying and durable patterns of rules and behaviours. As such, it becomes possible to confidently take the literature on organisational learning as a starting point from which to extrapolate the analytical

elements that best describe the characteristics of institutions in general, and of environmental institutions more specifically.

Organisational learning theorists posited that organisations are "*patterns of communications and relations among groups of human beings*, *including the processes for making and implementing decisions*" (Simon 1997, p 18). As such, organisations provide their members with the information, assumptions, goals and attitudes that inform decision-making. They also present them a set of stable and comprehensive expectations about what other members will do, which reduce uncertainty and hence the costs of cooperation. In other words, organisations represent specific configurations of actions that create a repertoire of procedures (or what Simon called "*standard operating procedures*") helping members pursue their immediate goals, or accomplish specific and given tasks (Simon 1997).

The originality of Simon's work lies in his understanding of organisations as non-rational actors. If rationality is described on the basis of an actor's ability to select the best possible means to achieve a given end, organisations cannot be perfectly rational because they are incapable of imagining all the solutions to a given problem. To account for this restriction, Simon introduced the concept of "*bounded rationality*", which refers to "*the physical and psychological limits of man's capacity as alternative generator*, *information processor*, *and problem solver* [*which*] *constrain the decision-making process of individuals and organisations*" (Simon 1997, p 90). Based on this assumption, five key characteristics of organisations may be: (a) they play a role in facilitating understanding by 'disassembling' complex problems into a number of roughly independent parts; (b) the course of action/s they select may not be the most optimal and efficient, but only a 'satisficing' one; (c) they generate alternatives by following relatively stable and sequential search processes, and stop at the first solution that turns out to be 'good enough'; (d) they rely on prompt corrective actions to eliminate deviations between actual and desired aims, and thus avoid uncertainty; and (e) they (and individuals within them) elaborate repertoires of action that constitute the range of possible choices in recurring situations (Simon 1997).

Although instructive in terms of how decision-making processes within organisations happen, and hence of how organisations produce action, Simon's analysis fails to explain how organisations *change* in response to differing external and/or internal conditions. In fact, the author circumvents the problem by arguing that organisations try, as much as possible, to avoid uncertainty. Further, he argues that when uncertainty does occur, they adapt their standard operating procedures to respond to it on an *ad hoc* basis. Other scholars, mainly within the tradition of new institutionalism, also described institutional structures as fairly resistant to external changes and deliberate reforms. This is what political scientist Johan Olsen defined as "*the garbage can model*": since policy-making is future-oriented, the only way for organisations to produce 'satisfactory' decisions to specific problems is to rely on previous practice (Olsen 2001). Learning, therefore, is routine-based, history-dependent, and target-oriented (Olsen 2001; Levitt and March 1988). Following this line of thought, organisational learning mechanisms are nothing more than the reuse or rejection of actions within a given set of repertoires.

Clearly, none of these analyses sufficiently takes into account uncertainty. What happens if the problems to be solved do not present the characteristics of their precedents *at all*? Or if change happens at such a pace that organisational routines and procedures cannot possibly be updated fast enough? To address these concerns, a new stream of literature has emerged that specifically focuses on the *adaptive capacity* of institutions to respond to abrupt, uncertain, and unintended changes. The starting point for this research was offered by the institutional learning literature, according to which institutions are "*humanly devised constraints that structure human interactions* [*and*] *are made up of formal constraints* (*rules*, *laws*, *constitutions*), *informal constraints* (*norms of behaviour*, *conventions*, *and self-imposed codes of conduct*), *and their enforcement characteristics*" (North 1994).[18] As such, institutions are social constructs, with their proper normative, cognitive and regulative dimensions (Scott 1995). This implies that institutional learning takes place at the level of the institution itself, rather than at the level of its individual members, as described by the literature on administrative behaviour (Lee 1993).

To be fair, the shift from a focus on learning to one on adaptation in the institutional context already began in the late 1970s, when the concept of adaptive management first emerged in reference to ecosystems (Holling 1978). However, it was only in the last two decades that this concept was successfully applied to the broader field of natural resources management (Lee 1993; Gunderson and Holling 2002). The recognition that institutions are socially constructed entities with normative, cognitive and regulative dimensions made it much easier to analyse the evolution of their responses to internal and/or external stimuli (Berkes and Folke 2002; Scott 1995). Landmark research on this topic has been conducted by Berkes and Folke (2002), who explicitly focused on the cognitive dimension of institutions in the study of ecosystem dynamics and local knowledge. Central to Berkes and Folke's work was the notion of institutional learning, which occurs on the basis of institutional memory, or a "*memory of experience*" that provides the context for the modification of resource use rules and regimes (Berkes and Folke 2002). Institutional memory also incorporates local and traditional knowledge, which are prerequisites for the management and sustainable use of resources, biological diversity and ecosystems (Berkes and Folke 2002). This conceptual framework for the analysis of linked socio-ecological systems is based on a nested set of ecosystems and management practices, which, in turn, are embedded in a complex institutional structure. The linkage between the two is provided by ecological knowledge and understanding, without which sustainable natural resource use would be highly unlikely (Berkes and Folke 2002).

In addition to studying the learning mechanisms of institutions tasked with natural resources management, scholars have also started focusing on the concept of adaptation, mostly as a consequence of the growing awareness of climate change in

[18] Another useful definition of institutions is the one provided by Elinor Ostrom, according to whom institutions are "*the set of rules actually used by a set of individuals to organise repetitive activities that produce outcomes affecting those individuals and potentially affecting others*" (Ostrom 1992, p 56).

general, and of its impacts on hydrological systems more specifically (Adger et al. 2005). Studies on adaptation, which were initially scenario-based, now increasingly assess current and future instances of adaptation to new climatic conditions, and adaptive capacity (Carter et al. 2007). In the context of large international organisations, adaptation has been defined as a "*strategic behaviour that aims at preserving the goals*, *identity and boundaries of the organisation in response to stress*, *and to adjust its operational practices to ensure political survival*" (Haas 1990, p 2). As such, adaptation is always incremental, and does not involve the production of new knowledge that challenges the organisation's basic assumptions or goals, as learning does (Haas 1990). Adaptation simply integrates new knowledge into institutional decision-making procedures, so that the same goals can be achieved even when external circumstances and conditions have changed. These reflections represent a preliminary attempt to move from the analysis of organisational learning to that of adaptation. In fact, the problems that water institutions will have to solve in the face of climate change do not require the modification of their fundamental values, assumptions and goals, but rather the updating of their behavioural patterns to adjust quickly enough to different circumstances. In this sense, the incorporation of uncertainty into institutional procedures and structures is crucial, as is the strengthening of their capacity to reduce it, as much as possible, by means of knowledge generation and information sharing.

2.3.3 Institutions and the Environment: Tackling the Issue of Scale

Before continuing the discussion of the ways in which institutions learn and evolve, we need to take a step back and reframe our considerations around institutions and environmental issues more specifically, as this is the domain within which this study is inscribed. To this end, a useful starting point is provided by the (relatively) recent research on institutions and environmental change. Here, institutions play a critical role in both causing and solving problems that arise from human-environment interactions. Viewed under this light, Hardin's tragedy of the commons becomes a story about "*missing or inappropriate rights and rules governing the actions of users of renewable but depletable resources*" (Young 2008, p 4).

Research on institutions and environmental change has typically evolved in three main directions (Young 2002; March and Olsen 1989; Scott 1995). (1) The collective action perspective assumes that individuals have preferences that are exogenous to their membership in groups, they act on the basis of some sort of utilitarian calculation, and they endeavour to maximise payoffs to themselves as individuals (Olson 1965). Institutions are formed through an explicit or implicit process that involves the development of social contracts. However, since individuals behave according to their own preferences, problems of burden-sharing and compliance loom large (Barrett 2003). By contrast and (2), the social-practice perspective posits

that the identities of individuals are shaped in part by group membership, and that they are influenced by a logic of appropriateness rather than one of consequence. In this sense, compliance with institutional rights and rules becomes a matter of second nature or habit (March and Olsen 1989). (3) More recently, a third perspective – called the knowledge-action perspective – has emerged. It stresses agency, individual leadership, and the role of governance systems in shaping the ways in which environmental problems are understood and treated (Breitmeier et al. 2006). According to some scholars, these three perspectives must be used together to correctly illuminate the role that institutions play in causing and addressing particular environmental problems (Young 2008, p 8). Difficulties in reforming institutions, for example, can be attributed both to the transaction costs associated with institutional bargaining and to the "stickiness" of standard operating procedures.

Institutions arise in different settings and play a variety of roles. That being said, whenever they develop as a response to the need for steering mechanisms to guide societies towards socially-beneficial outcomes, they become constitutive elements of the governance system. This is why the discussion on transnational and multilevel governance (Sect. 2.2.2) is particularly relevant for this study. As a matter of fact, environmental issues have triggered some of the most innovative experiments in new forms of governance (von Moltke 1997). Of course, other elements such as belief systems, norms and culture need to be brought into the equation, since they operate alongside institutions as mechanisms guiding the behaviour of actors towards collectively-desirable outcomes (Young 2008). In addition, researchers have distinguished between broad, overarching arrangements (or institutions designed to address a wide range of substantive issues), and issue-specific institutions (also categorised as "regimes") created to solve a particular problem at a range of levels, from the local to the global (Young et al. 2008). The political scientist Oran Young used the idea of "interplay" to refer to the interactions between and within institutions at similar (horizontal interplay) and different (vertical interplay) levels of social organisation (Young 2002).

Another relevant distinction in the case of water resources management is the one between formal and informal institutions, which is based on the "*differential nature of processes of development*, *communication and enforcement*" (Pahl-Wostl 2009, p 356). Accordingly, in formal institutions rules are openly codified, officially accepted, and enforced by the state. By contrast, informal institutions convey norms of behaviour and socially-shared rules that are self-enforcing or enforced outside official channels (e.g., through traditions, social and cultural norms, organisational codes of behaviour, personal networks, and the black market) (Helmke and Levitsky 2004). Evidence shows that both formal and informal institutions play an important role in water resources management because of their potential to "*set rules and demarcate responsibilities between actors*, *co-ordinate mechanisms to minimise jurisdictional overlaps or deficiencies*, *bridge the gap between political and natural boundaries*, *match responsibilities*, *and serve as authorities and facilitators of action*" (GWP 2004, p 44).

The literature on resource and environmental regimes can also provide useful insights into the issues under discussion since it examines the issues of causality,

design, scale, and fit, all of which are essential to understand institutional performance and learning patterns. In terms of causality, for example, institutionalist scholars have tended to treat the effects of institutions as non-linear: institutions are only one component of more complex responses aimed at facilitating collective learning and action. As such, their influence is partly determined by their interaction with other actors, which means that it is important to focus on the *effects* of institutions on the behaviour of actors more than on anything else. In other words, it is the capacity of institutions to guide behaviour that determines whether or not efforts to solve environmental problems will be successful in the final instance (Young and Levy 1999).

The literature on institutionalism also points to the need to adequately account for the problem of scale, especially when studying institutional arrangements for environmental and resource regimes. The concept of scale relates to the transferability of knowledge on institutions from one level of social organisation to the other (Young et al. 2008). For instance, a fundamental question is whether or not information about the effectiveness of regimes operating at the local level can be transferred to the national and/or international level, and vice versa. A notable finding in this sense is that there are similarities between resource and environmental regimes operating in small-scale traditional societies, and those working at the international level (Young 2002). Neither setting comprises states in the conventional sense of the term, as they depend heavily on stakeholder involvement and on the power of legitimacy (Young et al. 2008). Research has also highlighted that there is no optimal level of socio-political organisation at which to address a given environmental and/or resource-related issue (Young et al. 2008).

Finally, the literature on institutionalism has considered the problem of fit. This is a very common concern for resource and environmental regimes as it is not always easy to design institutions that correctly match the relevant biophysical system, especially since the latter is increasingly affected by anthropogenic forces.[19] Indeed, temporal and/or spatial misfits between institutions and biophysical and socio-ecological systems are common, and are often extremely difficult to eliminate since the rhythms of decision-making procedures differ from the cycles of biophysical systems. A particularly acute problem arises when normally stable biophysical systems are affected by rapid events that produce nonlinear modifications, better known as "*state changes*" (Gunderson and Holling 2002).

More specifically, scholars have highlighted a number of factors that combine to create mismatches between biophysical and governance systems. First, and as already noted, there is the rapid growth of anthropogenic drivers in socio-ecological environments. Researchers lack the required experience to connect the component parts of these "*coupled systems*" (Young 2008, p 26), and it is often difficult to forecast the occurrence of nonlinear changes in complex systems (Ebbin 2004).

[19] Human actions have had far-reaching effects on biophysical systems for hundreds of years, an observation that has led prominent scientists to argue that the earth has made a transition from the Holocene era to a new one best described as the Anthropocene (Steffen et al. 2004; Crutzen and Stoermer 2000).

Additionally, political dynamics, such as the presence of interest groups (Grossman and Helpman 1994), may skew decision-making in one direction that does not match the characteristics and needs of the biophysical system. Efforts to eliminate or ease these types of mismatches may require institutional reform. Accordingly, it is important to better understand how to create institutions that are neither too flexible (since this would actually increase the likelihood that governance systems become epiphenomena of states' or particular actors' choices and interests), nor excessively stringent on reform, lest it becomes difficult to later eliminate mismatches.

2.3.4 Changing Climate, Changing Institutions?

After having illustrated the specific characteristics of those institutions that are mandated to govern the environment and its interaction with human societies, it is time to go back to the debate on adaptation to understand whether (and how) this occurs (if at all) in reality. Adaptation has become a buzzword in concomitance with the scientific, academic and political discourses on climate change that have emerged and assumed increasing prominence since the 1990s. Because we have already reached the point 'of non-return' with climate change, meaning that we can only partially mitigate its inevitable impacts, we are now left with the only option of adapting, for as much as it is possible, or trying to prevent the worst to happen.

The most authoritative source of scientific knowledge on climate change, the Intergovernmental Panel on Climate Change (IPCC) defines adaptation within human systems as "*the process of adjustments to actual or expected climate change and its effects*, *in order to moderate harm or exploit potential benefits*" (Field et al. 2011, p 10). According to a number of anthropological studies (Diamond 2004; Orlove 2005), human societies have learnt ways to adapt to climate variability and change, for example by means of technical infrastructure projects, already a long time ago. This ability has been referred to as "*reactive or autonomous adaptation*" (Tompkins and Adger 2005). However, the point that the IPCC makes is that the ways in which societies have handled the climate in the past, and the range of currently available coping mechanisms may not be sufficient to address the new challenges brought about by anthropogenic climate change in the future (van Aalst et al. 2008). In reality, adaptation rarely occurs automatically, rather, it is a consequence of the intentional actions performed by a person or a community (Adger et al. 2004) within a suitable enabling environment (Levine et al. 2011). Moreover, adaptation practices can be either anticipatory or reactive and, depending on the degree of spontaneity, autonomous or planned (Smith et al. 2010). It follows that a distinction can be drawn between adaptation as a programmatic approach, which is largely deliberate and seeks to facilitate sustainable and effective adaptation, and adaptive actions and processes that are activated by households, communities or institutions to explicitly anticipate or react to shocks and stresses.

In this sense, it is also important to note that adaptive actions are not necessarily positive: in some cases, short-term gains or benefits can lead to increased vulnerability in the long-term, a dynamic that is generally known as "*maladaptation*" (Barnett and O'Neill 2010). Avoiding maladaptation is difficult both earlier and later on in the process, as adaptation occurs within the context of different temporal and spatial scales and competing cultural and social goals that must be continuously balanced and negotiated (Adger et al. 2005). This disjunction between the complex interactive nature of adaptation actions and the levels at which they take place in reality constitutes an important object of study for scholars, and can be considered as falling under the previous problems of "fit" and "scale" discussed by Oran Young and colleagues (Young et al. 2008). For example, policy decisions mandating the implementation of infrastructural measures for adaptation purposes are likely to be taken at the national level, while their consequences will be experienced mostly at the regional level or within local communities (Brunner 2010).

It should also be considered that, especially at the local level, adaptation is rarely a response to climatic stimuli alone. Indeed, in many cases, it is the economic and socio-political consequences of a climate event that trigger adaptive actions, rather than the climate event *per se* (Smit et al. 2001). This means that the consequences of a climate event are not only direct functions of its physical characteristics, but also "*of the way in which a society has organised the relation to its resource base*, *its relations with other societies*, *and the relations among members*" (Rayner and Malone 1998). Accordingly, in order to understand how societies can cope with and adapt to climate stressors, the focus must be put on the political, socio-cultural and economic factors that can either promote or inhibit the capacity of individuals or groups to adapt (Smit et al. 2001). On these lines, and building on the more established literature on vulnerability (Plummer and Armitage 2007), the concept of adaptive capacity has been coined to denote the capacity of actors (collectively or individually) to respond to, create and shape variability and change in the state of a system (Walker et al. 2004; Adger et al. 2005; Chapin et al. 2009). More precisely, the IPCC defines adaptive capacity as "*the ability or potential of a system to respond successfully to climate variability and change*, *and to include adjustments in behaviour*, *resources and technologies*" (IPCC 2007, p 2). As such, adaptive capacity refers to "*the potential to adapt*, *if and when needed – and not necessarily to the act of adapting or its outcome*" (Levine et al. 2011, p 3), and incorporates the social and physical preconditions that are needed to enable adaptation, both in its proactive form (planning for future climate change) and its reactive one (the spontaneous reaction to events) (Nelson et al. 2007). Adaptive capacity contributes but does not coincide with the processes of creating robustness, adaptability, flexibility, resilience, and coping ability (Smit and Wandel 2006), and is fundamentally context-specific; it varies from country to country and community to community, between social groups and individuals, and over time (Smit and Wandel 2006).

The first group of scholars working on adaptive capacity argued that factors such as economic and physical resources, access to technology, information and skills, infrastructure, institutions, equity, social capital and collective action all contribute to its development and implementation (Pelling and High 2005; Adger 2003; Yohe

and Tol 2002; Smit et al. 2001). Among these determinants, however, increased flows of information and knowledge, democratic decentralisation (i.e., increased participation and representation), social capital and networks, and resource availability were highlighted as playing a particularly essential role (Engle 2007; Eakin and Lemos 2006; Brooks et al. 2005; Haddad 2005). All these components are related to institutional and governance mechanisms, including laws, rights, formal and informal institutions, and public policies (Yohe and Tol 2002; Adger et al. 2005; Nelson et al. 2007; Agrawal 2008; Engle and Lemos 2010). Recently, more nuanced evidence has been presented from the resilience community suggesting that in the process of developing adaptive capacity in different institutional contexts, flexible approaches that embrace the concept of experimentation and 'learning by doing' are also important (Gunderson 1999; Olsson et al. 2004; Pahl-Wostl 2007).

The measurement of adaptive capacity has always posed significant challenges to scholars, since it refers to the *potential* of individuals and societies to respond to change, and not to a specific condition that is already there and can be directly observed and recorded. Therefore, researchers have to content themselves with investigating the characteristics of adaptive capacity without actually quantifying them.

Within the water sector, the discourse on adaptive capacity has been translated into a desperate call for a better understanding of adaptive processes as crucial components of sustainable water resources management (Pahl-Wostl 2007). Different approaches have been lauded as relevant for building institutional adaptive capacity in the water sector, including the IWRM, adaptive management, and adaptive governance (see Sects. 2.1.2 and 2.2.4) (Yohe and Tol 2002; Adger et al. 2005; Eakin and Lemos 2006). The basic argument is that flexibility and robustness must be incorporated into water management institutions by means of risk-pooling mechanisms, which emphasise diversification and consider a variety of future scenarios under which alternative solutions can be evaluated (Figge 2004; Aerts et al. 2008). More attention, however, needs to be paid to cross-sectoral cooperation, i.e., the integration of water resources management with related sectors, such as finance and insurance, and regional economic development and livelihoods (Aerts and Droogers 2009). Finally, the focus should be on both agency and the structural or technical flexibility of the water system, since effective social responses to events such as floods and droughts are often related to institutional structures and effective governance (Moench and Dixit 2004).

If applied to the study of institutions and mechanisms for institutional learning, adaptive capacity translates into the concept of *institutional adaptive capacity*. Institutional adaptive capacity has been investigated by scholars of different disciplines, who have demonstrated that when adaptive capacity starts within an institutional system, learning occurs and results in an overall change of the structural conditions that stabilise the regime. This mechanism is also described as "*system innovation*", and is supposed to produce new regulatory frameworks, norms and values (Mysiak et al. 2010). The fundamental question that researchers have carefully examined relates to the conditions that enable these systems to become learning systems in the first place, also in response to the need to address the "*growing*

number of failures among current approaches and the increasing vulnerability of socio-ecological ecosystems" (Olsson et al. 2006, p 1). Adaptive governance is one of the approaches that have been proposed in this sense, implying a move from the conventional view of institutions as static, rule-based, formal and clearly bounded, towards one that sees them as dynamic processes of change (Pahl-Wostl 2007). Another approach is the adaptive management one, which understands each phase of the management process as an opportunity for further learning, and which embraces uncertainty step by step, as circumstances change (Pahl-Wostl and Sendzimir 2005). Adaptive management focuses on methods such as learning by doing, scenario planning and social learning, with the goal of increasing the flexibility that is required to revisit inappropriate management practices (Pahl-Wostl 2007). In parallel, the concept of adaptive co-management has also emerged, combining the iterative learning dimension that is typical of adaptive management with collaborative management in which rights, responsibilities and obligations are jointly shared (Huitema et al. 2009).[20]

At the heart of these policy-learning approaches is the premise that institutions can use experience from the past to inform responses to present and future challenges (Huntjens et al. 2011). Learning is highlighted in a number of studies as a vital component for building the flexibility that is essential to cope with uncertainty and change (Berkes and Folke 2002; Folke et al. 2005; Nelson et al. 2007; Pahl-Wostl 2007). Nevertheless, learning in itself is not enough: it must be complemented with a requisite institutional framework (Folke et al. 2005), comprehensive of bridging organisations such as networks, associations, cross-sectoral partnerships, political coalitions, and social movements (Pahl-Wostl 2007). These aspects become particularly salient when addressing the impacts of climate change, since factors such as the lack of information and high uncertainty about potential effects are combined with long decision-making time-frames, which result in the delay of important adaptation actions (Sprinz 2009).

[20] The concept of co-management focuses on the creation of a community of institutional learning at the collective, rather than the individual, level (Berkes and Folke 2002). It examines participation and multi-level governance as potential routes for incorporating different forms of knowledge and learning. Scholars working in this field have suggested that the combination of collaborative management and adaptive management approaches builds more robust socio-ecological systems, as it more aptly takes into account cross-scale dynamics and linkages, and higher complexity (Berkes and Folke 2002; Pahl-Wostl et al. 2007; Huitema et al. 2009). It follows that both adaptive management and co-management strongly embrace the idea of "*learning by judicious doing*" (Holling 1978), which represents a significant departure from the more traditional approach of rigid and irreversible planning and anticipatory management.

2.4 Challenging the Literature: Now, What's Next?

The climate and water systems have traditionally constituted the object of investigation of 'hard' sciences such as climatology, physics and hydrology. More recently, however, political science and IR scholars have demonstrated interest in these topics, too. This trend reflects the increased societal awareness that resource scarcity and pollution problems cannot be addressed only from a technical point of view but additionally require to take the governance dimension into account. The introduction of climate change as a research topic in political science and IR has informed studies on regime formation. Further it has demonstrated how the traditional role of the state, a pillar of realist and neorealist theories, is gradually being challenged by the emergence of new actors at higher and lower governance levels. The typical concern of these disciplines with the classical theories of common property and collective action, as well as with the analysis of the international management of shared resources, has translated into an improved understanding of how water resources can be managed in such a way as to avoid 'tragedies of the commons'.

As highlighted by the ground-breaking work of Elinor Ostrom, human beings have always been able to solve problems of collective action by establishing institutions (Ostrom 1990). Institutional functions and objectives have constituted the object of study of political scientists and IR theorists all since the very beginning of these disciplines. What is particularly interesting for the purposes of this study, however, is the more recent research on institutions in relation to environmental change, which focuses on whether institutions at different levels matter in tackling environmental problems, such as natural resources management and climate change.

In the water sector specifically, attention has been put upon a range of issues. These include the assessment of the administrative and geographic levels at which water should be managed, the weak governance of public or private water utilities, the issue of private sector participation, the context-specific nature of water governance (i.e., which laws/modes of governance work in which countries), and the ways of reducing water demand. New governance prescriptions, such as the IWRM approach, have been formulated to provide solutions to increasing internal and external pressures on water resources. More recently, the concepts of adaptive water management (AWM) and adaptive governance have been elaborated to try and better incorporate flexibility to address uncertainty to respond to the expected impacts of climate change.

Clearly, therefore, one of the key words in the water world today is that of "change". In reality, change has always been a constant in the life of people, communities and societies in both developed and developing countries, and in all historical periods. Change can consist of shocks (sudden and acute events like wars and displacements), as well as stresses (slow modifications in the external and internal conditions of a system), both of which compel systems to adapt through time. Climate change adds yet another layer of complexity to the global challenges of poverty and inequality, rapid population growth, underdeveloped markets, inadequate infrastructure and service provision, and weak governance systems. So far,

adaptation has tended to happen mostly in a reactive manner that focuses on short-term and immediate needs, thereby enhancing the risk of negative unexpected consequences (and hence maladaptation) to occur. As a consequence, the focus is now increasingly put on the need to learn how to proactively anticipate the effects of complex transformations so as to respond with long-term and sustainable measures and actions at multiple scales.

There are numerous calls for water governance and associated management institutions to adopt the required degree of flexibility that would allow them to increase their resilience to future uncertainty and climate change impacts. Notwithstanding, there is still ample room for discussion on the conditions that build this potential for adaptation (or adaptive capacity). In other words, it is clear that institutional adaptive capacity should be established to facilitate system transformation towards the integration of uncertainty and the consequent ability to respond to change. However, it remains unclear *how* this process does or should occur. Another question that arises automatically is whether robust and resilient governance frameworks, or rather flexible and adaptive ones, are required to implement effective and sustainable adaptation responses. Can institutions for water resources management be both, resilient and able to adapt to new challenges and hydro-climatic realities? Of course, it will be a matter of trade-offs between the generation of institutional characteristics that are needed for climate-resilient structures and the establishment of adaptive conditions. This being said, there is nevertheless a need for cross-case comparisons to show how robustness and transformative potential of the structures and conditions might be balanced, as well as to identify the ways in which these tensions can be managed within different governance frameworks.

References

Adger WN (2003) Social capital, collective action, and adaptation to climate change. Econ Geogr 79(4):387–404

Adger WN, Brooks N, Kelly M (2004) New indicators of adaptive capacity. Tyndall Center for Climate Change Research, Norwich

Adger WN, Arnell NW, Tompkins E (2005) Successful adaptation to climate change across scales. Glob Environ Chang 15(2):77–86

Adger WN, Agrawal S, Mirza MMQ, Conde C, O'Brien K, Pulhin J, Pulwarty R, Smit B, Takahashi K (2007) Assessment of adaptation practices, options, constraints and capacity. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (eds) Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge

Aerts J, Droogers P (2009) Adapting to climate change in the water sector. In: Ludwig F, Kabat P, van Schaik H, van der Valk M (eds) Climate change adaptation in the water sector. Earthscan, London

Aerts J, Botzen W, Van der Veen A, Krykrow J, Werners S (2008) Portfolio management for developing flood protection measures. Ecol Soc 13(1):41

Agrawal A (2008) The role of local institutions in adaptation to climate change. Working paper. In: International Forestry Resources and Institutions Program # W081-3. University of Michigan, Ann Arbor

Allan JA (2003) IWRM/IWRAM: a new sanctioned discourse? SOAS/KCL Water Issues Group occasional paper 50. SOAS/King's College London, London

Ammon G, Fischer M, Hickmann T, Stemmermann K (eds) (1996) Föderalismus und Zentralismus: Europas Zukunft zwischen dem deutschen und dem französischen Modell. Schriftenreihe des Europäischen Zentrums für Föderalismus Forschung Tübingen, vol 11. Nomos Publishers, Baden-Baden

Andonova LB, Betsill MM, Bulkeley H (2009) Transnational climate governance. Glob Environ Polit 9(2):52–73

Ansell C (2000) The networked polity: regional development in western Europe. Governance 12:303–333

Armitage D (2008) Governance and the commons in a multi-level world. Int J Commons 2(1):7–32

Bache I, Flinders N (2004) Themes and issues in multi-level governance. In: Bache I, Flinders M (eds) Multi-level governance. Oxford University Press, Oxford, pp 195–206

Barnett J, O'Neill S (2010) Maladaptation. Glob Environ Chang 20(2):211–213

Barrett S (2003) Environment and statecraft: the strategy of environmental treaty making. Oxford University Press, New York

Berkes F (ed) (1989) Common property resources – ecology and community based sustainable development. Belhaven Press, London

Berkes F (2007) Community-based conservation in a globalized world. Proc Natl Acad Sci 104(39):15199–93

Berkes F, Folke C (1994) Investing in cultural capital for the sustainable use of natural capital. In: Janson AM et al (eds) Investing in national capital: the ecological economics approach to sustainability. Island Press, Washington, DC

Berkes F, Folke C (2002) Back to the future: ecosystem dynamics and local knowledge. In: Gunderson LH, Holling CS (eds) Panarchy: understanding transformations in human and natural systems. Island Press, Washington, DC

Besley T, Coate S (1999) Centralized versus decentralized provision of local public goods: a political economy analysis. Working paper series 7984. National Bureau of Economic Research, Cambridge, MA

Bodansky D (2001) The history of the global climate change regime. In: Luterbacher U, Sprinz D (eds) International relations and global climate change. MIT Press, Cambridge, MA

Breitmeier H, Young OR, Zürn M (2006) Analyzing international environmental regimes: from case study to database. The MIT Press, Cambridge, MA

Brooks N, Adger WN, Kelly P (2005) The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. Glob Environ Chang 15:151–163

Brugnach M, Dewulf A, Pahl-Wostl C, Taillieu T (2008) Toward a relational concept of uncertainty: about knowing too little, knowing too differently, and accepting not to know. Ecol Soc 13(2):30

Brunner RD (2010) Climate adaptation and the drunkard's speech. 29th Annual Institute of the Society of Policy Scientists. Yale Law School, New Haven

Bulkeley H, Watson M, Hudson R (2007) Modes of governing municipal waste. Environ Plan A 39(11):2733–2753

Buzan B, Waever O, de Wilde J (1998) Security: a new framework for analysis. Lynne Rienner, Boulder

Carter TR, Jones RN, Lu X, Bhadwal S, Conde C, Mearns CG, O'Neill BC, Rounsevell MD, Zurek MB (2007) New assessment methods and the characterisation of future conditions. Climate change 2007: impacts, adaptation and vulnerability. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (eds) Climate change 2007: impacts, adaptation

and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge
Cash DW, Moser SC (2000) Linking global and local scales: designing dynamic assessment and management processes. Glob Environ Chang 10:109–120
Chapin FS, Folke C, Kofinas GP (2009) A framework for understanding change. In: Chapin FS, Kofinas GP, Folke C (eds) Principles of ecosystem stewardship resilience-based natural resource management in a changing world. Springer, New York
Choucri N (1995) Global accords: environmental challenges and international responses. MIT Press, Cambridge, MA
Ciervo M (2009) Geopolitica dell'Acqua. Carocci Editore, Roma
Conyers D (1984) Decentralization and development: a review of the literature. Public Adm Dev 4:187–197
Crutzen PJ, Stoermer EF (2000) The 'Anthropocene'. IGBP Newsl 41:17–18
Daoudy M (2007) Conceptualizing and disentangling cooperation. Presentation given at the third international workshop on hydro-hegemony, 12 and 13 May 2007. London School of Economics, London, UK, London Water Research Group
De Stefano L, Edwards P, de Silva L, Wolf AT (2010) Tracking cooperation and conflict in international basins: historic and recent trends. Water Policy 12(6):871–884
Demsetz H (1967) Towards a theory of property rights. Am Econ Rev 52(2):347–379
Diamond JM (2004) Collapse: how societies choose to fail or survive. Viking Adult, New York
Dinar A, Kemper K, Blomquist W, Kurukulasuriya P (2007) Whitewater: decentralization of river basin water resource management. J Policy Model 29:851–867
Downing TE (2009) Experience and evidence: mainstreaming climate information into adaptation planning. In: World climate conference 3, Geneva, Switzerland
Eakin H, Lemos MC (2006) Adaptation and the state: Latin America and the challenge of capacity-building under globalization. Glob Environ Chang 16(1):7–18
Ebbin SA (eds) (2004) Institutions and the production of knowledge for environmental governance: empirical evidence from marine and terrestrial systems. Special issue, Int Environ Agreem Polit Law Econ 4(2):105–109
Eckerberg K, Joas M (2004) Multi-level environmental governance: a concept under stress? Local Environ 9(5):405–412
Ehrenfeld D (1972) Conserving life on earth. Oxford University Press, New York
Engle NL (2007) Adaptive capacity of water management to climate change in Brazil: a case study analysis of the Baixo Jaguaribe and Pirapama River Basins. School of Natural Resources and Environment, University of Michigan, Ann Arbor
Engle NL, Lemos MC (2010) Unpacking governance: building adaptive capacity to climate change of river basins in brazil. Glob Environ Chang 20(1):4–13
Engle NL, Johns OR, Lemos MC, Nelson DR (2011) Integrated and adaptive management of water resources: tensions, legacies, and the next best thing. Ecol Soc 16(1):19
Field CB, Barros V, Stocker TF, Qin D, Dokken D, Ebi KL, Mastrandrea MD, Mach KJ, Plattner GK, Allen SK, Tignor M, Midgley PM (eds) (2011) Intergovernmental Panel on Climate Change special report on managing the risks of extreme events and disasters to advance climate change adaptation. Cambridge University Press, Cambridge
Figge F (2004) Bio-folio: applying portfolio theory to biodiversity. Biodivers Conserv 13:827–849
Folke C, Hahn T, Olsson P, Norberg J (2005) Adaptive governance of social-ecological systems. Annu Rev Environ Resour 30:8.1–8.33
Galaz V (2007) Water governance, resilience and global environmental change – a reassessment of integrated water resources management (IWRM). Water Sci Technol 56(4):1–9
Giordano M, Giordano M, Wolf A (2002) The geography of water conflict and cooperation: internal pressures and international manifestations. Geogr J 168(4):293–312
Gleditsch NP (1998) Armed conflict and the environment. A critique of the literature. J Peace Res 35(4):363–380

Gleick PH (1992) Effects of climate change on shared water resources. In: Mintzer IM (ed) Confronting climate change: risks, implications and responses. Cambridge University Press, Cambridge, pp 127–141
Gleick PH (1993) Water and conflict: fresh water resources and international security. Int Secur 18(1):79–112
Gleick PH (2003) Global freshwater resources: soft-path solutions for the 21st century. Science 302:1524–1528
Global Water Partnership (GWP) (2000) Integrated water resources management. TAC background papers No. 4. Global Water Partnership – Technical Advisory Committee (GWP-TAC), Stockholm
Global Water Partnership (GWP) (2004) Integrated water resources management (IWRM) and water efficiency plans by 2005. TAC background papers No. 10. Global Water Partnership – Technical Advisory Committee (GWP-TAC), Stockholm
Grossman GM, Helpman E (1994) Protection for sale. Am Econ Rev 84(4):833–850
Grote JR, Gbikpi B (2002) Participatory governance: political and societal implications. Leske and Budrich, Opladen
Gunderson LH (1999) Resilience, flexibility and adaptive management – antidotes for spurious certitude? Conserv Ecol 3(1):7
Gunderson LH, Holling CS (eds) (2002) Panarchy: understanding transformations in human and natural systems. SCOPE/Island Press, Washington DC
Gupta J (2008) Global change: analyzing scale and scaling in environmental governance. In: Young OR, King LA, Schroeder H (eds) Institutions and environmental change: principal findings, applications, and research frontiers. The MIT Press, Cambridge
Haas EB (1990) When knowledge is power: three models of organizational change in international organizations. University of California Press, Berkeley/Los Angeles
Haddad BM (2005) Ranking the adaptive capacity of nations to climate change when sociopolitical goals are explicit. Glob Environ Chang 15:165–176
Hall PA, Taylor RC (1996) Political science and the three new institutionalisms. Polit Stud 44:952–973
Hardin G (1968) The tragedy of the commons. Science 162:1243–1248
Hassing J, Ipsen N, Jonch Clausen T, Larsen H, Lindgaard-Jorgensen T (2009) Integrated Water Resources Management (IWRM) in action. The United Nations World Water Assessment Paper, jointly prepared by DHI Water Policy and UNEP-DHI Centre for Water and Environment. UNESCO: Paris, France
Helmke G, Levitsky S (2004) Informal institutions and comparative politics: a research agenda. Perspect Polit 2(4):775–740
Holling CS (1978) Adaptive environmental assessment and management. Wiley, London
Homer-Dixon T (1994) Environmental scarcities and violent conflict: evidence from cases. Int Secur 19(1):5–40
Hooghe L, Marks G (2003) Unravelling the central state. But how? Types of multi-level governance. Am Polit Sci Rev 97(2):233–243
Huitema D, Mostert E, Egas W, Moellenkamp S, Pahl- Egas W, Pahl-Wostl C, Yalcin R (2009) Adaptive water governance: assessing the institutional prescriptions of adaptive (co-management from a governance perspective and defining a research agenda. Ecol Soc 14(1):26
Huntington SP (1965) Political development and political decay. World Polit 17:386–430
Huntjens P, Pahl-Wostl C, Rihoux B, Schlüter M, Flachner Z, Neto S, Koskova R, Dickens C, Nabide Kiti I (2011) Adaptive water management and policy learning in a changing climate: a formal comparative analysis of eight water management regimes in Europe, Africa and Asia. Environ Policy Gov 21:145–163
Hurlbert M (2009) The adaptation of water law to climate change. Int J Clim Chang Strateg Manag 1(3):230–240
Intergovernmental Panel on Climate Change (IPCC) (2001) Climate change 2001: the scientific basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental

Panel on Climate Change. Houghton JT, Ding Y, Griggs DJ, Noguer M, van der Linden PJ, Dai X, Maskell K, Johnson CA (eds) Cambridge University Press, Cambridge/New York, 881 pp
Intergovernmental Panel on Climate Change (IPCC) (2007) Climate change 2007: the physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M, Miller HL (eds) Cambridge University Press, Cambridge/New York, 996 pp
Intergovernmental Panel on Climate Change (IPCC) (2014) Climate change 2014: impacts, adaptation, and vulnerability. Part a: global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (eds) Cambridge University Press, Cambridge/New York
International Conference on Water and the Environment (ICWE) (1992) The Dublin statement and report of the conference. Retrieved July 30, 2014 from: http://www.wmo.int/pages/prog/hwrp/documents/english/icwedece.html
Jones T, Phillips B, Williams C, Pittock J, Davis T (2003) Conserving rivers: lessons from WWF's work for integrated river basin management. World Wildlife Fund (WWF), Gland
Keck ME, Sikkink K (1998) Activists beyond borders: advocacy networks in international politics. Cornell University Press, Ithaca
Keohane RO (1982) The demand for international regimes. Int Organ 36:325–355 (Sage, London/Newbury Park)
Keohane RO, Ostrom E (1995) Local commons and global interdependence. Heterogeneity and cooperation in Two domains. Sage, London
Klare M (2001) Resource wars: the new landscape of global conflict. Henry Holt and Company, New York
Kneese AV, Sweeney JB (eds) (1993) Handbook of natural resources and energy economics. Elsevier, Kidlington
Kooiman J (1993) Modern governance: new government-society interactions. Sage, London
Kooiman J (2003) Governing as governance. Sage, London
Lee K (1993) Compass and gyroscope: integrating science and politics for the environment. Island Press, Washington, DC
Levine S, Ludi E, Jones L (2011) Rethinking support for adaptive capacity to climate change. Overseas Development Institute (ODI), London
Levitt B, March JG (1988) Organizational learning. Annu Rev Sociol 14:319–340
Lipschutz R (1997) Networks of knowledge and practice: global civil society and protection of the global environment. In: Brooks AL, Van Deever SD (eds) Saving the seas: values, scientists, and international governance. Maryland Sea Grant College, College Park
Lomborg B (2001) Resource constraints or abundance? In: Diehl PF, Gleditsch NP (eds) Environmental conflict. Westview, Boulder
Lowndes V (2001) Rescuing Aunt Sally: taking institutional theory seriously in urban politics. Urban Stud 38(11):1953–1971
Ludwig F, Kabat P, van Schaik H, van der Valk M (eds) (2009) Climate change adaptation in the water sector. Earthscan, London
Luterbacher U, Sprinz DF (2001) International relations and global climate change. MIT Press, Cambridge, MA
Maas A, Anderson RL (1978) And the desert shall rejoice: conflict, growth and justice in arid environments. MIT Press, Cambridge, MA
March JG, Olsen JP (1984) The new institutionalism: organizational factors in political life. Am Polit Sci Rev 78:738–749
March JG, Olsen JP (1989) Rediscovering institutions: the organizational basis of politics. The Free Press, New York

Marks G (1993) Structural policy and multilevel governance in the EC. In: Cafruny A, Rosenthal G (eds) The state of the European community. Lynne Rienner, Boulder, pp 391–411
Mayntz R (2006) Governance theory als fortentwickelte Steuerungstheorie? In: Schuppert GF (ed) Governance-Forschung: Vergewisserung über Stand und Entwicklungslinien. Nomos Verlag, Baden-Baden
Medema W, McIntosh BS, Jeffrey PJ (2008) From premise to practice: a critical assessment of integrated water resources management. Ecol Soc 13(2):29
Meinzen-Dick R (2007) Beyond panaceas in water institutions. Proc Natl Acad Sci U S A 104(39):15200–15205
Moench M, Dixit A (2004) Adaptive capacity and livelihood resilience: adaptive strategies for responding to floods and droughts in South Asia. Institute for Social and Environmental Transition, Boulder
Mysiak J, Henrikson HJ, Sullivan C, Bromlyey J, Pahl-Wostl C (eds) (2010) The adaptive water resource management handbook. Earthscan, London/Sterling
Nelson DR, Adger WN, Brown K (2007) Adaptation to environmental change: contributions of a resilience framework. Annu Rev Environ Resour 32:395–419
North DC (1990) Institutions, institutional change and economic performance. Cambridge University Press, Cambridge
North DC (1994) Economic performance through time. Am Econ Rev 84:359–368
Olsen JP (2001) Garbage cans, new institutionalism, and the study of politics. Am Polit Sci Rev 95(1):191–198
Olson M (1965) The logic of collective action. Harvard University Press, Cambridge
Olsson P, Folke C, Berkes F (2004) Adaptive comanagement for building resilience in social-ecological systems. Environ Manag 34(1):75–90
Olsson P, Gunderson LH, Carpenter SR, Ryan P, Lebel L, Folke C, Holling CS (2006) Shooting the rapids: navigating transitions to adaptive governance of social-ecological systems. Ecol Soc 11(1):18
Orlove B (2005) Human adaptation to climate change: a review of three historical cases and some general perspectives. Environ Sci Policy 8(6):589–600
Ostrom E (1990) Governing the commons. The evolution of institutions for collective action. Cambridge University Press, Cambridge
Ostrom E (1992) Creating institutions for self-governing irrigation systems. Institute for Contemporary Studies Press, San Francisco
Ostrom E (2005) Understanding institutional diversity. Princeton University Press, Princeton
Ostrom E (2008) The challenge of common pool resources. Environment 50(4):9–21
Ostrom E, Tiebout CH, Warren R (1961) The organization of government in metropolitan areas: a theoretical inquiry. Am Polit Sci Rev 55:831–842
Ostrom E, Fenny D, Pitch H (1988) Rethinking institutional analysis development: issues, alternatives and choices. ICEG, Panama
Ostrom E, Burger J, Field CB, Norgaard RB, Policansky D (1999) Revisiting the commons: local lessons, global challenges. Science 284:278–282
Ostrom E, Dietz T, Dolsak N, Stern PC, Stonich S, Elke UW (eds) (2002) The drama of the commons. National Academies Press, Washington, DC
Pahl-Wostl C (2007) Transition towards adaptive management of water facing climate and global change. Water Resour Manag 21(1):46–92
Pahl-Wostl C (2009) A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. Glob Environ Chang Hum Policy Dimens 19(3):354–365
Pahl-Wostl C, Sendzimir J (2005) The relationship between IWRM and adaptive water management. NeWater Working Paper 3. Available online at: http://www.newater.uni-osnabrueck.de/index.php?pid=1020
Pahl-Wostl C, Holtz G, Kastens B, Knieper C (2010) Analyzing complex water governance regimes: the management and transition framework. Environ Sci Pol 13:571–581

Parry ML, Canziani OF, Palutikof JP (eds) (2007) "Climate change 2007: impacts, adaptation, vulnerability". Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge
Pattberg P, Stripple J (2008) Beyond the public and private divide: remapping transnational climate governance in the 21st century. Int Environ Agreem Polit Law Econ 8(4):367–388
Pelling M, High C (2005) Understanding adaptation: what can social capital offer assessments of adaptive capacity? Glob Environ Chang 15:308–319
Peters BG (2000) Institutional theory: problems and prospects, Political science series 69. Institute for Advanced Studies, Vienna
Peters BG, Pierre J (2000) Developments in intergovernmental relations: towards multi-level governance. Policy Polit 29:131–135
Phillips D, Daoudy M, Ojendal J, Turton A, McCaffrey S (2006) Transboundary water cooperation as a tool for conflict prevention and broader benefit-sharing, Global development studies no. 4. Ministry of Foreign Affairs, Stockholm
Pierre J (2000) Introduction: understanding governance. In: Pierre J (ed) Debating governance authority, steering and democracy. Oxford University Press, Oxford
Plummer R, Armitage D (2007) A resilience-based framework for evaluating adaptive co-management: linking ecology, economics and society in a complex world. Ecol Econ 61(1):62–74
Postel S (1999) Pillar of sand: can the irrigation miracle last? Worldwatch Institute/Norton, New York
Poteete AR, Janssen MA, Ostrom E (2010) Working together: collective action, the commons, and multiple methods in practice. Princeton University Press, Princeton/Oxford
Rayner S, Malone E (1998) Human choice and climate change, Volume 3: the tools for policy analysis. Battelle, Columbus
Rhodes RAW (1996) The new governance: governing without government. Polit Stud 44(4):652–667
Rhodes RAW (2007) Understanding governance: ten years on. Org Stud 28:1243–1264
Risse T (2004) Global governance and communicative action. Gov Oppos 39(2):288–313
Risse-Kappen T (1995) Bringing transnational relations back in. In: Risse-Kappen T (ed) Bringing transnational relations back in: non-state actors, domestic structures and international institutions. Cambridge University Press, Cambridge, pp 3–33
Rogers P, Hall A (2003) Effective water governance. Global Water Partnership Technical Committee, Sweden
Rosenau JN (1995) Governance in the twenty-first century. Glob Gov 1(1):13–43
Rosenau JN (2000) Change, complexity and governance in a globalizing space. In: Pierre J (ed) Debating governance. Oxford University Press, Oxford, pp 167–200
Runge CF (1981) Common property externalities: isolation, assurance and resource depletion in a traditional grazing context. Am J Agric Econ 63:595–606
Scholz JT, Stiftel B (eds) (2005) Adaptive governance and water conflict: new institutions for collaborative planning. Resources for the Future, Washington, DC
Schrodt P (1985) Adaptive precedent-logic and rational choice: a comparison of two approaches to the modelling of international behaviour. In: Luterbacher U, Ward MD (eds) Dynamic models of international conflict. Lynne Rienner, Boulder
Scott WR (1995) Institutions and organizations. Sage, Thousand Oaks
Shah A (1998) Balance, accountability and responsiveness: lessons about decentralization. Working paper 2021. World Bank, Washington, DC
Shiva V (2002) Water wars: privatization, pollution, and profit. South End Press, Cambridge, MA
Simon H (1997) Administrative behaviour, 4th edn. The Free Press, New York
Smit B, Wandel J (2006) Adaptation, adaptive capacity and vulnerability. Glob Environ Chang 16(3):282–292
Smit B, Pilifosova O, Burton I, Challenger B, Huq S, Klein RJT, Yohe G (2001) Adaptation to climate change in the context of sustainable development and equity. In: McCarthy JJ,

Canziani OF, Leary NA, Dokken DJ, White KS (eds) Climate change 2001: impacts, adaptation, and vulnerability. Cambridge University Press, Cambridge
Smith BC (1985) Decentralization: the territorial dimension of the state. George Allen & Unwin, London
Smith MS, Horrocks L, Harvey A, Hamilton C (2010) Rethinking adaptation for a 4°C world. Philos Trans R Soc 369(1934):196–216
Sprinz DF (2009) Long-term environmental policy: definition, knowledge, future research. Glob Environ Polit 9(3):1–8
Steffen W, Sanderson A, Tyson PD, Jäger J, Matson PA, Oldfield F, Richardson K, Schellnhuber HJ, Turner BL II, Wasson RJ (2004) Global change and the earth system: a planet under pressure. Springer, New York
Steinmo S, Thelen K, Longstreth F (eds) (1992) Structuring politics: historical institutionalism in comparative analysis. Cambridge University Press, Cambridge
Stubbs P (2005) Stretching concepts too far? Multi-level governance, policy transfer and the politics of scale in south-east Europe. Southeast Eur Polit VI(2):66–87
Thobani M (1995) Tradable property rights to water: how to improve water use and resolve the water conflicts, Finance & private sector development note no. 34. World Bank, Washington, DC
Thompson G, Frances J, Levacic R, Mitchel J (1991) Markets, hierarchies and networks: the coordination of social life. Sage, London
Tompkins EL, Adger WN (2005) Defining response capacity to enhance climate change policy. Environ Sci Policy 8:562–571
Toynbee A (1946) A study of history. Oxford University Press, Oxford
Trawick P (2008) Scarcity, equity and transparency: general principles for successfully governing the water commons. In: Wiegandt E (ed) Mountains: sources of water, sources of knowledge. Springer, Geneva
Trolldalen JM (1992) International river systems. In: International environmental conflict resolution: the role of the United Nations. World Foundation for Environmental Development, Washington, DC
Tropp H (2007) Water governance: trends and needs for new capacity development. Water Policy 9(Suppl 2):19–30
Turton AR, Hattingh HJ, Marce GA, Roux DJ, Claasen M, Strydom WF (eds) (2007) Governance as a trialogue: government-society-science in transition. Springer, Berlin/Heidelberg
United Nations Development Programme (UNDP) (1997) Governance for sustainable human development. Retrieved from http://mirror.undp.org/magnet/policy/
United Nations Development Programme (UNDP) (2006) Beyond scarcity: power, poverty and the global water crisis. Human development report 2006. Oxford University Press, New York/Oxford
United Nations Development Programme (UNDP) (2008) Integrated water resources management for river basin organisation. UNDP-CAPNET training manual. UNDP, New York
United Nations Educational, Scientific and Cultural Organization (UNESCO) (2006) Water: a shared responsibility. The United Nations World Water Development Report 2. UNESCO, Paris; Berghahn Books, New York
van Aalst MK, Cannon T, Burton I (2008) Community level adaptation to climate change: the potential role of participatory community risk assessment. Glob Environ Chang 18(1):165–179
von Mettenheim K (1996) Presidential institutions and democratic politics. John Hopkins University Press, Baltimore
von Moltke K (1997) Institutional interactions: the structure of regimes for trade and the environment. In: Young OR (ed) Global governance: drawing insights from the environmental experience. The MIT Press, Cambridge, MA
Walker B, Holling CS, Carpenter SR, Kinzig A (2004) Resilience, adaptability and transformability in social-ecological systems. Ecol Soc 9(2):5

Wallis JJ, Oates WE (1988) Decentralization in the public sector: an empirical study of state and local government. In: Rosen HS (ed) Fiscal federalism: quantitative studies. The University of Chicago Press, Chicago

Wandschneider PR (1984) Managing river systems: centralization vs. decentralization. Nat Resour J 24:1043–1066

Weaver RK, Rockman BA (1993) Do institutions matter?: government capabilities in the United States and abroad. The Brookings Institution, Washington, DC

White G (1998) Reflections on the 50-year international search for integrated water management. Water Policy 1(1):21–27

Wiegandt E (2008) From principles to action: incentives to enforce common property water management (chapter 5). In: Wiegandt E (ed) Mountains: sources of water, sources of knowledge. Springer, Dordrecht, pp 63–83

Wittfogel KA (1956) The hydraulic civilizations. In: Thomas WL (ed) Man's role in changing the face of the earth. University of Chicago Press, Chicago

Wolf AT (2007) Shared waters: conflict and cooperation. Annu Rev Environ Resour 32(3):421–449

Wolf AT, Hamner JF (2000) Trends in transboundary water disputes and dispute resolution. In: Lowi MR, Shaw BR (eds) Environment and security, discourses and practices. Macmillan, London

World Bank (1993) Water resources management: a world bank policy paper. World Bank, Washington, DC

World Bank (2003) Sustaining development in a dynamic world. Transforming institutions, growth, and quality of life. World Bank and Oxford University Press, Washington, DC

Yohe G, Tol RSJ (2002) Indicators for social and economic coping capacity: moving toward a working definition of adaptive capacity. Glob Environ Chang 12:25–40

Young OR (1989) International cooperation: building regimes for natural resources and the environment. Cornell University Press, Ithaca

Young OR (2002) The institutional dimensions of environmental change: fit, interplay, and scale. The MIT Press, Cambridge, MA

Young OR (2008) Institutions and environmental change: the scientific legacy of a decade of IDGEC research. In: Young OR, King LA, Schroeder H (eds) Institutions and environmental change: principal findings, applications, and research frontiers. The MIT Press, Cambridge, MA

Young OR, Levy MA (eds) (1999) The effectiveness of international environmental regimes: the causal connections and behavioural mechanisms. The MIT Press, Cambridge, MA

Young OR, King LA, Schroeder H (eds) (2008) Institutions and environmental change: principal findings, applications, and research frontiers. The MIT Press, Cambridge, MA

Chapter 3
Is It Possible to Investigate the Future with Knowledge from the Past? A Conceptual Framework to Study Institutional Adaptive Capacity

There are some enterprises in which a careful disorderliness is the true method.

(Herman Melville)

Abstract The following chapter presents the conceptual and methodological approach of this study, both relying on the theoretical foundations of vertical and horizontal governance, institutions and adaptive management of water resources. In that, we enrich multi-level governance with insights from institutionalism, to untangle its dynamics; and from adaptive capacity, to derive a typology for water governance frameworks. In this chapter, we present the challenges posed by identifying the determinants of institutional adaptive capacity across governance scales. To this end, we combine theory and data-driven approaches to arrive at own determinants and categories in an iterative fashion. We thus distil a final set of five categories of hypothesised determinants: (a) government and governance; (b) infrastructure; (c) information management; (d) human and social resources; and (e) finances and risk. Based on the prevalence of determinants of adaptive capacity and their interactions across scales, a typology of four different governance frameworks is proposed: resistant, reactive-incremental, proactive-incremental and adaptive. We show how the different adaptation strategies and measures allow identifying the type of framework in place by using semi-structured expert interviews from across a representative sample of formal and informal institutions dealing with water resources management in the case studies of the Po River Basin in Italy and the Syr Darya River Basin in the Kyrgyz Republic.

Keywords Qualitative methodology • Expert interviews • Institutional adaptive capacity • Comparative method • Adaptive governance • Water institutions

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3.1 Drawing from the Knowledge of Others

The previous chapter has highlighted a number of studies that have, directly or indirectly, contributed to our understanding of institutional adaptive capacity. We have seen where this concept comes from, in response to what theoretical and analytical challenges it was formulated, and what its main characteristics and implications are. In this book, we will fundamentally recur to a combination of studies on institutionalism and multi-level governance to explain interactions between institutions across scales and the implementation of adaptive actions in the water sector. Further, and stepping out of the political science and IR frameworks, studies on adaptive capacity more specifically have also been considered in order to identify the critical system determinants that lead to the observed typologies of governance arrangements.

The review of the literature that has been conducted in the previous chapter not only provided some useful references upon which to build the conceptual framework, but also revealed the existence of a number of gaps in the current knowledge on institutional adaptive capacity. First of all, we have seen how the literature on institutions and environmental change has illustrated the role of institutions in tackling environmental problems deriving, for example, from the management of common pool resources. However, scholars have also observed that institutional action is often constrained by problems of scale and fit (Cash and Moser 2000; Young 2008, p 18). This means, on the one hand, that a given level of socio-political organisation may not actually be the optimal one to address specific environmental and/or resource-related issues. On the other hand, institutions do not always match the relevant biophysical system, as the latter is increasingly affected by anthropogenic forces that produce non-linear modifications, or state changes (Berkes and Folke 2002; Chapin et al. 2009, p 14). These problems of management and allocation are particularly acute in the case of water resources management, since water flows without respecting political or administrative boundaries, and is often held as a common pool resource (Wiegandt 2008).

Therefore, given the importance of the multi-level dimension of institutional action in the water sector, it makes sense to enrich the literature on multi-level governance with insights from institutionalism and adaptive capacity. Broadening multi-level governance with institutionalism will aid untangling the intersecting dynamics that lie at the basis of the institutional framework for the management, distribution and utilisation of water resources. In fact, the literature on multi-level governance usefully stresses the need to look at the multiplication of functional linkages between policies, actors and principles in order to understand current governance processes in the environmental field (Pattberg and Stripple 2008; Andonova et al. 2009). If combined with the research stream that specifically focuses on how institutions act in a given context to perform socially-desirable functions, the potential outcome is an account of how institutional systems tackle transnational and multi-level environmental and social problems by horizontally and vertically interacting with each other (Pahl-Wostl et al. 2010).

We have seen that most of the literature on institutional adaptive capacity tries and identifies the conditions that (at least theoretically) seem to enable institutional adaptive capacity. Our addition to this consists in combining these conditions in order to produce a typology of water governance systems, based on the capacity of their constituting institutional entities to adapt to change. While the traditional literature has tended to characterise governance according to the organisation and allocation of political roles and functions within a given system (e.g. Rhodes 2007; Thompson et al. 1991), we joined those authors (e.g. Ostrom 2005; Pahl-Wostl et al. 2010) differentiating governance arrangements on the basis of their capacity to learn, change, transform, and/or adapt. In turn, the elaboration of a typology of adaptive governance systems makes perfect sense in the water sector, where, in the past few decades, different prescriptions have been proposed, focusing first on the role of the state, then looking at markets, and finally stressing the importance of user groups and decentralisation reforms (Meinzen-Dick 2007). In the face of increasing disturbances in water systems, such as biodiversity loss, population growth, economic development and climate change, attention needs now to be turned towards understanding the specific characteristics of governance approaches that foster adaptability. The current literature on adaptive governance has persistently focused on the development of theory, thereby assuming that governance arrangements such as the IWRM and AWM are all desirable or key to increasing adaptive capacity. This highly inductive approach has created a gap between theory and practice (Medema et al. 2008) that can now be filled with studies such as this one, contrasting institutional and governance settings on the basis of their effective ability to mobilise adaptive capacity.

Finally, despite the growing body of evidence on adaptive capacity, governance and management, there is still significant scope for the scientific validation and evaluation of many of the assumptions in the literature, particularly in cases that cross both spatial and temporal scales (Chapin et al. 2009). For example, although a governance regime may not present a national or river basin plan for adaptation to climate change, it is possible that water users at the local level have already developed some techniques for coping with uncertainty. Focusing on one governance scale only risks missing some of these processes, and hence fails to explain how adaptive capacity is mobilised in concrete cases. As a consequence, new research is needed that moves beyond the simple assessment of adaptation strategies and plans, and investigates instead adaptive actions in a cross-scale perspective. The relative paucity of careful empirical studies exploring adaptive actions at different levels in periods that might be representative of a future warmer world remains a challenge for the operationalisation and characterisation of adaptive capacity. Similarly, scholars in the field of adaptive capacity have typically been concerned with studying the impact of individual conditions of institutional adaptive capacity, and have not (yet) paid attention to how these are interconnected with each other (e.g. Yohe and Tol 2002; Adger et al. 2005; Eakin and Lemos 2006; Pahl-Wostl et al. 2007). The time has come to assemble these conclusions and to take a step further towards identifying the institutional framework and processes that are most suitable to activate adaptive capacity. The present book aims to do exactly that; to explore the

mechanisms that link together the conditions for institutional adaptive capacity across governance scales by undertaking a dynamic and multi-level analysis of water institutions and how they respond to change.

3.2 Laying the Ground: Analytical Challenges and Definitions-Not as Easy as It Seems

The final set of determinants and sub-determinants used to characterise institutional adaptive capacity in this work is the result of a combination of theory- and data-driven approaches, in an effort to compensate for some of the challenges associated with the measurement of adaptive capacity. In fact, since adaptive capacity remains "latent" in nature, refers to dynamic processes occurring at multiple scales, and lacks baseline data, the process of discovering the conditions to operationalise is inevitably plagued by a number of pitfalls, errors, and contentions. Some of these can be addressed, while others cannot be solved with the knowledge and methods that are currently available in this field. It is nonetheless important to recognise them for the sake of intellectual honesty and in the hope that future researchers will be able to succeed where present research has failed.

First of all, investigating institutional adaptive capacity requires the identification of generic determinants at various scales in order to build models that describe its evolution over time and across space. In this study, the conditions that determine adaptive capacity refer to multiple levels of action and are described on the basis of how well they perform within specific water systems. However, the problem of the applicability of these findings to other socio-political and economic realities remains. On the one hand, it is important to maintain a context-specific approach by analysing how determinants are conjugated in each institutional case. On the other hand, it would be also useful to export these results outside a particular context in order to understand the extent to which individual conditions, and combinations thereof, can contribute to a specific outcome. In other words, research has not clarified yet the extent to which findings are transferable. This is an indeterminacy that obviously casts significant doubts regarding the possibility of creating a general typology of governance arrangements based on the degree to which they show adaptability to change. The analysis of two river basins located in very diverse socio-political and geographic contexts, far from solving the problem of transferability, represents at least a first attempt to overcome this difficulty.

Another major criticism that has been made to existing studies of adaptive capacity is that they rarely conduct an empirical verification of the non-correlation between the different indicators of adaptive capacity, particularly at local and regional scales, and in the water sector (Engle and Lemos 2010). This leads to the problem of ensuring that process indicators and outcome-associated determinants of adaptive capacity are adequately differentiated. For example, it could be questioned whether participation and information are *prerequisites* for constructing an

enabling environment for adaptive capacity, or rather *outcomes* of the presence of a sufficient degree of adaptive capacity within a given institutional system. This issue is further aggravated by the fact that, despite the recognition that the fit between prescriptions and context is what really matters (Ingram 2011), preferences concerning the right mix of modes of governance (e.g. hierarchy/state, market/private, and decentralisation/civil society) are still prevalent within the literature on adaptation and vulnerability. Acknowledging this problem, the present study has developed its own determinants and categories in an iterative way, combining theory with data-driven analysis. Furthermore, institutional adaptive capacity is not considered as a process indicator, but rather as an outcome in its own right. Therefore, it is described as "*the ability of a system to adjust to climate change* (*including climate variability and extremes*), *to moderate potential damages*, *to take advantage of opportunities*, *and/or cope with consequences*" (Engle and Lemos 2010), rather than as "*the set of resources*, *and the ability to employ those resources*, *that are prerequisites to adaptation*" (Nelson et al. 2007).

Even when accounting for all these caveats, the assessment of whether institutional adaptive capacity exists continues to represent an empirical challenge, especially since adaptive capacity refers to the *potential* for adaptation to occur, rather than the concrete adaptation *actions* that are (or are not) already in place in a given context (Brooks 2003). Most of the studies on this subject have taken an action-oriented perspective, focusing on the purposeful activities ("adaptations") that moderate harm from climate change (Smit and Wandel 2006; Eisenack and Stecker 2012). Since the first definition of adaptive capacity in the IPCC Third Assessment Report (IPCC 2001), there has been an increasing number of research efforts aimed at outlining generic and specific adaptive capacities at various scales (e.g. Yohe and Tol 2002; Brooks et al. 2005; Eakin and Lemos 2006; Engle and Lemos 2010). All these studies, however, have encountered data and conceptual problems in qualitatively characterising adaptive capacity, or in incorporating uncertainty into the analysis.

In conclusion, despite the uncertainties that are inherent to adaptive capacity, its empirical assessment remains a strongly-required and highly-demanded endeavour. Whilst the notions of exposure and sensitivity are backed up by a long history of research, adaptive capacity has only recently entered the agenda of scholars in different disciplines, which partly justifies the many doubts that still plague its study. Yet, achieving a more thorough understanding of the potential for adaptation at multiple and interconnected scales is a fundamental step towards assisting policy-makers to fairly and effectively allocate resources to respond to the expected impacts of climate change. Comparing adaptive capacity across countries can also help identify leverage points to reduce vulnerability to climate variability and change, which is likely to be manifested through the increasing frequency and severity of hazards, at least in the short- to medium-term. Before proceeding with the conceptual framework and the research design, it is important to clarify the main concepts that will be used in this study. These are presented in Table 3.1.

Table 3.1 Definition of key terms used in the research design

Concept	Reference	Definition
Climate change	CDKN (2012)	A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use
Water governance	GWP (2004)	The range of political, social, economic and administrative systems that are in place to develop and manage water resources and the delivery of water services at different levels of society
Institutions	Young et al. (2008)	Systems of rights, rules and decision-making procedures that play a complex role in both causing and addressing problems that arise from human-environment interaction. As a consequence, they give rise to social practices, assign roles to the participants in these practices, and govern the interactions among the occupants of the various roles
	North (1990)	
Risk	Brooks et al. (2005)	Risk is conceptualised as relating to compound "climate-related disasters" triggered by climatic or meteorological hazards (e.g., storms, droughts, extreme precipitation events), but mediated by the sensitivity or vulnerability of the exposed systems. Therefore, risk is a function of hazard and vulnerability
	Smith (1986)	
Extreme event	CDKN (2012)	The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable
Adaptive capacity	IPCC (2001)	The ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantages of opportunities, or to cope with the consequences
	Adger et al. (2005)	The capacity of actors (collectively or individually) to respond, to create and to shape variability and change in the state of the system, or the ability to mobilise (scarce) resources to anticipate or respond to perceived or current stresses
	Chapin et al. (2009)	

Source: Author

3.3 A Conceptual Approach for Analysing the Determinants of Institutional Adaptive Capacity

As stated above, the main objective of this study is to shed light on those system properties in the water sector that might enable action in response to climate and socio-economic changes. To this end, adaptive capacity is understood as *the ability of a specific governance arrangement to adjust to the impacts of climate change, including climate variability and extremes, by putting in place adequate preventive measures that also moderate damages and take advantage of emerging*

opportunities (readapted from: IPCC 2001, p 983). Reference is explicitly made to the social component of the system (and not to the natural one), which means that the analysis focuses on the capacity of institutions for water resources management to collectively face the threats posed by climate variability and change, rather than on the capacity of individuals to adapt to climate change as a function of their access to resources. In other words, the object of investigation is institutional adaptive capacity, and not societal or individual adaptive capacity.

As mentioned, the selected determinants of adaptive capacity were derived from a combination of theory- and data-driven approaches to account for the fact that adaptive capacity and relative vulnerability are latent in nature and, as such, cannot be assessed only against empirical observations. Therefore, the variables for inclusion were defined on the basis of theoretical insights on the nature and causes of vulnerability, complemented with first-hand experiences of human-environment interactions as they emerged from a number of preliminary interviews that were conducted with key stakeholders in the two considered case studies (see Sect. 3.4). Methodologically, the combination of bottom-up (inductive) and top-down (deductive) approaches allowed for the generation of a context-specific but transferable analysis, thus also tentatively addressing the challenge of scaling up adaptation research (Smit and Wandel 2006) by aggregating findings at the regional, national and community level. The proposed indicators only refer to the institutional dimension of adaptive capacity. Both the formal and informal institutions that make up the water sector were considered.

As already noted, the literature on climate change adaptation has abundantly identified governance and institutional mechanisms as key determinants of adaptive capacity (Nelson et al. 2007; Brooks et al. 2005). Empirical studies proved that institutions and governance mechanisms can either facilitate or inhibit successful responses. However, more research is needed to uncover the specific processes that explain their capacity to respond in the first place, and how these processes relate and influence each other at multiple levels of action (Engle and Lemos 2010). Even supposing that well-established and functioning institutions are equivalent to high adaptive capacity, and that under-funded and unstable institutions equal low adaptive capacity in theory, it is not clear whether and why this is the case in practice. What does "well-established and functioning", or "under-funded and unstable" institutions mean? What are the intervening variables that explain the relationship between institutions and adaptive capacity on a case-to-case basis? This book attempts to unpack these mechanisms.

It is true, and it must be recognised, that the influence of fluctuations in the determinants is not necessarily direct or clear, and that this renders any attempt to develop systematic indices for measurement and comparison extremely difficult. For this reason, attention is here focused on *how* the different mechanisms linking institutional factors to adaptive capacity play out in two different geographic and social contexts, as well as across multiple scales of political action. The hypothesised determinants of adaptive capacity were considered in relative terms, indicating: (a) how much a determinant contributes to adaptive capacity; and (b) to what extent the same determinant contributes to adaptation outcomes in combination with other

determinants. The formulation of indices of adaptive capacity was avoided, as it risks limiting the analysis to either an aggregate assessment at the national and regional levels (which is too broad for contextualisation), or small-scale case studies (which make generalisations difficult) (Brooks et al. 2005). As the literature on transnational and multi-scale governance has widely highlighted, adaptive capacity must be examined across scales in order to understand how different institutions at different levels interact to produce a common response to impending changes. Knowledge should neither be applicable to individual case studies only, nor be so general that it overlooks the context-specific characteristics of each water system.

Adaptive capacity is now almost a mainstream concept for scholars in the field, although significant challenges persist in its characterisation and measurement (Yohe and Tol 2002). Early determinants of adaptive capacity included a variety of system-, sector- and location-specific features. These regard, for instance, the range of available technological options for adaptation, the availability of resources and their distribution across the population, the structure of critical institutions, the stock of human and social capital, the system's access to risk-spreading processes, the ability of decision-makers to manage credible information, and the public's perception of stress (IPCC 2001). These determinants drew heavily on the vulnerability literature, and although they constituted only a broad-brush attempt at identifying the components of adaptive capacity, they still represent an important starting point from which a more nuanced range of governance and institutional indicators can be developed (Engle and Lemos 2010).

Since 2001, further encouraged by the IPCC's stance on this issue, a growing body of literature has emerged to identify the determinants of adaptive capacity (Yohe and Tol 2002; Brooks et al. 2005; Folke et al. 2005; Pelling and High 2005; Eakin and Lemos 2006; Engle and Lemos 2010). All these studies have argued that more flexible, democratic and participatory designs increase adaptive capacity (Engle and Lemos 2010). In fact, if stakeholders are represented and given the opportunity to participate actively in the decision-making process, they will also be more likely to buy-in and be empowered to effectively respond to the expected impacts of climate change. In turn, this happens as a consequence of adequate knowledge use and the presence of networks that support social learning and flexibility, thus informing better decisions at the resource management level. While this theoretical framework seems flawless on paper, it has not yet been empirically investigated, which means that it is unclear *how* these institutions and governance mechanisms systematically build – or not – the adaptive capacity of water systems to respond to the impacts of climate change (Engle 2007; Wilbanks and Kates 1999).

After having identified the determinants of institutional adaptive capacity as proposed by the literature, we have embarked upon a process of "testing" these determinants with a list of key stakeholders in the research sites. This attempt to match theory- and data-driven approaches immediately revealed a number of important discrepancies and enabled to compile a final list of determinants in an iterative process. Some of the determinants which are considered important by scholars, once assessed empirically, turned out to be of little importance for the performance of the

observed water systems vis-à-vis climate change (e.g. equity). Similarly, determinants that were revealed as important for building the adaptive capacity of institutions within a specific water system in the interviews, have not been discussed in literature and thus seemed to be missing from the list (e.g. technical assistance). Therefore, the initial categories were distilled, re-labelled and merged to guarantee that the final list was adequate to grasp the reality in the two case areas under consideration. The following five categories of determinants resulted from this process: (a) government and governance; (b) infrastructure; (c) information management; (d) human and social resources; and (e) finances and risk (see Table 3.2). These allow exploring, measuring and developing a more nuanced characterisation of adaptive capacity in its institutional dimensions. More specifically, it addresses the question of what it is that builds *ex novo* or increases the adaptive capacity of institutions to respond to climate-induced changes. Wary of the fact that it would be difficult – and of little value – to claim an unequivocal causal link between an outcome and a specific governance approach or institutional characteristic, these determinants are taken as contributing conditions that explain adaptive capacity.

3.4 The Problem of Fit: Arranging Determinants and Processes Towards a Typology of Multi-level Governance Frameworks

In the previous sections, emphasis has been placed on the multi-level nature of the determinants of adaptive capacity. A disjuncture typically exists between where adaptive actions effectively take place and the levels at which adaptive capacity *is thought* to be located, which is also where research generally focuses. For example, the planning of climate change adaptation policies tends to occur at the national level, but the consequences and impacts of such policies are then experienced locally by citizens and communities (Brunner 2010). Young described this as a problem of "fit" (Young et al. 2008) – meaning that inadequate attention is devoted to the complex linkages between socio-ecological and biophysical systems and their manifestation across governance and geographical scales. To address this problem of fit, we will use the concept of multi-level governance. Multi-level governance is here taken to indicate instances in which water resources management occurs at multiple scales, be it at the river basin, local, national, or international one. It thus refers to the diffusion and incorporation of recommendations, legislation, and polices from different decision-making centres (e.g. the incorporation of EU directives into the national legislative framework). It further regards the participation in transnational projects and networks (e.g. participation in a project on irrigation set-up and funded by the World Bank), and the delegation of tasks and responsibilities in terms of water resources management to institutions at different levels of the governance system (e.g. the establishment of River Basin Authorities or Water Users Associations).

Table 3.2 List of determinants selected for the analysis of institutional adaptive capacity (left) and their definition (right)

Hypothesised determinants	Definition
Government/governance: The political dimension of a specific governance system, including all the organisational aspects based on legitimate and institutionalised administrative and bureaucratic practices to enable and guide decision- and policy-making in the water sector	
Water management paradigm	The specific way in which tasks and functions in terms of water resources management are allocated and performed within the general governance framework
Risk and emergency management	The existence of adequate political responses and activities related to disaster risk management and reduction (DRR), including measures to prevent or address emergency situations, as well as early warning mechanisms
Political stability	The extent to which a political system can be defined as secure, predictable and reliable, i.e., the extent to which the elected government can stay in power for the full duration of its mandate, and is able to implement legislative and institutional changes in the system (whenever this is required) and thereby satisfies a majority of constituents
Participatory processes	The context-specific involvement of relevant stakeholders and the public in decision- and policy-making (to various extents) with reference to water resources management, as well as the presence of institutionalised mechanisms for discussion, debate and confrontation between water users, preferably at the river basin level
Legislation and administrative measures	The existence of adequate and enabling legislation, plans, and/or provisions, as well as of a coherent administrative structure aimed at implementing sustainable and effective measures in terms of water resources management, as well as disaster risk management and climate change adaptation
Flexibility, planning and time	The more or less rigid nature of legislative and administrative provisions, as well as the ease with which the process of designing, establishing and operationalizing institutions is carried out, and the capacity of the system to plan and integrate long-term considerations into its decision- and policy-making
Coordination and integration	The existence of mechanisms and/or bodies for achieving direction, control, and coordination of individuals and organisations with varying levels of autonomy, to advance the interests or objectives to which they jointly contribute, and to integrate the results from decision- and policy-making that has taken place in other (related) policy domains
Conflict resolution mechanisms	The presence of institutionalised processes for dealing with and resolving the conflicts arising over water resources management and allocation at different levels, by means of consensus building, negotiation and adjudication mechanisms performed by competent and legitimate authorities
Infrastructure: The availability of material resources and technological and innovation options related to water resources management (and disaster risk management and climate change adaptation), as well as the possibility of accessing technical assistance and investments for the operation and maintenance of the existing asset base	

Technology	The presence (or absence) within a specific institutional system of conditions such as water-access technology, computer technology, technological flexibility, and technological exposure, which can contribute to increasing the responsiveness of the system to climate-induced changes
Technical assistance	The presence of support mechanisms provided by technicians, engineers or institutions with infrastructure and technical competences, and of external actors (e.g., international organisations and donors) to offer assistance related to technical matters aimed at facilitating the implementation of climate-resilient governance frameworks in the water sector
Material resources and infrastructure	The availability of and access to adequate water-related infrastructure, such as hydropower, canalisation and irrigation, sewage and drainage infrastructure, as well as the status and quality in which it is found
Investments (operation and maintenance)	The existence and accessibility of mechanisms and legislative and institutional provisions for channelling investments into the operation and maintenance of infrastructure at different governance levels
Innovation	The capacity of the system to create an enabling environment for the development and experimentation of new strategies or technologies, to revive old ones in response to new conditions, and to explore niche solutions to take advantage of emerging opportunities
Information management: The ways in and processes through which various types of information (e.g., on water availability and quality, climatic and weather trends, socio-economic indicators, and natural disasters) are gathered, analysed, managed and applied by individuals and organisations in the water sector	
Uncertainty	The degree to which uncertainty is accounted for, addressed (minimised) and integrated into decision-making, as to leave it flexible enough to account for eventual and unforeseen changes
Traditional knowledge and management practices	The extent to which traditional knowledge is integrated into decision- and policy-making in the water sector, as well as the ways in which traditional management practices and culture have influenced, and hence are reflected in, the current water governance system
Monitoring, assessment and evaluation	The presence and accessibility of mechanisms, instruments and means to conduct monitoring, assessment and evaluation of existing practices and policies for water resources management
Information and data-sharing and accessibility	The presence of institutionalised mechanisms for data and information-sharing, for example in the form of on-line databases that are simultaneously accessible to multiple users in different locations
Communication and awareness- raising	The extent to which climate change and its expected impacts are communicated to the general public and water managers alike, and hence their awareness and perceptions of impending climate-related challenges, threats and potential conflicts
Climate and scientific information	The availability of and access to good quality (salient, credible and legitimate) scientific and environmental data, as well as the capacity of competent institutions to translate them into usable and comprehensible information for decision-making purposes, with processes of data- and information-collection and dissemination happening across multiple scales.

(continued)

Table 3.2 (continued)

Hypothesised determinants	Definition
Human and social resources: The extent to which the individual and collective dimensions of institutional systems are integrated, thereby reflecting: (a) the individual contributions to water resources management provided by organisational staff, experts, water users and stakeholders (e.g., in terms of their expertise, professional backgrounds, knowledge, and education); and (b) the social and institutional context in which water resources management takes place, shaped by perceptions, group and power relations, and the establishment of partnerships and networks across multiple scales of governance	
Social and institutional capacity	The availability, within institutions, of: (a) human capital, and hence the specific knowledge, professional background, education, and expertise of individuals within institutions; and (b) social capital resulting from staff and resources being put together, thus indicating the general level of preparedness and professionalism of an institution to perform its responsibilities and functions in terms of water resources management
Perceptions, prioritization and sensitivity	The perceptions of climate change and related topics in specific geopolitical and social contexts, together with the priority that is assigned to each of them by policy-makers and the general public alike, and their sensitivity to climate-related risks
Partnerships and networks	The presence of more or less institutionalised cooperative arrangements and relations between individuals, organisations, agencies and institutions, interacting across scales and thereby improving access to information and resources, as well as the coordination of actions in different sectors and the resolution of collective action problems and conflicts
Leadership and political willingness	The presence and role played by leaders in decision- and policy-making processes, thereby indicating their political commitment, initiative, legitimacy and authority, as well as the general level of political will that exists in the system to implement a certain course of action as far as water resources management and/or climate change adaptation and/or disaster risk management are concerned
Group relations, representation of interests	The relations and distribution of power between members of a group, eventually determining the extent to which their different interests and needs are represented in the decision-making process, including equity concerns
Experience	The overall preparedness of specific individuals and societies to respond to the impacts of climate change on water resources, based on the practical and theoretical tools that they have at their disposal to respond
Education and training	The availability of and access to a functioning educational system, offering, inter alia, specific knowledge and technical training on water resources management as well as climate change, including training and capacity-building in the form of conferences, seminars, etc.
Finances and risk: The existence of diversified financial resources (e.g., a broad set of private and public financial instruments), as well as the general level of economic development of a specific country, and the individual and market incentives to initiate one course of action rather than another	
Individual and market incentives	Accounts for both the individual incentives to act (i.e., the motivations linked to the personal profit that a person or a category of persons may obtain from a specific course of action) and the market incentives (i.e., the incentives that the configuration of a market/sector (e.g., hydropower) offers to adopt certain policies or activities rather than others)

Financial instruments	The availability and accessibility of both private and public financial resources to prevent climate risks, anticipate and cover the costs of natural disasters, and provide the required economic resources for investments and innovations
External donors	The transfer of financial and economic resources from e.g., international and regional donors to communities/local/national government through their participation in projects or development aid
Economic development	The general level of income and wealth distribution in a specific region/country
Budget (and costs)	The presence of an appropriate, independent and permanent budget to cover the costs of water resources management, including initiatives aimed at implementing climate change adaptation and disaster risk management

Source: Author

In other words, multi-level governance, both vertical (shifting political power up to transnational levels and down to local communities and horizontal (mobbing responsibilities from governmental actors/authorities towards non-governmental actors) (Eckerberg and Joas 2004, p 407), is here considered as a cross-cutting analytical category that allows understanding the relations between determinants at different scales of action. If applied to the study of institutional adaptive capacity in the water sector, this conceptualisation points to the need to understand both the capacity of institutions to respond to change in a given system *and* the extent to which they interact with each other across and between scales. Accordingly, adaptive capacity does not only depend on how determinants interact to motivate one course of action or another, but also on the governance level/s at which this interaction takes place.

The hypothesis that underpins our analysis is that climate change adaptation in the water sector takes place through cascading decisions in a landscape made up of institutional agents. These range from individuals (e.g., water users and farmers), firms and civil society to public bodies and governments at the local, regional and national levels, as well as international organisations. A general distinction is made between actions that involve the creation of policies and regulations to build adaptive capacity, and those that implement operational adaptation decisions. Actions associated with building adaptive capacity may include communicating climate change information, building awareness of its potential impacts, maintaining well-being and economic growth, protecting property or land, and exploiting new opportunities. By contrast, the activities associated with implementing adaptation decisions are more likely to focus on avoiding or reducing the cumulative adverse impacts of climate change, ensuring that adaptive measures taken by one organisation do not adversely impact those of others, and minimising the distributional impacts of adaptation (Adger et al. 2005).

Bearing these considerations in mind, the proposed applied conceptual framework is based on four main hypotheses. First of all, the identified determinants of adaptive capacity interact across multiple governance levels to produce a specific adaptation outcome. This interaction occurs both horizontally (across governmental and non-governmental/formal and informal institutions) and vertically (across governance scales "below" and "above" the state). Secondly, top-down governance processes are particularly well suited for creating the legislation, policies and regulations that build adaptive capacity. It is likely that these processes are driven by the state, or by a specific agency tasked with this function at the river basin level (if an IWRM approach is implemented). Instead, actions that implement operational adaptation decisions are likely to occur at more localised levels (i.e., farmers or water users), and are only subsequently scaled up towards higher levels (i.e., the state, the river basin level if IWRM is implemented, or the international level) the more adaptation becomes institutionalised. Finally, horizontal and vertical governance (i.e., the creation of partnerships, networks, and participatory decision-making procedures across governance levels and types of institutional actors) favour the operationalisation of adaptation decisions by activating the enabling determinants of adaptive capacity that are reciprocally connected and occur simultaneously.

Therefore, the fundamental research question motivating this book is the following: ***What are the determinants of institutional adaptive capacity in the water sector that allow for building/enhancing its capacity to respond to the expected impacts of socio-economic and climate-related changes***? Attention is devoted to water systems, which are inherently constituted of an ecological and a social dimension. The ecological part comprises the abiotic and biotic components that can be characterised by different attributes such as resource availability, quality, biodiversity, the degree of human influence, and natural storage capacity. These aspects will be described by referring to existing studies in order to adequately contextualise the research. However, attention will be primarily focused on the social dimension of water systems, as it is there that institutional interactions and processes occur to define responses to change. In other words, the water sector is understood as a dynamic system consisting of a natural component, which determines the amount of available water (input), and a human component, which accounts for water demand (output). This input-output interaction takes place throughout a spatial scale that ranges from, and cuts across, the global level to the local one. As noted in the literature review (see Chap. 2), the ways in which water resources are governed depend on the water governance system, defined as the multiple interactions among institutions that have decision-making powers over the allocation, distribution and management of water within a specific context.

Therefore, institutional adaptive capacity refers to the ability of institutions at different levels to cope with and adjust to the consequences of climate-induced and socio-economic changes, and/or to implement responses that incorporate opportunities for transformation. In this sense, each governance outcome is hypothesised to result from the presence or absence of specific determinants of adaptive capacity, and by their combination at multiple scales.

The governance types that are envisaged and presented above are:

1. A resistant (or "sticky") governance framework: This system is characterised by non-adaptive institutions, which are generally not able to adapt to change through learning mechanisms.
2. A reactive-incremental governance framework: This is a system where institutions make changes one after the other, mainly in a reactive way, i.e., to respond to specific situations as they occur. The measures taken are merely responsive, but not anticipatory.
3. A proactive-incremental governance framework: This is defined as a system where institutions make changes one after the other, mainly in a reactive way, i.e., to respond to specific situations as they occur. Measures are mostly reactive and preparatory, but some preventive measures are also taken.
4. An adaptive governance framework: This is a system where institutions are flexible enough to introduce and institutionalise change proactively, by successfully anticipating the impacts of change, integrating uncertainty into their decision-making patterns, and coming up with transformative solutions that address change in a sustainable and effective way.

A governance system will fit into one or the other category amongst those presented above depending on the degree to which it puts in place (more or less gradually) the following adaptation strategies and measures[1]:

(a) Prevention measures: Aimed at preventing the negative effects of climate change and variability on water resources management. They include the minimisation or complete prevention of urban development in flood-prone areas, and the development and implementation of water-efficient methodologies in water-dependent sectors (e.g., agriculture, industry and tourism).
(b) Measures to improve resilience: Seeking to reduce the negative effects of climate change and variability on water resources management by enhancing the capacity of natural, economic and social systems to adapt to the impacts of future climate change. They include, for example, switching to crops that are less water-demanding or more salt-resistant, and operating dams and water reservoirs in such a way that sufficient water is retained and stored in the wet season to balance the water needed in the dry one.
(c) Preparation measures: Aimed at reducing the negative effects of extreme events on water resources management. They include early warning systems, emergency planning, awareness-raising, water storage, water demand management, and technological developments.
(d) Response measures to alleviate the direct effects of extreme events: These include establishing safe drinking water and sanitation facilities inside or outside affected areas during extreme events, and moving assets out of flood zones.
(e) Recovery measures: Seeking to restore the economic, social and natural system after an extreme event, and include activities for the reconstruction of public infrastructure, the restoration of electricity, and the rebuilding of houses.

The existence of measures (a), (b) and (c) indicates that a given water governance system has successfully adopted a proactive and transformative approach to climate-related change. However, adaptation can also happen in a reactive way, which means that the system responds *ex post*, or after extreme events have already happened. As suggested by the United Nations Economic Commission for Europe (UNECE 2009), a reactive-incremental governance system is characterised by measures (d) and (e). When none of these measures is in place, the system is simply resistant, or non-adaptive: it is incapable (or unwilling) to mobilise and eventually alter its basic components and assets in order to produce the required responses to predicted as well as unforeseen problems. By contrast, a successful adaptation strategy includes all the following measures: prevention, improving resilience, preparation, reaction and recovery (UNECE 2009). Of course, "no measures" and "all the measures" represent the two extremes of a continuum, and real cases tend to be located somewhere in between.

[1]This list of adaptation measures and strategies is taken from the United Nations Economic Commission for Europe (UNECE 2009, pp 79–83).

3.5 What Methodological Approach? Expert Interviews and Data Analysis in Comparative Case Studies

In order to collect the data used to respond to the research question explicated above, we recurred to context-based qualitative research. Basically, expert interviews have been used to investigate and assess the adaptive capacity to climate-related and socio-economic changes of the two specific water governance regimes analysed: the one governing the Syr Darya River Basin in Kyrgyzstan, and the one for the Po River Basin in Italy. The research approach was purposely kept qualitative since "*qualitative methods best serve the purposes of addressing research questions that require explanation or understanding of social phenomena and their contexts*, *and explore issues that hold some complexity*" (Ritchie and Lewis 2003, p 2). The ontological position that underpins this study is subtle realism, according to which the social world is accepted to exist independently from the individuals' subjective understanding of it, but remains accessible to the researcher through his/her personal interpretation (Ritchie and Lewis 2003, p 19). This automatically excludes resorting to quantitative methods, since these assume that the social world "*lends itself to an objective form of measurement*, *and that social scientists can reveal the nature of that world by examining lawful relations between elements that have to be abstracted from their context*" (Morgan and Smircich 1980, p 498).[2]

Amongst the range of available qualitative methods, interviews were selected in light of their capacity to provide the researcher with an interpretation of the different ways in which actors represent and construct reality in a given context (Mason 2002). Systematic interviews allow gaining access to the exclusive knowledge of experts in the water sector in order to retrieve their specific practical experience, understanding and vision of the problems under analysis. In this study, an expert is "*a person disposing of special knowledge and decision-making power*, *as well as of the institutional authority to construct reality*" (Mauser and Nagel 2009, p 19). This category also includes knowledgeable citizens and top-level economic, political and governmental decision-makers. The expert interview technique was chosen because water resources management is a field that involves technical expertise that is best understood by interrogating the very actors that possess it. Moreover, this decision makes sense since experts in the water sector are generally entrusted with decision-making power, meaning that they do not only reconstruct knowledge, but also manage its practical consequences under conditions of climate-related uncertainty. In sum, the interviews aimed at systematically retrieving information and reconstructing the 'objective' special knowledge of experts on the adaptive capacity of water governance systems (Mason 2002; Mauser and Nagel 2009).

[2] These comments do not seek to deny the relevance of quantitative methods, or the fact that they can be used to good effect in comparative qualitative analysis in social science (Ragin 1987). Rather, they highlight the relevance and usefulness of qualitative techniques to make sense of the complex nature of social phenomena that offer more positivist approaches to understanding a system's behaviour (Miles and Huberman 1994).

Therefore, water experts were selected across a representative sample of formal and informal institutions dealing with water resources management in the two cases. Interviews were planned in a semi-structured way with the use of a number of indicative questions collected in a topic guide. In addition, face-to-face interactions were privileged whenever possible in order to allow establishing a direct relationship between the interviewee and the interviewer. Otherwise, interviews were conducted with Skype. In general, interviews took place during 2- to 3-month periods of fieldwork conducted both in Italy and Kyrgyzstan. After returning, supplementary conversations were organised to further deepen or extend the issues that emerged from the analysis of the collected information.

In analysing the data that were generated from the interviews, responses were initially grouped according to pre-defined broad categories, which were then modified into categories of meaning based on the data itself through a process of inductive reasoning. According to Lincoln and Guba (1985), this method (which the authors called the "*constant comparative method*") allows for the data to be broken down into discrete units, and subsequently coded as categories that the researcher deems significant for the project's focus-of-inquiry. Categories undergo content and definition changes as units are compared and categorised, and as understandings of the properties of categories and the relationships between them are developed and refined over the course of the analytical process. As summarised by Taylor and Bogdan (1984): "*In the constant comparative method*, *the researcher simultaneously codes and analyses data in order to develop concepts*; *by continually comparing specific incidents in the data*, *the researcher refines these concepts*, *identifies their properties*, *explores their relationships to one another*, *and integrates them into a coherent explanatory model*" [126].

As a first step, interviews have been recorded, transcribed and translated from Russian, Kyrgyz and Italian into English, and then imported into NVivo. NVivo is a computer-assisted qualitative data analysis software (CAQDAS), globally recognised as a reputable tool for managing and supporting the type of analytical work that was undertaken in this study (Bazeley 2007). Clearly, using a CAQDAS does not relinquish the hermeneutic task to the logic of the computer: NVivo was merely used as a tool for efficiency, and did not conduct the analysis and drew the conclusions itself. Importantly, NVivo served to ensure the transparency of the analytical process, since it allowed logging data movements and coding patterns. As a result, all the stages of the analytical process are traceable.

The initial process of data transcription and importation provided a valuable assessment of emerging key themes, and revealed the issues that needed to be covered in subsequent interviews. Archival data (e.g. legal and policy documents) and material from presentations, seminars, conferences and focus groups were also imported into NVivo, and subsequently linked to the transcripts to bring together the primary data and the theories under review. The same procedure was performed for the relevant literature and other electronic sources (e.g. web pages). Demographic data such as 'institution type' (e.g. public, research institute, governmental organisation, etc.), 'institution level' (e.g. local, sub-national, etc.), and 'institution sector' (e.g. agriculture, industry, tourism, etc.) were also recorded.

Specifically, 12 discrete cycles of analysis were planned and conducted. There were two separate cycles of coding for each research site (Northern Italy and Kyrgyzstan), four cycles aimed at managing the codes (including one of merging common and unique codes from each site for cross-case analysis), and one cycle of data reduction through the consolidation of codes into more abstract theoretical categories. In the last four analytical rounds, writing was used as a tool to prompt deeper thinking and reporting on the data (Bazeley 2007). This approach is consistent with Miles and Huberman's suggestion that the researcher should work through cycles of inductive and deductive analysis to better map out relationships, and thus allow codes to change, develop and emerge. To ensure analytical reliability, multiple rounds of coding were performed, instead of recurring to multiple coders, which is what the literature often suggests (Miles and Huberman 1994).

The analysis of the data from the interviews was conducted in five main stages, which were repeated for the two research sites individually, and then in a comparative mode. These stages also determined the structure of Chaps. 4, 5, and 6, where results are reported. The first stage was dedicated to assessing the absolute importance of the hypothesised determinants of adaptive capacity and consisted in running generic matrix queries for each category of determinants. In stage 2, attention was focused on understanding the relative importance of determinants in relation to each other, in order to identify interactions between conditions in different categories. The next and third stage consisted in assessing the multi-level dimensions of determinants, i.e., examining how they related to each other across different governance levels, both horizontally and vertically. In this phase, generic matrix queries were run to plot each hypothesised determinant of adaptive capacity against different sets of governance levels, and more specifically: water users, the local level (e.g. municipalities, local self-governments), the sub-national level (e.g. regional and provincial administrations), the river basin level, the national level (e.g. ministries, the state), and the international level (e.g. IOs, the EU, external donors, and international NGOs).

In the stages 2 and 3, the determinants were analysed in terms of their contribution to adaptation measures and responses. "Barriers" and "bridges" were identified not only by coding the structural elements of the response according to a normative indication, but also by recalling actors' perceptions on which aspects of the system aided or impeded solutions and adaptive responses to climate change. Therefore, two additional analytical categories were created: one grouping the references to the adaptation responses for each case (bridges), and the other the references to the obstacles, challenges and problems encountered before or when implementing adaptation actions (barriers). In stage 4, the determinants were studied in terms of their specific contribution to adaptation responses. This was done by tracking their frequency within the analytical category of "*adaptation responses and measures*", which was further divided into three sub-categories: proactive, reactive, and ideal/required adaptation responses and measures. In stage 5, the hypothesised determinants were examined in reference to the analytical category of "barriers" to understand which condition played out as an obstacle to adaptation, to which extent and why. In both these last stages, the multi-level dimension was accounted for, so as to

allow identifying the governance level/s at which bridges and barriers to adaptation were more likely to manifest in each case study. A chi square statistical test was run to test the significance of the results (detailed in Appendix 4).

3.6 An Unusual Choice of Case Studies: Comparing Italy and Kyrgyzstan

We decided to use the case-oriented comparative method (among many other available social science methodologies) primarily because of its focus on processes within a limited number of cases, towards identifying differences and similarities in light of a given hypothesis (George and Bennett 2005, p 13). The comparison of instances of institutional adaptive capacity in two contexts as diverse as the Po River Basin (in Northern Italy) and the Syr Darya River Basin (in Kyrgyzstan), therefore, aimed at explaining different outcomes on the basis of some conditions that are either present or absent among otherwise similar cases (Hopkin 2010, p 287). The comparative method also turns out to be quite appropriate one for this study in light of its "*capacity to determine the different combinations of conditions associated with specific outcomes or processes*" (Ragin 1987, p 5).[3]

At this point, an attentive reader may wonder what similarities are to be found between Northern Italy and Kyrgyzstan, and whether we should have rather opted for other, more similar case studies. Substantial doubts may be raised about the effectiveness (and feasibility) of comparing cases that are embedded in radically different socio-economic, political and cultural contexts like Northern Italy and Kyrgyzstan. However, it should be remembered that the object of the comparison was the river basin, and not the country. Moreover, we explicitly intended to consider cases from both developing and developed countries in order to expand the traditional focus of studies on adaptive capacity from developing countries in Sub-Saharan Africa or Latin America (e.g. Brooks et al. 2005; Adger and Vincent 2005; Engle 2007; Engle and Lemos 2010) to the European and Central Asian contexts, which have so far been rather overlooked by the literature.[4] Amongst developed states, Italy was a particularly interesting case given its peculiar water governance system, which is characterised by a mixture of private- and state-management, with a strong involvement of sub-national and local governments and civil society. As for

[3] It can be said that the foundations of the comparative method were established by Charles Ragin in 1987 in his landmark book entitled "The Comparative Method: Moving beyond Qualitative and Quantitative Strategies". There, Ragin described cases as "configurations, or combinations of characteristics." In turn, "comparison in the qualitative tradition involves comparing configurations – a holism that contradicts the radically analytic approach of most quantitative work." Therefore, "comparative social science uses attributes of macro-social units in explanatory statements, to explain and interpret macro-social variation." Ragin (1987, p 4).

[4] Two exceptions are the study by Yohe and Tol (2002), which examined case studies from the Rhine and the Netherlands, and Hill and Engle (2011), which considered Switzerland and the United States, *inter alia*.

developing countries, we started from the consideration that Central Asia is poorly represented in studies on the impacts of and potential responses to climate change. The choice of the Syr Darya River basin in Kyrgyzstan was motivated by its similarity with the Po River basin in geomorphological and climatic terms; both river-basins are nivo-glacial, the climate is alpine, water is generally abundant, and extreme events such as floods are common occurrences.

There is a growing recognition that both regions will be significantly affected by climate change, and will therefore be called upon to adequately respond, adapt, and mitigate. In this sense, the present study, by comparing two diametrical different cases as Italy and Kyrgyzstan, constitutes an attempt to gain further understanding of the potential transferability of the adaptive capacity discourse and findings from one socio-economic, political, or even cultural context to another. In fact, the similarities between the two case studies do not refer to the relationship between the dependent and independent variables, but to 'external' geographical and climatic conditions. In turn, this allows for an interpretation of the observed outcomes based on the variation across cases in socio-economic and political (institutional) terms. Moreover, since Kyrgyzstan resulted in being an ideal case to illustrate the resistant governance scenario and Italy better fitted the incremental governance one, their comparison turned out to be an optimal way to analyse and understand what conditions are more likely to lead to one adaptive outcome or another. It also enabled to capture according to which interactive processes, and at what scales this occurs.

Both the Po and the Syr Darya River Basins (and especially the latter) have an important transboundary dimension. However, for the purposes of this study, only the portions falling within the (respectively) Italian and Kyrgyz borders were considered. This choice was motivated by the specific interest in water governance and institutional arrangements, which, while undeniably interacting at multiple scales, are still fundamentally rooted within a state-based legislative, political and management system. In fact, despite most of the literature on water resources management considers the river basin as the main unit upon which policies and actions should be planned and implemented, the reality is that state-based administrations at different levels retain most of the competences in this sector. As a consequence, it was more realistic to look at policy units corresponding to the political jurisdictions that fall within the Italian part of the Po River Basin and the Kyrgyz section of the Syr Darya River Basin, rather than at the hydrological boundaries of the two river basins.

The Po and Syr Darya river basins can be considered fundamentally similar in terms of the geomorphological characteristics of their water systems and their climate conditions. Indeed, both are mountain watershed nivo-glacial regimes, in which climate change has been documented to have an impact on glacial melt and the elevation of the snow line. Similarities, however, finish here. The two regions, in fact, have diverse demands on water resources for productive, consumptive and ecological services. In addition, they operate under highly different water governance modes, and are characterised by divergent political, economic, development, social, cultural and environmental situations. Therefore, it can be said that the two case studies were selected given the strong variation of the independent variables, such as the institutionalised arrangements for participation in decision-making, the availability

of and access to climate information, scientific data and technical resources, the adequacy of budget and financial instruments, and the presence of social and human capital.

3.7 Summary

Building on the literature on institutions and institutional change, multi-level governance and adaptive capacity, this chapter outlined the conceptual and methodological framework underpinning the present research. To this end, Sect. 3.1 illustrated this work's expected contributions to the existing scholarship in political science and environmental studies. In particular, we envisaged significant contributions to the literature on multi-level governance by enriching it with insights from institutionalism in order to untangle the intersecting dynamics that lie at the basis of the institutional framework for the management, distribution and utilisation of water resources. Our addition to the literature on institutional adaptive capacity as it currently stands consisted in combining the conditions that (at least theoretically) would enable institutional adaptive capacity to produce a typology of water governance frameworks, based on the capacity of their constituting institutional entities to adapt to change. Finally, we tried to identify the institutional framework and processes that are most suitable to activate adaptive capacity by exploring the mechanisms that link together the conditions for institutional adaptive capacity across governance scales.

In Sect. 3.2 we identified a number of analytical challenges related to the definition, understanding and measurement of adaptive capacity. In particular, we identified the following problems: generic versus specific determinants at different scales, the applicability of findings to different socio-political and economic contexts, and the verification of the non-correlation between the different indicators of adaptive capacity. As an attempt to overcome them, we presented several conceptual and methodological solutions. First of all, the proposed conditions that determine adaptive capacity refer to multiple levels of action and are described on the basis of how well they perform within specific water systems. To address the problem of transferability and to deduct useful insights from different governance frameworks on adaptation capacity, processes and scale, we analysed two river basins that are located in very diverse socio-political and geographic contexts. Acknowledging the difficulty of proving non-correlation between determinants, we developed them in an iterative way, combining theory with data-driven analysis.

Section 3.3 presented the process by which the hypothesised determinants and sub-determinants of institutional adaptive capacity have been generated through a combination of theory- and data-driven approaches. This accounts for the fact that adaptive capacity and relative vulnerability are latent in nature and, as such, cannot be assessed only against empirical observations. After having identified the determinants of institutional adaptive capacity as proposed by the literature, we embarked upon a process of "testing" these determinants with a list of key stakeholders in the

research sites. We thus came up with the following five categories of determinants: (a) government and governance; (b) infrastructure; (c) information management; (d) human and social resources; and (e) finances and risk. Each category included a number of conditions, that were analysed in terms of their absolute importance in the context under consideration, but also in terms of their reciprocal relationship at governance scale at which they manifested.

In Sect. 3.4, we described the adopted research design in greater detail, introducing the different water governance frameworks and related adaptive measures, followed by the methodological approach this book has taken (Sect. 3.5). We recurred to systemic expert interviews to investigate and assess the adaptive capacity to climate-related and socio-economic changes of the two specific water governance regimes investigated. Water experts were selected across a representative sample of formal and informal institutions dealing with water resources management in the two cases, and interviewed in a semi-structured way with the use of a number of indicative questions collected in a topic guide. The analysis of the data was conducted with the NVivo software to ensure the transparency of the analytical process, as all the stages of the analytical process remain traceable. Twelve discrete cycles of analysis were planned and conducted, consisting of both inductive and deductive analysis to better map out relationships.

Finally, Sect. 3.6 expanded on this methodological approach and illustrated the reasons for choosing a case-oriented comparative method, including its focus on process within a limited number of cases, towards identifying differences and similarities in light of a given hypothesis. The comparison of instances of institutional adaptive capacity in two contexts as diverse as the Po River Basin (in Northern Italy) and the Syr Darya River Basin (in Kyrgyzstan) thus aims at explaining different outcomes on the basis of some conditions that are either present or absent among otherwise similar cases (Hopkin 2010, p 287). The following Chaps. 4 and 5 will present the results for the Po River Basin and for the Syr Darya River Basin respectively.

References

Adger WN, Vincent K (2005) Uncertainty in adaptive capacity. C R Geosci 337:399–410

Adger WN, Arnell NW, Tompkins E (2005) Successful adaptation to climate change across scales. Glob Environ Chang 15(2):77–86

Andonova LB, Betsill MM, Bulkeley H (2009) Transnational climate governance. Glob Environ Polit 9(2):52–73

Bazeley P (2007) Qualitative data analysis with NVivo. Sage, Los Angeles/London/New Delhi/Singapore

Berkes F, Folke C (2002) Back to the future: ecosystem dynamics and local knowledge. In: Gunderson LH, Holling CS (eds) Panarchy: understanding transformations in human and natural systems. Island Press, Washington, DC

Brooks N (2003) Vulnerability, risk and adaptation: a conceptual framework. Working paper 38, Tyndall Centre for Climate Change Research, University of East Anglia, Norwich

Brooks N, Adger WN, Kelly P (2005) The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. Glob Environ Chang 15:151–163
Brunner RD (2010) Climate adaptation and the drunkard's speech. In: 29th Annual Institute of the Society of Policy Scientists. Yale Law School, New Haven, Connecticut, USA
Cash DW, Moser SC (2000) Linking global and local scales: designing dynamic assessment and management processes. Glob Environ Chang 10:109–120
Chapin FS, Folke C, Kofinas GP (2009) A framework for understanding change. In: Chapin FS, Kofinas GP, Folke C (eds) Principles of ecosystem stewardship resilience-based natural resource management in a changing world. Springer, New York
Climate and Development Knowledge Network (CDKN) (2012) Managing climate extremes and disasters in the water sector: lessons from the IPCC SREX report. Retrieved 30 July 2014 from www.cdkn.org/srex
Eakin H, Lemos MC (2006) Adaptation and the state: Latin America and the challenge of capacity-building under globalization. Glob Environ Chang 16(1):7–18
Eckerberg K, Joas M (2004) Multi-level environmental governance: a concept under stress? Local Environ 9(5):405–412
Eisenack K, Stecker R (2012) A framework for analyzing climate change adaptations as actions. Mitig Adapt Strateg Glob Chang 17(3):243–260. http://dx.doi.org/10.1007/s11027-011-9323-9
Engle NL (2007) Adaptive capacity of water management to climate change in Brazil: a case study analysis of the Baixo Jaguaribe and Pirapama river basins. School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI
Engle NL, Lemos MC (2010) Unpacking governance: building adaptive capacity to climate change of river basins in Brazil. Glob Environ Chang 20(1):4–13
Folke C, Hahn T, Olsson P, Norberg J (2005) Adaptive governance of social-ecological systems. Annu Rev Environ Resour 30:8.1–8.33
George AL, Bennett A (2005) Case studies and theory development in the social sciences. MIT Press, Cambridge, MA/London
Global Water Partnership (GWP) (2004) Integrated water resources management (IWRM) and water efficiency plans by 2005. TAC background papers no. 10, Global Water Partnership – Technical Advisory Committee (GWP-TAC), Stockholm, Sweden
Hill M, Engle N (2011) Easing the tension: mobilising adaptive capacity across different scales and dynamics by looking through a lens of choice creation – lessons learnt from empirical research in Chile, USA and Switzerland. In: Resilience conference, 2–17 March 2011, Tempe, AZ, USA
Hopkin J (2010) Comparative methods. In: Marsh D, Stocker G (eds) Theory and methods in political science, 3rd edn. Palgrave Macmillan, Basingstoke, pp 285–307
Ingram H (2011) Beyond universal remedies for good water governance: a political and contextual approach. In: Garrido A, Ingram H (eds) Water, food and sustainability. Routledge, New York
Intergovernmental Panel on Climate Change (IPCC) (2001) Climate change 2001: the scientific basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate. Change JT, Houghton Y, Ding DJ, Griggs M, Noguer PJ, van der Linden X, Dai K, Maskell, Johnson CA (eds) Cambridge University Press, Cambridge, 881 pp
Lincoln Y, Guba E (1985) Naturalistic inquiry. Sage Publications Inc., Beverly Hills
Mason J (2002) Qualitative researching, 2nd edn. Sage, Thousand Oaks
Mauser M, Nagel U (2009) The expert interview and changes in knowledge production. In: Bogner A, Menz W (eds) Expert interviews. Palgrave MacMillan, Houndmills
Medema W, McIntosh BS, Jeffrey PJ (2008) From premise to practice: a critical assessment of integrated water resources management. Ecol Soc 13(2):29
Meinzen-Dick R (2007) Beyond panaceas in water institutions. Proc Natl Acad Sci U S A 104(39):15200–15205
Miles MB, Huberman AM (1994) Qualitative data analysis: an expanded sourcebook. Sage Publications, Beverly Hills
Morgan G, Smircich L (1980) The case for qualitative research. Acad Manag Rev 5(4):491–500

Nelson DR, Adger WN, Brown K (2007) Adaptation to environmental change: contributions of a resilience framework. Annu Rev Environ Resour 32:395–419
North DC (1990) Institutions, institutional change and economic performance. Cambridge University Press, Cambridge
Ostrom E (2005) Understanding institutional diversity. Princeton University Press, Princeton
Pahl-Wostl C, Sendzimir H, Jeffrey P, Aerts J, Berkamp G, Cross K (2007) Managing change towards adaptive water management through social learning? Ecol Soc 12(2):30–38
Pahl-Wostl C, Holtz G, Kastens B, Knieper C (2010) Analyzing complex water governance regimes: the management and transition framework. Environ Sci Pol 13:571–581
Pattberg P, Stripple J (2008) Beyond the public and private divide: remapping transnational climate governance in the 21st century. Int Environ Agreements Polit Law Econ 8(4):367–388
Pelling M, High C (2005) Understanding adaptation: what can social capital offer assessments of adaptive capacity? Glob Environ Chang 15:308–319
Ragin C (1987) The comparative method: moving beyond qualitative and quantitative strategies. University of California Press, Berkeley
Rhodes RAW (2007) Understanding governance: ten years on. Org Stud 28:1243–1264
Ritchie J, Lewis J (eds) (2003) Qualitative research practice: a guide for social science students and researchers. Sage Publications, Thousand Oaks
Smit B, Wandel J (2006) Adaptation, adaptive capacity and vulnerability. Glob Environ Chang 16(3):282–292
Smith S (1986) Theories of foreign policy: an historical overview. Rev Int Stud 12:13–29
Taylor SJ, Bogdan R (1984) Introduction to qualitative research methods: the search for meanings. Wiley, New York
Thompson G, Frances J, Levacic R, Mitchel J (1991) Markets, hierarchies and networks: the coordination of social life. Sage Publishers, London
United Nations Economic Commission for Europe (UNECE) (2009) Guidance on water and adaptation to climate change. United Nations Publications, United Nations, New York/Geneva
Wiegandt E (2008) From principles to action: incentives to enforce common property water management. In: Wiegandt E (ed) Mountains: sources of water, sources of knowledge. Springer, Dordrecht, pp 63–83 (Chapter 5)
Wilbanks TJ, Kates RW (1999) Global change in local places: how scale matters. Clim Change 43:601–628
Yohe G, Tol RSJ (2002) Indicators for social and economic coping capacity: moving toward a working definition of adaptive capacity. Glob Environ Chang 12:25–40
Young OR (2008) Institutions and environmental change: the scientific legacy of a decade of IDGEC research. In: Young OR, King LA, Schroeder H (eds) Institutions and environmental change: principal findings, applications, and research frontiers. The MIT Press, Cambridge, MA
Young OR, King LA, Schroeder H (eds) (2008) Institutions and environmental change: principal findings, applications, and research frontiers. The MIT Press, Cambridge, MA

Chapter 4
The Po River Basin

When you put your hand in a flowing stream, You touch the last that has gone before. And the first of what is still to come

(Leonardo Da Vinci)

Abstract This chapter presents in detail the case of the Po River basin. It starts by outlining its geographical and socio-economic characteristics, including how water is used for different economic purposes by relevant economic sectors, and when and why it gives rise to situations of conflict. As a second step, the main factors that determine and explain the vulnerability of the Po River basin are introduced, as well as its sensitivity and exposure to climate change. The chapter further describes the governance framework for water resources management in place, including actors, roles, policies and conflicts. We complement this overview on the institutional arrangements by looking at how climate change and disaster risk management are currently governed, and thus how the expected pressures could be dealt with. We identify the water governance system in Italy in general, and the Po River Basin in particular, being strongly fragmented and complex, with many institutions at different levels responsible for similar tasks related to water use, disaster risk management and environmental protection, without a distinctive mandate to address climate change through the implementation of appropriate adaptation measures. Analysing the interview data for the Po River basin, we find that the political dimension received greatest attention, immediately followed by the management of human, social and water resources, and information sharing, communication and awareness raising. In turn, financing adaptive capacity and infrastructure were emphasised least, indicating that in the Po River basin, water resources management seems to be strongly dependent upon (and influenced by) political factors, including all the organisational and administrative aspects that enable and guide decision and policy-making.

Keywords Po River basin • Po River basin authority • Basin plan • Climate change scenarios • Socio-economic scenarios • Water governance • Fragmentation

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4.1 Background Information: The Po River Basin and Italy

Throughout history, the Po River has been at the very centre of human and economic development in Northern Italy. The abundant waters flowing from the Monviso Mount in the Western Alps down to the Adriatic Sea irrigated flourishing crops of maize, rice and cereals and generated the electric power that was necessary to trigger the dynamic and successful process of industrial development that has put the Po Valley (*Pianura Padana* in Italian) at the heart of the Italian economy. Since ancient times, communities living along the Po River have tried to control its turbulent waters and limit the danger of floods, so that the neighbouring land could be secured for agriculture and human settlements. Large artificial levees were erected along the Po and its main tributaries, organised into a complex system that today extends for about 900 km. A number of navigable channels, called *navigli* (projected by one of the most famous scientists of human history, Leonardo Da Vinci) were created to connect the river to Milan – it was along the *navigli* that marble blocks were transported from the Candoglia Mount down to the valley in order to build the legendary *Duomo of Milan* (Milan Cathedral). The Po River basin is also an important reserve of unique ecosystems, whose survival today is threatened by heavy pollution (the product of industrial and environmental activities), coupled with unsatisfactory monitoring and an ever-increasing population with scarce environmental awareness and sensibility.

Demographic growth, irresponsible industries, exceedingly irrigation-intensive agriculture, and the development of tourism (particularly in the Alps) are all factors that threaten the sustainability of the Po's water and ecosystem resources. Enough to say that, in recent years, the traditionally water-rich *Pianura Padana* has suffered from grave episodes of droughts, leading water managers and politicians to even call for the adoption of emergency measures – a first time in the history of Northern Italy. Climate change will only worsen these already alarming trends in two obvious ways: by impacting on the intensity and frequency of extreme weather events, and by making water more and more scarce. As such, water resources management in the Po River basin represents a very interesting case for the analysis of institutional adaptive capacity. To what extent are institutions in the region ready to face the threats that impend upon their water resources? And, what kind of adaptation strategies, if any, are planned to respond to future water scarcity? How will institutions prevent flood-related disasters especially in mountain areas?

4.1.1 Geographical, Climatic, Socio-economic and Water System Characteristics

The Po River basin is the largest basin in Italy and one of the largest in Europe, covering an area of 74,000 km^2 (70,000 km^2 in Italy, 4,000 km^2 in Switzerland and France). Its waters cross six Italian regions: *Lombardy*, *Piedmont*, *Liguria*, *Emilia*

Romagna, *Veneto*, *Valle d'Aosta* (Aosta Valley), and the autonomous province of *Trento*. The Po River basin originates from the Monviso Mount, at 2,100 m a.s.l. – it then flows for 650 km until the Adriatic Sea at an average of 1,470 m^3/s. Its tributaries, descending from the Alps and Apennines, amount to a total 141 rivers, and 450 lakes (AdbPo 2010b, p 7). Its delta, covering about 380 km^2, is regarded as one of the most complex estuarine systems in Europe (UNEP 2004). The 58 % of the Po River's whole drainage basin falls within mountain territory (41,000 km^2), whilst the remaining part consists of alluvial plain (29,000 km^2), the so-called *Pianura Padana*. Total water resources in the basin amount to 80 billion of m^3/year. Since the river is typically subject to heavy flooding, it is controlled by dikes for over half of its length (AdbPo 2010b, p 8).

The climate of the basin area, strongly influenced by its orography, is typically alpine in the mountain zone, continental-warm in the flat basin area and Mediterranean on the coast. The average annual temperature, also mitigated by the presence of lakes, is around 5 °C on high Alps, 5–10 °C in medium mountains, and 10–15 °C in other zones. The average annual rainfall value is 1,200 mm per year, unevenly distributed both in space and time: the higher quantity of rainfall is concentrated in the zone of the lakes, in proximity of the higher mountains. As for the temporal distribution, the maximum rainfall is recorded during the spring season (AdbPo 2010a, p 30).

Covering some 24 % of the Italian national territory, the *Pianura Padana* has a resident population of about 17 million inhabitants (one third of Italy's total population). While the population density for the entire basin is about 232 inhabitants/km^2, the two main urban and industrial agglomerations remain the municipalities of Milan and Turin. The highest density of settlements is found in the Lambro-Olona-Seveso catchment basin (around Milan) with 1,478 inhabitants/km^2, while the lowest value corresponds to the upper part of the Trebbia and Parma sub-basins, with only 24–26 inhabitants/km^2 (AdbPo 2010a, p 30). Mainland uses in the region are: urban areas, agro-forests and uncultivated land. Mountains and hills cover the two-thirds of the basin; the remaining one-third is plain. There, agriculture is the main economic activity (together with livestock production), and is characterised by the intensive cultivation of rice, grapes, cereals, vegetables and fruits. In the mountains, the pre-alpine area is covered by forests, pasture and grassland, while the Alps host wide glacial valleys, some of which are cultivated. Finally, some reclaimed lands also exist in the provinces of Ferrara, Rovigo, Ravenna and Parma.[1] Table 4.1 provides a synthesis of the main socio-economic, geographical, and water system characteristics of the Po River basin.

[1] Land reclamation is the gain of land from the sea, or wetlands, or other water bodies, and restoration of productivity or use to lands that have been degraded by human activities or impaired by natural phenomena. Source: OECD, Glossary of Statistical Terms, retrieved July 29, 2014 from: http://stats.oecd.org/glossary/detail.asp?ID=1496

Table 4.1 General characteristics of the Po River basin

Po River basin: general characteristics	
Total length	650 km
Area	74,700 km^2
Average altitude of the basin	740 m a.s.l
Plain territory	28,400 km^2
Minimum flow	275 m^3/s
Maximum flow	10,300 m^3/s
Minimum daily flow rate at Pontelagoscuro	165 m^3/s
Maximum daily flow rate (peak flow) at Pontelagoscuro	10,300 m^3/s
Annual runoff	46.5×10^9 m^3/year (60 % precipitations)
Number of main rivers in the watershed	28
Extension of hydrographical network (natural and artificial)	55,700 km
Water volume of alpine lakes	1.25×10^9 m^3
Average flow	1,470 m^3/s
Average yearly precipitation	1,108 mm
Annual average temperature	5–10 °C
Population	16 million inhabitants (1/4 Italy) up to 1,478 inh/km^2
Average population density	225 inh/km^3
Economy (GDP)	38 % of total national GDP
Industry	37 % of total national industry
Labour force	46 % of total national employees
Agriculture	55 % livestock (in 5 provinces)
	35 % of total national agricultural product
Energy	48 % energy consumption at national scale
Municipalities in the basin	3,204

Adapted by author with data from AdbPo (2010a, p 71)

4.1.2 Characterisation of Water Use in the Po River Basin

Total water resources in the basin amount to 80 billion of m^3/year. Water abstraction from surface water bodies is about 25.1 billion of m^3/year (63 %), versus 5.3 billion of m^3/year from groundwater (37 %). However, different uses employ surface or groundwater in different percentages. Irrigation prevalently employs surface water (83 %), while the 80 % of potable water derives from groundwater sources, the 15 % from streams, and the 5 % only from surface water (Raggi et al. 2007, p 3). Urban runoff is unmeasured but plays an important role for irrigation purposes especially during periods of drought. Infrastructure for treating wastewater only partially covers urban areas, which can cause several problems in terms of water quality and pollution. Lakes also offer an important source of freshwater, particularly in the Lombardy region. Important artificial tracts intersect natural branches

the Po River basin for about 375 km (from Tanaro to Po di Goro); some of these sub-/basins are used for hydropower generation. Artificial reservoirs along the river and its tributaries are also exploited for flood control (AdbPo 2010a, b).

The current utilisation regime of water resources in the Po River basin is the result of the process of economic development that has characterised Northern Italy since the 1950s, which has translated in a strong increase in water demand. For example, in the brief period from 1975 to 1987, water withdrawals underwent an augmentation of 35 %. Overall, the Po area has become a strategic region for the Italian economy, with significant agriculture, livestock, industry and tourism sectors that account for the 40 % of the Italy's total GDP. However, two economic activities prevail: agriculture and industry. In fact, the Po basin is home to 37 % of Italy's industry, and provides 35 % of the country's agricultural production.

Agriculture in the *Pianura Padana* produces cereals, including rice, which notably requires heavy irrigation. Farming activity in general is carried out on 31,000 km^2 of cultivated land, 50 % of which is irrigated. Irrigation, therefore, represents the major use of surface water accounting for the 40 % of total water withdrawals from surface water. At the same time, industrial (excluding hydropower) and household consumption account for, respectively, 4.5 % and 11 % of total surface water withdrawals (these needs are prevalently met by groundwater resources). The specific amounts of water withdrawals are listed in Table 4.2.

The most important industrial activities in the area are chemicals, engineering, textiles, paper, and food production. To sustain their energy needs, hydroelectric stations and some coal/oil power stations using the water of the Po River as coolant have been built in the Pianura Padana, on the flanks of the Alps. More generally, electricity consumption in the Po River basin accounts for 48 % of the national total and is supplied by 269 hydroelectric plants and 11 thermal power plants (Raggi et al. 2007).

The legislative framework that governs the system for the release of authorisations for water withdrawals in Italy still makes reference to the "*Testo Unico sulle Acque*" (Royal Decree 11/12/1933) approved in 1933. It contains the standards for large and small water withdrawals, as well as for the public use of water resources; thus also specifying the various subjects that have the right to obtain this type of license in the first place. The 1933 Royal Decree was ground-breaking in its attempt to regulate water catchments directly, and to harmonise the scattered legislative and administrative scenarios that had governed water resources in the recently unified Italy.

Table 4.2 Water withdrawals for main economic sectors

User groups	Volumes withdrawn in millions of m^3/year	Abstraction from	
		Surface water (%)	Groundwater (%)
Household	2,500	20	80
Industry	1,537	20	80
Agriculture + livestock	17,700	83	17
Total	21,737	63	37

Adapted from Raggi et al. (2007)

However, the problem is that the 1933 Royal Decree remained in vigour until 1998, while the type and intensity of water use in the country had obviously undergone radical changes well before then. Especially significant were the alterations as a consequence of the process of industrialisation that took place after the Second World War in Northern Italy.

In 1998, at last, the Legislative Decree n.112 (dated 31/03/1998) was enacted to reallocate the management of public waters (including public water withdrawals, research, extraction and use of groundwater, and protection of the groundwater system) to regional and local administrations, provinces and town councils.[2] Yet, the 1998 legislation largely failed to consider water as a primary good to be protected and managed in an integrated way. The decree continued treating it instead as a tool to achieve sectorial objectives in terms of economic production (irrigation, hydropower and industry). Even today, withdrawal licenses are allocated on the basis of considerations related to the mere physical availability of water resources, without taking into account the water balance at the river basin level. Thus, despite the relative abundance of water that the Po River basin has always experienced (differently from the central and Southern parts of Italy with prolonged and almost structural conditions of water scarcity), conflicts between different water uses and users have started to arise in recent times. If we consider that water consumption for agriculture and livestock is estimated to account for 67.8 % of the total water availability in the Po River basin, it is easy to see that the other economic sectors, despite constituting an important part of the economy of the basin, may not be contented with the remaining 32.2 % of water resources that they receive (Braga and Bertolo 2006).

More generally, the current water governance in the Po River basin presents a number of problems at different levels of analysis. At the interregional scale, for example, quantitative water rights are a major factor of concern. Upstream regions (Piedmont and Lombardy) use a larger amount of water than downstream ones, thus leaving the latter in a situation of water shortage especially in the summer season, when lack of rainfall or winter snow increases the risk of droughts. In addition to water quantity issues, the Po River is affected by serious pollution in some areas

[2] For administrative purposes, since 1970, Italy is divided into 20 regions, which roughly correspond to the historical regions of the country – they are the first-level administrative divisions of the state. The regions are further divided into 110 provinces (*province)*, which, in turn, are subdivided into town councils or municipalities (*comuni*). The five 'special status' regions (*regioni a statuto speciale*) of Friuli-Venezia-Giuila, Sardinia, Sicily, Trentino-Alto Adige and the Aosta Valley are autonomous or semi-autonomous due to particular ethnic or geographical considerations. Participation in national government is a principal function of the regions, and regional councils may initiate parliamentary legislation, propose referenda, and appoint three delegates to assist in presidential elections. The regions can also enact legislation necessary for the enforcement of state laws and have the right to acquire property and to collect certain revenues and taxes. Regional and local elections are held every 5 years. Regions acquired a significant level of autonomy following a constitutional reform in 2001 (brought about by a centre-left government and confirmed by popular referendum), granting them residual policy competence. However, their financial autonomy is quite modest: they just keep 20 % of all levied taxes, mostly used to finance the region-based healthcare system.

(Raggi et al. 2007). Despite the existence of a license system to regulate the discharge of water from point sources, water quality controls are rare, and so are economic and financial measures aimed at reducing water pollution from the agricultural sector. Quality problems especially affect the regions of Emilia Romagna and Lombardy, due to the bad quality of the waters of the Lambro-Olona River. Downstream effects of pollution along the coast are also a cause of major concern for the tourist industry in the Adriatic Sea (Raggi et al. 2007).

Therefore, on the one hand, the Po River basin is "blessed" with generous amounts of natural water resources, as a consequence of the presence of the Alps and its accumulated water resources in form of snow, as well as a number of subalpine lakes with a large storage capacity. On the other hand, the intense exploitation of water resources in the last decades has translated into a significant source of stress for the water system, as oftentimes demand comes to exceed supply. Current climatic trends, in addition, threaten to reduce water availability even further by bringing about a decrease of total precipitations coupled with an increase of average temperatures (AdbPo 2010a).

It is therefore important to explore the climate as much as socio-economic scenarios that are forecasted for the Po River basin in order to assess what change will look like. This presents a fundamental preliminary step to understand what type of interventions are needed and how to best introduce them into the water governance system in Northern Italy to ensure that the needs and interests of all stakeholders continue to be met. As a synthesis of the analysis included in the 2010 Po River Basin Management Plan (AdbPo 2010a, b), Table 4.3 presents an illustration of the likely pressures that will influence future water demand in the Po River basin.

4.2 Climate Change and Socio-economic Scenarios in the Po River Basin

With regards to Europe, the IPCC AR5 concludes that significant changes in temperature and rainfall will occur with high confidence in Europe, with increases in temperature projected throughout Europe and increasing precipitation in the North and decreasing precipitation in the South (IPCC 2014). Additionally, there will be a marked increase in the frequency and intensity of heat waves, meteorological droughts and heavy precipitation events, although with variations across the continent (IPCC 2014). Climate change has already affected multiple sectors in Europe, and will continue to do so in the years to come. In the Mediterranean (Southern) region, tourism, agriculture, forestry, infrastructure, energy and population health are particularly vulnerable to the effects of climate change; in northern Europe, shifts in agriculture production will occur, and severe loss of ecosystem services is expected in Alpine regions with high confidence (IPCC 2014).

In this context, the Po River basin represents quite a special case, in that it is situated on the borderline between the area that is subject to Central Europe climate influences and the Mediterranean region. For Central Europe, climate scenarios

Table 4.3 Synthesis of main pressure factors on water resources in the Po River basin

Water use	Pressure factors
Household	Demographic growth (especially in recently industrialised urban areas, tourism destinations, and as a consequence of immigration)
	Decrease of water availability as a consequence of climate factors or the introduction of environmental requirements/constraints
	Insufficient maintenance of infrastructural network
	Increase of demand in certain seasons as a consequence of tourism
	Increase of non-civilian (commercial and industrial) utilizations, e.g., hotels, gardening
Industry	General tendency to reduce water consumption for industrial use, as a consequence of
	Evolution of the economy towards the tertiary sector (services)
	Diffusion of less water-consuming technologies, as a consequence of the introduction of more advanced environmental legislation on industrial waste and discharge
Agriculture (irrigation)	Irrigation is the most water-consuming sector. Still, the irrigation needs of parts of the river basin are not entirely met – also as a consequence of the "set aside" principle (defined by the EC Agricultural Policy of 2000 – and according to which farmers that want to access to public funding have to leave uncultivated 10–12 % of their lands each year)
	If, however, this principle is removed (as it happened in 2007–2008), more water will be needed for irrigation purposes – and eventually withdrawn from groundwater sources
Energy (hydropower)	Although not "consuming" the resource, water quality is affected and the modification of the natural course of the river (as water is stored in reservoirs for hydroelectric production)
	Already the hydropower potential of the Po River basin is exploited for its 90 %
	Today, investments in hydropower have augmented as a consequence of Italy's commitment in terms of climate mitigation (Kyoto Protocol) ⇒ it will be difficult to apply restrictions to the release of licenses in the future
	This is true especially for small hydropower, which have already drastically increased after the incentives offered by the liberalisation of the energy market (Decreto Bersani)

Adapted from AdbPo (2010a)

project an increase in total precipitations, which will be particularly concentrated in the flood season (autumn and spring). Instead, for the Mediterranean area, models indicate a 30 % reduction of summer precipitations (AdbPo 2011, p 1). A significant portion of the Po River basin also falls within the Alpine range, for which predictions are yet different. Given these fundamental uncertainties, it is necessary to define scenarios at the local and river basin levels in order to understand the most probable climate hypotheses for the future of the Po River. In particular, attention should be focused over the evolution of snow storage in glaciers and eventual changes in the hydrological regime of watercourses, which in turn will impact the quality of water bodies.

In the following Sect. 4.2.1, a more detailed view of the prospected impacts of climate change on water resources in the Po River basin is proposed. These are based on the findings reported by the Po River Basin Authority (Po RBA) in the 2010 Po River Basin Management Plan (AdbPo 2010a, b), as well as the most recent research on Alpine regions as presented by Giorgi and Lionello (2008), Simolo et al. (2012), and Brugnara et al. (2012). Section 4.2.2 then elaborates on socio-economic scenarios that are deemed equally relevant for the future of the basin.

4.2.1 Climate Change Impacts on Water Resources in the Po River Basin

4.2.1.1 Rainfall Projections

Meteorological records indicate that the total number of rainy days in Italy has decreased by 14 % from 1951 to 1996, particularly during the winter season. The amount of total annual precipitation has also diminished, especially in the central and southern regions of the country. In addition, during the same period, persistent droughts have grown more frequent (UN 2009). Similar trends have been observed in the Po River basin. There, average annual rainfall has diminished by 20 % since 1975, and the average yearly discharge at Pontelagoscuro, near the lower end of the river, has fallen by 20–25 %. Table 4.4 summarises the values of the average annual rainfall for the decade 1990–1999 with reference to the period 1960–1990 in the different areas of the Po watershed and disaggregated by season.

From here, it can be seen that winter and summer precipitations have diminished in all the considered areas, while autumn precipitations have increased (with the exception of the Adriatic area). In addition, it has been observed that the amount of rainfall has drastically declined in the months of January to August, which are also the months that can be used for planting and growing most of the agricultural crops cultivated in the basin (AdbPo 2011).

These trends are in line with the ones identified for the future of the wider Mediterranean region. There, precipitation will undergo a general increase in

Table 4.4 Average seasonal and annual rainfall (mm) in different sections of the Po River basin for the time period 1990–1999 with reference to the average value for the period 1960–1990

Region/season	Winter	Spring	Summer	Autumn	Year
Alps	−8.7	−12	5.2	11.8	−2.9
Adriatic coast	−17.6	−11.8	−13.3	−0.9	−10.9
Tirrenic coast	−20.7	−9.1	−7.5	38.3	0.2
Central Po basin	−17.9	−18.7	−13.1	16.9	−8.2
Western Po basin	−11	−29.9	−8.2	13.6	−8.6
TOT	−15.7	−17.9	−10.4	16.1	−7

Source: AdbPo (2011)

variability during both the wet/cold and the dry/warm seasons. This increase in precipitation variability appears to be generally consistent with the intensified hydrological cycle expected under warmer conditions. During wet periods, the precipitation intensities increase in response to greater atmospheric water holding capacity, while the wet periods are separated by longer dry periods due to feedback with generally drier land areas (Giorgi and Lionello 2008, p 98; Brugnara et al. 2012, p 1406).

More accurate projections for the Alpine range show that the Alps will experience the least pronounced drying, therefore playing an important role in mitigating the change towards drier climates. A decrease in winter total precipitations is still evident over the last 50–60 years, but its contribution to yearly trends is generally negligible (winter being the driest season) and balanced by a growth in autumn (Brugnara et al. 2012, p 1406). However, in the summer season, drying is prospected also for the Alps. This increase of summer variability, in conjunction with an increase in the mean warming, could lead to more frequent heat waves of magnitudes similar or even greater to the one that occurred in the summer of 2003 (Giorgi and Lionello 2008, p 102). In addition, looking at daily data, it is evident that the Alps will be subject to a significant increase in very intense precipitation, both in terms of the number of events and their contribution to total precipitation amounts (Brugnara et al. 2012, p 1406). It should also be noted that the spatial coherence of these increases is generally low, suggesting that higher resolution is needed to thoroughly assess the behaviour of heavy rainfall. Besides spatial variability, these trend strictly depend on the period studied and the season (Brugnara et al. 2012, p 1407).

4.2.1.2 Temperature Projections

On the basis of the data for the time period 1865–1996, it is possible to note that declining rainfall was accompanied by a general increase of both minimum winter and maximum summer temperatures. In Northern Italy, maximum temperatures have increased by nearly 0.6 °C and minimum temperatures by 0.4 °C. Particularly from 1988 onwards, annual temperatures have remained constantly higher than the average for the reference period 1960–1999. Winter and spring temperatures have all increased starting from the 1990s. In summer, temperatures have remained above the average from 1985 onwards – in the last 3 years, however, minimum temperatures have increased by up to 2 °C with respect to the time period of reference.

This change in average temperatures has further accelerated the melting of glaciers in the Alps. There, atmospheric warming has been found to be stronger and clearer than in other areas (Beniston et al. 2003), with summer warming starting to become particularly severe since the 1970s (Bocchiola and Groppelli 2010). A recent inventory of the Italian glaciers, performed from the Comitato Glaciologico Italiano, shows a decline of about 29 % in the glacier surface in the periods from 1959–1962 to 2005–2011 (Diolaiuti et al. 2012, p 443). More recent evidence points in the same direction, and even suggests that glaciers' area in the Italian Alps has undergone a 21 % reduction between 1991 and 2003: glaciers smaller than 1 km^2

have accounted for 53 % of the total loss in area (Diolaiuti et al. 2012, p 443). Despite the uncertainty that surrounds these findings, there is little doubt that reduced ice cover and ice melt are likely to have significant implications for aquatic biodiversity and hydropower production (Fatichi et al. 2013).

For the Mediterranean region (within which the Po Valley falls), it was found that in the warm season inter-annual variability tends to increase, which is consistent with the observed increase in precipitation variability and the associated feedbacks between the surface water and energy budgets. This increase in variability, along with the large mean warming, is expected to produce a much more frequent occurrence of extremely high temperature events and heat waves (Giorgi and Lionello 2008, p 98). In the cold season, the temperature variability shows only small changes, and mostly negative in the late decades of the century. This has been at least partially attributed to the decrease of snow cover under warmer conditions, which also reduces the effectiveness of the snow-albedo feedback mechanism (Giorgi and Lionello 2008, p 98).

In turn, these changes translate into a generalised reduction of the annual average discharge of the Po River, which from 2005 has gone below the 1,000 m^3 per second (meaning a reduction of 20 % in the last 30 years). In particular, water in the Po River has diminished by 30 % for the period between January and August, and by 50 % in the summer season.

To summarise, climate and hydrological observations in the Po River basin point towards a future scenario characterised by decreased rainfall, which nevertheless will tend to be concentrated in the autumn season, thus worsening the risk of extreme events like floods. Temperatures have already significantly augmented in the entire basin, leading to a drastic reduction of snow precipitations and the volume of glaciers, and hence increasing the risk of water crises of short to medium length. Finally, the discharge of the Po River has importantly decreased – a phenomenon that can be attributed only partly to changing climatic conditions. Human pressures, and especially the overly generous and unproductive regime of water concessions regulating withdrawals from the Po River, can also be taken as key explanations for this decline.

4.2.2 Not Only Climate Change: Analysis of Socio-economic Pressures in the Po River Basin

Climate change will not be the sole variable defining water availability for humans and ecosystems; socio-economic factors also intervene by crucially modifying water distribution and consumption patterns, as well as water quality. This is particularly true for the Po River basin, as a consequence of the intense industrial and agricultural activities that are conducted on its territory, as well as the behaviours and needs of its inhabitants, for example in terms of energy and potable water consumption, tourism and other services. Therefore, it is important to consider more in

detail how these interlinked dimensions are prospected to impact on the demand for water resources in the future, and hence how the balance between water demand and supply can potentially change.

As for water availability, the analysis conducted in the previous section using the IPCC scenarios demonstrates that the Po River basin will increasingly experience situations of "too little water" eventually leading to serious droughts (as it occurred in the years of 2003 and 2006), as well as "too much water", in which the chances of disastrous flood events will be heightened (like in the years of 2000, 2008 and 2010). The following paragraphs discuss how the different economic uses of the water resource (demand) are likely to vary against this unstable situation (supply).

4.2.2.1 Consumption by Households

In the Po River basin the total resident population has tended to slightly augment in the past 20 years, especially since 2000. This is mostly due to migratory movements, in turn resulting from the relatively higher economic development that Northern Italy has experienced since the end of the Second World War. During the 1960s, 1970s and 1980s migratory patterns were still prevalently internal and followed the South-North path. In turn, from the 1990s onwards immigrants from other countries (Eastern Europe and North Africa primarily) have also started to move to the urban centres of Milan, Turin and Genoa in order to be employed in the flourishing Northern Italian industrial sector. Therefore, while Italian families continued to pursue the low/no-growth rate that is typical of modern industrialised societies, the high degree of migration has contributed to shifting the population level higher and higher. This increase in resident population tends to be matched by a proportional growth in terms of withdrawals for domestic purposes, according to Eurostat data (2008).

4.2.2.2 Consumption by Agriculture

As already discussed, the agricultural sector in the Po River basin occupies an important share of the total economic activity in the region. Looking more closely at the trends for agricultural output and production as displayed in Fig. 4.1, it is possible to observe that both have tended to augment in the last 20 years. Nonetheless, fluctuations are rather significant, indicating the high vulnerability of this specific economic sector to natural and physical conditions.

Figure 4.2 further shows that the total animal and crop outputs have augmented, while the productions that have undergone the least increase are cereals and industrial ones.

With these considerations in mind, the trends in terms of water withdrawals for irrigation purposes may seem rather surprising. In fact, the consumption of water for irrigation purposes seems to diminish starting from 2003, pointing to the possibility that more effective irrigation techniques have been introduced in the agricultural

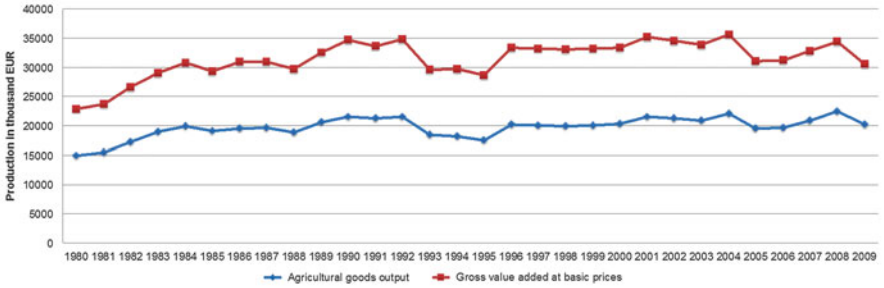

Fig. 4.1 Trends in the agricultural sector (in terms of gross added value of agriculture production to total GDP and total agricultural production in thousands of EUR) for the years 1980–2009 (Source: Eurostat (data extracted October 21, 2012))

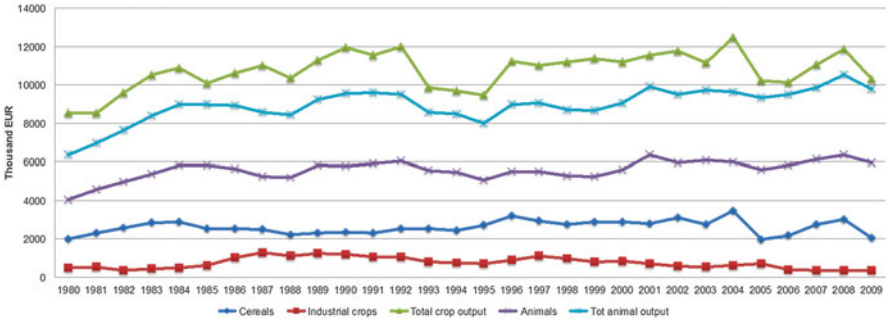

Fig. 4.2 Total agricultural output – total crop (including industrial crop) and animal output (in thousands of EUR), in the Po River basin for the years 1980–2009 (Source: Eurostat (data extracted on October 21, 2012))

sector of the *Pianura Padana*. However, a more accurate analysis of the different irrigation techniques adopted in the basin reveals that no substantial changes in irrigation techniques have occurred in the past 10 years. The only exception includes a slight decrease of the total agricultural land that is served by surface irrigation (constituted of water intensive ditches and traditional flood irrigation systems), which nevertheless remains predominant, and a minor increase of land with sprinkler irrigation systems.[3] As a consequence, one may speculate that the diminution of

[3] In general, three main irrigation methods can be identified. Surface irrigation involves the application of water by gravity flow to the surface of the field. Surface irrigation is the easiest and least costly method, but is usually highly inefficient (only less than 10 % of the water is taken up by the plant). Sprinkler irrigation systems instead, imitate natural rainfall: water is pumped through pipes and then sprayed onto the crops through rotating sprinkler heads. These systems are more efficient than surface irrigation, however they are more costly to install and operate because of the need for pressurised water. Finally, drip irrigation delivers water through the use of pressurised pipes and drippers that run close to the plants and can be placed on the soil surface or below ground. This method is highly efficient because only the immediate root zone of each plant is wetted. In addition, it allows for the precise application of water-soluble fertilisers and other agricultural chemicals. For an updated discussion of irrigation techniques, see (Conway 2012).

water withdrawals for irrigation purposes that occurred after the 2003 drought was due to a behavioural change from the side of water users in the agricultural sector, who, fearing future situations of scarcity, have simply started using less water to irrigate their fields. In turn, if this pattern towards improving the efficacy of irrigation techniques continues, it may, at least partly, compensate for the prospected increase of agricultural activity and production.

4.2.2.3 Consumption for Hydroelectric Production

Despite the fact that hydropower does not 'consume' water but only 'uses' it and then releases it back into the natural system, it is important to briefly discuss its role in the Po River basin. The abundance of water resources that has typically characterised the Po River basin has allowed the development of numerous hydroelectric installations along its course. On average, there are 890 hydroelectric plants located in the Po catchment, producing 8 GW (or the 48 % of the total Italian hydroelectric production). In total, the Po River basin counts 174 natural and artificial reservoirs regulating 1,858 million of m^3/year of water. Of these, 143 are exclusively used for hydroelectricity, while the others serve various other purposes. The average annual production of hydroelectricity in the Po River basin is 20 trillion of KWh (AdbPo 2010b).

In general, however, hydropower installations in Northern Italy tend to be out of date as a consequence of the fact that most of them were built before the 1950s and proper maintenance has been rare. In addition, withdrawals licenses have been released following an ad hoc approach, which responded to individual demands from hydropower producers. This fragmentation has, so far, impeded the implementation of coherent programs of infrastructural modernisation (AdbPo 2010b). Today, the Northern Italian hydropower sector, having developed without a coherent plan in mind, conflicts with other users of water resources, and in particular with the agricultural and environmental ones.

Figure 4.3 shows the evolutionary trend of hydropower production in the Po River basin for the period 1980–2011. Despite numerous variations, it can be seen that the overall tendency points towards a steady augmentation of the demand for electricity, which translates into the increased exploitation of water resources to this end. In addition, hydroelectricity is destined to augment as a consequence of Italy's commitments under the Kyoto Protocol (as a member state of the European Union) in terms of climate change mitigation. Recently, there has been a significant increase in the demand for licenses for new hydropower instalments and/or the restoration and rehabilitation of existing ones. Government authorities are trying to keep these demands in check, by posing higher environmental standards and requirements (CIPRA 2011).

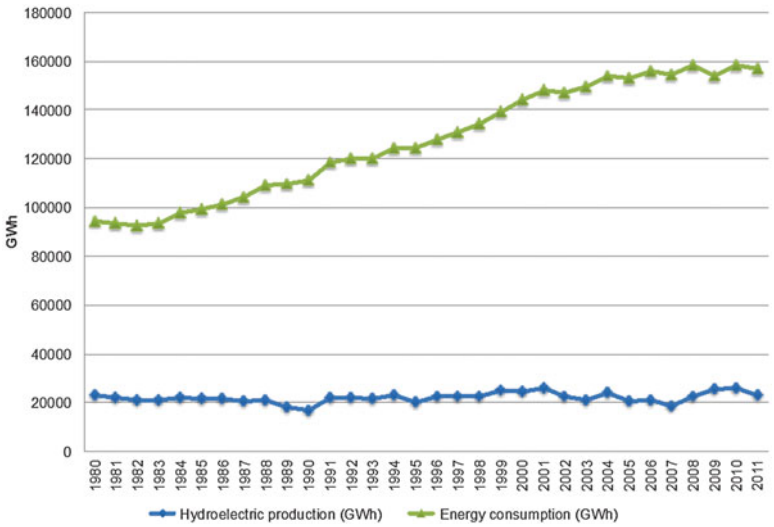

Fig. 4.3 Total energy consumption (GWh) and hydropower production for the Po River basin, 1980–2011 (Source: ISTAT online (data 2012))

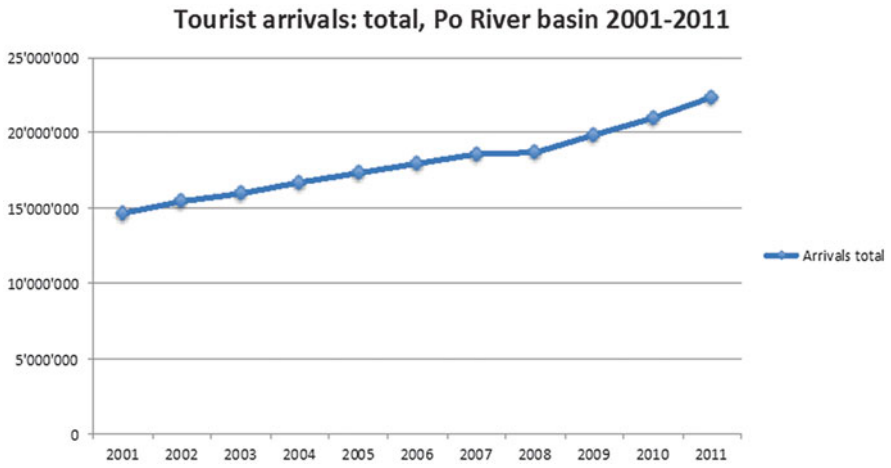

Fig. 4.4 Total number of tourist arrivals in the Po River basin from 2001 to 2011 (Source: Eurostat (data extracted: October 23, 2012))

4.2.2.4 Consumption by Services (Tourism)

As Fig. 4.4 demonstrates, tourism in the Po River basin has undergone a relatively significant augmentation in the last 10 years. In particular, mountain regions have become an attractive destination for skiing and other outdoors activities. In the valley, it is mostly the lake areas (Lombardy and Veneto) that receive high numbers of

Fig. 4.5 The Agriturismo La Tensa, located in Domodossola (Italy) is an illustrative example of the new tourism trends that have characterised the Po River basin (and in particular its Alpine regions) in recent years. Until the 1960s, the Tensa was a fraction of the municipality of Domodossola. However, its original inhabitants have progressively left the rough mountain life to move to the surrounding urban areas, leaving la Tensa and its land (once used for subsistence agriculture) empty and at the mercy of the expanding forest. Between 2000 and 2009, a number of interventions aimed at rehabilitating the area were carried out, following traditional construction methods (e.g. using local woods and stones) but reinterpreted to ensure their ecological compatibility and sustainability. For example hot water is produced by burning coming from the pruning of local fruit trees, and solar panels are used to produce hot water for domestic consumption and for the restaurant. The village, now at the entire disposal of tourists coming from all over the world, is surrounded by orchards producing peaches, pears, apples; a factory with cows, hens and pork; and beehives for the production of honey. Naturally, the restaurant only uses local products – some of which are also exported to local and national markets. For more information see: http://www.agriturismotensa.it/ (Source: Author)

visitors every year. More recently, an important industry around food and wine has also developed in the *Pianura Padana*, with thousands of tourists staying in so-called *agriturismi* (farm houses resorts) to enjoy local culinary specialties (see Fig. 4.5).[4]

The Alpine share of the Po River basin appears to be particularly vulnerable to the development of the tourist sector. In fact, tourism demands significant amounts of water in both the winter and summer seasons, during which the overall resource availability is actually lower. This problem is magnified by the tendency to exploit more intensively those areas that are located at higher altitudes (for example for skiing), where water supply is more difficult and hence more expensive because of

[4] *Agriturismi* are generally large rural houses where local families host guests and provide them with foods prepared from raw materials produced on the farm or anyway locally. They first started in the mid-1980s with the promulgation of Law 22 May 1985 no. 34 (called "Agriturismo law"), which allowed private houses situated in rural areas to host from six to ten guests. The law was conceived to respond to the increasing abandonment of rural areas in Italy, as a consequence of the diminishing profitability of small scale farming that had coincided with the process of industrialisation in the 1950s. Today, *agriturismi* are rather profitable enterprises, popular especially between the middle-upper class in Italy, and attract tourists from all over Europe.

the distance from villages and cities. During winter, the production of artificial snow clearly plays an important role in increasing water consumption for tourism, although artificial snow only represents a minor voice of the overall water demand at the river basin level. Climate change is predicted to reduce the amount of snow precipitations, thereby increasing the requirement for artificial snow even further, unless some explicit policies and incentives are provided to move ski resorts to higher altitudes (CIPRA 2011, p 14). In summer, tourism is developing around activities such as fishery, inland navigation, swimming and hiking. Also these developments can enter into conflicts with other water uses.

Concluding on the trends of sectoral water consumption, it is likely that, if they continue, agriculture will require an increased amount of water for irrigation purposes. This is due to the projected reduction of precipitations and the out-dated irrigation infrastructure and technology that is currently used in the *Pianura Padana*. The overall trend for the industrial and services sectors will also be a positive one, implying more pressing demands for water resources. If coupled with the need to recur to hydropower as a source of energy, as a probable consequence of Italy's commitments to GHGs reductions under the Kyoto Protocol, these considerations clearly point to an increased risk for disputes to emerge over the allocation and utilisation of the Po River's water resources.

4.3 Water Governance in Italy: Actors, Roles, Policies: and Challenges

As already evidenced, the Po River basin is located in a region that has traditionally been characterised by water abundance as a consequence of the natural storage capacity of Alpine glaciers and lakes. Therefore, the water situation in the Northern part of Italy is quite the opposite to the one of Southern Italian regions. Here, the water resources are considerably lower (due to the Mediterranean and dry climate), making situations of water scarcity and eventually droughts the norm rather than the exception. In order to take this double reality into account while responding to the increasing demands for water coming frantically from a society in rapid economic and demographic growth, the Italian policy and legislative framework regulating water resources management had to evolve considerably during the last century.

Until the early 1970s, water legislation, fundamentally based on the provisions of the 1933 Royal Decree on Water Resources, was kept reasonably simple.[5] In the 1970s, as a consequence of the need to implement European Community

[5]The legislative text of 1933 defined water merely in terms of its function to serve the general public interest, thereby implicitly distinguishing it from private water: from a legal point of view, this meant that water resources, which were previously considered as private, were now to be considered entirely public, unless they were of no use for the public interest at all. The 1933 regulation, through the instrument of *concessioni* (licenses) aimed at the achievement of economic and productive objectives, established a definitive public control over water resources, which remained in place until 1998.

environmental regulations, new legislative instruments were enacted: Law 319/1976 which aimed at the protection of water quality, and Legislative Decree 152/1999 that focused on quantitative aspects. The latter represented a significant attempt to adopt a more coordinated approach between the water sector and other regulations related to soil defence and water services. Beforehand, Legislative Decree 275/1993 had already tried to amend the licensing system (60 years after its first introduction in 1933) to make it more efficient and impartial; it was backed up in this sense by Law 36/1994 (hereafter *Galli Law*), which re-affirmed the principles of the 1933 legislation, according to which all water resources shall be considered public, water uses are organised in a hierarchical fashion, and the criterion of solidarity applies.[6] In addition, and fundamentally, the Galli Law introduced the concept of Integrated Water Services, leading to a complete reform of the water sector.

The 2000 European Community (EC) Water Framework Directive (WFD) (Directive 2000/60/EC), however, brought about the urgent need to, once again, reclassify and reorganise the entire legislative and administrative framework regulating the water sector in Italy. This occurred by means of Law 308/2004 and Legislative Decree 152/2006, referred to as the "*Environmental Code*" or "*consolidated text on the environment*", and subsequently amended in several occasions. Although recommended by the WFD, this Environmental Code lacked a 'strong' part dedicated to environmental principles (Bardelli and Robotti 2009). In it, water was no longer considered as a simple asset, but as an exhaustible resource to be managed and protected in an integrated fashion. However, although fundamentally including regulations on soil, water protection and water services within one legislative document, the coordination offered by Legislative Decree 152/2006 was only formal. Basically, the Environmental Code was the sum of other regulations on water (Laws 183/1989 and 36/1994, and Legislative Decree 152/1999), but did not considerably revise them. In addition, it left out the issue of water withdrawals concessions, which paradoxically remained regulated by the single text of 1933. Still, this piece of legislation is considered a first step towards the implementation of the IWRM principle in Italy.

Similarly to water legislation, also the Italian water policy is fragmented and addresses the issues of water exploitation, civil protection, and environmental and water quality in a sectorial way. From the 1970s onwards, the water policy regime has evolved towards incorporating a higher degree of *complexity*, characterised by broader and multiple policy objectives. It addressed quantitative and qualitative issues, and related water to its environmental and health dimension. The regime has also moved towards a higher degree of *decentralisation*, as an ever increasing number of actors have been brought in to perform water management-related tasks.[7]

[6] Law 5 May 1994, n. 36 'Disposizioni in materia di risorse idriche', *Gazzetta Ufficiale della Repubblica Italiana*, 19 January 1994, n. 14, article 1 (free translation by the author).

[7] From the 1970s onwards, Italy has started facing a gradual process of institutional decentralisation, which has led, inter alia, to the creation of regions in 1972 and 1978 (Law 112/1999).

The first fundamental change with respect to the traditional system for water resources management, whereby municipalities were in charge of withdrawing and distributing water resources, was brought about by the Galli Law (Law 36/1994), aimed at the modernisation of the hydraulic sector and the initiation of "a *new deal towards the privatisation of water services*" (Bardelli and Robotti 2009, p 3).[8] The Galli Law fundamentally attempted to reduce fragmentation by charging operators (and not municipalities) with both the production and distribution of drinking water within their territories of competence. This new Integrated Water Service Management (IWSM) approach was achieved through the establishment of Optimal Territorial Areas (OTAs), defined as specific relevant areas for the operation of water services, such as drinking water, wastewater treatments, sewers, and so forth. OTAs were defined on the basis of the river basins' geographical limits (principle of territorial aggregation), and fell under the jurisdiction of regional authorities. In addition, the reform initiated by the Galli Law recognised the centralisation of water management in comprehensive organs denominated River Basin Authorities (RBAs). These RBAs were already established in 1989 by Law 183/1989 and charged with the "*protection of lands, water rehabilitation, the use and management of hydro resources for the rational economic and social development, and protection of related environment*" (Art.1).

Basically, the Galli Law provided for four levels of regulatory responsibilities. At the national level, the Committee for the Control and Use of Water Resources (*Comitato di Vigilanza sulle Risorse Idriche*, COVIRI), a Ministerial body without enforcement powers, was tasked with the overall supervision of water resources management. At the basin level, Regions and Basin Authorities dealt with environmental regulation, infrastructural planning and benchmarking. At the sub-basin level, OTAs provided for service contract, economic regulation, and control of performance. Finally, at the local level, municipalities retained the ownership of the infrastructure and the responsibility for setting up the OTAs (Triulzi 2004). In 2006, the Environmental Code (Legislative Decree 152/2006) repealed the Galli Law, but the main legal framework for water services in Italy has remained anchored on the latter's provisions.

Despite the model proposed by the Galli Law, the Italian authorities followed Law 152/1999, stipulating that water resources should be primarily managed at the regional level. Accordingly, the most important bodies deputed with water resources management are the Regional Councils and the Regional Agencies for Environmental Protection (*Agenzie Regionali per la Protezione Ambientale* ARPAs). Each Region enacts its own laws, while Provinces are in charge of local implementation. At the national level, the Italian Ministry for the Environment, Land and Sea (IMELS) and the National Agency for Environmental Protection offer overall supervision and coordination of water management efforts.

[8] Before the Galli Law, almost 9,000 small operators worked in the Italian water sector and their dimensions did not constitute a sufficient basis for significant investments in technological renovation (Bardelli and Robotti 2009).

For the Po River basin, the most important body for water resources management, together with the regions, is Po River Basin Authority (RBA).[9] The Po RBA comprises of a Secretary General, an institutional committee, a technical committee and a technical-operational secretariat. As the main decision-making body, the institutional committee includes representatives of several ministries (Public Works/Environment, Territory/Agriculture, Forestry/Cultural Assets), the presidents of the Regional Councils in the basin, and the Secretary General. The technical committee, chaired by the Secretary General and formed by experts and regional representatives, is the consultative body of the institutional committee. The Secretary General, who is elected by the institutional committee, plays the central role of overseeing and coordinating the basin authority's activities and directing the secretariat.

The main objective of the Po RBA is the drafting and implementation of a River Basin Plan, which covers soil defence, hydrogeological and hydraulic reorganisation, and water and land utilisation within the entire river basin. Therefore, the plan represents an attempt of integrating all the water management and flood risk projects that are already in place at more decentralised levels, i.e., within municipalities, provinces and regions. The River Basin Plan is prepared by the Po RBA Secretariat in cooperation with the technical committee, and is adopted as a project proposal by the institutional committee. Subsequently, the proposal is published in the official gazette and regional newspapers so that all interested parties can comment on it. The regions analyse the comments collected within their jurisdiction and send a revised Basin Plan to the institutional committee for adoption (CABRIVolga n.d.). After a second approval by the institutional committee, the Basin Plan is passed on to the national level for final validation by the National Council of Ministers.

In compliance with its mandate under Law 183/1989 and with the EC WFD 2000/60, the Po RBA conducted the drafting and implementation process for the Po River Basin Plan in 2009. The main idea was that this document should integrate all the water and flood risk management plans that already existed at the regional level within the Po River basin. As mandated by the Basin Plan, and in line with the objectives of the EU WFD 2000/60, the Po RBA also conducted the consultation process that informed the Plan for the Water Balance for the Po River basin (*Piano di Bilancio Idrico del distretto idrografico del fiume Po*, henceforth PBI) and initiated a Draft Hydrogeological Risk Exposure Plan (*Piano stralcio per l'Assetto Idrogeologico*, henceforth PAI) in 2011, in accordance with the EU Directive on the Assessment and Management of Flood Risks (2007/60). The PAI aimed to produce a comprehensive mapping of the Po River basin's territory, in order to identify the zones that are most vulnerable to landslides, floods and other hydraulic risks. In turn, this vulnerability assessment served to guide the planning process of targeted protection and prevention policies. Interestingly, the provisions of the PAI had an immediate and legally binding effect on all public administrations and public entities.

[9] In Italian: *Autorità di Bacino del Fiume Po* (AdbPo 2010a).

The discourse on climate change has, so far, only limitedly entered the Italian water sector. In the Po River Basin, the Po RBA has played an important role in initiating a discourse on climate change adaptation. For example, climate change was defined a "*strategic and priority area of intervention*" in the Basin Plan (AdbPo 2010a, p 24) as a consequence of the concerns that were expressed by water users during the consultation process that was conducted between 2009 and 2010. According to the indications offered by the Po RBA, priority should be given to: (a) reversible actions to integrate uncertainty; (b) "soft adaptation" measures to account for the scarce availability of resources; (c) research and monitoring to increase the existing knowledge base; (d) building the water's system resilience by integrating policies in differing but relating sectors (soil and environmental protection, agriculture); (e) disasters risk prevention; (f) downscaling of climate models and projections to the local scale; and (g) information and data sharing, also and especially across disciplines, individual actors and organisations, including at the international level (AdbPo 2010a, p 24).

4.4 Having a Ferrari Without a Driving License: Institutional Adaptive Capacity in the Po River Basin

The following section discusses the main findings on institutional adaptive capacity that emerged from the interviews conducted with 30 water experts in the Po River basin.[10] As previously illustrated (Chap. 3), respondents were asked to mention different determinants of adaptive capacity falling into the dimensions of government and governance, infrastructure, information management, human and social resources, and finances and risk.

By looking at the number of times respondents mentioned these different determinants, it is immediately evident that, in the case of the Po River basin, the political dimension (government-governance category) was the one that scored the highest (36.8 % of total references). This was followed by the dimensions of human and social resources (23.8 %) and information management (19.6 %). Interestingly, the determinants associated with finances and risk and infrastructure were the ones to be least mentioned by respondents (10.3 % and 9.5 % respectively).[11] In addition, strong relationships could be identified between determinants in the human and social resources category and those in the government-governance one. Similarly, interviewees often discussed information-related determinants in association with human and social resources, and government-governance. In turn, it appears that linkages between the category of finances and risk and that of infrastructure with all the other categories were not so frequent.

[10] Fieldwork took place in the Po River basin from January to May 2011. A complete list of the interviews that have been conducted is presented in Appendix 1.

[11] The total and relative number of references for each combination of categories and determinants is reported in Appendix 3.

Therefore, at first sight, the interview data seem to indicate that in the Po River basin water resources management is considered to be strongly dependent upon, and influenced by, political factors, including all the organisational and administrative aspects that enable and guide decision- and policy-making. Changing institutional behaviour to integrate climate-related concerns, consequently, relies on the capacity of the political system to call for and implement modifications in the current water governance framework. Naturally, such capacity is strongly related to the human and social resources that are available in the system. Firstly, this regards the understanding of current problems and identification of appropriate solutions from the side of policy-makers and administrators. This, in turn, depends on their experience and professional background, as well as on the availability of educational and training opportunities. Secondly, human and social resources refer to the required leadership and political willingness to guide and facilitate learning processes and the implementation of new operational modes.

These considerations explain why the category of human and social resources came second in terms of its perceived relevance to address climate change. The ways and processes through which various types of information (on water availability and quality, climatic and weather trends, socio-economic indicators, natural disasters, etc.) are gathered, analysed, managed and applied by individuals and organisations in the water sector (i.e. determinants in the information management category) were also indicated by respondents as relatively important. Instead, the availability of and access to material resources and technological and innovation options, as well as financial and economic resources were not so crucial in the case of the Po River basin, as respondents only mentioned them in the 19 % of cases altogether. In fact, in the words of one interviewee, "*having the infrastructure and the money without the capacity to use and allocate it to solve the problems that effectively exist in the water sector today is like having a Ferrari and no driving license.*"[12]

4.4.1 Reconnecting Water to Politics

In the government and governance category, the water and risk and emergency management paradigms were frequently mentioned by respondents (19.3 % and 14.9 % of total references within this category, respectively). Indeed, these two conditions seemed to represent the core political structure within which actions in the water sector are supposed to take place. First of all, water management was seen as especially connected to the determinant of group relations and representation of interests, thus suggesting that interest groups play a critical role in the Italian water sector (as also noted by: Mosello 2007; AdbPo 2010a, b, 2012). Leadership and political willingness were also negatively connected to water resources

[12] Cit. from interview with respondent at national level, conducted by the author in Rome (Italy) on December 16, 2010.

management, reflecting a shared feeling among water managers and NGOs representatives that the political world is not adequately concerned by the problems that affect the water sector in the Po region today (see Raggi et al. 2007).

Insufficient budget was related to the current water management paradigm, which reflects the generalised situation of poverty of the environmental sector in Italy (as also reported in WWF 2011). The cross-references between failures in the water management paradigm, and climate and scientific information, as well as insufficient monitoring, assessment and evaluation pointed to two other grave problems that mark the water system in the Po River basin: (a) the lack of sufficient integration of scientific data into policy- and decision-making over water resources management; and (b) the insufficient monitoring of effective water withdrawals, which gives rise to the overexploitation and consumption of water resources. Interestingly, traditional knowledge and practices were also related to the difficulties that the water management paradigm is experiencing in Northern Italy today. This is especially true since they rely significantly on "hard" infrastructure solutions to address changes in water availability – an observation that is further confirmed by looking at the cross-references between problems in the water management paradigm and the material resources and infrastructure determinant.

The high number of references to the risk and emergency management determinant (14.9 % of total references in the government and governance category) can be read as a confirmation of the relevance of this sector in terms of water resources management. The Civil Protection Department (*Dipartimento della Protezione Civile*, DPC) is the central organ in charge of directing and coordinating disaster-related activities, and intervening in the management of events that require extraordinary resources because of their extent and duration. It has traditionally played a key role in flood management and post-flood recovery, together with more localised authorities like Municipalities and associations of citizens and groups of civil volunteers.[13] Disasters risk management was also related to education, training, communication and awareness-raising. In particular, respondents mentioned the importance of communicating the idea that risks cannot be annulled, but have to be opportunely and pre-emptively addressed. Channels of communication here include, for instance, educational programmes in schools for the general public, conferences, seminars and trainings for policy-makers. In this sense, experience of past extremes was indicated as a useful condition for better managing disaster risks, although inadequate social and institutional capacity was accused of acting as a great limitation to the effective implementation of preparatory actions in the water sector (see also UNECE 2009, p 41). Respondents said that material resources and

[13]The National service of civil protection was established with law no. 225 dated 24 February 1992, later integrated and modified by law no. 401 dated November 9, 2001 and no. 152 dated July 26, 2005. Over the years, the responsibility regarding civil defence has progressively been passed from the State to local authorities. The main steps of this process were legislative decree no. 112 dated 1998 and the modification of Title V of the Constitution with constitutional law no. 3 dated October 18, 2001, with which the Civil Protection became a concurrent subject of legislation, thus of regional competence.

infrastructure could help in this sense, but only for reactive adaptation; the same reasoning holds true for technology.

In terms of economic resources, it would seem that the water as well as the DRM sectors have suffered from the economic crisis that has been plaguing Italy – budgetary cuts have hit the environmental sector, with water resources and disasters risk equally being still considered as 'environmental' issues, more than others. External donors were said to be potentially helpful to overcome these limitations. A similar positive role was attributed by respondents to financial instruments like insurance mechanisms, although these have only been attempted in an experimental way in some areas.[14] Finally, interviewees pointed to climate and scientific information (28 % of total references in the information management category) as factors that contribute to risk and emergency management by addressing and reducing uncertainty, and helping plan and operationalise early warning systems.

Just as risk and emergency management, the coordination of actions and initiatives at different levels in the water sector, as well as the integration of other issues (such as health, agriculture, etc.) into water-related decision-making were deemed to be important conditions (17.5 % of references in the government and governance category) to help the water sector respond to the changes in resource availability and demand. According to respondents, however, water resources management in the Po River basin continues being generally characterised by a low level of coordination between activities and tasks at different governance levels, as well as by an insufficient degree of integration of related policies in other sectors (e.g., health, agriculture) (Raggi et al. 2007). In particular, unsuccessful coordination was mentioned in association with unequal power relations and the presence of interest groups, as well as with lack of political willingness and weak leadership. The problem of coordination was also said to affect the relationships between governmental agencies and scientific bodies, leading to the failure to adequately transform scientific and climate data into usable information for decision-making purposes (see also UNECE 2009, p 21).

The legislative, administrative and policy framework in its current status was generally said to be satisfactory in terms of its contents, although not always adequately implemented. For example, some respondents mentioned in this respect the legislative provisions according to which monitoring stations should be located along the course of the Po River to measure withdrawals for irrigation purposes. A further aspect regards that existing law would also provide for regular quality con-

[14] For example, the Piedmont Region has started, already in 2003, a project aimed at the re-localisation of infrastructure (i.e. buildings) situated in areas characterised by a high hydraulic and hydro-geological risk. Regional Legislative Decree No. 53-10220 has defined a number of initial criteria for the release of financial resources aimed at stimulating the process of relocation of private and public entities to more secure areas in a number of municipalities (29 in total). The criteria were further refined and updated in 2007, 2009 and 2010 – and facing the lack of economic resources that the Piedmont Region had at its disposal for this type of activity, a priority order between the criteria was also established. Overall, the project has led to the re-localisation of properties at risk in 8 municipalities, and proved a successful measure against the flood that hit the region in 2011.

trols of water resources, especially in areas characterised by a high industrial concentration. Nevertheless, more often than not, these regulations are blatantly disregarded. In turn, the non-implementation of legislative and administrative provisions was attributed to the complete lack of political will to actually deal with these problems. No open mention was made to corruption.

Under the determinant of flexibility, planning and incorporation of time dimension, respondents characterised the water system in the Po River basin as a rather rigid one. This is partly due to the lack of adequate institutional capacity to rapidly implement changes, which, in turn, was associated with insufficient budget. The rigidity that typically characterises the institutional framework of the Po River basin was said to be further reinforced by the bureaucratic culture that continues to predominate in Italy. The tendency to recur to hard infrastructure to adapt to environmental change, which actually perpetuates existing inequalities and does little to alleviate underlying vulnerabilities, would seem to contribute to it. In addition, interviewees denounced the persistence of a management approach based on short-termism, resulting from a generalised lack of understanding of what climate change is, and of its impacts on water resources. However, short-termism was also attributed to the particular structure of the political system in Italy, especially at the sub-national level, where policy-makers tend to pay more attention to those issues that enhance their chances to be re-elected, rather than to longer-term concerns such as climate change.[15] In a context characterised by a very limited budget, this implies that climate change adaptation is automatically placed at the bottom of the political agenda, and priority is given to more immediate preoccupations that have immediate visibility amongst the electorate.

Conflict resolution mechanisms were only briefly mentioned (2.6 % of references in government and governance category), and mostly in combination with participatory processes – with particular reference to the cases of the "*River Contract*", "*Lake Contract*" and "*Roundtables for Water Crises*" experiments (Riva and Cucca 2007).[16] Participatory processes were said to bring positive outcomes when associated with equal relationships within groups and the representation of the interests of all stakeholders involved in the water sector (see also UNECE 2009,

[15] Cit. from interviews with respondents at local and civil society levels (municipality administration, NGO representative), conducted by the author in the Piedmont region (Italy) in January 2011.

[16] Facing the drought event of 2003, which caused a generalised situation of reduced water availability in the Po River basin (especially for the downstream parts of the river basin, where water is predominantly used for agriculture), two instruments for participative negotiation were proposed and operationalised: the *Contratto di Fiume* [River Contract], and the *Contratto di Lago* [Lake Contract]. The voluntary subscribers to such contracts were compelled to work together to achieve the objectives foreseen by Regional Law 26/2003 (approved by the regional administration of Lombardy as a special measure to face the drought-related emergency), which called for the integration of public and private stakeholders into all decisions regarding the protection of water resources and ecosystems in the basin, as well as the prevention of hydro-geological risks. In addition, a number of collaborative agreements for a sustainable utilisation of the water resources were reached by means of so-called *Tavoli di Crisi Idrica* [Roundtables for Water Crises], in which all the main stakeholders participated under the coordination of the Po Basin Water Authority (Riva and Cucca 2007).

p 40). At the same time, leadership was attributed an important role in facilitating participatory processes. As an example, this was the case for the "*Roundtables for Water Crises*", where the Po RBA took a strong position and successfully coordinated the negotiation and consultation processes. Importantly, participation was also connected to communication and awareness-raising, which favoured the capacity of stakeholders to discuss and come to shared solutions over the management of water resources. When talking about conflict resolution, respondents mentioned some attempts at identifying the potential of disagreements between users, thereby intervening more in a "conflict prevention" sense. For example, they discussed the project SHARE-Alpine that primarily aimed at developing and testing a decision-support tool based on multi-criteria analysis in order to prevent conflicts over water allocation and utilisation between hydropower producers and farmers in the Aosta Valley (SHARE 2009).[17]

4.4.2 Human and Social Resources for Water Management in the Po River Basin

In the human and social resources category of determinants of institutional adaptive capacity, perceptions, prioritisation and sensitivity were most often mentioned by respondents (24 % of total references in this category), saying that, in the Italian water sector, climate change is still not seen (and consequently treated) as a priority issue. Instead, it is poorly understood especially by policy-makers at the national and sub-national levels, who therefore are not motivated enough to intervene in a proactive manner to prevent and/or mitigate its effects on water resources (see also UNECE 2009, p 44). The determinant of perceptions was associated with the budget one in the sense that, according to interviewees, the lower the perception of urgency that is attributed to current problems in the water sector (among which is climate change), the lower the budget that tends to be allocated to address them. Another important connection was made between the determinant of perceptions and the one of climate and scientific information, since the latter increases the sense of urgency around the issue of climate change, especially if opportunely communicated to decision-makers and the general public. However, uncertainties remain and

[17] The Sustainable Hydropower in Alpine Rivers Ecosystems (SHARE)-Alpine space project started in 2009 and ended in July 2012. It represented an attempt to create the necessary tools to inform decision-making on how to integrate economic and environmental standards in order to trigger "*a new generation of eco-investments to mitigate the impacts of hydropower and to restore the quality of water bodies*" (SHARE 2009). The approach underpinning the SHARE project merged scientific tools, local specificities and operational requirements, and was supposed to be operationalised by means of existing scientific tools adjustable to transnational, national and local regulations, and implemented by permanent panels of administrators and stakeholders. Lead by the ARPA of the Aosta Valley, and co-funded by the European Regional Development Fund, SHARE was supported and implemented by 13 partners, including universities, local authorities and NGOs from Italy, France, Germany, Austria and Slovenia.

strongly impact perceptions. In fact, from the interviews, it emerged that the high degree of uncertainty that surrounds the topic of climate change diminishes the capacity of decision-makers to understand it and hence to address it. Also, it causes distorted ideas that translate into useless or even damaging policies.

Further, social and institutional capacity was often called into question by respondents (22.8 % of total references). Accordingly, the water governance system in the Po River Basin and in Italy more generally, was said not to be adequately staffed. Mostly as a consequence of the budget constraints resulting from the economic crisis that has invested Italy in recent years (WWF 2011), organisations have poor funds for hiring competent personnel, or training the existing one on new issues and challenges, such as climate change. Human capacity tends to be scattered across institutions and is not organised into a network that can inform and implement concrete and integrated actions. This problem was denounced particularly by researchers. Individual and market incentives did not play a positive role either: interviewees denounced the lack of young professionals in the water sector, since salaries are comparatively lower than in other public domains.[18]

Numerous references were also dedicated to the determinant of group relations and representation of interests (18.2 % of total references in this category), a fact that is indicative of the importance that interest groups have in the water sector in Italy, and in the Po River basin more specifically.[19] The type and extent of the pressure that is exercised by these actors was said to be highly context-specific, meaning that it is not possible to identify one situation in which a certain course of action will be opposed for sure; each decision depends on the traditional configuration of interests in the territory. To provide an example, farmers, associated in consortia, have always represented a strong interest group especially in the Lombardy region where agriculture is an important part of the economy. In addition, the fragmented nature of the water management system in the Po River basin determines a situation in which it is relatively easier for interest groups to skew the decision-making process in one direction or another. For instance, concessions for water withdrawals are released by provincial administrations; therefore, farmers or hydropower producers can lobby local authorities to obtain them – it would probably be more difficult to present the same instance to a Minister in Rome. Respondents also mentioned that the amount of power that stakeholders have in the decision-making process depends on their economic position, meaning that, for instance, hydropower producers will

[18] Cit. from interviews with respondents at research sector level (two researchers), conducted by the author in Verbania (Italy) on July 7–8, 2011.

[19] In particular, the water sector is dominated by the interests of farmers, often associated in the form of so-called "*consorzi*" (consortia) or autonomous cooperatives with political representation; the position of farmers, demanding water for irrigation purposes downstream, is contrasted by that of hydropower producers, who also represent an important (and powerful) interest group in the region, especially after the liberalisation of the energy market in the 1990s. The tourism industry plays an important role as well: in the Alps, it demands water for artificial snow; in the valleys, it cares about maintaining the good quality of water in the lakes. In addition, more and more demand for drinking water and water services come from touristic locations (hotels, resorts, etc.) (AdbPo 2010a, 2012).

have more of a voice than fishermen over the management of water resources in a given territory. Of course, this represents a source of frustration and discontent for some.[20]

Significantly fewer references were made to the determinants of experience (10.1 % of total references), and education and training (9.5 % of total references). According to respondents, the water governance system in the Po River basin is provided with sufficient examples from past extreme events that can serve as a basis to identify what course of action needs to be undertaken in case of floods or droughts. Nevertheless, some of this experience is getting lost with time, and especially the younger generations show a constantly decreasing interest in the environment and the management of the territory in which they live. In addition, relying on knowledge and practices that were valid in the past may not be a good solution to deal with future changes, as these are likely to occur with a higher frequency and intensity. As for climate change more specifically, respondents denounced a lack of political experience to address the problem, as this is only a (relatively) new concern. Experience was often mentioned in association with insufficient budget and individual incentives, pointing to a situation in which the lack of budget hampers the possibility of the system to "buy" the expertise of professionals or technicians, and provides young professionals with little incentives to enter this field (see also what reported by CIPRA 2011, p 20).

Respondents, and especially NGOs and research institutes (9 % of total references), indicated education and training as useful ways to reduce the ignorance, and, in some cases, even scepticism, on climate change-related issues that still prevail in the water sector. The education and training determinant was particularly related to traditional knowledge and management practices; with some respondents discussing the role of education in passing on traditional knowledge in relation to the environment to future generations. More generally, education was connected to communication and awareness-raising, highlighting the importance of, for example, programmes in schools to build the awareness of the general public towards environmental issues. Amongst these, climate change of course should figure prominently.

Partnerships and networks (mentioned for the 8.7 % of total references) were said to be potentially able to make more resources available and accessible for institutions, especially economic resources, but also human resources and information. With this consideration in mind, it is interesting to note the connections between partnerships and networks and external donors, which highlight the important relationships formed within the context of EU-sponsored research projects. In fact, this particular type of partnership, according to respondents, was often used to increase the amount of available scientific and climate data and information. Finally, partnerships also seem to significantly solve problems related to the lack of social and institutional capacity, as they allow institutions to take advantage of the experience

[20] Cit. from interviews with respondents at water users and civil society levels (water users in fishery and tourism sectors and NGO representative), conducted by the author in the Piedmont region (Italy) in January 2011.

and professional competencies existing in other institutions at different governance levels, including the international one. However, respondents identified two problems in relation with this determinant. First of all, partnerships are formed by individuals and groups with varied interests that cannot always be harmonised to achieve a collective outcome. Secondly, if not institutionalised, partnerships risk remaining only *ad hoc* measures that are not sustained over time (see also Massarutto 2005; Riva and Cucca 2007).

Leadership and political willingness were mentioned as important factors in the water sector in the Po River basin, although to a lesser extent than the other human and social resources-related determinants (only 6.8 % of total references). In particular, the Po RBA was attributed a leading role in coordinating water resources management in the region – although, at present, it does not have the adequate resources to perform its functions in practice. Also regional administrations were perceived to have an important function in water resources management, especially since they are the ones that are mandated by law (Legislative Decree 152/1999) to produce regulations in their administrative territory of competence (see also Raggi et al. 2007, p 4). Especially at the more local level, the role of individuals and leaders was deemed to be crucial for the good performance of the system. Their level of sensibility to the topic of climate change was said to determine the type of actions that are being taken (or not) to address it.

4.4.3 Information Sharing, Communication and Awareness-Raising to Build Adaptive Capacity in the Po River Basin

Confirming the previous observations in relation to the education and training determinant, the factor that was most often mentioned in the information category was communication and awareness-raising (30.7 % of total references), directed at both policy-makers (9.8 % of the cases) and the general public (21.7 % of the cases). It was recognised that this determinant plays a crucial role in building the understanding of actors in the water system of what the critical challenges will be, and what adaptation tools and options are available to address them. NGOs and research institutes were said to be particularly important in this sense, as they contribute to raising the awareness of policy-makers as well as that of the general public, for example through the organisation of campaigns in schools to sensitise young people on the environment and related issues.[21]

[21] For example the ARPA of the Piedmont Region extensively engages in environmental education in schools, but also targeting the general public and decision-makers involved in environmental protection (e.g., within municipalities). One of its most recent initiatives has been the promotion of ecological solutions in primary and secondary schools, including trainings and courses for teachers and students aimed at conveying the concept of "energy saving", thus also introducing the discourse on climate change.

Moreover, reference was made to climate and scientific information. Interviewees from a research institute mentioned the lack of long-term data series in relation to temperature and precipitation, especially at the local level.[22] In general, the determinant of climate and scientific data was negatively associated with budget, especially when it came to translating data into concrete information that policy-makers can effectively use. Respondents mentioned the importance of collaborating with the private sector, which has the capacity, and funding, to task research institutes with the collection and analysis of data on a topic that is of interest for their activities. Equally, the private sector holds the financial resources to produce information on its own and then exchange it with public authorities, thus helping increase the available knowledge base. Climate and scientific information were also related to technology, and the same connection was made for communication and awareness-raising, as well as unproblematic information sharing.

Despite efforts at cumulating climate and scientific information to better understand the climate change issue, the determinant of uncertainty continued occupying an important role in the information management category (in terms of total references received in the interviews). In particular, in the case of the Po River basin, respondents highlighted how the great margin of uncertainty that surrounds the discourse on climate change and its impacts on water resources in the region represents an important impediment towards taking any concrete action to address it (see also what reported by Legambiente 2007). In turn, uncertainty did not only stem from the increasing risks and hazards that a potentially warmer world involves, but also from the very nature of the knowledge system used to map climate impacts.

Interestingly, respondents also discussed the determinant of traditional knowledge (11.7 % of total references), especially in mountain regions.[23] The need to retrieve the direct relationship that human beings and societies used to have with the territory in which they live and its resources was abundantly highlighted. According to most of the interviewees, this would translate into a more positive relationship with environmental risks, which should not be tentatively eliminated, but effectively addressed. Today, this attitude has succumbed to the desire of governing the territory at any cost to guarantee absolute security – an utopic concept, which leads to the aggravation of risks rather than to their attenuation. Quite interestingly, traditional

[22] Cit. from interview with respondent from research institute, conducted by the author in Aosta (Italy) on January 10, 2011.

[23] In the literature, traditional knowledge is defined as "*the cumulative body of knowledge, practices and beliefs about the relationship of living beings (including humans) with one another and with their environment that has been handed down through generations by cultural transmission*" (Upton 2012). However, in the coding process, traditional knowledge has been used to describe both the traditional management practices and culture in the water sector and the direct relationship of human beings with (or their 'direct experience of) their land and resources. For example, when farmers described their understanding of climate change based on the perception that rain had different patterns than in the past, this was classified as traditional knowledge, as their observations were based on their immediate relationship with the environment. In other words, traditional knowledge was used to indicate ways in which communities experience and respond to climate and environmental change, what in the literature is called "*practical adaptation initiatives*" (Upton 2012).

knowledge was also connected to innovation; some of the respondents actually argued that the real innovation in the water sector would be the re-discovery and incorporation of traditional managerial knowledge into current management practices.

One case that was discussed as an example of the above reasoning is the "*Roggia dei Borghesi*" in Domodossola, a small city in the Alps where a number of interviews with local water managers have taken place.[24] The artificial water stream ("*roggia*") that crosses the underground city, and that was at the origins of its prosperity already in the Middle Ages, remains managed today by an association of users called "*consorzio*" (consortium), independent from the municipal government (Mortarotti 1985). The *roggia* is mostly used for the irrigation of private gardens and pastures; concessions for water withdrawals must be demanded and released by the *consorzio* under the payment of a symbolic water fee, used to run the *consorzio* itself (Bravo and Marelli 2008). Another interesting example in this sense is the management of artificial canals, the so-called "*rus*" in the Aosta Valley, which were constructed in the thirteenth century principally for irrigation purposes (but also served domestic uses) (Sibilla and Viazzo 1995).[25] Today, the *rus* continue to be managed by village-based associations that are in charge of stipulating precise rules on how to distribute and use water resources resource. Each member of the association has access to water according to predefined shifts (*égances*), and the overall direction is assigned to one of its members, elected to act as director (*dirétur dir u*) (Camosso 2002).

[24] The "Consorzio degli utenti della Roggia dei Borghesi" [Association of Users of the Bourgeois' Stream] is traditionally constituted by land owners in the Domodossola municipality, whose lands are irrigated by the *roggia* itself (covering 169 ha), and was instituted in 1687. In the Ossola Valley where Domodossola is located, the use of water for irrigation purposes was regulated by customary law. The Toce River, which crosses the Ossola Valley was canalised into small streams, called *rogge*, to be used for the irrigation of the surrounding crops. Originally, the *Roggia* dei Borghesi (so-called because it crossed the town of Domodossola, where the bourgeois families resided) was used to irrigate crops, operate small industries, and feed public fountains. Today, the *roggia* is almost completely covered by new buildings and fed by the waters of a hydroelectric plant on the river Bogna, a tributary of River Toce. Nevertheless, it is still used to irrigate private gardens (Mortarotti 1985, p 62).

[25] It was the local landlord that decided upon the construction of new *rus*, generally as a response to specific demands coming from the farmers. Once the landlord gave his approval, those who had the right to water, that is to say, all the owners of a property within the landlord's territory, commonly appointed a committee that was responsible for the construction works and maintenance of the canals. The committee was composed of a defined number of representatives from each village. The *rus* also played an important role in terms of adaptation to the frequent floods that haunted the region (Sibilla and Viazzo 1995). With time, the rights of local landlords diminished and a new form of institution for water resources management emerged in the form of the consortium (*consorzio*). Consortia were village-based associations in charge with the collective management of common resources, including water, pastures, and forests. Within each consortium, a member was elected to act as director (*diréteur dir u*). His functions prevalently consisted of supervising the efficient management of the water resource and the correct behaviour of all members of the consortium; he worked on a voluntary basis and had the power to punish transgressors. A paid canal warden also controlled the canals from April to September, i.e. the months in which the canal was used, and reported eventual infractions to the *dirétur* (Camosso 2002).

4.4.4 Paying for Adaptive Capacity

As previously noted, the categories of finances and risk and infrastructure were only briefly discussed by respondents. Within finances and risk, the majority of the references went to the budget determinant (60.7 % of total references), and in particular to insufficient budget (39.2 % of total references made to the budget determinant). This observation points to the generalised lack of economic resources that affects the Italian water sector specifically, and environmental protection more in general. Budget was negatively related to material resources and infrastructure, as well as operation and maintenance interventions, indicating the lack of adequate economic resources destined to these specific aspects of water resources management. This trend has been worsened by the economic crisis that Italy has been experiencing, as well as by the general insensitivity of policy-makers at the national level to environmental topics (WWF 2011).[26] In many instances, the interviewed institutional representatives mentioned external actors (in particular the European Union) as a viable alternative to the internal lack of funding.

4.4.5 Can Hard Infrastructure Be Adaptive?

In the infrastructure category, it was the determinant of material resources that received most references (49.3 % of total references), followed by innovation (17.8 % of total references) and the operation and maintenance of existing infrastructure (15.1 % of total references). Therefore, the prevailing discourse pointed towards the general satisfaction of respondents with regards to the tools and infrastructure they have at their disposal for water resources management, although it was also said that adequate investments are not always made for their operation and maintenance. In general, water-related infrastructure in the Po River basin is quite old. This does not only refer to hydropower and irrigation structures, which have been built at the beginning of the twentieth century or at some moment after the Second World War, but also to urban facilities like aqueducts. Especially in urban

[26] The economic and financial situation of the Ministry of the Environment in Italy has been reported as dramatic especially starting from the Fourth Berlusconi's Government in 2008, during which there has been a "*complete neglect of environmental policy*" (WWF 2011). In 2011, the total balance sheet of the Ministry of the Environment had been reduced of one third with respect to 2008, a total reduction of 513 billion EUR, and has further decreased to 504 billion EUR in 2012. Although other Ministries have undergone expenditure cuts too (e.g. Ministry of Culture, Ministry of Agriculture), none has been so dramatically affected as the Ministry of the Environment, which currently occupies the last position in the Italian balance sheet (WWF 2011). Looking at the financial statement of the Ministry of the Environment, it is astonishing to remark that, from 2010 on, no budget at all has been dedicated to the restoration of polluted areas, or for refunding measures for the reduction of greenhouse gases emissions: and that the Fund for Sustainable Development has been completed emptied (while in 2009 it was given nine million EUR) – just to cite a few examples.

areas, the growth of the population has rendered some of these networks obsolete and in need of substitution (ISTAT 1999). It was to face these needs that the 1994 reform of the water sector introduced private participation into the management of the water system with the aim to encourage investments into the modernisation of the infrastructural network (Triulzi 2004). Today, it is increasingly evident that more investments are needed in the operation and maintenance of existing infrastructure. This realisation, along with the very large expenditure chapters in municipal budgets, has caused some city councils to begin working together to implement operation and maintenance interventions in their territory of competence. However, these initiatives are only at an initial stage (Triulzi 2004).

Respondents also expressed some more negative views with regards to material resources and infrastructure, particularly highlighting the persistent tendency of Italian water managers to rely on "hard" infrastructural projects to respond to extreme events – e.g., building a dike to prevent floods. While potentially useful, this type of interventions risks reducing the flexibility of the system to respond to events that, with all probability, will increase in frequency and magnitude. Italian law mandates hydraulic infrastructure to be designed with reference to return periods of the scale of a hundred years. Clearly, this provision needs to be reviewed in light of current climatic patterns; a task that will not be easy if one considers that a hundred years are 25 elections away for the average politician, who, as a consequence, will not be very interested to address the problem. In addition, respondents associated material resources with the monitoring, assessment and evaluation determinant. Accordingly, although the system is provided with adequate monitoring tools and instruments, the institutional capacity and the political willingness to operate them is often lacking (see also Raggi et al. 2007, p 9).

4.5 Summary

This chapter lays the foundations for answering to the crucial question of whether the Po River basin is ready to face the threats that impend upon its water resources. Stretching horizontally across Northern Italy, the Po River basin is one of the largest basins in Europe. Its traditionally abundant water resources have been allocated to different uses, serving to fuel the economic development of Northern Italy since the 1950s, particularly in the agricultural and industrial sectors. Today, the Po River Basin is put under increased stress by excessive withdrawals for irrigation and hydropower generation purposes, as well as by the demands coming from a booming (and thirsty) tourism sector. Human pressures, and especially the overly generous and unproductive regime of water concessions regulating water withdrawals in Italy, have contributed to decrease the discharge of the Po River basin. However, an important part has also been played by changing climatic conditions. In fact, climate and hydrological observations for this region point towards a future scenario characterised by decreased rainfall, with intense peaks in the autumn season (which will worsen the risk of floods). Temperatures have already significantly augmented in

the entire basin, leading to a drastic reduction of snow precipitations and the volume of glaciers, and hence increasing the risk of water crises of short to medium length.

This chapter describes a water governance system characterised by strong fragmentation and complexity, with many institutions at different levels being given responsibility over similar tasks related to water use, disaster risk management and environmental protection – but none with a specific mandate to address climate change through the implementation of appropriate adaptation measures. The policy framework in vigour does not improve the situation; on the contrary, it reinforces the confusion, despite recent attempts to reform the water sector in line with European guidelines and models.

Concluding and looking at the results of the interviews conducted with water experts in the basin, it was noted that the political dimension (represented by the government and governance category) was the one to be most frequently mentioned. Determinants in the human and social resources and information management categories immediately followed. Interestingly, the determinants associated with finances and risk and infrastructure were the ones that least appeared in our analysis; a fact that can be explained in light of the fact that, as one respondent put it, "*having the infrastructure and the money without the capacity to use and allocate it to solve the problems that effectively exist in the water sector today is like having a Ferrari and no driving license*". Therefore, our analysis would seem to indicate that in the Po River basin, water resources management is considered to be strongly dependent upon (and influenced by) political factors, including all the organisational and administrative aspects that enable and guide decision and policy-making. Regional administrations emerged as important actors in the water sector, followed by the Po River Basin Authority – that nevertheless has seen its financial, human and technical resources dwindling in recent years as a consequence of the economic crisis that is affecting Italy, as well as of the low priority that is generally attributed to environmental issues in the country.

References

Autorità di bacino del fiume Po (AdbPo) (2010a) Piano di Gestione del distretto idrografico del fiume Po. AdBPo, Parma, 24 Febbraio

Autorità di bacino del fiume Po (AdbPo) (2010b) Valutazione globale provvisoria dei problemi relativi alla gestione delle acque, significativi a livello di distretto idrografico del fiume Po. Allegato 9.2 all'Elaborato 9. Piano di Gestione del distretto idrografico del fiume Po, AdbPo: Parma, 24 February

Autorità di bacino del fiume Po (AdbPo) (2011) Valutazione globale provvisoria dei problemi relativi al bilancio idrico nel distretto idrografico del fiume Po. Incontro tematico "Scarsità e siccità – Cambiamenti climatici". Documento per la consultazione pubblica ai sensi dell'art.66, comma 7a del D. Lgs 152/06 e smi, AdBPo: Parma, 6 Ottobre

Autorità di bacino del fiume Po (AdbPo) (2012) Valutazione Ambientale Strategica: Rapporto Preliminare: Documento per la fase di consultazione preliminare ai sensi dell'art. 13, comma 1 del D. Lgs 152/06 e smi, Piano di Bilancio idrico del distretto idrografico del fiume Po. AdBPo: Parma, 6 Febbraio

Bardelli L, Robotti L (2009) The water sector in Italy. Working paper CIRIEC. Jan 2009. Available online at: http://www.ciriec.ulg.ac.be/fr/telechargements/WORKING_PAPERS/WP09-01.pdf
Beniston M, Keller F, Goyette A (2003) Estimates of snow accumulation and volume in the Swiss Alps under changing climatic conditions. Theor Appl Climatol 76:125–140
Bocchiola D, Groppelli B (2010) Spatial estimation of snow water equivalent at different dates within the Adamello Park of Italy. Cold Reg Sci Technol 63(3):97–109
Braga R, Bertolo B (2006) Elementi di bilancio idrico del bacino del Po. Notiziario Autorità bacino fiume Po 7:16–17
Bravo G, Marelli B (2008) Irrigation systems as common-pool resources: examples from northern Italy. J Alp Res 96(3):15–26
Brugnara Y, Brunetti M, Maugeri M, Nanni T, Simolo C (2012) High-resolution analysis of daily precipitation trends in the central Alps over the last century. Int J Climatol 32:1406–1422
CABRI-Volga (No date) The Po basin water board, Italy: case study. Retrieved 31 Jul 2014 from http://cabri-volga.org/DOC/D3-CaseStudies/CaseStudyPoBasin.doc
Camosso D (2002) Capitale sociale e azione collettiva. Uno studio di casi di consorzi irrigui della Valle d'Aosta. Thesis, Facoltà di Sociologia, Università degli Studi di Trento
Commissione Internazionale per la Protezione delle Alpi (CIPRA) (2011) Acqua e Cambiamenti Climatici. Relazione specifica della CIPRA, N.3/2011, Turin
Conway G (2012) One billion hungry: can we feed the world? Cornell University Press, Ithaca/London
Diolaiuti G, Bocchiola D, D'Agata C, Smiraglia C (2012) Evidence of climate change impact upon glaciers' recession within the Italian Alps. Theor Appl Climatol 109:429–445
Fatichi S, Rimkus S, Burlando P, Bordoy R, Molnar P (2013) Elevational dependence of climate change impacts on water resources in an Alpine catchment. Hydrol Earth Syst Sci Discuss 10:3743–3794
Giorgi F, Lionello P (2008) Climate change projections for the Mediterranean region. Glob Planet Chang 63:90–104
IPCC (2014) In: Barros VR, Field CB, Dokken DJ, Mastrandrea MD, Mach KJ, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (eds) Climate change 2014: impacts, adaptation, and vulnerability. Part B: regional aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge/New York
Istituto Nazionale di Statistica (ISTAT) (1999) Il sistema delle indagini sulle acque. ISTAT, Rome
Legambiente (2007) L'Emergenza idrica in Italia. Legambiente, Roma
Massarutto A (2005) Partecipazione del Pubblico e Pianificazione nel Settore Idrico. Paper presented at the conference "La partecipazione pubblica nell'attuazione della Direttiva Quadro europea sulle acque", Università Bocconi, Milano, 30 June
Mortarotti E (1985) L'Ossola nell'Età Moderna: Dall'Annessione al Piemonte al Fascismo (1743–1922). Edizioni Grossi, Domodossola
Mosello, R (2007) Studi svolti e problematiche affrontate relative al bilancio idrico del Bacino del Po. Presentation prepared for the 13th session of the permanent commission on territory, environment and culture of the Italian senate, Rome, Italy, February
Raggi M, Ronchi D, Sardonini L, Viaggi D (2007) Po basin case study status report. Università di Bologna, Bologna
Riva M, Cucca C (2007) Gestione partecipata dei recenti eventi di crisi idrica in Lombardia. Working Paper No. 8, Istituto Regionale di Ricerca della Lombardia (IRER), Milan
SHARE (2009) Project brief: balancing river ecosystems and hydropower requirements. SHARE – Sustainable Hydropower in Alpine River Ecosystems. Project reference number: 14-2-3-IT
Sibilla P, Viazzo PP (1995) Cultura contadina e organizzazione economica. In: Woolf SJ (ed) La Valle d'Aosta. Einaudi, Torino
Simolo C, Brunetti M, Maugeri M, Nanni T (2012) Evolution of extreme temperatures in a warming climate. Geophys Res Lett 38:L16701
Triulzi U (2004) The reform of the Italian water sector. Paper presented at the Water Week 2004 – Session 3 'How to engage with public and private sectors in urban WSS'. World Bank, Washington, DC, 24 February

United Nations (UN) (2009) Third World water development report. Case studies: The Po River basin, Italy. United Nations: New York. Retrieved July 31, 2014 from http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/case-studies/europe-north-america/italy-2009/

United Nations Economic Commission for Europe (UNECE) (2009) Guidance on water and adaptation to climate change. United Nations Publications, New York/Geneva

United Nations Environmental Programme (UNEP) (2004) Freshwater in Europe: facts, figures, and maps. UNEP, Geneva

Upton C (2012) Adaptive capacity and institutional evolution in contemporary pastoral societies. Appl Geogr 33:135–141

World Wide Fund (WWF) (2011) L'agonia del Ministero dell'Ambiente e delle Politiche Ambientali in Italia. Dossier WWF, WWF: Rome, Italy. Retrieved 31 July 31 2014 from http://www.wwf.it/UserFiles/File/News%20Dossier%20Appti/DOSSIER/Istituzionale/dossier%20ministero%20ambiente%20def.pdf

Chapter 5
The Syr Darya River Basin

Abundance does not come from the byis [rich people] But from the common people and from the land they cultivate

(Kyrgyz Proverb)

Abstract The second case presented in this book is the Syr Darya River basin, a transboundary watershed feeding with its glacier-melt waters most of the Central Asia region. In the first part, this chapter introduces the main geographical and socio-economic characteristics of the Syr Darya River basin as well as of the country where it originates and flows: Kyrgyzstan. Subsequently, the analysis shifts towards considering water resources management within the broader regional context of Central Asia. There, in fact, transboundary waters have been the very protagonists of diplomatic and political relations between the five Republics of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan all since their independence from the Soviet Union in 1991. As a consequence, their water governance systems are strongly interrelated, and can in no way be considered in isolation from one another. In the second part of this chapter, the key factors that determine and explain the vulnerability of the Syr Darya River basin, and of Kyrgyzstan more specifically, to the impacts of climate change are outlined, and a first analysis of the adaptive capacity of its institutional framework, based on the results of expert interviews, is presented. We find that, influenced by international actors, a decentralisation approach was adopted after independence in the Kyrgyz water sector, with increased roles and responsibilities being delegated at subnational levels. Nevertheless, the institutional and policy framework for water resources management remained fragmented and poorly implemented. Climate change adaptation is not yet on the political agenda and mostly occurs in an ad-hoc manner with stimulus from international donors and agencies. In addition, it is suggested that water resources management in the region is strongly dependent on social and political factors, rather than on more technical concerns such as information sharing or infrastructure.

Keywords Syr Darya River basin • Kyrgyzstan • Central Asia • Transboundary water management • Water conflict • Transition economies

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5.1 Background Information: The Syr Darya River Basin and Kyrgyzstan

5.1.1 Geographical, Climatic and Water System Characteristics

Kyrgyzstan is a landlocked country situated in Central Asia, bordering Kazakhstan on the North, China on the East, Tajikistan on the South and Uzbekistan on the West. The total area of the Kyrgyz Republic is 187.5 thousand km^2, constituted, for its 80 %, by the mountainous region of the Tian Shan, which justifies the occasional reference to Kyrgyzstan as "*the Switzerland of Central Asia*" and, for the remaining 20 %, of valleys and basins. The Issyk-Kul Lake, in the north-eastern part of the Tian Shan range, is the largest lake in Kyrgyzstan, as well as the second largest mountain lake in the world, after Titicaca. The Kakshaal-Too mountain range coincides with the Chinese border, the peak Jengish Chokusu (or Victory Peak) being its highest point (7,439 m). Instead, its lowest area crosses the Naryn River at 480 m above sea level (Aidareliev et al. 2002).

The climate varies regionally. The south-western Fergana Valley is subtropical and extremely hot in summer, with temperatures reaching up to 40 °C. The northern foothills are temperate and the Tian Shan varies from dry continental to polar climate, depending on the elevation. In the coldest zones, temperatures go below zero for around 40 days in winter, when even some desertic areas experience snowfall. More generally, from a climatic point of view, Kyrgyzstan can be classified into four zones: (a) a valley-sub-mountain zone (from 900 to 1,200 m), characterised by hot summers, snowless and temperate winters, with almost zero precipitation; (b) a mountainous zone (from 900–1,200 to 2,000–2,200 m), where the climate is temperate, with warm summers and cold, snowy winters; (c) a high-mountain zone (from 2,000–2,200 to 3,000–3,500 m) that is cooler in summer and has relatively snowless winters, with temperatures ranging from well below zero to 16 °C; and (d) a nival-belt zone (from 3,500 m), typified by a polar climate and covered with snowfields and glaciers (Kyrgyz Republic 2009; GFDRR 2011). Only 20 % of the Kyrgyz territory is suited to human settlements corresponding to the western border with Uzbekistan, particularly around Jalal-Abad, and the northern border with Kazakhstan. Therefore, the majority of the population lives in that region (Kyrgyz Republic 2009). The rest of the territory is considered as an area of non-compensated discomfort, where almost exclusively mining enterprises are found.

Water resources in Kyrgyzstan form a complex system of rivers, lakes, glaciers, seasonal blankets of snow, and waterlogged territories. The annual average volume of total water resources makes up 2,458 km^3, including 50 km^3 of surface river runoff, 13 km^3 of potential reserves of ground water, 1,745 km^3 of lake water, and 650 km^3 of glaciers (Mamatkanov et al. 2006; UNISDR 2010, p 7). The 76.5 % of the country's total territory belongs to areas that supply the basin of the Aral Sea, 10.8 % supplies the basin of Issyk-Kul Lake, 12.4 % the basin Tarim, and 0.3 % the

basin of the Balkhash Lake. Kyrgyzstan possesses 30 % of the total water resources in the Central Asian region, but can only exploit the 12–17 % of its surface water runoff, as a consequence of agreements with other Central Asian countries. Accordingly, the 47.2 km^3 of water resources that originate on the Kyrgyz territory are given to the Issyk-Kul recharge (3 km^3), and to Uzbekistan, Tajikistan, Kazakhstan and the Sinjan-Uigur autonomous region of China (32.2 km^3) (Allouche 2004; Hodgson 2010).

Most of the rivers are fed by glaciers and/or snowmelt, and peak flows occur from April to July. There are about 5,000 rivers in Kyrgyzstan, related to eight different hydrological basins, six of which are transboundary: the Syr-Darya (called Naryn before it reaches the Fergana Valley), Amu-Darya, Chui, Talas, Kar-Karya, and Tarim. The other two hydrological basins correspond to the closed lakes of Issyk-Kul and Chatyr-Kul, thus falling uniquely within the Kyrgyz borders (UNISDR 2010, p 7). There are also 13 artificial reservoirs covering a total area of 378.2 km^2, and with a volume of water of 23.41 km^3. More than ten large reservoirs for irrigation were built to regulate the runoff of the Chui, Talas, Naryn, Ak-Bura and Kara-Darya transnational rivers (Kyrgyz Republic 2009; Shkurov et al. 2007). In addition to rivers, Kyrgyzstan counts 923 lakes, the biggest of which are the Issyk-Kul (with an area of water surface of 6,236 km^2), Son-Kul (275 km^2), and Chatyr-Kul (175 km^2). There is also a significant amount of minor lakes and natural reservoirs with a common area of about 6,697 km^2 and an annual volume of water of about 1,745 km^3 (Shkurov et al. 2007). The 87 % of those lakes are located at heights of 3,000–4,000 m, in regions of tectonic origin (Kyrgyz Republic 2009, p 12).

As already mentioned, most of the country's rivers and lakes are fed by glaciers and snowmelt. Kyrgyzstan counts 8,208 glaciers of different sizes, corresponding to an area of 8,169.4 km^2, or 4.2 % of the country's total territory (Mamatkanov et al. 2006). These data, however, come from the "*Catalogue of Glaciers of the USSR*". Last updated in the 1960s, this inventory is still considered today as the main source of information on the conditions of glaciers in the country. It is natural to assume, therefore, that the parameters of glaciers may have changed significantly from what is reported in the catalogue. Research based on the extrapolation of results from glaciers monitoring estimated that glacier volume in the Syr Darya catchment has probably been reduced from 121 km^3 in the 1960s and 1970s to 101 km^3 in 2000 (Kyrgyz Republic 2009).

Kyrgyzstan is also rich in underground water, counting 44 deposits with a total flow that exceeds 13 km^3/year. However, known exploitable reserves of fresh underground water only amount to 2.2 km^3/year, 38 % of which is used for drinking purposes, 45 % for irrigation, 15 % for industry, and 2 % for pastures. Groundwater levels are subject to strong fluctuations every 10–30 years. For example, in 2003–2004 high levels of underground water were observed, which caused the flooding of a considerable number of settlements and the swamping of agricultural land (Shkurov et al. 2007). Figure 5.1 shows the physical map of Kyrgyzstan.

Fig. 5.1 Kyrgyzstan, physical map (Source: Google Earth [created by the author])

5.1.2 Socio-economic Characteristics of Kyrgyzstan

The Kyrgyz Republic is a low-income, mountainous, and predominantly agrarian country. It counts a population of 5.37 million people, distributed on a surface area of 200 km^2, and an average annual population growth rate of 1.5 % between 2005 and 2010. In the villages this percentage goes up to 1.6 %, while in urban areas it reaches 1.4 %, and is mostly due to internal migration movements towards cities aimed at searching for better employment opportunities (World Bank 2011a). The 63 % of the total population lives in rural areas, while the rest resides mostly in the cities of Bishkek and Osh. The active population, i.e. those aged between 15 and 60, constitutes around the 62.2 % of the total population, and the life expectancy at birth amounts to 69 years on average (World Bank 2011a).

Prior to 1991, Kyrgyzstan was one of the 15 Soviet Republics; as such, its economy was highly dependent on the centralised regime of the Soviet Union, based in Moscow. When it reached independence in 1991, Kyrgyzstan had to embark upon substantial reforms aimed at the development of its proper economic strategy, also in response to the severe phase of economic contraction that the country (and indeed, all Central Asian ex-Soviet Republics) was experiencing. A transition to market economy was hence promoted and tentatively carried out throughout the 1990s, leading to the privatisation of about 7,000 state enterprises by 2003. In the early 2000s however, it was abandoned as a consequence of domestic opposition and the lack of sustained foreign investment (World Bank 2011b). After the difficult years following independence, during which the country's GDP abruptly fell by

50 % with respect to the Soviet era, a steady economic growth started from 1995 onwards, resulting from increasingly dynamic agricultural, construction, industrial and transport sectors (Kyrgyz Republic 2009; National Statistics Committee 2007). Over 2006–2009, the growth rate of real GDP in Kyrgyzstan accelerated to 8 %, but in 2009 the economy felt the impact of the international crisis and the growth rate slowed to 2.9 % (World Bank 2011a, p 3). In contrast, private consumption grew steadily as a result of an increase in remittances from private migrants. Whilst in 2003 the volume of remittances was only of USD 154 million, or 6.9 % of GDP, in 2008 it made up USD 1,476 (29 % of GDP) (UNDP 2010).

More generally, the international economic crisis is having a significant negative impact on the country's finances, leading to a decline in economic growth deleteriously coupled with increasing inflation rates. In turn, this has decelerated trade and construction, as well as industrial output and direct investment, while credit rates and the consumer price index (CPI) have worryingly augmented. For all these reasons, at present, Kyrgyzstan's economic situation is particularly grave – and of course, this considerably influences its social and political stability. Several observers have indicated poverty and social discontent amongst the main motivations underlying the upheaval of April 2010 ultimately resulting in the ousting of President Kurmanbek Bakiyev.[1] It is also referred to as "Sec*ond Tulip Revolution*", after the first one that took place in 2005 and led to the overthrow of President Askar Akayev. According to a recent World Bank's report, the incidence of rural poverty is significantly higher than the one of urban poverty (37.1 % versus 22.0 %), expressed in another way, the majority of the total poor, 75.4 %, resides in rural areas (World Bank 2011b, p 7). In addition, the *oblasts* (provinces) that are predominantly agricultural and remote have higher rates of poverty (Issyk-Kul, Naryn and Osh oblasts – 46.1, 44.1, and 38.3 %, respectively).

The key pillar of Kyrgyz economy undoubtedly is agriculture, accounting for 29 % of the country's GDP (2010 figures) as well as for more than half of its labour force (World Bank 2011a). The agricultural sector has become the refuge of those workers that have been displaced from industrial activities after the substantial downfall of the industrial sector in the early 2000s. Because of its mountainous topography, however, only 7 % of the Kyrgyz territory is suitable for cultivation. This constitutes a major limitation to the further expansion of agricultural production. At present, the cultivated area (annual and permanent crops) amounts to 1.35 million ha, of which 1.07 million ha, or 80 % are irrigated (World Bank 2011a). Irrigated agriculture in Kyrgyzstan is confined to the main valleys and, therefore, concentrated in four regions: the Chu and Talas rivers in the north, the Naryn river in central Kyrgyzstan, the surroundings of Lake Issyk-Kul in the east, and the Fergana Valley in the southwest (World Bank 2011a).

Cereals are the crops that are most commonly grown in Kyrgyzstan, covering almost 60 % of the cultivated area. Wheat cultivation was broadly expanded after

[1] For more information and statistical data on these macroeconomic parameters and their evolution, refer to (UNDP 2010, p 70).

Fig. 5.2 Fruit stand in Dordoy Bazaar, in Bishkek. Nuts are also common produce in Osh and Jalal Abad, Kyrgyzstan being home to the biggest walnut-fruit forest in the world. In the mid-1980s, fruit and vegetable industry enterprises played an important role in Kyrgyzstan's economy. However, their contribution was drastically reduced after the collapse of the Soviet Union, because of the severing ties between the raw material suppliers and buyers of the finished goods and the increasing difficulties connected to crossing borders (Source: Author)

independence from 1990 to 2002. Barley, maize, potatoes, sugar beets, vegetables and cotton are other important crops for the Kyrgyz economy, together with rice and tobacco, primarily grown in the Fergana Valley. Fruit forests are widespread especially in the Southern part of the country, around the cities of Osh and Jalal Abad, and their products are sold to local markets (see Fig. 5.2). Furthermore, many Kyrgyz farmers raise livestock: milk, meat and wool production are important sources of agricultural income. Livestock breeding currently generates about 60 % of gross agricultural income in Kyrgyzstan, and occupies the largest share of the workforce in agriculture. Land reform, a controversial issue in Kyrgyzstan, has

proceeded very slowly since some initial pieces of legislation were enacted in 1998.[2] While most of the land has been privatised, productivity remains low due to a lack of investment and widespread environmental degradation.

Industrial production did not only drastically decline between 1990 and 1995, following the fall of the Soviet Union and the consequent disruption of the supply chain of raw materials and fuel, but was also subject to a radical restructuring. Before 1990, the Kyrgyz industry was primarily characterised by machinery construction and by the production of electrical equipment and electronics. When the economy of the Kyrgyz Republic finally stabilised after 1995, the light and processing industry took a primary position. In addition, after the operationalisation of the Kumtor gold-mining processing complex, the input of metallurgy into the Kyrgyz economy significantly increased (Kyrgyz Republic 2009). Today, however, the low diversification of industrial production has stalled the growth of this sector. In fact, three quarters of the industrial production derive from metallurgy (mostly gold), electrical power, natural gas, food processing, beverages and tobacco production. Advanced technology, electrical equipment and electronics only make up for less than 5 % of the total industry production (Kyrgyz Republic 2009). On the other hand, the construction sector has undergone a rapid growth since 2000, mostly because of large infrastructure projects such as highways and gold mines (World Bank 2011a).

Since deposits of fossil fuels are rather scarce, Kyrgyzstan is strongly dependent on energy coming from foreign countries; particularly natural gas from Uzbekistan. Hydropower plants produce over the 80 % of Kyrgyz electricity; the remainder comes from thermoelectric plants fuelled by coal, gas and oil. The hydroelectric potential of Kyrgyzstan is estimated to be over 160 billion kWh/year, of which only the 10 % is currently exploited.[3] Per capita energy consumption is high considering the average income, and the government has not yet advanced any comprehensive plan to reduce it. In addition, an estimated 45 % of the electricity is diverted illegally or leaks from the transmission system (Library of Congress 2007).

Contrarily to industry, the service sector in the post-Soviet era has substantially grown thanks to the appearance of small private enterprises at the beginning of the 1990s. Despite the attractiveness of Kyrgyzstan's mountains and lakes, little

[2] For more information on land reform and privatisation processes in the agricultural sector, see (Bichsel et al. 2009).

[3] The power generation infrastructure is made up of 17 electric stations with a combined capacity of 3,680 MW, including 15 hydro-electric stations (2,950 MW) and two thermo-electric stations (730 MW) (Juraev 2009, p 5). The five major hydro-electric power generator plants are located on the Naryn River below the Toktogul Reservoir, which together accounts for 97 % of the country's total hydropower capacity. The two thermo-electric plants located in Bishkek and Osh generate electricity and heating for these towns and the surrounding areas. In addition, the Karambata 1 and 2 power plants are under construction on the Naryn River, above the Toktogul Reservoir. The construction of these plants started in the 1980s, but was not completed due to the fall of the Soviet Union, and was resumed only in 2007. In 2006 the electricity production amounted to 14.3 billion kWh (FAO AQUASTAT 2012).

progress has nevertheless been registered in the tourist sector, mostly because the latter has received only minimal investments from the government's side. Today, tourism remains concentrated in the Issyk-Kul area, and is prevalently made up by Kazakh (60 %), Russian (25 %), and local (15 %) tourists.

To satisfy the water needs arising from the economic and social life of the country, Kyrgyzstan recurs to its surface water resources (20.6 % of annual total withdrawals). The annual flow of surface water on Kyrgyz territory amounts to about 44 km^3/year, while the total availability of renewable resources is slightly higher, 46.5 km^3/year (including surface and groundwater) (FAO AQUASTAT 2012). Due to its important supply function for neighbouring states, international agreements commit Kyrgyzstan not to consume more than 24 % of the total annual surface runoff. On average, this amounts to 11.6 km^3/year (FAO AQUASTAT 2012). Table 5.1 illustrates the withdrawals of water resources realised by the different economic sectors.

The consumption of water for agricultural irrigation represents the 94 % of total water use, while only the 3 % each is allocated to households and industries. The explanation for the huge share accounted for by agriculture is the marked predominance of irrigation. In fact, precipitations in the regions that are suitable for agriculture are very low, generally not exceeding 600 mm/year; a circumstance that makes rain-fed agriculture impossible in most places. Total water use amounts to about 10 km^3/year, and basically consists of surface water; groundwater represents only 6–7 % of total uptake and is mainly used for drinking purposes.

Table 5.1 Water withdrawals by sector and source, 1994/2002/2002

	Year	Value	Unit
By sector			
Agricultural	2000	9.45	km^3
Municipal	2000	0.32	km^3
Industrial	2000	0.31	km^3
Total	2000	10.08	km^3
Total water withdrawal per capita	2002	1,989	m^3
By source			
Surface water withdrawal		–	km^3
Groundwater withdrawal		–	km^3
Total freshwater withdrawal	2000	10.08	km^3
Desalinated water produced	2000	0	km^3
Reused treated wastewater	1994	0.0001	km^3
Pressure on water resources			
Total freshwater withdrawal as percentage of ARWR	2002	43.67	%
Agricultural water withdrawal as percentage of ARWR	2002	40.94	%

Readapted from FAO AQUASTAT (2012)

5.1.3 *Transboundary Waters and Security: Kyrgyzstan in Central Asia*

Water takes on special importance in Central Asia: covering more than 4 million km^2, the post-Soviet states of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan make up an area that is larger in size than India, Pakistan, and Bangladesh combined, and that is home to roughly 60 million people. The majority of water comes from the run-off of the high mountain ranges of Pamir and Tian Shan in the eastern part of Central Asia, feeding the two main rivers of the region, the Amu Darya and Syr Darya, flowing west and north towards the Aral Sea. Both the Amu Darya and the Syr Darya are transboundary watercourses.[4] Thus, the Central Asian region is linked by a highly complex and interdependent water system, which makes it impossible to understand one country's water situation in hydrological and political terms without also carefully considering its neighbours.

Since Central Asia is characterised by arid and semi-arid vegetation, initially agriculture was made possible by the development of sophisticated irrigation techniques. It comes with no surprise, therefore, that 3,500 years ago, the so-called "Mesopotamia" of Central Asia was already populated by advanced hydraulic societies, with refined irrigation systems to feed millions of hectares of land. At the beginning of the twentieth century, with the Soviet administration, new water-intensive irrigation technologies were introduced in order to cultivate cotton at a larger scale.[5] The traditional appreciation of the once inexhaustible Central Asian

[4] The Amu Darya is formed in Tajikistan from two tributaries, the Vaksh River, which rises in Tajikistan, and the Pyanch River, which also rises in Tajikistan and forms part of Tajikistan's border with Afghanistan. Thereafter, it flows through Turkmenistan and Uzbekistan before terminating into the Aral Sea. The Syr Darya is formed from two tributaries: the Naryn River and the Kara Darya, both of which rise in Kyrgyzstan. From Kyrgyzstan, the Syr Darya flows downstream to Uzbekistan, Tajikistan and Kazakhstan before terminating in the Aral Sea. In addition, the Chui and Talas Rivers are shared between Kyrgyzstan and Kazakhstan, while a number of smaller rivers flow from Kyrgyzstan into China (Allouche 2004, p 46).

[5] Central Asia, because of its particularly harsh climate and geographic configuration (the arid climate made it difficult to develop agriculture, and the region's distance from the sea cut it off from the main routes of international trade), was traditionally inhabited by nomadic populations from the steppe. The first forms of political power and unity were brought about by merchants travelling over the famous Silk Road, which, lying at the heart of Central Asia, connected Europe to China. Starting from the end of the sixteenth century, the development of firearms rendered nomadic populations powerless against the domination attempts of neighbouring Russia and China, which by the end of the nineteenth century had taken complete control over the region. The Eastern part of Central Asia, known as East Turkistan or Xinjiang, was incorporated into China; Mongolia and Afghanistan remained independent, but the former became a Soviet satellite state, and the latter was invaded in 1979. The rest of the Central Asian region was incorporated into the Union of Soviet Socialist Republics (USSR) in 1918. During the Soviet rule, Central Asia was heavily industrialised, and intensive cotton irrigation was introduced especially in the Fergana Valley. This translated into the construction of modern infrastructure, but also the suppression of local cultures, hundreds of thousands of deaths from failed collectivisation programs, and a lasting legacy of

water resources started diminishing even more dramatically in the 1960s, when a rapid increase in water demand coming from the central Soviet government in Moscow caused the depletion of river flows and ground water reserves, as well as the degradation of water and soil quality (Klötzli 1997).

Priority for the allocation of Kyrgyz waters was given to the cotton production in the Uzbek Soviet Socialist Republic (SSR) and to rice production in the Kazakh SSR, in order for the Soviet Union to become self-sufficient. The Kyrgyz SSR was given the mere role of water supplier. Major investments were made in the construction of dams, reservoirs, canals and other structures to promote and manage the transfer of water from its source point in the Kyrgyz mountains to the main growing areas fed by massive irrigation schemes in the Uzbek and Kazakh SSRs. The hydrological borders between the different SSRs were highly disregarded in the construction process of irrigation canals and dams. For example, the Toktogul Reservoir, with a total volume of 19 billion m^3, was built on the Naryn River in the Kyrgyz SSR. Although the series of dams that form the Toktogul Cascade were supposed to be 'dual purpose', i.e. impounded water was due to be used for both irrigation and hydropower generation, only a tiny fraction of the released water effectively went to irrigate the crops of the Kyrgyz SSR. Instead, most of the water was conveyed by canals to the downstream republics to irrigate their fields (Hodgson 2010, 2). The costs of water management within the upstream republics were paid or subsidised from Soviet central funds. These included the costs for monitoring and collecting data, the operation of inter-state irrigation canals, flood protection infrastructure as well as the costs of afforestation and the remediation of damage caused by floods, landslides and mudflows. In addition, the upstream republics received other benefits, such as the provision of cheap fuel and electricity (Hodgson 2010).

The demise of the USSR in 1991 brought about a dramatic change to water resources management in Central Asia. Both the Syr Darya and Amu Darya became international river basins covering the territories of five newly independent states. This process also caused a sudden power vacuum and the breakdown of the state-controlled subsidised provision system. The most difficult Soviet legacy faced by governments in the region in the wake of independence was represented by the deliberately tight links between the regional water management systems, which ignored the newly established political borders. At the same time, the one-sided economic development imposed by the Soviet Union had produced environmental depletion and degradation (Klötzli 1997). The solution of these complex problems was left in the hands of independent countries that did not have the capacity (or the willingness) to cope with them. The introduction of private land holding on the one hand, and the decentralisation of water allocation on the other, also led to a multiplication of water users and to unclear responsibilities concerning water allocation and the maintenance of related infrastructure (Bichsel et al. 2009). With regards to the management of both the Syr Darya and Amu Darya rivers, disputes between

ethnic tensions and environmental problems that still live on today, more than 20 years after the Soviet republics of Central Asia finally became independent. For a more complete history of Central Asia, see, for example: (Dani and Masson 2000) and (Ram 2000).

Kyrgyzstan, Kazakhstan, Uzbekistan, Turkmenistan and Tajikistan came into view after 1991. Mainly, these contentions focused upon the quantity and seasonability of water release, the maintenance of related infrastructure, and the economic value of water. These problems were further compounded by the fact that, because Central Asian countries had never been subject to international law, the common principles related to the management of inter-state waters could not be used to resolve disagreements (Hodgson 2010).

The first major attempt to consider the matter at a political level was during an inter-ministerial meeting in Almaty in February 1992, just 2 months after the collapse of the Soviet Union. The outcome of this meeting was the *Almaty Treaty on Cooperation in the Field of Joint Water Resources Management and Conservation of Interstate Sources* ("*1992 Almaty Treaty*"), which fundamentally reaffirmed the Soviet-era water sharing provisions that were set in 1984 and are still in force today. The agreement also led to the establishment of the Inter-state Commission for Water Coordination (ICWC), which was charged with the allocation of water to the canals and structures controlled by the Soviet-era Basin Valley Organisations (BVOs) (Allouche 2007, p 48). Interestingly, while Article 1 of the 1992 Almaty Treaty stated that "*recognising the community and unity of the region's water resources, the Parties have equal rights for their use and responsibility for ensuring their rational use and protection*", the national constitutions of Central Asian states affirmed their exclusive right to natural resources, including water, and excluded any claims from other states (Usubaliev 1998).

After 1992, a number of regional agreements followed, many of which focused on the Aral Sea and the waters of the Syr Darya and Amu Darya rivers specifically. For example, in 1998 the Governments of the Republic of Kazakhstan, the Kyrgyz Republic and the Republic of Uzbekistan signed an *Agreement on the Use of Water and Energy Resources in the Syr Darya Basin*, which stipulated a framework for the operation of the Toktogul Hydropower Cascade (Allouche 2007; Hodgson 2010).[6] This agreement also provided for the conclusion of annual contracts regarding the release of water from the Toktogul cascade and compensatory payments (in the form of energy resources such as coal, oil gas and electricity, or money) to Kyrgyzstan for its lost opportunity to generate electricity in winter (Hodgson 2010).

Other barter agreements, all basically grounded in the same approach as the 1998 one, were subsequently reached between the Central Asian States. Unfortunately, for one reason or the other, these contracts have constantly been breached, meaning that upstream countries were repeatedly left without light and heat as a direct result of the failure of downstream countries to supply energy (Hodgson 2010, p 3). The most recent agreement was signed in October 2008 by Kazakhstan, Kyrgyzstan and Tajikistan and provided for reciprocal supplies of water, oil and coal. Nevertheless,

[6] As Kyrgyzstan can receive very little irrigation water from Toktogul Reservoir, its interests would be best served by an operating regime that keeps the gates closed in spring and summer and releases water to generate electricity during the winter months. However, the spring and summer precisely correspond to the seasons in which Kazakhstan and Uzbekistan need water for irrigation (Hodgson 2010).

the abstention of Uzbekistan has made the agreement fundamentally useless, since Uzbekistan uses a high proportion of the river water originating in Tajikistan and Kyrgyzstan, and is the main supplier of gas to those countries (Hodgson 2010). Meanwhile, the river basin organisations as well as the ICWC are still there, although they have long ceased to play significant roles in terms of water allocation.

The core problem is that none of these agreements have really addressed the question of water allocation among Central Asian states, which continues to follow the Soviet scheme in favour of irrigation as acknowledged (or not) in the 1992 Almaty Treaty. The right claimed by upstream countries to be compensated for allowing water to flow downstream and for the operation and maintenance of the water infrastructure has been persistently opposed by downstream countries (Hodgson 2010). Tensions have started to surface particularly from 2001 onwards, when the Kyrgyz government made an attempt to introduce water pricing by adopting the *Law On Interstate Use of Water Units*, *Water Resources and Water Facilities of the Kyrgyz Republic*. According to Article 3, Kyrgyz waters would be supplied to downstream countries only on a 'paid' basis, and operation and maintenance costs of the water infrastructure should be shared (Tarlock and Wouters 2007; Votrin 2003). The law was severely criticised in Kazakhstan and Uzbekistan. The Kazakh leader, Nazarbaev, claimed that the law "*does not have any legal foundation* […] *it is impossible to set a price for irrigation water* […] *it contradicts international standards* […] *it is unacceptable for Kazakhstan*" (Usubaliev 2002). As of today, the Kyrgyz Ministry of Foreign Affairs has not yet attempted to implement the 2001 law.

The imposition of a half-hearted version of the Soviet central planning on the fractious Central Asian states shortly after the collapse of the Soviet Union did not prove to be a recipe for success (Mosello 2008). The distribution of the Syr Darya waters continues to be aimed at increasing the output of cotton and rice production (ICG 2002; World Bank 2011a). The recipients of the benefits, however, have now become the newly independent downstream states, which are in favour of maintaining the status quo. This transforms any development of water resources management in upstream countries into a situation with a high conflict potential (Allouche 2004). The dilemma for the Central Asian states is to agree on a balanced operating regime, which would allow the generation of energy in winter (benefiting upstream countries), and irrigation for large-scale agriculture in summer (benefiting downstream countries).

The projected impacts of climatic changes in the region, especially in the form of intensified water scarcity during the summer season, will likely complicate the definition and implementation of a common solution (EDB 2009). In addition, these gloomy considerations need to be projected against a scenario characterised by a growing population and rising ethnic problems, of which the civil conflict that took place in Osh in June 2010 was a bitter premonition.[7]

[7] On 11–14 June 2010, the region of Osh in Southern Kyrgyzstan was affected by violent turmoil, following the revolutionary movement that, a few months before (April 2010), had overthrown

5.2 Climate Change and Socio-economic Scenarios in the Syr Darya River Basin

According to the fourth IPCC report (and confirmed by the AR5), Central Asia is expected to experience an augmentation of average annual temperatures of 2 °C by 2022, and of between 4 and 5 °C by 2100 (Bates et al. 2008). A 12 % diminution of the annual runoff is also projected by 2020. These changes will result in more frequent and intense droughts, heat waves, and eventual crop losses. Furthermore, models predict that precipitations will increase in winter, but decrease in summer for the entire Central Asian region (Bates et al. 2008).[8] In this context, Kyrgyzstan is a particularly vulnerable case, given that water is the most precious bargaining chip the country has vis-à-vis its neighbours, and given that its people are strongly dependent on agriculture for their livelihoods. Enough to say that half of Kyrgyzstan's GDP derives from climate and weather-sensitive activities (GFDRR 2011) – agriculture is by far the most important livelihood activity, contributing to one-third of GDP and employing 65 % of the population. Industrial processing, the second most productive sector in Kyrgyzstan, is also highly dependent on the agricultural sector for the provision of raw goods (GFDRR 2011). Drought is a common occurrence in the country, as well as land and mudslides, avalanches, squalls, downpours, icing, frosts, breakthrough of glacial lakes, floods, rise of sub-soil waters, epidemics, crop diseases, pest and river erosion: on average, destruction and loss from natural disasters in Kyrgyzstan totals up to USD 30–35 million per year (GFDRR 2011). Therefore, it is important to understand with more precision what the impacts of climate variability and change, as well as socio-economic changes, will be on Kyrgyzstan, and on the Syr Darya River basin more specifically, in order to then proceed with an informed analysis of the capacity of Kyrgyz institutions to cope with these challenges.

5.2.1 Climate Change Impacts on Water Resources

According to the assessment conducted in the Second National Communication of the Kyrgyz Republic to the United Nations Framework on Climate Change (Kyrgyz Republic 2009), climate change will lead to a significant reduction of Kyrgyzstan's glaciers and snowfields, with major implications for the country's water resources. Already, research has showed that over the last century the air temperature within the territory of the Kyrgyz Republic has increased by 0.8 °C, and nearly one third of

President Kurmanbek Bakiyev from power. More specifically, "*an explosion of violence, destruction and looting in southern Kyrgyzstan killed many hundreds of people, mostly Uzbeks, destroyed over 2000 buildings, mostly homes, and deepened the gulf between the country's ethnic Kyrgyz and Uzbeks*" (ICG 2010, p 3).

[8] These projections are confirmed in the most recent 5th IPCC Assessment Report (AR5) (IPCC 2014a).

the glacial area of Central Asia has disappeared since 1930 (GFDRR 2011, p 5). Although these numbers should be treated with caution, it is clear that as glaciers shrink, floods will ensue with greater intensity in some areas, while water scarcity will become more acute in others, leading also to energy supply problems.

Climate scenarios show an average increase of annual temperatures from 3.6 to 5.8 °C in 2100, in relation to the base period 1961–1990 and assuming a minimal increase in the value of CO_2 concentration.[9] More specifically, summertime diurnal temperature ranges are projected to rise, suggesting a pronounced increase in maximum temperatures relative to minimum temperatures. Snow cover is also affected by climate change, as increasing temperatures reduce the proportion of solid precipitation and lead to earlier and more intense snowmelt. As a result, snow cover duration is likely to decrease (Aizen et al. 1997) and snowmelt will occur earlier in the year (Khalsa and Aizen 2008). As for annual precipitations instead, they will supposedly increase in the northern part of the country (1.3–2.1 % compared to the base period, irrespective of any scenario), and decrease in the south (−2.0 % and −3.1 % compared to the base period for scenarios A2 and B2, respectively) (Shkurov et al. 2007). It should be noted that the low resolution of available GCMs inadequately captures the topographic diversity and precipitation dynamics across Kyrgyzstan, and leads to a considerable amount of disagreement about how precipitations will behave in the future (GFDRR 2011). Therefore, although these projections reflect the current state of knowledge, changes in rain and snow precipitations remain characterised by high uncertainty (Sorg et al. 2012).

These significant modifications of the main climate parameters of Kyrgyzstan will have equally significant impacts on natural systems, as well as on the economic activities and livelihoods that depend on them. Consequences will be felt especially in the water sector, in terms of both the availability and quality of water resources. Paradoxically, the expected impacts of climatic changes will result in additional water releases in dry summers to compensate for rain shortfalls. At the same time, however, the buffering capacity of glaciers will be altered by climatic changes in a substantial, nonlinear and irreversible way (Beniston et al. 2011). In the first instance, shrinking glaciers will supply ample quantities of water in the form of increased glacial runoff (phase 1). In this phase, the depletion of glacial reserves may be seen as an advantage, as surface runoff surpluses could, over a number of decades, represent an opportunity to develop hydropower infrastructure and sell energy to neighbouring countries (Beniston et al. 2011). However, this water supply is far from being sustainable and will inevitably lead to a tipping point ("peak water", Baraer et al. 2012; Gleick and Palaniappan 2010) at which reduced glacier volume will start resulting in a decrease of summer runoff (phase 2) (Braun and

[9] These projections refer to the B2-MESSAGE emissions scenario, which is the one that accounts for the minimal value of CO_2 concentration by the year 2100 among scenarios of the B2 family with more moderate economic and demographic parameters. Instead, according to the A2-ASF scenario (that accounts for the maximal value of CO_2 concentration by the year 2100 among scenarios of the A2 family with more moderate economic and demographic parameters), the average annual changes of temperature will vary from 4.7 to 7.8 °C (Kyrgyz Government 2009, p 110).

Hagg 2009). The volume of summertime glacier meltwater may then no longer be sufficient to feed water into river catchments at a time of the year when precipitation amounts are low and the snowpack has already melted (Beniston et al. 2011). Moreover, the year-to-year variability of surface runoff tends to increase when glaciers lose some of their buffering capacity and runoff will thus respond more directly to inter-annually variable precipitation (Braun and Hagg 2009).

What remains uncertain, at present, is when the Syr Darya or its tributaries will cross this tipping point – some of them may even have already done so. The identification of a tipping point in glacial meltwater runoff is hampered by compensating effects, such as changes in precipitation and evaporation as well as anthropogenic influences. Actually, the increase in long-term average annual runoff of Syr Darya from 29.1 (average 1947–1972) to 30.4 km^3 (average 1973–2000; Mamatkanov et al. 2006) could be the result of increased glacier melting, but could have also been caused by increasing precipitation amounts. Numerical modelling of runoff components in the headwater catchment of the Syr Darya is needed to shed light on past and future changes in glacial runoff and to identify tipping points. Nevertheless, considerable uncertainties regarding the evolution of precipitation amounts and impacts on water availability will likely remain (Sorg et al. 2012).

As noted, climatic changes will also have severe impacts in terms of increased occurrence and intensity of extreme events in the country. Kyrgyzstan is already plagued by more than 20 different types of natural disasters that have hit its territory and population in the past – earthquakes, mudflows, landslides, floods, snow avalanches, droughts, and storms. While some of these processes occur as a consequence of geological and physical conditions, others, such as mudflows and floods, are strongly influenced by the climate. The mountainous configuration of the Kyrgyz territory increases the potential for disasters to occur, together with wrongfully planned economic activities (UNISDR 2010). For example, the practice of cattle breeding on mountain slopes, as well as the construction of houses in flood plains and the irrigation of agricultural sites with high levels of underground water, are all factors increasing the exposure of the territory to natural risks. More intense and frequent droughts are also expected in the country, increasing desertification especially in its southern regions. Arid and semi-arid deserts could increase by up to 23.3–49.7 % of the country's territory in 2100 in comparison to roughly 15 % in 2000 (World Bank 2013).

5.2.2 Present and Future Water Uses and Demand in Kyrgyzstan

Understanding the prospected impacts on the demand for water resources in the future, and hence how the balance between water demand and supply can potentially change, is particularly crucial in the case of Kyrgyzstan, where prospects for conflict arising out of situations of scarcity are magnified by its already tense relationships with its Central Asian neighbours.

In general terms, it is rather difficult to predict the long-term development of water consumption in Kyrgyzstan, due to the inherently unstable conditions of the country's national economy since its independence and transition to a market-oriented system (GWP 2006). According to a study realised by the UNDP Global Environmental Facility (GEF), three development scenarios can be considered for the main sectors of the Kyrgyz economy: minimum development, low development, and high development (see GWP 2006, p 4). The First Scenario (minimum development) envisages the rehabilitation of the agricultural and water sectors by means of simple interventions in the governance system and hence without adding land or water resources. The Second Scenario (low development) foresees a limited (but higher than in scenario one) increase in agricultural production with respect to the 1990–1991 level, while using the same amount of land and water resources. Finally, the Third Scenario (high development) predicts a high development of agricultural production: accordingly, by 2010–2025, all Kyrgyz population would be able to receive the daily caloric intake that is recommended for a healthy person. In this scenario, additional land and water resources are envisaged for agricultural production. Table 5.2 shows a summary representation of the three GEF scenarios. In the same UNDP/GEF study cited above, indices of water use/consumption at the level of 1999–2000 were adopted as the baseline. In this forecasting exercise, it was supposed that actual water consumption over the considered years exceeded the official statistical data of at least 10–20 % (to take into account the uncertainty of available statistics, due to the difficulties that are inherent in measuring effective water withdrawals and consumption in the country). Table 5.3 reports the results that were presented by the study in relation to the various sectors of the Kyrgyz economy.

According to the GEF study, overall water consumption and demand from the different economic sectors will increase to a significant extent by 2020. In particular, the demand for water supply for the rural population will be higher than for urban population, representing the 1.5–1.6 % of total water consumption (vs. the 1.2 % for urban population). Water supply for industrial enterprises will be more significant in urban areas, representing the 20–40 % of total water consumption (and only the 5 % in rural areas). Irrigated agriculture will continue to consume the 89–90 % of water resources. Similarly, all other water uses (energy, fishery, etc.) will augment significantly.

Table 5.2 Summary of water scenarios according to GEF/UNDP study

	Development scenarios		
Development indices	First	Second	Third
Irrigated land area (thousand ha)	415	416	493
Water intake/use (total, million m^3/year), including:	4,275/3,557	4,633/3,778	6,141/4,952
For developed lands	/	/	708/580
Improvement of water availability for irrigation of new lands	/	/	800/594

Readapted from GWP (2006)

Table 5.3 Real and estimated indices of domestic water use/consumption in the Kyrgyz Republic 2005–2010

Sectors of water use/ consumption	Forecast of water use/consumption (million m^3)				% tot water consumption in 2020
	2005	2010	2015r.	2020r.	
1. Municipal water consumption in cities and *rayons*					
1.1 Water supply for the urban population	95–100	105–111	121–126	138–146	1.2
1.2 Organisations, institutions and their infrastructure	17–18	19–20	21–22	24–26	0.2
1.3 Industrial enterprises	(20–40 % from water consumption by population)				
2. Water supply in rural areas					
2.1 Water supply for rural population	97–100	115–120	152–157	175–193	1.5–1.6
2.2. Organisations, institutions and settlements infrastructure	19–20	23–24	30–31	35–39	0.3
2.3 Industrial enterprises	(up to 5 % from water consumption by population)				
3. Irrigated agriculture	7,500–8,500	8,500–9,500	9,500–10,000	10,000–10,600	89–90
4. Industry (total)	350–400	500–550	600–650	630–700	5.9–6.0
5. Energy	10.5	11	11.5	13	0.1
6. Forestry	20.5	21	21.5	22	0.2
7. Fishery	65	70	75	80	0.6–0.7
8. Other sectors	30	40	50	60	0.5–0.6

Readapted from GWP (2006)

Matching these considerations with the results of the simulations run by Immerzeel et al. (2012) in a study commissioned by the ADB, it is evident that serious problems exist in Kyrgyzstan, where the inflows of the Syr Darya River is prospected to significantly decrease by 2050. As a consequence, the effective potential for augmenting future water intake volumes in Kyrgyzstan remains dangerously limited. The international water sharing quotas that oblige Kyrgyzstan to release a fixed percentage of its water resources to downstream countries in the Aral Sea basin greatly worsen this problem. In addition, at present, the 78 % of agricultural land is irrigated with water withdrawn from small (and unregulated) river flows (by using pumps). This implies that water reserves from small rivers during the vegetation period are being depleted. At the same time, further expansion of the irrigated agricultural area by using gravity systems, which use water from large rivers, presents limited perspectives because of the high costs of this particular irrigation method, as well as the amount of water it would subtract from other important uses, such as hydropower.

The UNDP/GEF study concluded that the only alternative options to meet future water demand would involve a redistribution of the annual flow of small rivers through the creation of accumulating reservoirs; the creation of an inter-basin transfer of water resources (from the Naryn and Tarim Rivers, for example); a more intensive exploitation of groundwater reserves; a more efficient use of return waters; and/or less water-intensive irrigation technologies, such as drip irrigation (GWP 2006, p 5). Realistically, however, these options require significant investments, which are unlikely to be realised in the country given its already strained financial situation and the instability of its government. Therefore, for the time being, measures aimed at water saving and improvement of water use productivity really seem the only viable solution.

5.3 Drawing the Governance Background

The next sub-sections will examine the main characteristics of the Kyrgyz water governance system, as well as the country's institutional framework for climate change adaptation and disasters risk management.

5.3.1 Water Governance Before and After the Soviet Era

In order to effectively understand the water governance system that characterises Kyrgyzstan today, the analysis must be temporally stretched back to the Soviet times. In fact, incorporation into the Soviet Union completely defined and shaped the system for water resources management in the country, as well as in the other Central Asian states. The traditional form of water management in the region dates back to the Arab occupation in the seventh century, when it revolved around the figure of the *mirab bashi*. The *mirab bashi* was an official responsible for decisions on water allocation for the main canal system; in addition, there were a number of minor *mirabs* that locally controlled secondary canals (O'Hara 2000, p 373).[10]

In 1923, however, the Soviet administration abolished this ancient system; Kyrgyzstan was divided into several hydrological units on the basis of soil type and climate, which served to specify the amount of water that had to be released in a determined period and for different crops. These hydrological standards, elaborated between 1940 and 1960, are still in use today (Herrfahrdt et al. 2006, p 45). Following the process of land collectivisation, central planning was imposed on farmers. In order to increase cotton production, with its high water consumption, moreover, the Soviets expanded the Central Asian irrigation network beginning in

[10] In Arabic, *mirab* means 'water master', while *bashi* means 'head'. The mirab bashi and mirabs were elected and paid by the peasant farms, depending on the degree of the water users' satisfaction with their work (O'Hara 2000, p 373).

the 1940s. To meet the irrigation needs of downstream republics huge reservoirs were built in Kyrgyzstan (O'Hara 2000, p 370). This policy led to an extreme over-exploitation of the region's water resources, with negative impacts on the environment that have persisted until today. Environmental depletion and degradation, loss of biodiversity, grave concerns for human health and pollution of water resources, ultimately leading to the dramatic shrinking of the Aral Sea resulted (a phenomenon that is commonly referred to as the "*Aral Sea syndrome*") (Klötzli 1997).

In the Kyrgyz territory of the Soviet Union, inter-farm canals fell under the responsibility of the state, and their operational costs were covered by the national budget. On-farm irrigation networks, in turn, belonged to the members of collective farms. Despite that, water end users were not involved in the operation and maintenance of irrigation systems: instead, their management was in the hands of a small number of specialised workers, the so-called 'irrigation brigades' (Herrfahrdt et al. 2006, p 45). In general, water governance in the Soviet system followed a highly engineered approach, according to which nature was viewed as something to be marshalled and directed by elaborate technology. Nevertheless, this system suffered from an inadequate flow of information between units of a hierarchical structure, and translated into inefficient water use, further compelled by the progressive deterioration of the Soviet-era irrigation infrastructure, already starting from the 1970s (O'Hara 2000, p 375).

After the collapse of the Soviet Union in 1991, the Kyrgyz Republic became responsible over night for financing, managing and maintaining its irrigation and water delivery systems. Privatisation programmes were introduced in Kyrgyzstan as early as December 1991. In the course of the following years, a vast array of state enterprises and state-owned utilities were transferred to private entities by means of vouchers and cash auctions (Abazov 1999). This process happened with the strong political backing and monetary support of international financial institutions, which assigned a high priority to privatisation in the newly independent states of Central Asia (Pomfret 2004). In the case of natural resources, Kyrgyzstan largely privatised excludable goods such as agricultural land and cattle, but retained state ownership of some common pool and key natural resources, such as forests, pastures and water (Bichsel et al. 2009, p 257).

The land reform process, with land privatisation as its final objective, created a sound misfit between existing water management practices and newly introduced land ownership patterns. A water governance reform was hence deemed necessary, and efforts in this sense culminated with the adoption of the Water Code in 2005 (Kyrgyz Republic 2005). The 2005 Water Code defined water as state property, but granted every person within the boundaries of Kyrgyzstan the right to use it for a finite list of purposes, including irrigation. Also, according to the Water Code, the state is not in charge with the management of tertiary and some secondary canal systems, which are instead handled by Water Users Associations (WUAs) (Kyrgyz Republic 2005). An irrigation service fee was introduced in 1995 (although only implemented in 1999), and while the inter-farm irrigation infrastructure remained state-owned, the ownership of on-farm infrastructure was transferred to formalised irrigation communities (Herrfahrdt et al. 2006; Sehring 2009b).

All in all, the reform of the water sector in Kyrgyzstan, as well as other reforms in the political and economic sphere, followed a decentralisation approach, thereby transferring state authority to lower political levels and delegating increasing functions and tasks to governmental and non-governmental bodies (Ibraimova 2009). The decentralisation process in the case of Kyrgyzstan was centred on the concept of 'local self-governance'. The most relevant body in this respect became the village administration (*aiyl ökmötü*), introduced in 1996. According to the law, the *aiyl ökmötü* is an independent entity from central government, and comprises clusters of villages, most of which were part of the same state or collective farm during Soviet times. It should be further noted that this reform of the political system was initiated and strongly supported by the UNDP and other international organisations, and implemented by the central government as a top-down process (Ibraimova 2009).

One particular aspect of the decentralisation process in Kyrgyzstan has been the creation of WUAs at the beginning of the 2000s. WUAs are non-commercial voluntary associations of water users that finance themselves through members' payments for water service delivery (Bichsel et al. 2009, p 258). Usually established along the boundaries of former state and collective farms, they are intended to operate, maintain and rehabilitate the irrigation system, deliver water to and collect water fees from end users, and purchase water from the state (Ul Hassan et al. 2004; Herrfahrdt et al. 2006; Sehring 2005). Strong financial and logistic support towards establishing and developing the WUAs was provided by the Asian Development Bank (ADB) and the World Bank (WB) (Alymbaeva 2004).

After independence, a key task of the Kyrgyz government was to restructure the institutional arrangements for water resources management that it had inherited from the Soviet period. To this end, a number of reforms were initiated, which aimed at reducing the administrative staff while improving the equity and efficient allocation of the available budget. In addition, coordination among public administration bodies was sought to eliminate the duplication of functions, separate rights and responsibilities and improve monitoring. In particular, reform programs in the water sector primarily concerned two sets of institutions: governmental water management organisations (at national and sub-national level) and local, village-based organisations.

At the national level, responsibilities for water resources management primarily fall within the sphere of competence of the Government of the Kyrgyz Republic (GoKR). It is tasked with developing, approving and amending water legislation and policy, ratifying international agreements, agreeing on the boundaries of hydrological basins, allocating responsibilities for the implementation of the Water Code among Ministries and State Agencies, and setting annual subsidies for irrigation and drainage and tariffs for Water Supply and Sanitation Services (WSS) (OECD 2011, p 6).[11] Instead, the State Committee on Water Economy and Melioration (SCWEM) controls the Republican Irrigation Fund, which represents the State's contribution to

[11] Following the national referendum of 27th June 2010, a new constitution has transformed Kyrgyzstan from the Presidential regime into being a Parliamentary Republic.

the funding of irrigation services. The SCWEM is responsible for the production of unified technical policy aimed at designing, constructing and operating state-controlled water systems (irrigation and rural water supply). It regulates relations with other states and international organisations on the use of the water resources that originate within the territory of Kyrgyzstan. In addition to its national office, the SCWEM is also present at Basin and Rayon levels (OECD 2011, p 7).

The Ministry of Natural Resources (MoNR) of the Kyrgyz Republic is tasked with operating the wide network of groundwater monitoring boreholes to measure water quality and levels. It also produces studies on hazardous natural and geological events such as flooding, mudflows, landslides and seismic activity. Another important actor at the national level is the State Agency for Environmental Protection and Forestry (SAEPF), which is responsible for the protection of Kyrgyzstan's natural environment, including the regulation of polluting substances discharged into water. As for drinking water, key responsibilities are attributed to the Ministry of Health (MoH), under which a Sanitary and Epidemiological Service exists and controls the quality of drinking water in urban and rural areas (OECD 2011, p 7). The Hydrometeorology Agency (Hydromet) conducts systematic observations of hydrological, meteorological, and agro-meteorological conditions, and is accountable to the Ministry of Emergencies. Hydromet operates a system of 'hydroposts' for measuring river levels throughout the country, which are also used to undertake water quality sampling (OECD 2011, p 7).

Always at the national level, the heads of relevant Ministries and State Agencies are all reunited in a National Water Council, which coordinates the activities related to water resources management, prepares the National Water Strategy, and drafts laws and regulations (to be presented and approved by the GoKR) aimed at implementing the 2005 Water Code (Kyrgyz Republic 2005). Among its tasks, the National Water Council also provides oversight to the work of the Basin Water Councils, which are responsible for water resources management in the respective hydrological basins. These councils include representatives from the respective Basin Water Administrations, local offices of the SAEPF, local State Administrations, NGOs, WUAs and other water users. As such, they constitute the link between the national and sub-national governance (*oblast* and *rayon*, or regional and provincial) levels. However, although formally created, the National Water Council did not seem to be operational yet as of July 2011 (OECD 2011).

Within *oblasts* and *rayons*, an important role is also played by the Basin Water Administrations, representing the SCWEM at the local level. Basin Administrations are responsible for the administration of the State Irrigation Fund and for the operation of the irrigation and collector drainage networks. Funds for the activities of the Basin Administrations largely come from the State (88 %), while irrigation fees paid by water users cover the rest (OECD 2011, p 8). Additionally, within each *oblast*, there are Rayon Water Administrations, acting on behalf of the SCWEM at the most-local level. *Rayons* have a Department for WUA support, which is another sub-division of the SCWEM. Departments for WUA support are responsible for

assisting WUAs in their irrigation management function and in the collection of fees and their transfer to the SCWEM.[12]

Finally, at the very bottom of the governance scale, WUAs deal with the local management of irrigation water and networks. As of April 2011, there were 475 WUAs in Kyrgyzstan, supporting more than 285,000 water users with their services (World Bank 2011c). The number of both registered and unregistered WUAs has been steadily rising since their first creation; for example, there were 223 WUAs in 2000, 266 in 2001, and 342 in 2004, covering around 595,500 ha (out of 1,047,200 ha) of total irrigated land (Alymbaeva 2004). In addition to formally registered WUAs, in some remote mountainous areas informal WUAs have taken over the management of water resources in order to operate and maintain on-farm irrigation systems (Alymbaeva 2004). In close collaboration with the Rayon Department for WUA Support, WUAs operate a locally-based administrative management system for the collection of irrigation tariffs and the maintenance of irrigation canals (see Fig. 5.3).

Fig. 5.3 WUA meeting in Osh. During these occasions, farmers (mainly smallholders) gather at the local school (or at the WUA's offices for larger WUAs) and discuss about seeds quality, establish shifts for the maintenance of irrigation canals, receive trainings from NGOs on new technologies to increase their crops' productivity (which is what is happening in the picture) and discuss to resolve eventual conflicts that may arise between them for instance in terms of water utilisation (Source: Author)

[12] In total, there are six Oblast Basin Management Departments (OBMD) in Kyrgyzstan, established in 1997 in correspondence with hydrological boundaries (approximately) – this particular configuration of the OBMDs (which later on turned useful towards the implementation of IWRM principles) was due to the Soviet organisation of water canals, which were all built within one oblast. Within OBMDs, there are a number of *RayVodKhozes*, or Rayon Water Administrations, which distribute water to secondary and tertiary canals. However, the RayVodKhozes are not structured according to the hydrological boundaries, which creates an important incoherence in the system (Tursunaliev 2002).

Alongside WUAs, in villages and small towns, the *ayil oktömüs* is another important actor; originally tasked with economic and social development at the local level only, it gradually took over support functions for WUAs, thus indirectly coming to deal with water resources management. Water and agricultural specialists in the *ayil okmötüs* provide farmers with advice on the cultivation of crops and help them plan their water needs. In the cities instead, the Municipal enterprises responsible for water supply and wastewater collection and treatment are called *Vodokanals*. These are independent municipal enterprises, which, from a financial point of view, rely almost exclusively on the collection of user charges from households and public and commercial enterprises. In some cases, they receive grants from the municipal budget or international donor assistance for the construction or rehabilitation of facilities, or to cover their operational expenditures. Finally, the traditional court of elders (*aksakal sotus*) has gained increasing importance after independence, up to being granted the status of formal organisation in 1995. The *aksakal sotus* consists of about five persons, mostly respected elders of the community, dealing with land and water management. It becomes particularly relevant when it comes to the settlement of conflicts between WUAs and farmers, or between farmers and other farmers (Sehring 2005, p 21).

5.3.2 Governance Framework for Climate Change Adaptation

The problem of climate change is a relatively new one in Kyrgyzstan, which implies that governmental authorities still treat it as any other environmental issues, such as pollution or soil degradation. As a consequence, any analysis of the governance framework that is in place to address climate change inevitably involves studying the legislative and institutional structures that regulate the environmental sector more generally. Since its independence, Kyrgyzstan has developed a rather decent legislative basis to order natural resources management, including water resources management. Its basic principles are outlined in the Constitution of the Kyrgyz Republic, according to which "*the citizens of the country have equal rights of access to the primary sources of life* (*clean air*, *water*, *land and other resources*)", as well as "*a right to an environment that is favourable to their lives and health and recovery of damages caused by actions in nature management*" (Art. 34). Natural resources are defined as a common property of the people and, as such, belong to the state.

More specifically on climate change, the existing institutional and legal frameworks predominantly deal with the issue of mitigation. Adaptation has only started being addressed. Regarding climate change prevention and adaptation in the Kyrgyz Republic, it is the State Agency for Environmental Protection and Forestry that has primary responsibility, but again actions in this domain are mainly initiated by international actors. Adaptation is not mentioned in the mandate of the National Committee on Climate Change. Measures in this sense were included in a number of major documents, including the Country Development Strategy (2009–2011),

Table 5.4 Examples of the adaptation measures that are listed in the Second National Communication of the Kyrgyz Republic to the UNFCCC (Kyrgyz Republic 2009)

Key sector	Adaptation options
Agriculture/food security	Technological improvements: Alteration of plant cultivation and cattle breeding; implementation of alternative approach to land cultivation in order to reduce the shortfall of water and mineral substances; implementation of more efficient irrigation practices; diversification of seed and cattle livestock varieties tolerant to expected climate change
	State support: Development and implementation of early warning systems as well as of improved daily and seasonal weather forecasts; adjustment of crop insurance programs in order to influence the strategy of risk management regarding crop losses caused by climate change; development of incentive programs to support peasants and farmers; implementation of agricultural grants to affect the agricultural production
	Economic mechanisms: Development of crop insurance program to reduce risk of income loss caused by climate change; investment into agricultural equities and futures in order to reduce risk of income loss; participation in programs on income stabilisation in order to reduce risk of income loss; diversification of income sources in order to reduce risk of income loss caused by climate change
Water	Increased investments in irrigation networks to better manage supply
	Lining more irrigation canals to reduce seepage losses
	Reducing the area of crop and pasture irrigated by inefficient flooding methods
	Increasing the area of lucrative fruit and vegetable crops irrigated by efficient drip and below-ground irrigation systems
Institutional responses	Increase enforcement of the legislation through the development of by-laws, resolutions, decisions and directives
	Improve and encourage interagency action in the process of forming and implementing the policy; support interagency coordination in natural resources and environmental management; improve decision making processes by focusing on a programme based approach to planning which includes appropriate assessment mechanisms to allow for full understanding of the issues at hand before decisions are made
	Improve the political and socio economic climate for attracting, adapting, and developing procedures and mechanisms for efficient natural resources use and environmental management
	Improved environmental management practices to conserve the natural resource base, by renewing institutional and policy support for addressing shortcomings in soil fertility management, water use, pest control, nutrient conservation, forest health and illegal logging

Readapted from GFDRR (2011)

the Concept of Environmental Security, and the National Energy Program (2008–2010) (UNDP 2010, p 65). However, ensuring that the issue of climate change is adequately addressed, especially in terms of adaptation, has not become a real priority in sectoral and regional strategies. So far, the only serious step towards adaptation has consisted in listing the required adaptation measures in the Second National Communication of the Kyrgyz Republic to the UNFCCC (Kyrgyz Republic 2009) (listed in Table 5.4).

In addition to the list presented in Table 5.4, it is important to note the role of international organisations and NGOs in implementing projects and activities aimed at vulnerability reduction. For example, the UNDP and the Global Environmental Facility (GEF) are also carrying out a project on capacity building for improved national financing of global environmental management in the Kyrgyz Republic. Such projects will assist the country in conserving its natural resources and preventing degradation through fiscal reform processes. Also, the World Bank's Central Asia Hydrometeorology Modernisation Project (CAHMP) is helping the Kyrgyz Republic, as well as the other Central Asian countries, to strengthen the capacity of the national hydro-meteorological service to improve the delivery of weather, water and climate services. Other UN agencies (WMO, UNEP, UNICEF), international NGOs (Helvetas and ACTED), and international donors (WB, ADB, Swiss Development Cooperation, German Development Cooperation, UK DFID, USAID) all have projects related to water resources management and/or disaster risk management; only some of them, however, specifically focus on climate change.[13]

One important aspect of climate change adaptation in Kyrgyzstan is the country's capacity to manage natural disasters, as one of the expected impacts of climate change is an increase in their frequency and impact (IPCC 2014b). Formally, it is the Ministry of Emergency Situations (MoES) that has competency over disaster risk management in the Kyrgyz Republic. In addition, a National Platform on Disaster Risk Reduction (DRR) has recently been established to bring together key stakeholders and promote cooperation and strategic planning. At a more general level, efforts at disaster risk management in Kyrgyzstan are taking place under the flag of the international community. A Disaster Response Coordination Unit (DRCU) was instituted, in its current form, in 2009. It consists of a high level forum with a mandate to harmonise the efforts of UN organisations, the Red Cross and Red Crescent Movement, and local and international NGOs in disaster preparedness and response. The DRCU is part of the Inter-Ministerial Commission on Disaster Management of the Kyrgyz Republic, and is chaired by the UN Resident Coordinator. It comprises seven sector groups on health, emergency shelter and camp management water, sanitation and hygiene, education, food security, protection, and early recovery. In addition, the DRCU is supported by two Rapid Emergency Assessment and Coordination Teams (REACT)- one based in Osh, and the other in Bishkek- that provide joint assessments of humanitarian needs in emergencies. The REACT teams are composed of personnel from UN organisations, the Red Crescent Society, and international and local NGOs.

[13] It should be noted that in order to regulate the relationship between international donors and the Kyrgyz government, a Joint Country Support Strategy (JCSS) has been developed as a joint effort of: ADB, the Swiss Development Cooperation, DFID, the World Bank Group, the United Nations Agencies, the Government of Germany, and the European Commission. The JCSS presents the core strategy of the major seven development partners to support the development agenda of Kyrgyzstan for the period 2007–2010, and covers environmental, agriculture and rural development, and governance issues (JCSS 2006).

5.4 Institutional Adaptive Capacity in the Syr Darya River Basin According to the Experts

Ensuing the previous sections with the general description of the geographical, socio-economic and water use characteristics of the Kyrgyz Republic, the climate change and socio-economic scenarios, as well as the presentation of its governance frameworks over time, it is now time to introduce the main findings on the adaptive capacity of the Kyrgyz water institutional system. These findings are based on the data that were collected from interviews with 36 water experts.[14] It is immediately evident that the category that was most often mentioned by respondents in association with water resources management and climate change is the human and social resources one (31.2 % of total references), although the difference with the government and governance category is only relatively small (29 % of total references). Interestingly, the other categories were mentioned to a significantly less extent: determinants in the finances and risk category were invoked 13.6 % of the times, those in the information management category 13.2 %, and those in the infrastructure category 13.1 %.[15] These data seem to indicate a situation in which water resources management is strongly dependent on social and political factors, rather than on more technical concerns such as information sharing, or infrastructure. Evidence, therefore, points to the need for a different understanding of water resources management in Kyrgyzstan, one that focuses on the interaction between individual and social institutions in the water sector, and on the ways in which perceptions shape their effective performance.

5.4.1 The Human and Social Challenge in the Kyrgyz Water Sector

Based on the number of absolute references for each category, and starting with human and social resources, the determinant of social and institutional capacity is the one that was most often mentioned by respondents (27.9 % of total mentions in the human and social resources category). However, references were made to *inadequate* social and institutional capacity, thereby indicating a situation characterised by a generalised deficiency of competent staff and personnel working on water resources management. Respondents also discussed the fact that young professionals tend to stay out of the water sector, which is typically underfunded, thus impeding intergenerational turnover. Underlying these patterns are the frequent connections between social and institutional capacity and budgetary constraints; no public funding translates into low salaries for the staff, which, in turn, means that competent

[14] A complete list of the interviews that have been conducted is presented in Appendix 1.

[15] The specific number of references (in absolute and relative terms) for each determinant and category is presented in Appendix 3.

personnel cannot be hired. Crucially, insufficient institutional capacity was also related to external donors. In fact, some respondents indicated that although international actors work in close collaboration with governmental agencies (at both the national and sub-national levels) and local NGOs, they maintain the primary initiative and control over projects and activities on the ground.[16] Social and institutional capacity was described as insufficient for collecting, analysing and integrating climate information into the decision-making process, and as inadequate to effectively take advantage of existing technology and innovation. Technical improvements are introduced by external donors, but then fail to be institutionalised within the system and, as a consequence, tend to be abandoned afterwards.

In this sense, interviewees highlighted the importance of education and training to instruct the youth on how to manage water resources and, more generally, to communicate environmental problems to the population that, to date, remains highly uninformed about these issues. In fact, the determinant of education and training was often mentioned in association with communication and awareness raising, thereby describing a situation in which the majority of the undergoing educational efforts target policy-makers and water users, as well as the general public. At present, education and training programmes primarily result from the initiative (and with the funding) of international organisations, although the latter then recur to local partners (e.g., NGOs) for implementation. Respondents further highlighted the importance of teaching how to access diversified financial instruments to farmers, such as micro-credits (Orolbaev and Valentini 2010, p 44), as indicated by the linkages between the determinant of education and training and that of innovation. For example, the Rural Advisory Services of Jalalabad, a local NGO supported by the Swiss NGO Helvetas, has offered trainings to more than 9,000 farmers on water-saving irrigation technologies and the introduction of new, less water-demanding crops, working with more than 90 trainers and organising a total of 472 experiments and demonstrations since 2000 (Gareeva 2011).[17]

Perceptions, prioritisation and sensitivity also abundantly entered the respondents' concerns (17.6 % of total references). In particular, reference was made to the fact that climate change has only started being considered a problem at the political level, and its consequences for Kyrgyzstan remain unclear to the majority. As in the case of Italy, the layman typically associates climate change with water scarcity – and since Kyrgyzstan has, so far, been characterised by water abundance, climate change has not yet raised particular alarm in the country. This, coupled with the difficult financial situation of a country like Kyrgyzstan that is struggling with poverty reduction and economic development, contributes to relegating climate change

[16] According to the Joint Country Support Strategy of 2006, Kyrgyzstan also suffers from the problem of salary-related loss of trained staff to other bodies or donor organisations, which affects the potential for capacity-building. It is recognised that while the mobility of trained staff within the country is not necessarily a loss to the national economy, it can slow down or disrupt implementation of certain projects and programs (JCSS 2006).

[17] Data were derived from a personal interview that the researcher conducted with the Director of the Rural Advisory Services in Jalalabad, Kyrgyzstan, on October 18, 2011.

to the very bottom of the political agenda (as also confirmed by Oppenheimer and Todorov 2006). The lack of political willingness, especially at the highest governmental levels, to address the problem of climate change, and more generally to seriously consider current issues in the water sector, is reflected in the recurrent mention that respondents made to the determinant of "leadership and political willingness" in its negative declination. In fact, leadership and political willingness were related to the budget determinant, thus supporting the previous observation according to which the lack of financial resources would seem to be one of the reasons why political leaders and decision-makers have not substantially intervened in terms of water resources management, let alone climate change adaptation. The determinant of experience was only mentioned in the 7.1 % of the cases, and mostly in relation to experience of past events, and how the latter contributes to building the capacity to respond to similar extremes in the future.

Partnerships and networks were identified by interviewees as useful ways to bring more resources, particularly economic but also information-related ones, into the system, as well as to solve problems and conflicts (14 % of total references to the category of human and social resources). In the water sector, partnerships were established mostly between international organisations and/or NGOs, since these are the actors that most often take the initiative to intervene in terms of water resources management in the first place. Interestingly, partnerships and networks were mentioned in relation to climate and scientific information. Accordingly, it would seem that it is in the framework of international projects that the required economic resources, expertise and monitoring stations for collecting the data are effectively made available in the country.[18] Partnerships were also reported to serve communication purposes. Respondents mentioned the role of environmental NGOs, constituted into an informal network headed by the Kyrgyz NGO Unison, in raising the environmental awareness of citizens through campaigns, the publication of magazines, and activities in schools. Equally, NGOs were found crucial in lobbying governmental authorities to take a more proactive stance on the issue of climate change.

But respondents also hinted at a number of difficulties associated with partnerships. For once, international actors do not always optimally interact with their local counterparts, for example because of language and cultural barriers, which impede the establishment of relationships of trust and positive collaboration.[19] In addition, not all local actors know how to access international funds, especially because of the complicated bureaucratic procedures that these often involve (see also Herrfahrdt et al. 2006, p 180).[20] The economic resources that are made available by international

[18] For example, the World Bank Central Asia Hydrometeorology Modernization Project (CAHMP) aims at strengthening the capacity of the national hydro meteorological service (Kyrgyzhydromet) to improve the delivery of weather, water and climate information and services.

[19] Cit. from interview with respondent at international level (international NGO), conducted by the author in Bishkek (Kyrgyzstan) on October 10, 2011.

[20] Cit. from interview with respondent at international level (international NGO), conducted by the author in Bishkek (Kyrgyzstan) on October 10, 2011.

projects can lead to competition between recipients.[21] Partnerships risk to be plagued by the reticence of their members to share information between each other, especially if they extend to the Central Asian regional context and hence involve organisations from different countries.

Furthermore, respondents widely discussed the determinant of group relations and representation of interests, although to a comparatively minor extent than the other determinants (6.5 % of total references in the human and social resources category). In particular, interviewees described a situation in which not all the interests of water users are adequately represented in the decision-making process, which tends to be perturbed by the frequent occurrence of corruption. According to a recent study conducted by the World Bank on Kyrgyz politics (World Bank 2012), the Kyrgyz regime has inherited many of the characteristics of the previous Soviet system. These regard the culture of control and the use of personal power, and the almost total absence of the concepts of accountability and rule-based decision-making. The combination of all these factors has allowed corruption and rent seeking to flourish, particularly at the highest governmental levels; from here, it then permeates through society (Sehring 2009a; World Bank 2012), and creates a "*neo-patrimonial state with conditions of systematic clientelism*" (Gawrich et al. 2010).[22] These dynamics can be found in the water sector as well, where public positions are often not attributed on the basis of the effective expertise and professional formation of individuals, but on their recommendation by or affiliation with influential political figures. In addition, it is also in the water sector where economic resources are often diverted towards the personal profit of some, at the expenses of the collective good (Sehring 2009a).

Under the determinant of group relations and representation of interests, respondents discussed the ethnic dimension, which is increasingly becoming a source of apprehension especially at the border between Uzbekistan and Kyrgyzstan, and after the June 2010 events. In fact, in the rural areas on the border, water for irrigation is of crucial importance as the cultivation of cotton is one of the main economic activities. In several cases, moreover, villages are dependent on water from the other side of the border. During the spring and summer seasons, this water becomes

[21] Cit. from interview with respondent at civil society level (local environmental NGO), conducted by the author in Bishkek (Kyrgyzstan) on October 14, 2011.

[22] This was particularly the case in the Akajev and Bakiyev eras, from the independence to 2010. Also after the first open parliamentary elections in 2010, however, the different Ministries continued to be controlled by different political parties, clans and power bases. Loyalty remains fundamentally based on traditional family or ethnic ties, old Soviet party ties, and, more recently, on new loyalties like one's business circle. Several scholars observed that the 2005 Tulip Revolution was triggered by the strong clientelism that had characterised the ruling of President Akajev, who was able to build a country-wide network of "presidential supervisors" that played as local agents of presidential rule (Huskey 2002). Bakiyev's regime was not very different, as he continued the well-known pattern of distributing state positions and public offices to members of his family. Fundamentally, the change from Akajev to Bakiyev represented a change of power from one area clan to another, which is the main reason that lies behind the Second Tulip Revolution of April 2010.

scarce, primarily because of mismanaged and broken irrigation systems, thus provoking tensions between and within villages (see also: ACTED 2011). Ethnicity, it was said, may add to these tensions and cause real conflicts at the local level.

5.4.2 *Bureaucracy, Partnerships and Perceptions: Key Ingredients of Water Resources Management in Kyrgyzstan*

In the government and governance category, the determinant that was most often mentioned as linked to the capacity of the country to respond to climate and socio-economic changes was the water management paradigm one (21.5 % of total references), followed by risk and emergency management (15.3 % of total references). As for the former, respondents discussed in particular the Soviet legacy in the water sector, which today translates into a very rigid bureaucratic structure, obsolete infrastructure, and a managerial class that has received its education in Soviet times and has not updated it since (see also Allouche 2007; Bichsel et al. 2009). Partnerships and networks, and especially those established between local and community actors and international ones, were reported to have positive effects in terms of introducing the discourse on climate change adaptation. Moreover, perceptions were indicated as fundamental in defining the characteristics of the water management paradigm in force. At present, for example, users consider water as if it was a non-exhaustible resource, a practice that will clearly not be sustainable in the future. However, perceptions of water scarcity are still not common as a consequence of the traditional water richness with which Kyrgyzstan has been always blessed (or cursed). In this sense, communication and awareness-raising were indicated as useful ways to modify this understanding and introduce the idea that water-saving technologies should be adopted especially in the agricultural sector. Not surprisingly, the determinant of traditional knowledge and management practices was mentioned quite often in connection with the water management paradigm. In fact, without a strong control from the central state, water resources management in rural areas remains strongly influenced by the direct knowledge of the territory that farmers have developed throughout experience. At the same time, however, innovation was invoked as a factor of success in the water sector – and here respondents particularly referred to the introduction of water-saving techniques for irrigation purposes.

In terms of disasters risk management (DRM), the Kyrgyz system was said to be characterised by the tendency to react ex-post, once the event has struck, rather than in an anticipatory mode. References to preventive responses were only made by those international actors that are currently trying to change the mind-set of national and local decision-makers in this direction. While the legislative framework in the risk and emergency sector was deemed to be generally acceptable by the majority of respondents, its implementation was depicted as challenging, mostly as a consequence

of the lack of technology and resources. From the interviews, it emerged that it is international organisations that conduct most of the education and training efforts in this sense. Correspondingly, DRM was also related to communication and awareness-raising directed at both policy-makers and the general public, and concerning preventive and reactive strategies in an equal manner.[23] Nevertheless, efforts at responding to extremes were reportedly plagued by difficulties in sharing information especially concerning training modules, as a consequence of the high degree of competition between organisations working on DRM.

The "coordination and integration" determinant was mentioned almost to the same extent as risk and emergency management (13.2 % of total references for the government and governance category). Coordination and integration were linked to education and training, positive relations within groups, and the role of leadership and political willingness. In that, they suggested that these elements may contribute to building the capacity of the water governance system to gradually integrate issues such as health and agriculture. Nevertheless, coordination and integration tended to be characterised as rather unsuccessful, which reflects quite well the fragmented status in which the water governance system is found in Kyrgyzstan. As evidenced, attempts of introducing the IWRM approach in the country have resulted in a confused patchwork of legislation. More specifically, respondents denounced the failure of IWRM under two fundamental aspects. First of all, it did not effectively bring about an integrated approach to water resources management in the country, as related sectors such as health, risk and emergency management and agriculture are still in the hands of different Ministries that do not enter into dialogue with each other. Secondly, the difficult relations with neighbouring countries have impeded the effective management of the Syr Darya waters at the river basin-level. Actually, each country manages its water separately, on the basis of weak international agreements. In turn, these agreements are sources of tension within and between states, and which provisions do not satisfy any of the involved parties.

Another interesting reference was made to the incapacity to coordinate current measures and responses in terms of water resources management with the traditional ways of dealing with problems by farmers and communities. This leads to the unacceptability of interventions at the local level, and often to their overall inefficacy as a consequence of the disconnection from ecological reality. Another issue that was mentioned by respondents in relation to coordination was the requirement to organise the efforts of the increasing number of international organisations and donors that are operative in the country. This last objective has been achieved, at least partly, with the establishment of the "Development Partner Coordination Council" aimed at strengthening the coordination amongst the major donor organisations active in the Kyrgyz Republic. This approach is supposed to facilitate the implementation of joint reviews and policy analysis, while enhancing policy dialogue with the government.

[23] For a report on projects that have been initiated in this sense, see UNISDR (2010).

Related to coordination and integration – or the lack thereof – the legislative, administrative and policy determinants also received a relatively high number of references during the interviews (10.7 % of total references in the government and governance category). Apparently, almost no regulation exists that explicitly addresses the issue of climate change, and this was attributed to the non-commitment of political leaders. In addition, the social and institutional capacity that would be required to enact and implement adequate provisions to address climate change in the water sector, and actually to reorganise water resources management more in general, was said to be missing. For once, this was linked to the low salience that environmental concerns typically receive in the country. At the same time, respondents highlighted the fact that climate change constitutes a relatively new problem for Kyrgyz administrators, which means that they still have insufficient knowledge and experience of it.

One of the consequences of the unimportance that climate change is given politically was said to be the short-termism that typically characterises the Kyrgyz water governance system. In addition, especially the representatives of international organisations lamented the rigidity of the national administration and bureaucracy, which were deemed to be exceedingly slow in integrating and operationalising new procedures. The more or less rigidity of the institutional system was also related to its social and institutional capacity. More precisely, respondents argued that institutions in Kyrgyzstan tend to be immobilised by the failure of their constituent parts to step out of the bureaucratic model that was imposed during the Soviet period. Hence, the necessary moving towards a more process-oriented and adaptive one that anticipates emergent problems, resolves conflicts and coordinates policy implementation (as specified by Pahl-Wostl et al. 2010) is unaccounted for. Not surprisingly, insufficient budget was indicated as one of the reasons for this institutional stickiness. One reason is also because Kyrgyz policy-makers are somehow bound to dedicate the limited economic resources at their disposal to more pressing priorities, among which poverty reduction is obviously at the top of the list. In this sense, reference was made to the determinant of economic development more generally.[24]

The short-termism of the Kyrgyz political system was also attributed to its high political instability, as illustrated by the repeated turnover of the administrative personnel. This makes it impossible to carry out programs and projects in the long-term. Indeed, the determinant of political stability was mentioned a significant number of times by respondents (5.2 % of total references for the government and governance category), and always in a negative sense. Accordingly, it was said that political stability is hampered by the precarious economic situation of the country, which was the cause of its frequent episodes of unrest and, more recently, the

[24] According to the Kyrgyz Country Development Strategy (CDS) for 2012–2014 (and reflecting the CDS for 2007–2010), priority should be given to the implementation of several economic reforms aimed at ensuring macroeconomic stability and average annual economic growth, as well as the increase of real income and improvement of health and education services to reduce poverty rates (IMF 2012).

revolution that has transformed Kyrgyzstan from a presidential republic into a parliamentary one in 2010. In turn, political instability and widespread corruption were reported to be a source of grave concern for external donors. As a result, donors are gradually being driven away from Kyrgyzstan, as the country is perceived as a "*too dangerous investment for our money*".[25] At the same time, external donors were accused to be an inherent part of the rent-seeking apparatus that characterises Kyrgyz politics. In fact, conditionality for the disbursement of funds in terms of policies, institutional arrangements and legal frameworks provided incentives for officials to say what different donors want to hear, pass the laws and regulations that donors propose, and establish the institutions that donors recommend (see also World Bank 2012).

Related to the determinant of political stability, and particularly to its sub-determinant of corruption, was the finances and risk category. Corruption was associated with insufficient budget, pointing to a situation in which underfunded institutions – and consequent low salaries paid to employees – would seem to encourage the following behaviours: official bribe-taking; the multiplicity and duplication of functions of governmental bodies; overestimated costs of services, goods and materials provided to the government; the allocation of budget resources to non-target issues; and the participation of "friendly" companies only in tenders. However, in the governmental sphere, where the highest levels of corruption were reported, this phenomenon was rather linked to four aspects: (1) the inefficiency of the government, (2) the unmanageable administration (flexibility, planning and incorporation of time dimension determinant), (3) the inconsistency of the activities of its constituting bodies (coordination and integration determinant), and (4) a general tendency to allow a small and powerful group of politicians to secure their private immediate benefits rather than the development of long-term and sustainable strategies (group relations and representation of interests determinant) (as also observed by Marat 2008).

In the case of the Syr Darya River basin, the determinant of international relations was also included in the analysis. This was to assess the relative importance of Kyrgyzstan's political and diplomatic relations with neighbouring countries as far as water resources management is concerned. As predicted, respondents referred to this aspect rather often (10.6 % of total references in the government and governance category), especially pointing to the difficult and tense regional discourse on water allocation and sharing with Uzbekistan and Tajikistan.[26] In fact, from the

[25] Cit. from interview with respondent at international level (IO), conducted by the author in Osh (Kyrgyzstan) on October 18, 2011.

[26] According to a report from the ICG, the reasons for tense relationships on water between the Central Asian countries are the following: (a) regional water systems were designed during the Soviet Union period, while now they are managed by five different states; (b) Central Asian economies are dominated by irrigated agriculture practices, the output of which maintains the ruling elite's grip on power; (c) Central Asian states have increasingly adopted "zero-sum" positions on water resources and at the same time increased their consumption to unsustainable levels; and (d) downstream countries are militarily and economically stronger than upstream countries, which has produced a power asymmetrical relationship in the region (ICG 2002).

interviews it emerged that the general perception amongst Kyrgyz people is that their interests in terms of how water is distributed at the regional level are being widely disregarded (see also Mamatkanov et al. 2006).[27] Kyrgyz people consider water as a "*gift from nature*"; therefore, they are entitled to enjoy it to its full extent, and they should not be forced to trade it abroad. On the one side, water managers at the national, sub-national and local levels in Kyrgyzstan lament the provisions of international agreements. On the other side, however, water inevitably remains a strategic resource, which Kyrgyzstan can use to influence negotiations with its neighbours to secure energy and other goods.[28] For example, it is as a consequence of its water resources that Kyrgyzstan has managed to attract the attention of China, which today, together with Russia, is one of the biggest investors in the country (Berkofsky 2012).

Cooperation with the other Central Asian countries would seem to be favoured by education and training, especially if conducted by "impartial" international actors that manage to get leaders and politicians from different countries together to discuss common problems and look for common solutions. Interestingly, the international relations determinant was also mentioned in association with perceptions, as the "threat" posed by climate change was said to be a potential issue over which cooperation could be facilitated in the future (EDB 2009). Of course, this would happen only once an adequate and functioning system for information sharing is established, as this was still indicated as one of the main obstacles in the region.

Respondents were very generous in describing the types of conflict resolution mechanisms that are available especially at the community and local level. There, conflict resolution mechanisms fundamentally involve traditional methods of dispute settlement, including the recourse to the court of the elders. The recent episodes of civil unrest that took place in the Southern part of the country (Osh and Jalabad) in June 2010 were abundantly discussed, and were said to have had negative repercussions on the political situation of the country in general (especially in terms of its relationships with Uzbekistan), and on water resources management in

[27] As an illustration of these claims, it is worth reporting the words of a respondent: "Neighbouring countries have oil, gas, coal and other natural stocks, and in addition they use agricultural fields. Our country has no such stocks, but it has water resources, and these are a gift that we receive every day, and have a great value for us. However, while they are allowed to sell their oil and gas on the market, we have to give away our water resources on "friendly" terms, and this is not fair for us." Cit. from interview with respondent at local level (water user and member of WUA), conducted by the author in Jalalabad (Kyrgyzstan) on October 16, 2011.

[28] The GoKR faces significant challenges in terms of achieving efficient and equitable allocation of water resources among competing users within the Kyrgyz Republic and with downstream countries. Under international agreements, Kyrgyzstan is allowed to use 20 % of the total annual water inflows (precipitation) for its own purposes and must leave 80 % in the country's rivers for downstream countries. In some river basins in Kyrgyzstan, the quantities and timing of release of water to downstream countries is controlled by large hydropower storage reservoirs. In recent years, there have been tensions resulting from Kyrgyzstan's need to retain water during summer months (when downstream countries need it for irrigation) and release large quantities in winter months for electricity generation (when downstream countries don't need it – and even resulting in some flooding) (OECD 2011, p 13).

particular, as they increased the tensions between Kyrgyz and Uzbek communities, potentially leading to more localised conflicts.[29] Amongst the mechanisms for conflict resolution, respondents also mentioned the positive role that trainings on environmental issues – such as water-saving technologies in agriculture, when conducted at the local level with farmers – often have in terms of creating relations of trust between participants, which, in turn, facilitate the resolution of problems. In other words, trainings can become useful forums for conflict prevention (as also reported by ACTED 2011). Conflict resolution was also mentioned in connection with external donors, as the latter often intervene, although indirectly, in potentially tense situations, for example by funding projects aimed at increasing the degree of information sharing to establish cooperation at the regional scale.[30]

5.4.3 The Key Role of International Donors (and of Budget Constraints) in Kyrgyzstan

In the finances and risk category, the determinants of external donors and budget were mentioned by respondents significantly more often than all the other determinants (39.2 % of total references), thereby indicating the important role they play in the Kyrgyz water sector. Budget was discussed almost exclusively in negative terms; respondents described a situation that is generally characterised by shortage of funds, or their misallocation as a consequence of corruption. This is true for the water sector, and holds valid for broader environmental issues as well. Kyrgyzstan is one of the poorest countries in the Central Asian region and its limited resources are mostly devoted to poverty reduction and economic development, while other social (e.g., education, health) and environmental concerns are addressed by international organisations or with funding from external donors (see, for example JCSS 2006; IMF 2012).

[29] In April 2010, a popular revolt called for the President of the Kyrgyz Republic, Kurmanbek Saliyevich Bakiyev, to leave the country and resign. Following his departure, people belonging to its clan in the South of the country started using violence as a sign of protest, which transformed in an ethnic unrest against the Uzbek minority in the country.

[30] For example, Mercy Corps have initiated two long-term development projects that focused on the Fergana Valley (the Community Action Investment Program and the Peaceful Communities Initiative). Both these projects are based on the idea that the potential for conflict can be reduced by addressing some of the basic infrastructure and social needs of the communities through a participatory decision-making process. Also, the SDC had a 4-year peace-building project in the Fergana Valley entitled the "Regional Dialogue and Development Project", aiming at the prevention of tensions, disputes and conflicts in cross-border areas and multi-ethnic communities of Kyrgyzstan, Tajikistan and Uzbekistan. Other actors involved in conflict resolution in the country, and especially in Southern Kyrgyzstan, are: the Aga Khan Foundation, the Foundation for Tolerance International, the Organisation for Security and Co-operation in Europe (OSCE), International Alert, the American University of Central Asia (AUCA), the UNDP, and the SDC. This information is contained in the "*Desk Review on Conflict in Southern Kyrgyzstan*" produced by ACTED after the June 2010 events in Kyrgyzstan (ACTED 2011).

The crucial role that external donors play in funding, managing and operating water-related infrastructure is reflected in the numerous connections that respondents made between these two categories. For instance, international donor-funded projects have been fundamental for establishing Community Drinking Water Users Unions in rural areas, which can decide the level of water services they want according to their ability (or willingness) to pay (OECD 2011).[31] In addition, the World Bank is intervening to support the rehabilitation and reconstruction of Hydromet stations throughout the country (CAHMP Project). Other external donors' investments focus on the provision of technical assistance and the introduction of new technology.[32]

Nevertheless, external donors were not always discussed in positive terms. Donors' aid programs were sometimes criticised for being based on their own preformulated presumptions, without a real understanding of the local reality.[33] In addition, some respondents pointed to the fact that, at least for some issue areas, international organisations are taking over the role of the government. National authorities are very much in favour of delegating certain problems, such as climate change, to international actors, thus relieving themselves from this burden while still bringing money and jobs to the country. The risk with this approach, however, is that if international interventions do not involve a capacity-building component, or are not adequately contextualised, they fail to be sustainable in the long-term.[34]

The other determinants – individual and market incentives, economic development and financial instruments – were mentioned significantly less often than external donors and budget (8.5 %, 7.8 %, and 5.2 % of total references, respectively). Individual and market incentives were generally discussed in connection with corruption, and the distorted political and decision-making system that presides over the allocation and management of water resources in the country. Under the heading of individual and market incentives, respondents also pointed to the lack of motivation for young professionals to enter this sector, which is gradually leading to the

[31] For example, the World Bank has engaged in the financing of the urban and water sector in the Kyrgyz Republic since the early 2000s, with the objective of supporting the Kyrgyz government to improve access to basic services. The WB's current project portfolio in the country addresses basic needs for water supply, sanitation and other urban services over the entire spectrum of urban and rural areas (World Bank 2011c).

[32] Again, it is worth citing the case of the World Bank's activities in the country. Through the Second Village Investment Project, the Small Towns Infrastructure Project, the Second Rural Water Supply and Sanitation Project, and the Bishkek-Osh Urban Infrastructure Project, the World Bank has: (a) trained more than 64,000 local government officials and community members in principles of budgeting and planning; (b) helped 1,500 villages to improve their social and economic infrastructure; and initiated about 5,000 μ-projects including on drinking water, electricity, primary health facilities and schools (World Bank 2011c).

[33] According to Schulte (2008), for example, a typical case in point would be the legislation on self-governance, which was supposed to create a basis for decentralisation following on the Western model, but instead resulted in weak implementation and fragmentation in the case of Kyrgyzstan.

[34] Cit. from interview with respondent at international level (international organisation/donor), conducted by the author in Bishkek (Kyrgyzstan) on October 28, 2011.

dispersion of talents and the failure to replace the old Soviet managerial class. The discourse on economic development, especially carried out by national and sub-national administrators, recalled the one on budget. Here, respondents used the poor economic condition of Kyrgyzstan as an excuse to justify its non-engagement with the topic of climate change, and especially climate change adaptation. This conclusion is aligned with earlier empirical findings, according to which human beings would be able to handle only a finite pool of worry, which means that as concerns about one kind of risk increases, other risks automatically become less salient. Finally, insurance and micro-credits were named amongst the financial instruments that could help the water sector adapt to climate change, or even only perform its functions in a more effective and sustainable way.

5.4.4 Managing Information in the Kyrgyz Water Sector: The Transboundary Challenge

In the information management category, climate and scientific information is the determinant that respondents mentioned most often (27 % of total references), although with a rather negative connotation. In fact, reference was made to the insufficiency of available information, as well as a general situation of confusion in terms of "*who is in charge with collecting what information and how*."[35] Put simply, national research institutes were said not to have the material resources (e.g., monitoring stations) to collect and analyse adequate and sufficient climate and weather data. Paradoxically, data series on temperatures and precipitations exist for the past as they were collected regularly in Soviet times, but have stopped being reliable and continuous as of the 1990s. Other data, such as socio-economic indicators, are collected by a range of different organisations, including international ones, but lack common guidelines that ensure their comparability or the possibility to include them into shared databases. This results, for once, in the difficulty of users to be certain about the legitimacy of the source of the data, and hence their validity and reliability. In addition, it leads to a duplication of efforts and lack of rationalisation in the production of statistics, which instead would be fundamental for informing planning efforts in the water sector, also in view of preparing for and responding to the prospected impacts of climate change.[36]

[35] Cit. from interviews with respondent at international level (three IOs), conducted by the author in Bishkek (Kyrgyzstan) on November 1–4, 2011.

[36] Indeed, this is true for all environmental- and natural resources management-related information. As reported in the Joint Country Support Strategy elaborated by donors in 2006, "*Although the past decade has seen repeated attempts to improve the quality, relevance and reliability of environmental and natural resources management information, there is a sense that this continues to be collected without a clear purpose in some cases while remaining patchy in areas of great practical importance. A good deal of data reconciliation would be needed but is rarely undertaken as new demands side-line the task of quality checks and interpretation*." (JCSS 2006).

From the interviews, it emerged that communication and awareness-raising is mostly done by international and national NGOs, and targets the general public more often than policy-makers. A NGO representative admitted that this is because policy-makers are harder to reach, and it is often impossible to engage them in a dialogue about environmental issues as they have other priorities to address.[37] Ideally, one would start to educate the population, so that citizens could then lobby policy-makers to take action in the environmental sphere. This type of awareness-raising efforts was deemed to be critical in Kyrgyzstan, where, at present, there is a very low understanding of environmental problems in general, and climate change in particular.

The determinants of climate and scientific information and communication and awareness-raising were also connected to budget, as these activities require substantial investments in order to be implemented to a useful degree. Respondents tended to attribute the deficiency of data and information on climate change, but also other socio-economic indicators, to the lack of funding of national Ministries and research institutions deputed with their collection. Similarly, the relatively limited extent to which communication about climate change has, so far, occurred was attributed to the almost inexistent budget of environmental NGOs. The only channel through which funding for communication and awareness-raising in the environmental sector occurs was said to be through the donor community. Indeed, since Kyrgyzstan lacks functional mechanisms for cooperation between NGOs and other sectors – government bodies, political parties and businesses, which could fund NGO operations – international organisations remain NGOs' key partner. For this reason, NGOs' priorities are often contingent upon the policies of international donors.

Information sharing (mentioned 18 % of the times) was described as problematic. Representatives of international organisations discussed the difficulty of working in a context like Kyrgyzstan. In fact, as a consequence of the predominant Soviet mentality, data and information on water resources management are considered as a hard currency and, as such, are not easily and voluntarily shared by national authorities. This attitude significantly hampers the efforts of international organisations in the water sector, as well as in terms of climate change adaptation and disaster risk management. In some cases, international actors proceed with the collection of their own data, but this is not always possible within their mandate or limited human and financial capacity (also observed by World Bank 2011c; Gareeva 2011). In addition, the sharing of information and data on transboundary water resources does not happen almost at all with neighbouring countries, which fundamentally impedes the integrated management of the Syr Darya River basin.

The determinant of monitoring, assessment and evaluation (M&E) was mentioned the 11 % of the times; under this heading, respondents tended to describe a situation characterised by the fundamental absence of monitoring mechanisms. On the one side, the social and institutional capacity to perform these types of activities was said to be absent. National and sub-national departments with competencies in water resources management are highly under-staffed, and often the personnel is not

[37] Cit. from interviews with respondent at civil society level (local NGO), conducted by the author in Bishkek (Kyrgyzstan) on October 14, 2011.

professionally trained in M&E. Secondly, monitoring stations and other tools aimed at measuring water withdrawals and pollution date back from the Soviet period and are today either broken or obsolete.[38] This observation is backed up by the important number of references to the determinant of material resources and infrastructure (35.4 % of total references in the infrastructure category). Fundamentally, most of the respondents described the same situation, whereby material resources are there, but are mostly in need of being repaired and/or updated (see OECD 2011, p 14).

5.4.5 Infrastructure and Technology: Key Determinants of Institutional Adaptive Capacity, or Not?

Under this category, respondents mentioned numerous problems in relation to the existing infrastructure for water supply, wastewater, irrigation and supply services (included in the determinant of material resources and infrastructure). Furthermore, budget was frequently referenced in association with material resources and infrastructure, as well as investments into their operation and maintenance. This linkage resulted particularly evident in the case of funding mechanisms for irrigation infrastructure, which posits that irrigators pay for the water they use on the basis of a predetermined rate. This rate is set by the SCWEM in accordance to the degree of water scarcity (or "climate severity") that characterises each season: when the climate is harsh and water is scarce, the fee will be lower. As a general rule, water costs three to five times more during the growing season, but rates are kept exceptionally low, varying from 0.002 to 0.03 KGS/$m^{3,}$ in order to take into account the poverty of rural population and its consequent inability to pay higher sums (OECD 2011).[39] Nevertheless, these tariff rates only allow to cover a minor share of the actual costs related to the operation and maintenance of the water supply system. Even if all fees were collected (which seldom happens), they would only pay for the 30 % of total costs. In addition, the practice of setting the tariffs below cost recovery promotes the excessive consumption of water resources and undermines the effective utilisation of the irrigation infrastructure – today, drainage and irrigation systems are deteriorating to such an extent that they are even leading to the reduction of agricultural productivity (Orolbaev and Valentini 2010; OECD 2011). The Kyrgyz Government intervenes by covering, on an annual basis, a significant part of these expenditures

[38] Between 1990 and 2010, the number of functioning hydrological monitoring stations (hydroposts) on rivers in Kyrgyzstan has fallen from 127 to 77. A similar trend has been observed regarding the number of observation boreholes used to monitor the level and quality of ground water (OECD 2011, p 14).

[39] 0.03 KGS/m^3 corresponds to approximately USD 0.70 per 1,000 m^3. According to the 2010 ADB's study on "*Pricing System and Mechanisms of Irrigation Costs Recovery*", actual costs of O&M of inter-farm systems in Kyrgyzstan would amount to approximately USD 8 per hectare, which means that desired costs exceed actual ones by 2.5–5 times. In addition, the recommended costs would meet only moderate needs to ensure the sustainable operation of irrigation and drainage systems, but these do not secure possibilities for substantial upgrade of the infrastructure (Orolbaev and Valentini 2010, p 11).

Fig. 5.4 Irrigation canal in the Jalal-Abad oblast of southern Kyrgyzstan. Some of the irrigation systems in Kyrgyzstan were constructed by communities of water users prior to or in the decades following the entrance to the region of Tsarist Russia in the late nineteenth century; afterwards, irrigation systems were developed with government support (from the centralised government of the Soviet Union), and put under the management authority of the Kolkhozes (collective farms) and Sovkohzes (state farms). Following the collapse of the Soviet Union in the 1990s, land redistribution took place on a village by village basis, and plots of land were allocated to individuals instead of households. With independence, Kyrgyzstan inherited a deteriorated water infrastructure, a shortage of financial means and professional capabilities, and a hierarchical governance system inadequate to meet new challenges. Today, irrigation systems are developed and managed by Water Users Associations (WUAs), formed at the village (aiyl okmotu) level, which are responsible (often with training and technological support from NGOs and international agencies) for the operation and maintenance of irrigation systems in their areas of competence (Source: Author)

so that the irrigation infrastructure is fundamentally maintained within the public budget. However, this limits the opportunity to fund other socially important projects, such as the rehabilitation of the WUAs' irrigation and drainage systems, which, as a consequence, have to be carried out at the expense of external credits and donor assistance (Orolbaev and Valentini 2010) (see Fig. 5.4).[40]

[40] Total investments into these activities are estimated to approximately KGS 1.22 billion, in specific units – approximately KGS 196.5/ha per year (USD 4.8/ha per year). The costs required for the rehabilitation of inter-farm irrigation network are estimated to range from USD 70 to 280 million.

Not surprisingly, therefore, also the determinants of technical assistance and investments into the operationalisation and maintenance (O&M) of infrastructure were mentioned relatively frequently (18.4 % and 13.6 %, respectively). Both technical assistance and O&M efforts come primarily from international organisations, although recently the Chinese Development and Cooperation Agency and some donors from India have started directing their attention to Kyrgyzstan too (Berkofsky 2012). In terms of technology (mentioned 15.7 % of the times), respondents particularly pointed at the role that web-based communication is starting to play in the country. The Internet, e-mail and other new communication technologies were said to facilitate awareness-raising directed to the general public, while these instruments remain rather underutilised by politicians and administrators. In addition, technology potentially facilitates information sharing; respondents particularly referred to the role that the Internet and e-mail communication are playing in terms of enhancing the exchange of data and information between decision-makers or water managers at different levels. Finally, it is also interesting to highlight the relationship between traditional knowledge and innovation. In this sense, it is worth mentioning one respondent saying that in Kyrgyzstan "*there is not much need for innovation, but it would be beneficial to rediscovery the old methods and apply them to solve current problems*".[41]

5.5 Summary

The Syr Darya River basin is a transboundary watershed, feeding with its glacier-melt water most of the Central Asian region. In this book, we only considered the part of the river basin that falls within the administrative borders of the Kyrgyz Republic. Water is a key resource in Kyrgyzstan, and it is on this resource that most of the country's history has been constructed, and that has fundamentally shaped the relations with its Central Asian neighbours. Indeed, the entire Central Asia is linked by a complex water system – the interdependence of which was reinforced when the region was part of the Soviet Union, and new water-intensive irrigation technologies were introduced to cultivate cotton at a large scale. For this reason, the demise of the Soviet Union in 1991 brought about a dramatic change to water resources management in Central Asia. Also, it caused a sudden power vacuum and the breakdown of the state-controlled subsidised provision system. Today, water represents a security issue in the region; the big dilemma is for upstream countries (like Kyrgyzstan) to retain the water resources they need for their economic development, while respecting the international agreements that 'oblige' them to pass a certain quota of water to downstream countries, which use it for agricultural production.

At the same time, the scope of annual investments into the technical rehabilitation of inter-farm systems shall be at least USD 15 million (USD 15/ha per year) (Orolbaev and Valentini 2010, p 12).

[41] Cit. from interview with respondent at local level (WUA Director), conducted by the author in Nookat (Kyrgyzstan) on October 17, 2011.

Climate change, by impacting on the amount and quality of water resources will put additional strain to these already tense relations. In fact, based on available climate models, it is expected that, although enhanced glacier melt rates due to climate change will provide an inflow of additional water into rivers over the short-term, in the medium- to longer-term the buffer effect of glaciers will disappear. This will lead to an increase in water stress especially in summer, thereby enhancing the risk of droughts. Changing precipitation patterns, reduced runoff and increasing temperatures are also expected, with direct consequences especially for the agricultural sector. This situation is worrisome in a country like Kyrgyzstan, which economy still largely depends on the agricultural sector. The new pattern of intra-annual runoff distribution will also mean that less water will be available for energy generation in the summer. An increase in the intensity and frequency of extreme events, and in particular flooding – including glacial outburst flooding in the mountains – and droughts in the southern regions is also expected. This will have consequences for the livelihoods and very physical security of Kyrgyz citizens, and in particular the most vulnerable categories of the population (e.g. the elderly, children, rural women).

According to our analysis of the determinants of institutional adaptive capacity in the Syr Darya River basin (focusing on Kyrgyzstan in particular), the category of human and social resources was the most mentioned one by respondents, followed by the government and governance one. Interestingly, the other categories were mentioned significantly less (in absolute terms), thereby pointing to a situation in which water resources management seems to be strongly dependent on social and political factors, rather than more technical concerns such as information sharing or infrastructure. Thus, evidence suggests the need for a different understanding of the way in which water resources are governed in Kyrgyzstan, one that focuses on the interactions between individual and social institutions in the water sector, and on the ways in which perceptions shape effective performance.

The decentralisation approach adopted after independence in the Kyrgyz water sector has given increased roles and responsibilities to authorities at the provincial and village level, and in particular to the Water User Associations (WUAs), created under the input and guidance of international donors and agencies. At the national level, however, the institutional and policy framework for water resources management has remained fragmented and poorly implemented, mostly as a consequence of the limited availability of financial and human resources. Corruption and political instability are other macro-factors that have played against effective water resources management in the country. The need for climate change adaptation is not yet embraced by policy-makers, or by the general public, so that adaptation occurs on an ad hoc basis, and mainly under the initiative of international agencies and NGOs. The precarious security situation in the region, and the at times tense relationships with its neighbours for the sharing and management of their common water resources have meant that regional solutions to address the climate change challenge have not been very popular as of today.

References

Abazov R (1999) Policy of economic transition in Kyrgyzstan. Centr Asian Surv 18(2):197–223

Agency for Technical Cooperation and Development (ACTED) (2011) Desk review on conflict in Southern Kyrgyzstan. Draft study prepared for the project: "Socio-economic mapping and analysis of the South of Kyrgyzstan with a focus on potential macro and micro-level sources of tension", July

Aidaraliev AA et al (2002) Mountains of Kyrgyzstan. National Center for Development of Mountain Regions of Kyrgyzstan, National Academy of Sciences of the Kyrgyz Republic, International Institute of Mountains. Publishing House Technology, Bishkek

Aizen VB, Aizen EM, Melack JM, Dozier J (1997) Climatic and hydrologic changes in the Tien Shan, Central Asia. J Clim 10:1393–1404

Allouche J (2004) A source of regional tension in Central Asia: the case of water. CIMERA, Graduate Institute for International Studies, CP 6, Geneva

Allouche J (2007) The governance of Central Asian waters: national interests versus regional cooperation. Central Asia at the Crossroads, Issue 4, United Nations Institute for Disarmament Research (UNISDR), Geneva

Alymbaeva A (2004) Institutional development of Water Users Associations in Kyrgyzstan. Thesis submitted in fulfillment of the Masters in Public Policy at the Rochester Institute of Technology (RIT), Rochester, New York, Feb

Baraer M, Mark BJ, McKenzie JM, Condom T, Bury J, Huh K, Portocarrero C, Gomez J, Rathay S (2012) Glacier recession and water resources in Peru's Cordillera Blanca. J Glaciol 58(207):134–150

Bates BC, Kundzewicz ZW, Wu S, Palutikof JP (eds) (2008) Climate change and water. IPCC Technical Paper, IPCC Secretariat, Geneva

Beniston M, Stoffel M, Hill M (2011) Impacts of climatic change on water and natural hazards in the Alps: can current water governance cope with future challenges? Examples from the European "ACQWA" project. Environ Sci Policy 14:734–743

Berkofsky A (2012) China's strategic involvement in Central Asia-strategies: results and obstacles. ISPI Analysis No. 128, Istituto per gli Studi di Politica Internazionale (ISPI): Milan, July

Bichsel C, Fokou G, Ibraimova A, Kasymov U, Steimann B, Thieme S (2009) Natural resource institutions in transformation: the tragedy and glory of the private. In: Hurni H, Weismann U (eds) Global change and sustainable development, north-south perspectives, 578 pp. Geographica Bernensia, Bern [ISBN: 978-3-905835-13-7]

Braun LN, Hagg W (2009) Present and future impact of snow cover and glaciers on runoff from mountain regions – comparison between Alps and Tien Shan. Assess Snow Glacier Water Resour Asia 8:36–43

Dani AH, Masson VM (eds) (2000) UNESCO history of civilizations of Central Asia. UNESCO, Paris

Eurasian Development Bank (EDB) (2009) The impact of climate change on water resources in Central Asia, Sector Report. Eurasian Development Bank (EDB), Almaty

FAO AQUASTAT (2012) AQUASTAT database. Food and Agriculture Organisation. Retrieved 21 Oct 2012 from http://www.fao.org/nr/water/aquastat/main/index.stm

Gareeva A (2011) Awareness building of integrated local risk management. Final Project Report, CAMP Alatoo, Swiss Agency for Development and Cooperation (SDC) and German Agency for Development and Cooperation (GTZ), Bishkek

Gawrich A, Melnykovska I, Schweickert R (2010) More than oil and geography – neopatrimonialism as an explanation of bad governance and autocratic stability in Central Asia. Paper to be presented at the Workshop on "Neopatrimonialism in Various World Regions", German Institute of Global and Area Studies (GIGA): Hamburg

Gleick PH, Palaniappan M (2010) Peak water limits to freshwater withdrawal and use. Proc Natl Acad Sci U S A 107(25):11155–11162

Global Facility for Disaster Reduction and Recovery (GFDRR) (2011) Vulnerability, risk reduction and adaptation to climate change. Kyrgyz Republic. Global Facility for Disaster Reduction and Recovery (GFDRR), The World Bank Group: Washington DC, April. Retrieved 28 Oct 2012 from http://sdwebx.worldbank.org/climateportal/home.cfm?page=country_profile&CCode=KGZ

Global Water Partnership (GWP) (2006) "Road Map": planned steps towards realisation of the IWRM principles and rationale of the essential activities in the Kyrgyz Republic. Global Water Partnership Central Asia and Caucasus, Bishkek

Herrfahrdt E, Kipping M, Pickardt T, Polak M, Rohrer C, Wolff CF (2006) Water governance in the Kyrgyz agricultural sector: on its way to integrated water resources management? German Development Institute, Bonn

Hodgson S (2010) Strategic water resources in Central Asia: in search of a new international order. EU-Central Asian Monitoring (EUCAM), Policy Brief No. 14, May

Huskey E (2002) An economy of authoritarianism? Askar Akaev and presidential leadership in Kyrgyzstan. In: Cummings SN (ed) Power and change in Central Asia. Routledge, London

Ibraimova A (2009) Legal and institutional framework for empowerment of rural communities in the Kyrgyz Republic. Etudes et colloques, 53. Publications of the Institute of Federalism, Fribourg

Immerzeel WW, Lutz AF, Droogers P (2012) Climate change impacts on the upstream water resources of the Amu and Syr Darya River basins. Report FutureWater: 107. FutureWater: Wageningen, The Netherlands. Retrieved 26 Oct 2012 from http://www.futurewater.nl/wp-content/uploads/2012/03/Upstream_Report_FW_web.pdf

Intergovernmental Panel on Climate Change (IPCC) (2014a) Climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (eds) Cambridge University Press, Cambridge/New York

Intergovernmental Panel on Climate Change (IPCC) (2014b) Climate change 2014: impacts, adaptation, and vulnerability. Part B: regional aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Barros VR, Field CB, Dokken DJ, Mastrandrea MD, Mach KJ, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (eds) Cambridge University Press, Cambridge/New York

International Crisis Group (ICG) (2002) Central Asia: water and conflict. ICG Asia Report No. 34, Osh

International Crisis Group (ICG) (2010) The pogroms in Kyrgyzstan. ICG Asia Report No. 193, Osh

International Monetary Fund (IMF) (2012) Kyrgyz Republic – poverty reduction strategy paper – country development strategy 2012–2014. IMF Country Report No. 12/112. IMF, Washington, DC

Joint Country Support Strategy (JCSS) (2006) Kyrgyz Republic: Joint Country Support Strategy (JCSS) FY 2007–2010, environment assessment working group, preliminary thematic note. Draft. Nov

Juraev S (2009) Energy emergency in Kyrgyzstan: causes and consequences. Policy brief no. 5, EU-Central Asia Monitoring (EUCAM)

Khalsa SJS, Aizen VB (2008) Variability in Central Asia seasonal snow cover during the MODIS period of record. Geophys Res Abstr 10:1–2, EGU2008-A-0443

Klötzli S (1997) The water and soil crisis in Central Asia: a source for future conflicts? Environment and Conflict Project (ENCOP) Occasional Paper 11. ETH Zurich & Swiss Peace Foundation, Zurich

Kyrgyz Republic (2005) Water code of the Kyrgyz Republic. Kyrgyz Republic, Bishkek

Kyrgyz Republic (2009) Second national communication of the Kyrgyz Republic to the UN framework convention on climate change. Kyrgyz Republic, Bishkek

Library of Congress – Federal Research Division (2007) Country profile: Kyrgyzstan. January. Retrieved 29 Oct 2012 from http://lcweb2.loc.gov/frd/cs/profiles/Kyrgyzstan.pdf
Mamatkanov DM, Bazhanova LV, Romanovsky VV (2006) Water resources of mountainous Kyrgyzstan at present. Ilim, Bishkek
Marat E (2008) New Kyrgyz government dominated by Bakiyev family, cronies. Eurasia Daily Monit 5:9
Mosello B (2008) Water in Central Asia: a prospect of conflict or cooperation? J Public Int Aff 19:151–174
National Statistics Committee (2007) Living standards of the population of the Kyrgyz Republic 2002–2006. The annual publication. National Statistic Committee, Bishkek
O'Hara SL (2000) Lessons from the past: water management in Central Asia. Water Policy 2(4–5):365–384
Oppenheimer M, Todorov A (2006) Global warming: the psychology of long-term risk. Clim Chang 77:1–6
Organisation for Economic Co-operation and Development (OECD) (2011) National Policy Dialogue on Strategic Financial Planning for Water Resource Management in Kyrgyzstan. Interim report on the pilot project. Nov
Orolbaev E, Valentini K (2010). Final report on support to IWRM and Tariffs and Financial Policy. EU-UNDP Project (2009–2012) on "Promoting Integrated Water Resources Management and Fostering Transboundary Dialogue in Central Asia". UNDP, Bishkek
Pahl-Wostl C, Holtz G, Kastens B, Knieper C (2010) Analyzing complex water governance regimes: the management and transition framework. Environ Sci Pol 13:571–581
Pomfret R (2004) Aid and ideas: the impact of western economic support on the Muslim successor states. In: Rol Y (ed) Democracy and pluralism in Muslim Eurasia. Frank Cass, London, pp 77–99
Ram R (2000) Central Asia: a textbook history. Munshiram Manorharlal Publishers, Delhi
Schulte Y (2008) Benchmarking the process of democratization in Kyrgyzstan by defining the role and functions of NGOs. In: Social Research Centre, American University of Central Asia (eds) Kyrgyzstan today. Policy briefs on civil society, migration, Islam, corruption. Social Research Centre, Bishkek, pp 4–11
Sehring J (2005) Water User Associations (WUAs) in Kyrgyzstan: a case study on institutional reform in local irrigation management. Discussion Paper, 24. Centre for International Development and Environmental Research, Giessen
Sehring J (2009a) The politics of water institutional reform in neopatrimonial states: a comparative analysis of Kyrgyzstan and Tajikistan. VS Verlag für Sozialwissenschaften, Wiesbaden
Sehring J (2009b) Path dependencies and institutional bricolage in post-soviet water governance. Water Altern 2:61–81
Shkurov E, Makeev T, Koshoev M (eds) (2007). Kyrgyzstan: environment and natural resources for sustainable development. Prepared by: State Agency on Environmental Protection and Forestry Under the Government of the Kyrgyz Republic, and United Nations Development Program in the Kyrgyz Republic. Bishkek
Sorg A, Bolch T, Stoffel M, Solomina O, Beniston M (2012) Climate change impacts on glaciers and runoff in Central Asia. Nat Clim Chang 2(10):725–731
Tarlock D, Wouters P (2007) Are shared benefits of international waters an equitable apportionment? Colo J Int Environ Law Policy 3(18):523–536
The World Bank (2013) Kyrgyz Republic climate change profile
Tursunaliev U (2002). Ways of reforming the water legislation. Water Rights Newsl 12, Bishkek
Ul Hassan M, Starkloff R, Nizamedinkhodjaeva N (2004) Inadequacies in the water reforms in the Kyrgyz Republic: an institutional analysis. Research Report No. 81. International Water Management Institute (IWMI), Colombo
United Nations Development Programme (UNDP) (2010) The Kyrgyz Republic: the second progress report on the millennium development goals, 2nd edn revised and amended. United Nations Development Programme (UNDP) Kyrgyzstan, Bishkek

United Nations International Strategy for Disaster Risk Reduction (UNISDR) (2010) In-depth review of disaster risk reduction in The Kyrgyz Republic. UNISDR, Sub-Regional Office for Central Asia and Caucasus, Almaty

Usubaliev T (1998) Water is more precious than gold. Water resources of Kyrgyzstan are its national wealth. Sam Publication House, Bishkek (in Russian)

Usubaliev T (2002) The law of the Kyrgyz Republic on interstate use of hydraulic unites, Water resources and water facilities of the Kyrgyz Republic. Sham Publication House, Bishkek (in Russian)

Votrin V (2003) Transboundary water disputes in Central Asia: using indicators of water conflict in identifying water conflict potential. Thesis submitted in partial fulfilment of the requirements for the Master in Human Ecology, Vrije Universiteir Brussel, Ixelles

World Bank (2011a) Kyrgyz Republic: profile and dynamics of poverty and inequality, 2009. Document of the World Bank, Poverty Reduction and Economic Management Unit, Europe and Central Asian Region, Oct

World Bank (2011b) World development indicators database: Kyrgyz Republic data profile. Retrieved 3 Nov 2012 from http://data.worldbank.org/data-catalog/country-profiles

World Bank (2011c) World Bank – Kyrgyz Republic partnership, program snapshot. Washington, DC: World Bank, April. Retrieved 25 Oct 2012 from http://siteresources.worldbank.org/INTKYRGYZ/Resources/Kyrgyz_Republic_Snapshot_March2011_full.pdf

World Bank (2012) Political context and implications of change of government in Kyrgyzstan. Background document, Governance Thematic Working Group, World Bank, Washington, DC

Chapter 6
Resistant, Reactive or Proactive Institutions? Exploring Adaptive Water Resources Management in the Po and Syr Darya River Basins

Adaptation to climate change is already taking place, but on a limited basis
(very high confidence);
Adaptation measures are seldom undertaken in response to climate change alone
(very high confidence);
There are substantial limits and barriers to adaptation
(very high confidence)

(IPCC 2007)

Abstract The following chapter presents, interprets and compares the findings from the Po River basin in Italy and the Syr Darya River basin in Kyrgyzstan with respect to the capacity of institutions in the water sector to address the prospected impacts of climatic and socio-economic changes. The analysis suggests that for the Po River basin, the political willingness to mobilise and translate adaptation into concrete responses and longer-term action plans is missing. In Kyrgyzstan, the conditions for adaptation are not established, thus requiring substantial efforts to build adaptive capacity of institutions in the water sector by activating all the considered aspects, i.e. infrastructure, information, finances, human and social capital, and political willingness and structure. The second part of this chapter compares the two water governance systems under review in terms of how the multi-level dimension played out in shaping the relationships and defining the impacts of the hypothesised determinants of adaptive capacity. Our analysis importantly highlights the relevance of international institutions in advancing concerns about adaptive capacity in the case of Kyrgyzstan, and of domestic regional institutions in the case of the Po River basin. Finally, we suggest some policy-relevant adaptation measures to include consistent data collection and dissemination, cross-sectoral collaboration, promotion of domestic political responsibility and initiative, awareness-raising of climate change impacts among key stakeholders, and a regional strategy.

Keywords Institutional adaptive capacity • Adaptive water management • Multi-level governance • Po River basin • Syr Darya River basin • Information sharing • Regional cooperation • Political willingness • Participatory decision-making

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6.1 Crossing Bridges, Building Institutional Adaptive Capacity in the Po and Syr Darya Basins

6.1.1 From Reactive to Proactive: What Does It Take? The Case of the Po River Basin

In the Po River basin, the determinants that were most often associated with adaptation responses and measures were those in the government and governance category (63 cross-references). Significantly lower in number were references to the determinants in the information management (28 cross-references), human and social resources (25 cross-references), infrastructure (22 cross-references), and finances and risk (only 8 cross-references) categories.[1] Looking at adaptation in response to climate change specifically, however, information management was indicated as the most important category, while financial and economic resources were not even mentioned. Ideal measures were linked to the political and social dimension, and marginally involved information and infrastructure-related determinants. The finances and risk category only appeared under required adaptation measures, thereby indicating that, although to a lesser extent than the other determinants, also economic resources were considered as potentially useful conditions to build adaptation. Comparing proactive and reactive responses, it can be further seen that reactive responses were mentioned more often by respondents than proactive ones, which reflects previous studies on the Po River basin according to which adaptation in the water sector has occurred in response to specific challenges and crises, rather than in prevention and preparation to them (AdbPo 2011, 2012).

Reactive measures were mentioned particularly at the regional, national and local levels. Interestingly, they were the only ones to be cross-referenced with decentralisation processes and with the river basin approach. Instead, proactive measures were referred to by national and regional actors, and only very limitedly by local ones. Additionally, they were mostly linked to vertical "top-down" governance processes, suggesting that they require an input from upper levels, e.g. in terms of enacting an enabling legislative framework, initiating collaborative partnerships, ensuring coordination, etc., in order to be effectively operationalised. This particular finding would seem to reinforce the empirical evidence from other recent research (see, e.g. Huntjens et al. 2011) according to which bottom-up governance and decentralisation reforms are not necessarily vital conditions for adaptive and integrative management approaches, opposed to what earlier theory had suggested. Actually, the measures that were characterised as transformative or adaptive in the case of the Po River basin were driven by top-down policy and legislative frameworks, although with a substantial input from environmental organisations and associations of water users. However, it should be noted that these results do not appear to be statistically significant. The Chi-square test that was performed on the data on multi-level governance and bridges to adaptive capacity in the Po River case,

[1] See Appendix 3.

in fact, results in a high p-value (0.42), which does not allow significantly stating that the different categories of determinants actually have a different impact on institutional adaptive capacity.[2]

Looking at the specific determinants within each category, it is possible to draw some preliminary conclusions in terms of what factors, according to respondents, would seem to be more conductive to adaptation measures and responses. In the finances and risk category, the only determinant that was positively mentioned in association with adaptation was the one of financial instruments. More specifically, financial instruments were considered as ideal measures for both reactive and preventive adaptation. Respondents, particularly within regional administrations, discussed the role of insurance for creating the conditions that would allow the water system to introduce adaptation responses to future climatic changes. Amongst the ideal measures that respondents mentioned, there was the proposal to use general tax revenues to fund the provision of potable water and hygiene services, which would also serve to pay for adaptation measures once these become necessary.[3]

In the government and governance category, it is worth noting the strong association (in terms of absolute number of references) that respondents established between risk and emergency management and adaptation measures and responses. The governance regime for risk and emergency management was seen as an enabling factor for climate change adaptation. At present, however, this happens only in a reactive way, as interventions still tend to occur on an ad hoc basis. For example, in the case of the devastating flood that hit the region of Piedmont in 2000, compensations and reparations were paid to damaged citizens and businesses after the event had struck. Preventive measures of relocation, which would have allowed significantly reducing the amount of both economic and human losses, had not been envisaged before. This reflects the general situation that characterises the Po River basin in terms of adaptive measures and responses, which are mostly implemented on a case-by-case basis – meaning that the reactive dimension tends to prevail over the preventive one.

Current efforts to implement the EU Flood Directive (2007/60), aimed at introducing a system for risk monitoring in the Po River basin, are gradually leading

[2] See Appendix 4.

[3] In the current system instead, citizens pay a water fee to the municipality in which they reside (or the company that is charged with water services by the municipality in certain cases), which is used for the operation and maintenance of aqueducts and other water-related infrastructure. The amount of the fee must be maintained very low, as water is perceived as a public good and citizens are not willing/do not perceive it as fair to pay for it. Therefore, the income from water fees remains limited and does not cover investments into the operation and maintenance of the infrastructure, for example. To solve this problem, the tendency has been to recur to private contractors, which use their own budget to operate water services in certain municipalities, although under the specific mandate and control of the municipal government (a system that was introduced by the Galli Law in 1994). Under Silvio Berlusconi's government in 2010, an attempt was made to privatise water services entirely, but it was voted against in the 2010 Referendum, which expressed the popular willingness and determination to maintain water a public good. One of the requests made by the popular movement initiating the Referendum initiative was to solve the problem of lack of funding in the water sector with general tax revenues.

towards the adoption of a more proactive-transformative approach in this sector – and consequently also in the water one. In specific, the Flood Plan and the Basin Management Plan for the Po River are supposed to be integrated in 2015. The process of drafting the Flood Plan for the Po River basin is currently in the hands of the Po RBA, conducting it in consultation with relevant stakeholders. Once effectively concluded, the Flood Plan will represent a fundamental measure for disaster risk management, including provisions for facilitating inter-institutional cooperation and dialogue. It thus will address the current fragmentation of the system by connecting, sharing and maximising the value of the existing knowledge and information that is available within the river basin. However, this process should be accompanied by "*a new awareness and direct relationship with the territory*, *something that has been gradually lost as a consequence of the increased bureaucratisation with which these functions are today performed*".[4]

In general terms, respondents considered the system for water resources management that is in force in the Po River basin as incapable to adequately address climate change. However, being characterised by a strong degree of decentralisation (Raggi et al. 2007; Triulzi 2004), it was said to allow for some individual actions to be initiated locally, although their subsequent integration in a comprehensive and coherent framework of action does not happen on a regular basis. Interestingly, the river basin was almost unanimously recognised as the ideal site for adaptation.

In fact, some adaptation measures are reportedly underway there, mostly as a consequence of the positive role played by the Po RBA. For example, the Basin Management Plan (PBI) was said to be contributing, at least from an ideal point of view, to the transformation of the existing water management paradigm. Moving this paradigm from a reactive (based on ad hoc requests and withdrawal concessions) and fragmented (managed by regional and provincial administrations) one to a system that is successfully able to allocate water on the basis of its effective availability and taking into account multiple demands (see also: AdbPo 2010; Bardelli and Robotti 2009).[5]

Looking then at the human and social resources category, a first observation relates to the role played by the determinant of group relations and representation of interests, which was positively associated with adaptation responses and measures.

[4] Cit. from interview with respondent at local level (Mayor), conducted by the author in the Piedmont region (Italy) on July 7, 2011

[5] Importantly, in fact, the PBI includes two measures that have potentially overlapping effects in terms of adaptation. First of all, it mandates for interventions aimed at restoring the natural hydraulic-environmental conditions of those areas that have a low value from an agricultural point of view, but are fundamental to contain the effects of floods. Secondly, it explicitly provides for land conservation and environmental protection (in compliance with the quality objectives set by the EU WFD for 2027), specifically in those parts of the basin that are defined as "most vulnerable" and exposed to risk, such as mountain areas (AdbPo 2010, 2011). The PBI also describes some specific actions to address the prospected impacts of climate change, such as interventions on aqueducts, the definition of a register listing all the concessions for water withdrawals, and the implementation of measures aimed at reducing water consumption especially for irrigation purposes. According to the Plan, all these measures should be reversible and easily applicable (AdbPo 2011).

This connection fundamentally implies that the more or less egalitarian and fair representation of stakeholders' interests in the decision-making process increases the overall capacity of the system to adapt (as also reported by Parry et al. 2007; Swanson et al. 2009; Mysiak et al. 2010). This was evident in the case of the River Contract and Lake Contract experiments, as well as for the Roundtables for Water Crises, where responses to situations of emergency were said to be a consequence of the participation of, and consultation with, all concerned subjects (AdbPo 2011; Riva and Cucca 2007). On this matter, partnerships and networks were also said to bear the potential to increase the adaptive capacity of the system, particularly by rendering additional resources, primarily economic resources, but also expert personnel, data and information, available and by favouring problem solving. It was found that most of the existing partnerships and networks in the Po River basin are formed and maintained in the framework of international projects aimed at addressing climate change and other environmental issues (e.g. the EU's Seventh Framework Programme).

Respondents further identified social and institutional capacity as an ideal and required factor that contributes to building the system's capacity to respond to the prospected impacts of climate change in a proactive way. However, there are indications that currently this condition is not present to a sufficient extent. For example, in the DRM sector, respondents pointed to the necessity not only to release adequate financial resources for interventions, but also, and most crucially, to invest in the human and institutional capacity that is required to forecast natural disasters and extremes. Similarly, the role of leaders and political willingness were considered important for climate change-specific adaptation, although, also in this case, respondents mostly talked in abstract and not in relation to the actual situation on the ground. Indeed, in more than one interview, it emerged that some administrators and politicians do not even recognise anthropogenic climate change, or strongly underestimate its effects in the case of the Po River basin, and consider it as a phenomenon that "*will hit African countries*, *or submerge some islands*, *but certainly not Italy or Europe*".[6]

Climate and scientific data and information were importantly linked to adaptation, especially in its proactive dimension. Respondents pointed to the role of data series on temperatures and precipitations in informing the current understanding of climate change, and hence in planning adequate responses to it. In this sense, information sharing between institutions and with colleagues working in the same field, for example in the framework of international projects funded and coordinated by the European Union, was said to be a key condition for building the adaptive capacity of institutions to respond to climate change (as also observed by Scholz and Stiftel 2005). Of course, adequately communicating these data to administrators and politicians, i.e., transforming data into information that can be directly used for decision-making purposes, always represents a challenge. In some cases, this task was facilitated by administrations purposefully mandating research on a specific

[6] Cit. from interview with respondent at research sector level (Senior Researcher), conducted by the author in Verbania (Italy) on July 10, 2011.

aspect of the climate change issue, or of other problems affecting the water sector. In other cases, however, research results tended to be lost, either because of a low degree of interest in the question from the political side, or because of the lack of institutionalised communication between policy and science.

In the category of infrastructure, material resources were especially mentioned in connection with adaptation responses and measures. For example, respondents stressed the need to modify the current irrigation system in the Po Valley towards less water-consuming technologies (e.g. drip irrigation). A much-discussed example in this sense was the case of the regional administration of the Aosta Valley. It has substantially invested in the realisation of automatised drip irrigation systems, also as a consequence of the lobbying of farmers' associations (*consorzi*), which are particularly sensible to the need for more effective water resources management, coupled with land and soil protection.

Innovative solutions were related to adaptation too, although mostly in response to ad hoc situations – one illustration for this was provided by the SHARE project in the Aosta Valley, aimed at elaborating a multi-criteria decision-support tool based on Geographic Information System (GIS) mapping and socio-economic indicators. This multi-criteria decision-support tool would serve to ensure that water-related decisions and policies take into account a number of fundamental criteria, which regulate the release of concessions for water withdrawals (SHARE 2009). Other innovations were introduced by farmers shifting to less water-consuming crop varieties, as well as by the regional administration of the Aosta Valley, which stopped funding artificial snow-making in the Alps under a certain altitude. Yet, these measures have not been institutionalised, and are merely left to the initiative of individuals, with some economic incentives being provided in a few cases by regional administrations.

6.1.2 Acknowledging the Need for Institutional Change in the Syr Darya River Basin

Shifting the analysis of specific references to adaptation measures and responses to the case of the Syr Darya River basin in Kyrgyzstan, the determinants that were mostly mentioned as favouring this type of outcome were those in the government and governance category (34 cross-references), followed by infrastructure (31 cross-references) and human and social resources (29 cross-references). Information management and finances and risk were considered relatively less important by respondents, and were brought up in connection with adaptation measures only 19 and 15 times, respectively. Looking at climate change adaptation more specifically, the categories of government and governance and human and social resources maintained a predominant role, while infrastructure was not even brought up once.[7]

[7] See Appendix 3.

Interestingly, this distribution changes to a significant extent when the differentiation between proactive and reactive adaptation is introduced. In fact, proactive adaptation was related to determinants in the government and governance, human and social resources and infrastructure categories, thus more or less reflecting the same distribution that held valid for adaptation in general. In turn, reactive adaptation was connected more to the infrastructure category, only secondarily to government and governance and human and social resources, and very limitedly to information management and finances and risk.[8] In general terms, references to reactive adaptation tended to prevail over those to proactive adaptation. For example, it was noted that the Ministry of Emergency Situations would only intervene after a natural disaster has occurred, rather than in a preventive sense: international organisations reported that a discourse on risk prevention is completely absent at the domestic level (see UNISDR 2010; GFDRR 2011).

Within the government and governance category, the determinant that was most often associated to adaptation responses and measures is the legislative, administrative and policy framework one, although mostly in an idealistic way, since evidence shows that legislation on this matter is actually absent in Kyrgyzstan. It is also interesting to note that the determinants of legislative, administrative and policy framework and risk and emergency management were most often mentioned in connection with proactive/transformative adaptation, while all the other determinants primarily referred to reactive adaptation. On the one hand, this observation can be taken as supporting the conclusion that reactive adaptation has, so far, prevailed in the Kyrgyz case. On the other hand, there seems to be an increasing awareness of the need to introduce a more transformative approach to face climate-related challenges. Interestingly, the analysis of the governance level/s at which this specific finding is more common reveals that it is not only international actors and donors that recognise the requirement for preventive adaptation, but also representatives of the Kyrgyz government within Ministries and provincial governments, as well as farmers and water users in the villages.[9]

Adaptive responses were mentioned in relation to the determinant of disaster risk and emergency management, as the latter stands for one of the few sectors in which some adaptive measures have effectively been undertaken. For example, a number of international and non-governmental organisations and donors – together with the Kyrgyz Ministry of Emergency Situations (MoES) – are working with communities to increase the level of public awareness of climate-related risks, and to build the capacity of the population in the fields of disaster preparedness and risk reduction.[10] This is also partly occurring in the water sector, where international actors have started cooperating with local communities to implement water-saving irrigation technologies. Despite the fact that these types of measures do not directly target climate change, they are nonetheless believed to move in the right direction. Likewise, participatory processes seem to be conductive to adaptation. Respondents

[8] Ibid.

[9] Ibid.

[10] More information on this type of activity is reported in: GDFRR (2010).

referred to the establishment of WUAs, providing for the participation of farmers in water-related decision-making processes, as a useful way to facilitate the implementation of adaptive management practices at the local level.

Also the determinants in the human and social resources category were labelled as "ideal" or "required" conditions to trigger adaptation measures. This is true especially for the determinant of perceptions, prioritisation and sensitivity; if adaptation is to happen at all, respondents, and especially IOs representatives, pointed towards the need to attach a sense of urgency to the climate change discourse when communicating it to Kyrgyz policy-makers, water managers, and people (as also observed by Moser and Dilling 2004). Likewise, the determinants of social and institutional capacity, and leadership and political willingness were identified as useful, but not yet present to a sufficient extent in the case of Kyrgyzstan.

Environmental NGOs were crucially associated with activities aimed at raising awareness of environmental problems, including climate change. According to respondents (and as supported by the literature on the topic, see Bekkulova 2011), environmental NGOs in Kyrgyzstan engaged in such activities at their own expense or with the assistance of external donors.[11] Educational trainings conducted within the framework of international projects, in particular, were discussed as some of the most successful measures to introduce a discourse on climate change adaptation, especially at the local level where adaptive actions are more urgently required. In addition, education could improve the relationships between water users, especially in cases of mixed ethnicity where the potential for conflict is higher.

Trust can thus serve to cement partnerships and networks; at the local level, this referred chiefly to the relationship between members of the community, e.g., farmers in a village. At a higher level, however, trust was discussed in the context of collaborations between local actors and governmental ones, and/or international organisations. In turn, the establishment of partnerships and networks was recognised as a positive step towards building the adaptive capacity of the water governance system in Kyrgyzstan, especially because they release additional economic, social and informational resources. More specifically on climate change adaptation, it emerged that informal social networks are efficient vehicles for the transmission of information and resources particularly in disaster preparedness and response, and reconstruction at the local and community levels. Local social capital, expressed through neighbourliness or more formalised community organisation, was also said to play a critical role in evacuation and emergency response and recovery.

Determinants in the information management category were perceived as not being particularly conductive to adaptation. The accessibility to climate and scientific information was reported to have been greatly enhanced by the establishment

[11] For example, in March 2010, with the support of the OSCE Centre in Bishkek, a project "*Integration of Environmental Security and Sustainable Development Issues into the Education Sector in Kyrgyzstan*" was carried out in order to support sustainable development. Also, it is worth citing the activity of the environmental movement BIOM, which has issued more than ten different environmental posters, covering issues such as food safety, climate change and health, which have been widely distributed in all regions of the country (Bekkulova 2011, p 6).

of a dedicated website in 2005, hosted by a central environmental authority in Kyrgyzstan with the support of the UNDP office in Bishkek. In addition, *Kyrgyzhydromet* maintains its own website, which presents monthly data on air, water quality, and radioactivity. Similarly, the Internet portal CARnet, created by the UNDP and operated by a network of civil society representatives, offers also regularly updated source of environmental information, freely and publicly accessible to anyone. Communication and awareness-raising were further identified as an important component of adaptation efforts, especially if directed at the general public. Here, the development of an environmental sensitivity in Kyrgyzstan was deemed to be a first essential step towards understanding and hence addressing climate change and its impacts in the country.

Finally, the finances and risk category was the one that received the least number of references in association with adaptation responses and measures: actually, its determinants were mostly mentioned as barriers to adaptive capacity, rather than bridges. Only external donors were indicated as potential drivers towards introducing a discourse on adaption in the country. Especially at the local level (WUAs' representatives), external support was deemed to be an important element to determine the effective performance of institutions in the Kyrgyz water sector. For example, it was said that international donors could intervene by providing WUAs with training, advocacy and advisory support, as well as financial assistance. In addition, international projects were seen as the normal site within which preparatory adaptation measures, such as the improvement of water use efficiency and agricultural crop diversification, were generally carried out.[12]

6.1.3 Comparing River Basins: Common Bridges to Institutional Adaptive Capacity?

From the analyses above, we can clearly see that in both the Po and Syr Darya cases, the government and governance category was the one to be most often associated with adaptation and adaptive responses (42 % of total references in Italy and 26.5 % in Kyrgyzstan).[13] However, for the Po River basin the difference between government and governance and the other categories was remarkable, while this was less the case in Kyrgyzstan. This could be explained on the basis of the fact that, generally, in the Po River basin the practical conditions to adapt to climate change (for

[12] In particular, a key international donor for these projects was said to be the GEF Small Grants Program, which finances demonstration projects in Central Asia. The projects within this program are typically short-term, small scale and aim at demonstrating the validity of tools and solutions such as drip and moisture charging irrigation, rehabilitation of degraded soils, sustainable grazing methods, diversification of agricultural crops, and reforestation.

[13] The absolute number of references made by respondents to the different categories of determinants, as well as their relative weight expressed in percentage of the total are reported in Appendix 3.

example, in terms of required infrastructure or experience) are already there, and what is missing is the political willingness to mobilise and translate them into concrete responses and longer-term action plans. On the contrary, in Kyrgyzstan, the conditions for adaptation are not present to start with: therefore, efforts at building the adaptive capacity of institutions in the water sector compulsorily need to involve all the considered institutional aspects (infrastructure, information, finances, human and social capital, and political willingness and structure). More specifically, in the Kyrgyz case, respondents stressed the importance of infrastructure-related determinants towards drafting and implementing adaptive solutions. Immediately afterwards they referred to human and social resources. Instead, in the Po River, information management was considered the second most relevant category for adaptation purposes, followed by the human and social resources one. Interestingly, in both areas, the finances and risk category was discussed only negligibly by respondents.

Looking at climate-specific adaptation, the category of information management became more important than the government and governance one (42 % vs. 31.6 % of total references) in the Po River case, while the categories of government and governance and human and social resources maintained their predominance in Kyrgyzstan (39 % and 30 % of total references, respectively). This is quite an interesting finding, which points to the fact that in the Po River case information is the most precious factor that stakeholders have at their disposal for addressing climate change – especially as it reduces the uncertainty that still surrounds this topic. When it comes to Kyrgyzstan, however, climate change remains a political question, at least for the time being. In both cases, finances and risk continued to be considered of little value for adaptation purposes. In Kyrgyzstan, however, finances and risk were associated more often to climate-specific adaptation than to adaptation in general, thus identifying a stronger connection between climate change and the need for economic resources to respond to its impacts. More generally, when discussing ideal or required measures, all respondents put the accent on political, and human and social resources, thus indicating that, to an equal extent in the Po and Syr Darya cases, climate change adaptation tends to be understood as a political matter before anything else.

Additionally, in both contexts, government and governance-related determinants were the ones to be most often mentioned in connection with proactive and transformative adaptation; although comparatively more in Italy than in Kyrgyzstan: 43 % vs. 33 % of total references. These findings point to the fundamental role that policy plays in introducing measures that: (a) prevent the negative effects of climate change on water resources management; (b) reduce the negative effects of extreme events on water resources management; and (c) improve the resilience of the water system (see also: UNECE 2009a, pp 79–83). In Kyrgyzstan, proactive adaptation was further significantly associated to human and social resources (28 % of total references) and infrastructure (19 %), while in Po River basin case it was information management (19 %) and human and social resources (17 %) that were considered as more important for implementing transformative adaptation. Once again, finances and risk were only limitedly related to proactive adaptation in both cases, and

significantly less for Northern Italy than for Kyrgyzstan. Instead, reactive adaptation was most often linked to government and governance-related determinants in Italy (46 %), while in Kyrgyzstan it frequently figured in relation to the category of infrastructure (37 %).

The chi-square statistical test revealed that these results are statistically significant. With a p-value of 0.01, in fact, it is possible to reject the null hypothesis, according to which the determinants contribute to an equal extent to adaptive capacity in the two cases at a 5 % significance level. Thus it can be confidently argued that the categories that contribute to building institutional adaptive capacity vary amongst the two cases. The significance of the results augment even more if the statistical analysis is performed on the data related to the determinants (instead of the categories, as in the previous case), as the chances of being mistaken when rejecting the null hypothesis are less than 0.000001 %.[14]

6.2 Identifying Barriers to Institutional Adaptive Capacity

6.2.1 Challenging Politics and Interests in the Po River Basin

In the Po River basin, the government and governance category is the one that was most often associated with challenges, conflicts and problems, immediately followed by human and social resources.[15] Curiously, the determinants related to infrastructure are the ones that were considered the least problematic, indicating that the construction, operationalisation and maintenance of regulating infrastructure seemed to occur on a regular basis, as a part of normal management practices. From the interviews, it also emerged that most of the problems that adaptation encountered in the water sector in Northern Italy could be attributed to the governance context. In general, in fact, respondents understood climate change as a phenomena that would only make existing problems worse, thus supporting the discourse of climate change as a "*threat multiplier*" (Downing 2009). Accordingly, present and future challenges in the water sector will be predominantly related to governance issues (Folke et al. 2005; UNDP 2006; UNECE 2009a). Climate change-specific problems were mentioned to a significant extent, particularly in the category of information management. In this respect, the water system in the Po River basin was said to be experiencing important challenges in terms of collecting and interpreting climate data and information, as well as integrating them into decision-making processes (see also WWF 2003).

[14] See Appendix 4.

[15] Of course, this particular distribution can be read as being related to the fact that government and governance and human and social resources were also the categories to be most often connected to adaptation responses and measures – as such, it is relatively not surprising that they were indicated as the ones that raised more concerns.

In the government and governance category, barriers arose quite prominently in connection with the determinant of political stability. On the one hand, the volatility that has characterised the Italian political system in recent times (although a generally prevailing phenomenon troubling the country since the beginning of the Italian Republic in 1948) represents an obstacle for the effective management of water resources, since decisions that are taken within one administration can easily change when another steps in.[16] On the other hand, respondents highlighted the fact that administrators and politicians tend to invest only in those actions that have immediate visibility and hence positive repercussions for their political career. Discussing rigidity, some interviewees argued that it is not just a characteristic of Italian institutions and bureaucracy, but has become part of the way in which the territory itself is configured. For example, it is known that current irrigation practices in the Po Valley are highly water consuming, and that new methods would be required in order to face more frequent situations of water scarcity in the future. However, the network of irrigation canals has remained unchanged for so many centuries that it is today a constituting part of the landscape, thus rendering its modification very costly.

The determinant of coordination and integration raised a number of governance-related problems as well. For once, the different sectors that have a complementary role in water resources management still act in parallel, rather than in synergy. Moreover, the Po RBA, which was originally given competency over the coordination of the activities of the various agencies and organisations at the river basin level, has been progressively delegitimised in recent years, and has been provided with an ever decreasing budget (see also WWF 2003; Raggi et al. 2007). It was also said that integrated water resources management is a challenge in the Po region because of the lack of technical and institutional capacity to effectively implement it (WWF 2003; Sgobbi and Fraviga 2006). To make things worse, the legislative, administrative and policy framework that is in force in the water sector, in addition to being fragmented and often blatantly disregarded, does not explicitly mandate for climate change adaptation (Raggi et al. 2007; Sgobbi and Fraviga 2006).

According to interviewees, participatory processes and conflict resolution mechanisms were not opportunely institutionalised, which means that they only occur in response to ad hoc situations. This hinders the system's capacity to prevent future tensions and disagreements. Nevertheless, some respondents also pointed out that involving stakeholders in the decision-making process was not always an easy or

[16] Since its inception in 1948, the Republic of Italy has had 62 governments. Since the average duration of a government is fixed by the Italian Constitution to a 4-year term, this data is indicative of the high instability that characterises Italian politics. The Italian system has typically been regarded as a deviant case in the political science debate about governmental systems, since the country was said to lack the basic pillars that constitute modern democracies, namely: the possibility of governmental alternation within democratic institutions, the existence of political parties in competition with each other and the presence of reciprocally legitimised political forces (Salvadori 2001, p 14). As such, Italy has been defined as a "partitocracy" (e.g., Calise 1994) whereby the power over public policy and indeed, over the life and death of Italian governments, is shifted away from the formal governmental institutions and falls into the hands of political parties, their general secretaries and leaders (Calise 1994).

ideal mission. For once, participation may give rise to even more conflicts because contrasting interests and needs have to be addressed at the same time. Furthermore, stakeholders may not be adequately informed about the specific problems under discussion. For example, if they are not aware of the different degrees of vulnerability of the territory, their decisions risk leading to maladaptation. Similarly, respondents denounced the relative absence of conflict resolution mechanisms for water resources management: some attempts in this sense have been made with the River and Lake Contracts in 2003, but only in the Lombardia region. Furthermore, their non-institutionalisation has meant that the opportunity to use these tools in "normal" circumstances is lost (Riva and Cucca 2007; WWF 2003).

In the human and social resources category, barriers (primarily related to the governance dimension) were mostly discussed in association with the determinant of perceptions, prioritisation and sensitivity. In fact, according to respondents, there was still a limited understanding of climate change and its consequences for the water sector. Climate change tended to be related, especially by the general public, only to the reduced availability of water resources. In addition, the general view was that the impacts of climate change will be felt in the longer-term, and hence do not represent an immediate threat today. These preconceptions, coupled with the current situation of the Italian environmental sector, reportedly affected by a dramatic lack of resources, resulted in the relegation of adaptation to the bottom of the political agenda.

Likewise, interviewees denounced the inexistence of a serious interlocutor at the national level on environmental issues. The Ministry of the Environment, due to recent budgetary cuts, was described as 'a phantom', and no other institution has taken up its role. Related to these problems was the reported inexperience of institutions in the basin to manage certain 'extraordinary' situations; one respondent stressed the fact that while floods are relatively well-understood by administrators and water managers, due to their frequent occurrence in the past, droughts and situations of water scarcity are relatively new phenomena. Consequently, the water governance system has not integrated them yet into its operational routines, which means that no permanent and expert staff is dedicated to manage water scarcity – solutions are found on an ad hoc basis. Notwithstanding this, if the problem persists in time, different, more institutionalised responses will be required (see also CIPRA 2011, p 20).

As already noted in Chap. 4, strong interest groups in the Po River basin oftentimes skewed the decision-making process in their favour, thus blocking efforts towards adaptation if the latter risked resulting in a negative change of the status quo. The Po River basin is situated in the very rich economic region of Northern Italy, which implies that water serves multiple scopes. Conflicts between users can arise with scarcity, but also in regular times if the interests of one group are better represented than the interests of another, equally or more powerful, group. Often, in fact, considerations driven by the profit of a minority prevail over decision-making aimed at ensuring what is best for the water system as a whole, which eventually leads to the overexploitation and degradation of the resource (Scholtz and Stiftel 2005). Since water is considered and treated in Italy as a public good, it is almost

inevitable that its management becomes subjected to the interests of political actors, a situation that is especially common in regional and provincial administrations.

Also the determinant of social and institutional capacity was said to represent a challenge, particularly at lower governance levels where there are less resources to hire competent staff. One of the situations that respondents denounced more frequently was the voluntary character of participation in certain users' associations, which, while ensuring that political interests are kept out of the decision-making process, can cause the lack of professional and technical figures in the long-term. Similarly, respondents lamented that the limited budget they have at their disposal makes it impossible to ensure that experts are employed on a permanent basis, which, in turn, compels the organisation to rely on interns or short-term positions only.[17]

Amongst the information-related determinants, the ones that were most often mentioned in connection with barriers were climate and scientific information and communication and awareness-raising. As for climate and scientific information, respondents denounced the fact that there are still some aspects of the water system that have received little attention. For example, not enough research has been devoted to the quality status and availability of groundwater resources. As for communication and awareness-raising, it was argued that it is difficult to make people, both the general public and policy-makers and administrators, understand what climate change is, since the available knowledge on this topic remains very "scientific" and hence not immediately graspable by the layman. Research institutes have started engaging in this translation work, but especially politicians in the provinces and municipalities were said not to be very receptive, as they have other shorter-term priority issues to address.

The determinant of monitoring, assessment and evaluation was indicated as posing a number of problems, mostly because the monitoring of both water resources' quality and withdrawals, as well as the implementation of related legislation and policies were not performed in a constant and transparent way (Sgobbi and Fraviga 2006). In fact, M&E tools, in the case of the Po River basin, are not well integrated into the decision-making process, which represents a deviation from what is recommended by the European Union, and hampers the system's flexibility to introduce revisions and modifications of policies and actions. Furthermore, respondents pointed to the fact that data and information sharing did not always happen in a fluid manner. This, as far as climate information was concerned, is a consequence of the limited coordination and dialogue between the organisations producing the information and those using it.

As the above analysis abundantly highlighted, budget represents an important source of challenges for the water sector in the Po River basin (and in Italy more broadly). In the interviews, budget was considered to be insufficient for institutions to perform their various tasks in terms of water resources management, despite the reported attempts to rationalise existing resources, especially human and informational ones.

[17] Cit. from interview with respondent at research sector level (two researchers), conducted by the author in the Piedmont Region (Italy) on July 10–11, 2011.

In addition, respondents denounced the misallocation of the already limited finances (Engle and Lemos 2010). This problem was particularly discussed by researchers, who have to engage in international projects and partnerships with other institutional actors in order to make leverage of available resources and knowledge as the only possible solution to this crisis (CIPRA 2011).

Although the determinants in the infrastructure category were comparatively less mentioned in association with barriers than all the other determinants, it is nevertheless worth mentioning them. The determinant of material resources is the one that was predominantly associated with challenges and conflicts. This is primarily because, in the view of respondents, addressing risks with "hard" infrastructural measures, as it has been the tendency in the past (and still is, partly, at present) simply transfers risks in time and space, without really addressing them. In turn, this creates conflicts between users if, for example, the risk is solved upstream and transferred downstream. In addition, since there remains a wide margin of uncertainty over the level of vulnerability of the different geographies of the basin, rigid interventions that are difficult to be modified or reversed if future conditions change drastically or in unexpected directions may be inadequate (Parry et al. 2007). In the words of the UNECE, "*measures that are highly inflexible or where reversibility is difficult should be avoided*" (UNECE 2009a, p 78).

It should be noted that these results do not appear to be statistically significant. The Chi-square test that was performed on the data on multi-level governance and barriers to adaptive capacity in the Po River case, in fact, results in a high p-value (0.69) which does not allow significantly stating that the different categories of determinants actually have a different impact on barriers to institutional adaptive capacity.[18]

6.2.2 *Challenges to Institutional Adaptive Capacity in the Syr Darya River Basin*

In the case of the Syr Darya River basin, the categories that were most often mentioned in association with challenges, conflicts and problems (understood as "barriers" to adaptive capacity in the present context) were government-governance (85 cross-references) and human and social resources (85 cross-references). Barriers were predominantly associated with governance aspects. Of course, this observation should not be interpreted in the sense that climate and water-related problems did not affect Kyrgyzstan at all, on the contrary. However, they were not *perceived* by respondents as the most salient challenges.[19] Once again, this finding would

[18] See Appendix 4.

[19] The specific climate impacts that are expected for Kyrgyzstan have already been highlighted in Chap. 5. Nevertheless, Kyrgyzstan also suffers from serious problems of water pollution, partly inherited from the Soviet period. More specifically, some of the problems that have been identified in the Kyrgyz water sector are: (i) low water use efficiency (including leakage from irrigation and

seem to confirm the proposition that eventual conflicts over water resources will be triggered by political and social factors, rather than by conditions of scarcity *per se*, and that climate change will only amplify existing problems (see also UNDP 2006; Downing 2009; Ostrom et al. 1999).

In the government and governance category, the water management paradigm is the determinant that was most often connected with barriers to adaptive capacity, especially when conjugated at the river basin level. This can be read as an indicator of the negative role that tensions and conflicts with neighbouring countries played also in terms of climate change adaptation. In fact, according to the literature, climate change will probably hit hardest in transboundary water management situations, given the increased difficulty for countries to manage shared waters (Timmerman and Bernardini 2010). Likewise, respondents expressed the idea that, for now, there is not a comprehensive and integrated strategy regulating how to best utilise and protect water resources. Only bits and pieces of legislation are in vigour, concerning, for example, the allocation of quotas within regionally agreed water abstraction totals. In turn, this hampers the development of a common strategy for climate change adaptation at the regional level, and hence also at the state one. Yet, it is recognised that the inclusion of climate change provisions in regional plans would be a required first step towards implementing adaptation nationally. One respondent even commented that "*these measures could facilitate a regional approach to water distribution challenges in Central Asia*".[20]

The fragmentation of the water management paradigm was identified as one of the most critical barriers to adaptive capacity. As already discussed, the decentralisation reform of the Kyrgyz water sector, initiated by the 2005 Water Code (Kyrgyz Republic 2005), fundamentally resulted in the delegation of water management functions and responsibilities to a number of different authorities at different levels, without nevertheless mandating for coordination and monitoring.[21] In addition,

water supply networks; (ii) avoidance of pumped water sources for drinking use, and recourse to surface water sources (which, however, are un-protected from contamination and lead to water supplies which are potentially unsafe and often susceptible to high turbidity when river flows are high); (iii) inefficient allocation of water resources internally and to downstream countries; (iv) insufficient surface/groundwater quantity and quality monitoring; (v) diffuse and point source pollution of water resources deriving from, e.g., discharges from wastewater treatment works operated by municipal water enterprises, discharges from industrial and commercial enterprises directly to water bodies with or without prior treatment by that enterprise, and discharges from tailing dams for mining activity (including radioactive uranium); (vi) incomplete coverage of improved water supply and sanitation; (vii) intermittent and unreliable piped water supply; and (viii) poor operational efficiency of water infrastructure (OECD 2011).

[20] Cit. from interview with respondent at international level (IO Project Manager), conducted by the author in Bishkek (Kyrgyzstan) on October 1, 2011

[21] Until October 2009, the Department of Water Resources was the formal national authority for water resources management and for the management of state irrigation and drainage systems simultaneously. In 2010, however, this entity was abolished and substituted by a State Committee of Water Resources. In October 2011, in correspondence of the first elections of the newly established parliamentary Republic (following on 1 year of Interim Government), this body was again replaced by the SCWEM (Orolbaev and Valentini 2010).

there seemed to be a low level of integration especially of water and agriculture adaptation measures into other national programs, due to the high level of policy sectorisation that characterises the Kyrgyz political context. More generally, it was observed that many of the integration/coordination activities promoted and required by the Water Code were not occurring in practice. For example, the issuance of abstraction and discharge permits was still in the hands of separate agencies, and the same discourse is valid for the management of water quality and water availability aspects, as well as surface and ground waters.

Political stability and the problem of corruption were mentioned as significant barriers hampering the introduction of a strategy for climate change adaptation. For once, the difficult political situation of the country was said to impede long-term planning and programming. In addition, the diffused corruption that permeates the Kyrgyz decision-making system distorts the list of political priorities, driving concerns related to climate change further away from the top. External donors are becoming increasingly worried and sceptical about investing in the country, as their resources have previously disappeared or have not been allotted for the right purposes. At the more local level, water users denounced the common occurrence of episodes of bribery within WUAs. These resulted in some farmers (generally the wealthier ones, located upstream) having more rights than others in terms of how much water they are allocated and permitted to consume.[22] For example, respondents explained that ditch-riders, hired by WUAs to control water distribution, were frequently corrupted to assign water out of the agreed schedule. This phenomenon was attributed to the absence or weak enforcement of laws and regulations by WUAs, as well as by *rayon* and *oblast* governments. Not only insufficient controls would seem to negatively affect the accountability of management and executive bodies, but they also encourage the overall poor performance of WUAs, and decrease the confidence of farmers in their work.[23]

The determinant of risk and emergency management was also discussed in relation to the challenges and problems hampering the prospects for adaptation in the Kyrgyz water sector. In particular, international respondents denounced the total lack of understanding, from the side of national decision-makers especially, of the need to introduce a discourse on prevention in the country. The DRM sector remains focused on interventions ex-post, thereby not allowing for the implementation of protection measures, which would instead guarantee important economic savings (as noted by Folke et al. 2005). At present, the funds for mitigating the consequences of natural disasters come from the state budget and administrative-territorial divisions, but only cover 10 % of the damages caused by disasters to the population (GFDRR 2010).

The bureaucratic characteristics of the administrative and institutional system of the Kyrgyz Republic, inherited from the Soviet Union, were indicated as an obstacle to the easy and rapid introduction of new measures aimed at climate change adaptation

[22] These results coincide with the findings that were reported by Alymbaeva in her study on WUA's performance in Kyrgyzstan (Alymbaeva 2004, p 45).

[23] These findings are in line with what is reported by (Herrfahrdt et al. 2006, p 140).

(see also World Bank 2012). Particularly this regarded the lack of adequate policy-making structures and the prevalence of a culture of control and exercise of power through decree. Respondents illustrated this aspect by mentioning, for instance, the excruciatingly long process for the preparation of a National Adaptation Strategy. Some international organisations also denounced the complex bureaucratic procedures that are required to initiate and implement projects, which often discourage them from working in the country in the first place. Indeed, the presence of international donors in Kyrgyzstan was very limited before the events of June 2010, when organisations such as UNDP, UNICEF, ACTED or the International Red Cross were almost 'forced' to intervene in Kyrgyzstan as a consequence of the civil conflict (ICG 2012).

Related to the rigidity of Kyrgyz institutions is the reference to the legislative, administrative and policy framework as a barrier to climate adaptation. This is because, as respondents eloquently explained, legislation on climate change adaptation is non-existent in the country. In addition, the Kyrgyz water sector, and the environmental sector more generally, were described as being affected by the classic "*implementation gap*" (World Bank 2012, p 4). Accordingly, it would seem to be quite commonplace in Kyrgyzstan to pass legislation or establish institutions that then fail to operate in practice because authorities do not understand their content, or have very strong incentives to continue existing practices. While it is frequently donors that promote legislative changes on the assumption that these will 1 day translate into practical reforms, what they fail to do is to discuss and work through realistic implementation plans, including resource requirements and appropriate behavioural changes, with the relevant domestic authorities (see also: World Bank 2012).

Participatory mechanisms were rarely indicated as problematic, although some issues were raised in relation to the informational vacuum that exists about the mandate, functions and decisions of WUAs, which, in turn, hampers the capacity of farmers to take part in their activities.[24] More specifically, as far as WUAs are concerned, some respondents argued that water users are not always involved in management decisions in practice, which, as a consequence, risks converting WUAs into "*mere water supply organisations rather than real water users associations*" (Herrfahrdt et al. 2006, p 145). In addition, as many WUAs' directors occupied leading positions in the Soviet *kolkhozes* (collective farms) (and, as a consequence, remain influential today), farmers, instead of performing water management-related tasks on their own, often prefer delegating responsibilities to their leaders (see also Wegerich 2000). The success of WUAs, therefore, appears to depend first and foremost on their leaders (Wegerich 2000); a factor that can act in a positive sense. This is the case if the leader has a strong personality and is motivated to achieve collective outcomes, but it can also have very negative consequences if the leader does not represent the interests of water users.

In the human and social resources category, the determinant that was deemed to be the most important source of problems was the social and institutional capacity

[24] This finding aligns itself with Alymbaeva (2004).

one. For once, respondents pointed to a generalised lack of awareness of issues related to climate change within national and subnational governments. In contrast, at the more local level, there appears to be a major understanding of climate change and its impacts. Farmers, for example, although they did not refer explicitly to climate change, were aware of the fact that weather patterns are altering, and that in recent years more situations of water scarcity have occurred. Since they are likely to have experienced similar situations in the past, farmers also knew, at least to a certain extent, how to deal with these changes. Nevertheless, their experience remained employed on an ad hoc basis and was not reflected in more widespread practices that could benefit other villages/regions/communities in the country. In addition, it was not farmers that took decisions in the water sector, but bureaucrats and administrators with far less practical competencies. The other side of the coin, however, is that farmers and water users also generally lacked the political experience that is necessary for managing water resources in a coordinated and integrated way, and this represented a problem especially within WUAs. Since the salaries tend to be very low, moreover, it was difficult for WUAs to hire qualified staff. Not only did this hold valid for irrigation specialists, but also for managers that are able to adequately fulfil their administrative duties, such as the drafting of plans or budgets.

The determinant of group relations and representation of interests was also mentioned in connection with barriers to adaptation, mostly referring to the ethnicity dimension, according to which not all groups in Kyrgyzstan would have access to the same amount of adaptation options, especially in the Fergana Valley.[25] However, the ethnic component *per se* did not figure so prominently as a barrier to adaptive capacity. Reflecting on what has already been suggested by earlier research on this topic, the interpretation of conflicts in ethnic terms should be in principle avoided in the Central Asian region. While it is clear that the limited availability of water resources represents an important source of tensions, and the dysfunctional state of infrastructure contributes to fuelling the competition between groups over their control and use, most often than not these are more socio-economic problems than inter-ethnic ones (Bichsel 2005).

All the determinants included in the finances and risk category were basically identified as barriers to adaptive capacity, although to a different extent. The determinant that seemingly caused more problems was the budget one. Economic constraints were partly attributed to the overall poverty of Kyrgyzstan, but some

[25] The Fergana valley is an intermountain depression in Central Asia, between the mountain systems of the Tian Shan in the north and the Gissar-Alai in the south. Although the valley forms a single, continuous geographic unit, it is politically very divided. At present it encompasses three provinces of Kyrgyzstan (Osh, Jalal Abad and Batken), three provinces of Uzbekistan (Andijan, Fergana and Namangan) and the Sogd Province in Tajikistan. The Fergana valley forms the backbone of agriculture in Central Asia. Some 45 % of the irrigation areas of the Syr Darya basin, in fact, are located here. Ethic divisions and resource scarcity make this region particularly vulnerable to violence, which has already occurred in 1990, when bloody clashes between inhabitants of the Kyrgyz town of Osh claimed over 300 lives, or earlier, in 1989, when hundreds of the Meskhetian Turks were killed in the Uzbek town of Fergana in what was called one of the most dramatic episodes of inter-ethnic relations in the Soviet Union (Votrin 2003, p 22).

respondents also alluded to the lack of political willingness to allocate funding to the environmental sector, especially given the struggle that the country is conducting to meet its economic development and poverty reduction objectives. At the local level, budgetary problems especially touched WUAs. Pursuant to the 2005 Water Code, WUAs are supposed to collect two types of fees: (a) a water fee payable to the government for water transportation; and (b) an O&M fee retained by the WUA to cover its operational and administrative expenses. These two payments are collected from farmers in a single instalment, which can be done in cash and in-kind (crops) (Alymbaeva 2004, p 54). However, the average collection rate was reported to be between 47 % and 69 % (Alymbaeva 2004, p 54), which clearly does not ensure the financial sustainability of WUAs. In turn, the lack of financial resources impairs the capacity of WUAs to perform their tasks, and results in: (a) the shortage of equipment (transport, communication, data processing, etc.) to operate, maintain and rehabilitate irrigation systems (Herrfahrdt et al. 2006, p 139); (b) their inability to take over all relevant infrastructure, which in many cases are left in the hands of the district governments (Herrfahrdt et al. 2006, p 140); and (c) low salaries that hinder the possibility for WUAs to hire qualified staff (Herrfahrdt et al. 2006, p 140).

Interestingly, the determinant of financial instruments was the one that respondents mentioned less frequently, mostly because financial instruments are not yet particularly widespread in the country (OECD 2011). One respondent made an important comment on the limited access of water users, especially farmers, to loans from local banks because of high interest rates (see also Alymbaeva 2004, p 62). Although microfinance starts to be considered as a viable measure to reduce the climate vulnerability of the poorest communities, thereby also embedding the potential to contribute to adaptation (see, e.g. Agrawala and Carraro 2010), its development in Kyrgyzstan is still at a very infant stage. Indeed, none of the microfinance institutions that are currently present in the country were reported to engage in climate change adaptation directly.[26]

External donors were mentioned in connection with barriers to adaptation, too. Mostly this was because their particular presence in the country gave rise to a number of problems. For one, interventions carried out by international actors risked not being sustainable, as the government often left climate change adaptation in their hands without contemporarily building the required institutional capacity to take over the same role in the future. Secondly, the staff of international organisations often came from Western countries and had little knowledge of the local cultural and social characteristics. Therefore, it turned to be very complicated for them to

[26] Kyrgyzstan's largest rural finance institution is The Ayil Bank (formerly known as the Kyrgyz Agricultural Finance Corporation). It was established in 1998 with funding assistance from the World Bank and other international donors with the aim to provide credit to private farmers as part of the restructuring of rural economy. Other microcredit companies in Kyrgyzstan are Kompanion, Bai Tushum, and Finca, all working with the support of international donors, also collaborating with them in the implementation of some projects at the local level (e.g., Kompanion collaborates with the Swiss NGO Helvetas by releasing educational loans for youth). Source: information collected by the author during fieldwork.

propose interventions that were respectful of the environment and traditions of the Kyrgyz people. Finally, the widespread presence of international organisations and donors in the country, especially since the June 2010 events, has sometimes resulted in the duplication of their functions and consequent dispersion of resources. The Joint Country Support Strategy (JCSS) that donors have agreed upon already in 2006 attempted to address this last problem (JCSS 2006). Nevertheless, the JCSS remained silent on how to avoid competition between local actors to access external funds, another phenomenon that has allegedly limited the effectiveness of donors' interventions.

In the information management category, climate and scientific information were mentioned in connection with barriers to adaptation as respondents denounced their insufficiency and exclusion from the decision-making process. Also the lack of reliable statistics on socio-economic indicators was considered to be an important impediment to the formulation of sound interventions. Monitoring, assessment and evaluation were also seen as problematic. Interestingly, stakeholders described a situation in which the main problem was not the absence of tools and infrastructure for this task. In fact, compared to other countries, for example in the Sub-Sahara African region, where infrastructure was never built to start with, Kyrgyzstan has inherited from the Soviet Union a complex network of monitoring stations. However, this infrastructure has not been regularly updated and maintained and, therefore, throughout the years, has fallen in dismay. Today, Kyrgyz hydrologists cannot properly monitor water quality and quantity, and meteorologists have problems in collecting valid climate and weather information. In this sense, the two determinants of material resources and infrastructure and their operation and maintenance – or, more fittingly, the lack thereof – were mentioned as barriers to adaptive capacity. In particular, respondents described the unsatisfactory situation of Kyrgyzstan's observational network and hydro-meteorological infrastructure (World Bank 2009). The introduction of automated technologies, generally supported by international donors, did not help hydro-meteorological services meet the modern requirements that would be necessary for effective forecasting (World Bank 2009).

Also the determinant of information and data sharing was mentioned as a barrier to climate change adaptation, especially in its regional dimension, and for the same reasons that have already been discussed in relation to the international relations determinant. More specifically, respondents pointed to the fact that current adaptation to climate change (or the lack thereof) is characterised by scientific uncertainty and a low level of policy-science dialogue. The reduced incentives to share data across institutions aggravate this situation, and lead to the insufficient availability of support tools and adaptation planning methods for decision-making purposes.

In the infrastructure category, the three determinants of technology, technical assistance and innovation were only limitedly connected with barriers to adaptive capacity, and seemed to play a positive role instead. However, one specific issue was discussed in relation to the determinant of innovation. In fact, from the interviews, it emerged that in some villages innovation, equated with interventions aimed at providing standardised new technology, was clearly constrained by a dominant culture, which frowned upon doing things differently. This culture could not even be

challenged by the introduction of 'approved' innovation by external authorities or experts. Opportunities to find out where, how and by whom local innovation was happening were thus being missed.[27]

As in the case of Italy, however, these results do not appear to be statistically significant, and should therefore be taken with caution. The Chi-square test that was performed on the data on multi-level governance and bridges to adaptive capacity in the Syr Darya River case, in fact, results in a high p-value (0.38), which does not allow significantly stating that the different categories of determinants actually have a different impact on institutional adaptive capacity.[28]

6.2.3 Comparing Obstacles to Institutional Adaptive Capacity: Politics or Finances?

Comparing the barriers to adaptation that respondents mentioned in the two case studies under review is a useful exercise in order to identify not only the conditions that determined adaptive capacity, but also those that potentially hampered it. In turn, this is a fundamental precondition to be able to propose solutions that could transform obstacles into effective enablers of adaptive capacity.

A first look at the references to the different categories of determinants in association with barriers reveals that problems were particularly found in the government and governance category in Northern Italy (38.7 % of total references), while in Kyrgyzstan they were more common in the finances and risk category (27.9 %).[29] Fundamentally, therefore, it could be said that in Italy it is politics that gave rise to most of the obstacles to climate change adaptation, while in Kyrgyzstan the challenge was more of a financial type, i.e., economic resources are simply insufficient to pay for adaptation measures.

In both contexts, human and social resources caused one fourth of the total barriers to adaptation. In Kyrgyzstan the same percentage also referred to government and governance determinants, which hence seemed to be less problematic than in the case of Northern Italy. Also, in Kyrgyzstan, information management was associated with barriers to adaptation more often than infrastructure (11 % vs. 9 % of total references), while the opposite is true for Northern Italy – there, infrastructure represented a barrier in the 19 % of the cases, while this percentage dropped to 12 % for information management. For Kyrgyzstan, problems related especially to information sharing at the regional level, which allegedly impeded the elaboration of a

[27] These findings are in line with Levine et al. (2011).

[28] See Appendix 4.

[29] See Appendix 3.

common strategy for climate change adaptation. In Northern Italy, reliance on a "hard infrastructural" approach to adaptation was said to be insufficient and inadequate to respond to future climate challenges.

In both contexts, climate- and water-related challenges were mentioned much less frequently than governance ones. Once again, this confirms the general observation that problems in the water sector are today prevalently of a governance nature, and that climate change will only represent an additional factor of pressure. This holds valid for both the Syr Darya and Po River basins, despite the profoundly different nature of their governance and institutional systems. For climate and water-specific challenges, information-related determinants were mentioned more often than all the other ones in both Northern Italy and Kyrgyzstan. These results point to the high level of uncertainty that still surrounds the issue of climate change, but also to the generalised lack of adequate and sufficient data and information, as well as opportunely downscaled climate models and monitoring systems to address its impacts. With the exception of the finances and risk category, which was never mentioned in any of the two sites in relation to climate-specific barriers, government and governance and infrastructure followed information management in terms of absolute number of cross-references with climate-specific challenges.

Instead, governance-related barriers were primarily discussed in association with government and governance determinants in both Northern Italy and Kyrgyzstan (29.1 % and 25 % of total references, respectively). The same holds true for determinants in the human and social resources category. In Northern Italy, the categories of finances and risk and information management were only mentioned 10 % of the times, while they were called into cause as barriers to adaptation much more often in the case of Kyrgyzstan (17 % of total references). Finally, the infrastructure category was only limitedly associated to barriers towards adaptation in both cases (8.3 % vs. 4.9 % of total references, respectively), which is somehow intuitive as infrastructure, because of its technical nature, tends to give rise to less governance-related problems.

The chi-square statistical test revealed that these results are not very significant. With a p-value of 0.15, in fact, it is not possible to confidently reject the null hypothesis (according to which the determinants constitute barriers to adaptive capacity to an equal extent in the two cases), and to hence argue that the categories that hamper institutional adaptive capacity actually significantly vary in the two cases. However, if the analysis is performed on the determinants, instead of on their aggregation into categories, the significance of the results increases (p-value of 0.15), making it possible to say that the extent to which the hypothesised determinants actually block adaptation measures to occur is different in the two cases of the Po River basin and the Syr Darya River basin.[30]

[30] See Appendix 4.

6.3 The Multi-level Dimension of Adaptive Capacity: Discussion

As evidenced in the two previous sections, in both the Po and Syr Darya River cases the multi-level governance dimension was crucial to understand the ways in which institutional actors interacted with each other towards putting in place (or not) certain adaptive outcomes. In this section we want to compare the two water governance systems under review in terms of how the multi-level dimension played out in shaping the relationships and defining the impacts of the hypothesised determinants of adaptive capacity. Before starting this exercise, however, it is important to note that not all the governance levels were equally represented in the two cases in order to reflect the different importance that institutions and institutional actors have in the considered water systems.[31] For example, international actors in Kyrgyzstan played a fundamental role in water resources management, especially in terms of addressing the prospected impacts of climate change. Therefore, the international level was strongly represented in the interviews. In Italy, this was clearly not the case; the only international component related to the European Union, which indirectly influenced water management in the Po River basin through international research projects and guidelines and regulations. In the Po River basin, sub-national authorities, and particularly regional administrations, were the actors that played the most significant role in terms of water resources management, and were therefore interrogated more often than international ones.

Some interesting differences can also be noted at the national level, which was comparatively more represented in the Kyrgyz case. This observation does not indicate that state authorities have a lower significance in water resources management in Italy than in Kyrgyzstan. Rather, while the Syr Darya River basin was approximated to the entire country of Kyrgyzstan, the Po River basin only falls in one part of Italy – quite naturally, as a consequence, national authorities would have a minor role to play there. The local level was almost equally represented across the two cases, and the same discourse holds true for civil society. In Kyrgyzstan, the research sector, being predominantly state-owned, was merged with the national level. In Italy instead, research was indicated under a separate category to highlight its very specific and independent views on the issues under discussion.

Shifting the comparison to governance processes, it is interesting to note that international projects were discussed more often in the Po River case than in Syr Darya one – a finding that would seem somehow counterintuitive given the previous remarks related to the important role of international organisations, non-governmental organisations and donors in water resources management and climate change adaptation in Kyrgyzstan. The emphasis that Italian respondents put on this dimension, however, can be read as a symptom of the fundamental role that external donors are increasingly coming to play in the country to compensate for the diminishing economic resources and problematic situation in which the environmental

[31] See Appendix 3.

sector is found. This prevailing context is a result of the economic crisis, but also, and quite importantly, of a generalised tendency on the part of politicians and administrators to consider the environment as a second-order problem, relegating it behind other more pressing (and more acclaimed by the electorate) concerns. In other words, in both the Italian and the Kyrgyz cases, the impossibility and/or incapacity of local and national actors to tackle the climate change challenge was simply addressed by relying, to a more or less important extent, on external subjects to come up with solutions and adequate interventions. Some responses were also proposed by individual or groups of water users within small-scale territorial units, but they remained isolated and fragmented, and were not included in a more integrated and comprehensive strategy at the river basin level.

Interestingly, both countries have attempted to reform their water sector towards implementing the IWRM approach, thereby decentralising decision-making functions according to the principle of subsidiarity. Nevertheless, IWRM still presents significant challenges, which have impeded, to date, the initiation of a discourse on integrated *and adaptive* water management. The adoption of a river basin approach was particularly problematic in Kyrgyzstan, given the strained relationships with its Central Asian neighbours. For the Po River basin instead, problems arose internally between powerful interest groups – administrators and politicians at different sub-national levels that are unwilling to portion the benefits they derive from water resources.

Interestingly, the statistical analysis that was performed to assess the significance of the difference between the two cases in terms of how much each governance level/process contributed to barriers and bridges to adaptive capacity revealed that these results can be taken with a high degree of confidence. In fact, the p-values resulting from the chi-square test run on the data on governance levels and barriers and bridges to adaptive capacity correspond to 0, indicating that the null hypothesis can be rejected with confidence.[32]

6.3.1 *Bridges at Multiple Scales: Local Action, National Regulation, International Financing and Cooperation to Build Institutional Adaptive Capacity*

Looking at the distribution of references to adaptive responses and measures according to the different governance levels that were considered in this study reveals that adaptation was mostly discussed at the international level in the Syr Darya River basin (60.8 % of total references to adaptation), and at the sub-national level in the Po River basin (38 %).[33] In the case of Kyrgyzstan, this reflects the previous

[32] See Appendix 4.

[33] The distribution of absolute and relative references to adaptation measures and responses across governance levels is presented in Appendix 3.

considerations according to which the discourse on climate change adaptation has actually been initiated by – and still prevalently rests within – international organisations and donors. As a result, they have substantially taken over the role of the national government and other decision-making authorities on a number of development-related matters, including water resources management and climate change adaptation. Instead, in the Po River basin, institutional actors at more localised levels, prevalently regional administrations and water users, are starting to implement adaptation measures under the important guidance of the Po RBA. This trend mirrors the more generalised move towards decentralisation that has characterised many policy sectors in Italy, and that has resulted in the transfer of decision-making powers and administrative functions to sub-national authorities at the expenses of national ones, on the basis of the principle of subsidiarity.

The national level was found to be more important for adaptation purposes in the case of the Po River (despite its basin constitutes only one part of the Italian territory) than in the one of the Syr Darya River (23 % of total references in Italy verses 10 % in Kyrgyzstan). The same discourse holds valid for civil society (6.8 % in Italy verses 5.4 % in Kyrgyzstan). This disparity is likely to be due to the fact that Italy, despite the current economic crisis, remains a rich and developed Western country, in which the state retains most of the economic, social, institutional and material resources that are required to address the issue of climate change. In addition, Italy is part of the European Union, where the discourse on climate change, mostly in terms of mitigation but increasingly also in terms of adaptation, is high on the political agenda, thereby influencing the attitude of member states in this sense. On the contrary, Kyrgyzstan is a country of recent independence, in the midst of a difficult transition from socialist to market economy, surrounded by neighbours competing for water and energy resources, and currently experiencing grave socio-economic problems that result in high levels of poverty and political instability.

Italy can also profit from a vibrant and well-established civil society, which in Kyrgyzstan instead, after decades of communist regime, is more a novelty. Water users in the Po River basin are constituted into powerful associations, which have direct linkages and influence over the decision-making process at national, sub-national and local levels. In Kyrgyzstan, water users are prevalently poor farmers that lack almost any form of representation in the political process, and whose interests and needs tend to be blatantly ignored.

Interestingly, in both cases, references to climate-specific adaptation and to ideal or required measures followed the same pattern as those to general adaptation: international actors were the ones discussing them more often in Kyrgyzstan, while this tended to occur at the sub-national level in the Po River basin. In Italy, however, it was also representatives from Ministries and other authorities at the national level that discussed ideal measures and acknowledged the need for climate change adaptation. This understanding seemed to be lower amongst politicians in Kyrgyzstan, for whom climate change is still a concern that lay with the internationals, or a way to attract funding from the donors.

In Kyrgyzstan, the prevalence of the international level in the adaptation discourse was valid for both proactive and reactive adaptation. Nevertheless, while

reactive adaptation was also discussed at the local, civil society and national levels, proactive adaptation remained a concern of international organisations and external donors only. In Northern Italy instead, national and sub-national institutional actors referred to proactive and reactive adaptation at the same time. Water users tended to discuss responsive measures more than preventive ones, while the opposite is true for the research sector. Like for general adaptation, both reactive and proactive adaptation occurred across vertical governance processes in Kyrgyzstan, as well as in the framework of international projects. In the Po River case, respondents added decentralisation and the river basin approach to these two dimensions.

To sum up, our analysis importantly highlighted the relevance of international institutions in advancing concerns about adaptive capacity in the case of Kyrgyzstan, and of domestic regional institutions in the case of the Po River basin. This finding acquires particular relevance given the centrality of the institutional argument in this study, and motivates two interesting reflections. First of all, climate change adaptation is not solely a matter of national politics, but international institutions also play a role in proposing strategies, policies and guidelines for implementation by domestic institutions. Therefore, mechanisms of diffusion are a variable that needs careful examination. Using the classification proposed by Börzel and Risse (2009),[34] the mechanism of persuasion, according to which international actors try to convince domestic ones about the importance of adopting adaptation measures by leading the way, has tended to prevail in Kyrgyzstan. The effectiveness of international institutions in this sense was enhanced by coupling persuasion with manipulation. This occurs by means of policies of conditionality that seek to influence the cost-benefit calculations of national and sub-national decision-makers, as well as capacity-building activities and the provision of technical and financial assistance. In the Po River basin, where domestic institutions are actually part of the international organisation that is exerting diffusion (i.e. the European Union), the main mechanism was rather one of socialisation, whereby actors changed their behaviour as a result of wanting to be seen as members of society "in good standing". Even with Italian domestic institutions and especially regional authorities, however, the EU was required to provide incentives, for example within the framework of research projects. Therefore, mechanisms of diffusion ideally have to be embedded in a process

[34] According to Börzel and Risse (2009), there are four direct mechanisms of diffusion, which are typical of regional organisations such as the European Union: (a) physical or legal coercion; (b) manipulation or utility calculations; (c) socialisation; and (d) persuasion. The first mechanism is physical or legal coercion, but this is strictly speaking only relevant within the internal politics of the EU, since the EU does not have recourse to legally coercive mechanisms in international politics. The second is the manipulation of utility calculations. This can occur through either policies of conditionality, in which the one actor seeks to manipulate the cost-benefit calculations of another actor, or through capacity-building activities such as the provision of technical and financial assistance, in which one actor seeks to alter the capacity of another actor to make strategic choices. The third mechanism is socialisation, which can result in complex learning through which actors redefine their identities and interests. Successful socialisation involves actors changing their behaviour as a result of wanting to be seen as members of society "in good standing". The final direct mechanism is persuasion, according to which actors try to persuade each other about the validity claims inherent in any causal or normative statement (Börzel and Risse 2009, p 7).

that, at least to a certain extent, reassures the actors that are at the receiving end that their benefits will be kept higher than the costs they incur to implement the suggested policy/idea/strategy.

The second set of reflections that can be drawn from this analysis, and particularly from the case of Kyrgyzstan, points to the importance of understanding how donors and international assistance can foster climate change adaptation. There are already some studies on this topic in the development field, for instance looking at the mechanisms through which development interventions build adaptive capacity (e.g. Levine et al. 2011). Further research should be devoted to examine whether international interventions can be explicitly designed to address climate change adaptation, or they should rather be left to do so through unintended impacts. In other words, is it more effective to design climate change adaptation interventions, or to embed them within broader development strategies? From the present study, it would seem that the integration of adaptation with other relevant development plans could help avoid coordination problems and consequent duplication of functions and dispersion of funds.[35] Also, while some international interventions may secondarily provide adaptation benefits, the implementation of direct actions and strategies in this sense can reduce uncertainty and hence result more appealing for domestic policy- and decision-makers.

6.3.2 Barriers to Institutional Adaptive Capacity Equally Manifesting at Multiple Governance Levels

If drivers to adaptation measures and responses manifest across multiple governance levels, it should be expected that barriers behave the same way. Indeed, while it is clear that adaptation is favoured at some particular governance levels, it is also evident that it is there that problems in the definition and implementation of adaptation measures will be generally experienced. Similarly to what the analysis has highlighted for institutional bridges, barriers were often mentioned at the international level for Kyrgyzstan, and at the sub-national level in the case of the Po River basin. Additionally, in Kyrgyzstan barriers were abundantly described at the national level, while this happened significantly less in Northern Italy.

If these findings are projected against the multi-level analysis of adaptive measures that was conducted in the previous section, there is a complete change of scenario between the two cases. While the national level appeared to be relatively important in Northern Italy in terms of adaptation measures but not in terms of barriers, tin Kyrgyzstan barriers were mostly mentioned at the national level. In the case of the Po River basin this fundamentally means that the state and its administrative bodies retained control over environmental policy by fulfilling (or attempting to)

[35] In turn, this would help solve the problems of lack of coordination and contrasting interests among the donors that some authors have identified in relation to environmental aid effectiveness (see, e.g., Connolly et al. 1996).

monitoring and coordinating functions, while opening to sub-national and local actors for effective implementation. Instead, in the case of Kyrgyzstan, this role has been transferred to international actors, as national authorities, at present, have not completely embraced the climate change discourse. However, despite not being able, or willing, to implement solutions, they remained acutely aware of the problems that afflict the water system, and that will hinder its prospects for successful adaptation to the impacts of climate, but also socio-economic changes. Barriers to adaptive capacity were additionally mentioned at the civil society level in the Po River case, where environmental NGOs were strong actors in the water sector, with years of experience in lobbying governments on issues of water quality and ecosystem protection and, more recently, climate change mitigation and adaptation.

Interestingly, governance-related challenges prevailed in both contexts, and were reported in connection to international projects in Northern Italy and with reference to the river basin level in the Syr Darya case. As discussed before for the Po region, collaborations with other institutional actors within the framework of projects – generally EU-mandated and funded- helped increase the availability of economic, human, informational and material resources for building the water system's adaptive capacity to respond to climate change. Nevertheless, the very fact that domestic actors had to recur to these types of solutions for implementing adaptation highlights their inability to work independently. In addition, respondents argued that domestic institutions do not always have the adequate expertise or capacity to carry out the complex and time-consuming research- and management-related tasks demanded by international projects, for example as a consequence of limited personnel with an overcharge of functions. Instead, in the case of Kyrgyzstan, barriers to adaptation were associated for the most part with the river basin approach as a consequence of the difficult political situation in the Central Asian region and the strained relations that the country has with its neighbours. This is particularly the case as far as water resources management is concerned, impeding the adoption of a common position and point of departure to tackle climate change adaptation.

Looking individually at the different determinants, it is possible to see that they all represented (with the exception of information management and infrastructure) a source of problems and challenges for adaptation, especially at the international level in Kyrgyzstan and at the sub-national level in the Po River basin. Finances and risk were deemed to be problematic also at the local level in both regions, which indicates that the availability of and access to economic resources tended to be more difficult there than at upper governance levels. This was true especially in the Italian case as, according to respondents, the decentralisation reform contributed to further reducing the budget of local administrations. Complaints about economic resources also came from state authorities in Kyrgyzstan, who lamented the low budget that the state has at its disposal in general, and the need to allocate it to other priority sectors (e.g. poverty reduction) first. Concerns about finances were widely expressed by the civil society – a typically underfunded sector relying on contributions from citizens in Italy and from international donors in Kyrgyzstan.

It is at the national level that the government-governance category was most frequently mentioned in relation to barriers to adaptation measures. This was the

case in Kyrgyzstan more than in Northern Italy, pointing to the fact that Kyrgyz leaders are well aware of the important political limitations that hamper prospects for adaptation, but take no action to redress them. For example, respondents in Kyrgyzstan discussed the inadequacy of the legislative framework in the water sector to respond to climate change impacts, mentioning the current efforts for drafting and putting in place a National Adaptation Strategy. However, this process was also reported to be lying almost entirely in the hands of the UNDP. In both cases, the civil society played an active role in denouncing the negative influence of some political factors on adaptation actions, including the political unwillingness to take action and the lack of coordination and integration mechanisms.

Human and social resources were said to represent an obstacle to adaptation responses and measures particularly at the civil society level, as well as at the international level in Kyrgyzstan and at the sub-national level in Northern Italy. Civil society highlighted the fact that the perceptions of the climate change issue of the general public and policy-makers alike have led to short-term thinking and, at best, reactive adaptation measures. Interestingly, this discourse was very similar in the two cases, despite their clear socio-economic and political differences. In the Po River basin, human and social resources-related barriers were mostly attributed to decentralisation processes. Hereby a situation was again identified in which the multiplication of decision-making competences and centres, without an appropriate coordination, has resulted in an epidemic duplication of functions and consequent dispersion of resources; economic ones, but also in terms of social capital.

For the information management category, barriers were especially identified in connection with transnational collaborations for the Po River basin. However, it should be highlighted that transnational projects were also described as potential solutions to eliminate difficulties related to the collection and analysis of climate information, as well as to their integration into the decision-making process. In Kyrgyzstan, information management was mentioned as a challenge primarily at the international level. Respondents lamented the extreme difficulty of collecting reliable data and statistics in the country, and pointed to the lack of communication and information-sharing between institutions at the regional level. In the case of the Po River, information management was mentioned as an important barrier by researchers, who described the persistent difficulty of communicating science – and especially climate science- to policy-makers.

Finally, the multi-level dimension did not seem to be particularly relevant to describe barriers in the infrastructure category. In Italy, no references in this sense were made at all. In Kyrgyzstan, these were the only determinants that were not associated with barriers at the international level. It was mostly at the national, sub-national and local levels that infrastructure seemed to give rise to challenges linked to the degraded status of the observational network and hydro-meteorological infrastructure in Kyrgyzstan.

6.4 Summary: Assessing Problems, Proposing Solutions

This study has employed a qualitative methodology based on expert interviews to investigate the capacity of institutions in the water sector to address the prospected impacts of climatic and socio-economic changes. More specifically, we have tried to highlight what drivers and/or barriers prompt and/or hamper the implementation of adaptation measures to respond to prospected climatic and socio-economic changes. What emerges for the two case studies under review, the Po River basin in Italy and the Syr Darya River basin (considered in its Kyrgyz part) can be visualised in Figs. 6.1 and 6.2 – and better described in the upcoming summary section.

6.4.1 Po River Basin

Climate projections for the Po River basin point towards a general increase in precipitation variability during both the wet/cold and the dry/warm seasons. However, the average annual rainfall is expected to continue its decreasing trend, especially for the months of January to August, which are also the months that can be used for planting and growing agricultural crops. More frequent heat waves of magnitudes similar or even greater to the one that occurred in the summer of 2003 are expected. For institutions in the water sector, these forecasts mean that they will have to be able to respond to more devastating floods, but also to more frequent situations of water scarcity, eventually leading to prolonged droughts. The agricultural sector is expected to be particularly hit by these changes, and will hence demand the implementation of structural adaptation measures that reduce its vulnerability.

From the interviews, it was evident that climate-specific adaptation will be facilitated by the *mise en place* of an adequate political framework. In particular, legislation on climate change adaptation would be a welcome introduction, as well as the availability of and access to climate, weather and water-related data to inform decision-making and planning processes. In the short-term, reactive responses can be favoured by information sharing between institutions and the introduction of innovative solutions. In the long-term, it will be instead crucial to work towards increasing the awareness of decision-makers and the general public on the need to take preventive measures to prepare for the impacts of climate change on water resources in different economic sectors.

Current efforts to implement the EU Flood Directive (2007/60) in Italy are gradually leading towards the adoption of a more proactive-transformative approach at least in the DRM sector. For example, the Po River Basin Management Plan (PBI) mandates for interventions aimed at restoring the natural hydraulic-environmental

Outcome	Category				
	Government and governance (63)	**Information management (28)**	**Human and social resources (25)**	**Infrastructure (22)**	**Finances and risk (8)**
Bridges	Risk and emergency management (26)	Climate and scientific information (11)	Group relations, representations of interests (10)	Material resources and infrastructure (12)	Financial instruments (2)
	Flexibility, planning (24)	Communication and awareness-raising (9)	Partnerships and networks (6)	Innovation (8)	
	Legislative, administrative, policy framework (17)	Traditional knowledge (4)	Perceptions, prioritisation (5)	Investments (O&M) (3)	Budget (1)
	Participatory processes (12) Water management paradigm (12)	Uncertainty (4)	Experience (5)	Technology (2)	
	Coordination and integration (9)	M&E (2)	Social and institutional capacity (3)		
	Participatory processes (3)	Traditional knowledge (1)	Social and institutional capacity (2)	Investments (O&M) (1)	
	Flexibility, planning (3)		Partnerships and networks (2)		
	Coordination and integration (3)		Perceptions, prioritisation (1)		
	Risk and emergency management (1)	Communication and awareness-raising (1)	Social and institutional capacity (1)	Innovation (1)	
	Participatory processes (1)				
Barriers	**Finances and risk (92)**	**Government and governance (83)**	**Human and social resources (64)**	**Information management (30)**	**Infrastructure (15)**
	Budget (61)	Risk and emergency management (16) Water management paradigm (16)	Perceptions, prioritisation (25)	Climate and scientific information (11) Communication and awareness-raising (11)	Material resources and infrastructure (12)
	External donors (28)	Coordination and integration (15)	Social and institutional capacity (22)	Uncertainty (6)	Investments (O&M) (4)
	Individual and market incentives (18)	Flexibility, planning (14)	Group relations, representation of interests (19)	Traditional knowledge (5)	Technology (2)
	Economic development (17)	Legislative, administrative ad policy measures (7) Participatory processes (7)	Experience (6) Leadership and political willingness (5)		Innovation (1) Technical assistance (1)

Fig. 6.1 Summary of references to categories of determinants of institutional adaptive capacity in the Po River basin. In brackets, number of cross-references to the determinant for each outcome. Colour code: Grey scale of colors refers to relevance: *dark grey* = relevant (majority or close to majority of references) until *light grey* = not significant (almost no references)

Outcome	Category				
	Government and governance (34)	**Infrastructure (31)**	**Human and social resources (29)**	**Information management (19)**	**Finances and risk (15)**
Bridges	Legislation, administrative and policy measures (13)	Innovation (16)	Perceptions, prioritisation (10)	Climate and scientific information (10)	Budget (8)
	Risk and emergency measures (9)	Material resources and infrastructure (9)	Education and training (8)	Communication and awareness-raising (4)	Donors (6)
	Water management paradigm (8)	Technology (7)	Social and institutional capacity (6)	Traditional knowledge (3)	Economic development (5)
	Flexibility, planning (7)	Technical assistance (4)	Partnerships and networks (5)	Information sharing (2)	Individual and market incentives (4)
	Participatory processes (3) Political stability (3)	Investments (O&M) (3)	Leadership (2)		Financial instruments (2)
	Flexibility, planning (4)		Partnerships and networks (2)		
	Risk and emergency management (3)		Leadership (1)		
	Water mgt paradigm (1)		Leadership (1) Social and institutional capacity (1)		
Barriers	**Government and governance (102)**	**Human and social resources (85)**	**Finances and risk (60)**	**Information management (48)**	**Infrastructure (34)**
	Water mgt paradigm (25)	Social and institutional capacity (40)	Budget (36)	Traditional knowledge (19)	Material resources and infrastructure (20)
	Coordination and integration (22)	Perceptions, prioritisation (30)	External donors (22)	Climate and scientific information (14)	Investments (O&M) (11)
	Political stability (20)	Leadership (13) Group relations, interests (11)	Individual and market incentives (12) Economic development (11)	M&E (7)	Technology (7)
	Risk and emergency management (14)	Experience (7)	Financial instruments (1)	Communication and awareness-raising (5)	Innovation (1) Technical assistance (1)
	Flexibility, planning (13)	Education and training (5) Partnerships and networks (4)		Info-sharing (4) Uncertainty (3)	

Fig. 6.2 Summary of references to categories of determinants of institutional adaptive capacity in the Syr Darya River basin. In brackets, number of cross-references to the determinant for each outcome. Colour code: Grey scale of colors refers to relevance: *dark grey* = relevant (majority or close to majority of references) until *light grey* = not significant (almost no references)

conditions of those areas that have a low value from an agricultural point of view but are fundamental to contain the effects of floods. However, the prevailing mind-set and attitude of decision-makers remain skewed towards responding to disaster risk with reactive actions that have immediate visibility amongst the electorate and hence positive repercussions for their political career. In addition, while flood events have happened quite frequently in the past, thus building up the experience of the population to deal with them, droughts are a relatively new phenomenon in the Po River basin. As a consequence, their occurrence generally finds water managers and policy-makers unprepared, which translates into patchy and ineffective responses. To complete this bleak picture, both the DRM and water sectors are largely underfunded: more investments would be necessary especially to "buy" the human and institutional capacity that is required to forecast and respond to natural disasters and extremes, and to allocate water resources in a sustainable and effective way between its different economic uses.

As for the agricultural sector more specifically, the introduction of adaptation measures is currently hampered by the rigidity that characterises the configuration of the territory. It is known that current irrigation practices in the Po Valley are highly water consuming. Nevertheless, the network of irrigation canals has remained unchanged for so many centuries that it is today a constituting part of the landscape, thus rendering any modification very costly. In addition, the agricultural sector in Northern Italy is characterised by the presence of relevant interest groups that have a powerful voice in local politics and are hence able to oppose changes that would, at least in the short-term, cause them more harm than good. Decentralised water resources management, not adequately coordinated and planned, has encouraged this negative pattern by increasing the power of local decision-making authorities and, consequently, their liberty to respond to individual or group interests as they like. Yet, the inclusion of specific measures for water saving in the PBI represents an encouraging development. Some pioneering regional administrations have already started investing into automatised drip irrigation systems.

Moreover, future increases of water demand for domestic and industrial purposes, as well as for tourism, especially in mountain areas, are predicted. Current trends indicate that also the use of water for hydropower generation will augment as a consequence of the population's higher consumption of energy and Italy's commitments under the Kyoto Protocol, and possibly any new treaty afterwards. The question, therefore, is whether and how conflicts between these uses can be avoided. In this sense, the interviews highlighted the importance of taking an integrated approach to water resources management, one that considers water availability for the entire river basin, and that balances demand and supply in an effective and sustainable way. Unfortunately, in the case of the Po River, integration is far from being achieved. For once, the different sectors that have a complementary role in water resources management continue to act in parallel rather than in collaboration with each other. Besides, the Po RBA, which was originally given competencies to coordinate the activities of the various agencies and organisations in terms of water resources management at the river basin level, has been progressively delegitimised in recent years. At the same time, the legislative, administrative and policy framework

that is in force in the water sector, in addition to being fragmented and often blatantly disregarded, does not explicitly mandate for climate change adaptation. Some positive improvements have been made with the PBI, which describes specific actions to address the impacts of climate change in different sectors. Of particular interest is the provision for establishing a register of all water withdrawals concessions, which should serve to identify potential conflicts before they emerge. In the Aosta Valley, a multi-criteria decision-support tool has also been developed to better take the different economic uses of the resource into account, so as to regulate the release of concessions according to actual demands and needs.

Like integration, perceptions were found to be a key determinant to avoid conflicts over water resources. To date, there persists a limited understanding of climate change and its impacts on the Po River basin. Climate change is associated to the reduced availability of water resources, and perceived as a long-term issue with no immediate consequences in the present. Therefore, the first obligation is to make the general public conscious of the real problem. To this end, education and awareness-raising campaigns are critical tools, as well as the restoration of a more natural and direct relationship with the environment. In addition, it will be important to institutionalise conflict resolution mechanisms, as well as participatory processes. Finally, adequate funding mechanisms and infrastructure for monitoring the correct performance and respect of regulations on the side of water users across the basin territory could help impede situations of conflict to develop in the first place.

6.4.2 Syr Darya River Basin

Climate scenarios for the Syr Darya River basin (in its Kyrgyz extension) show that, although in the short-term shrinking glaciers will provide ample quantities of water especially in dry summers, this supply is doomed to reach a tipping point, after which summer runoff will actually start decreasing (Beniston et al. 2011; Braun and Hagg 2009). The interviews revealed that infrastructure-related determinants could constitute a driver towards adapting to this type of situation. In fact, and as also suggested by a number of authors (e.g. Abbink et al. 2010), the construction of hydropower dams that "replicate" glaciers by storing water resources in the winter season to release them during summer are a useful way to redistribute seasonal precipitations. For instance, the foreseen construction of the Verkhnenarynsky hydropower cascade upstream of the Toktogul reservoir would allow Kyrgyzstan to generate an electricity surplus in winter, and use the Toktogul reservoir to re-regulate the Naryn river flow towards an irrigation mode in summer (Abbink et al. 2010). Unfortunately, however, this is only an isolated. The more general lack of investments into functional and new water infrastructure and other technical innovations has, so far, greatly hampered the capacity of the Kyrgyz water system to respond to prospected scarcities.

Climate models and forecasts additionally predict climate change to have severe impacts in terms of increased occurrence and intensity of extreme events in

Kyrgyzstan. According to the qualitative analysis proposed in this study, the DRM sector is actually the only one in which some adaptive measures have been effectively undertaken. However, risk and emergency management in Kyrgyzstan remains based on interventions ex-post, thereby not allowing for the implementation of prevention measures, which would instead guarantee important economic savings.

An increase of water demand for irrigation, industrial and domestic purposes was also foreseen. Evidence from the interviews has demonstrated that, at present, it is external donors and international organisations that are mostly thinking about long-term solutions to potential water-related conflicts. For example, these actors are supporting farmers at the local level in the implementation of water-saving irrigation techniques and crop diversification. While their interventions can be considered as positive first steps towards more nationally-owned solutions, the risk is that domestic authorities do not step in and leave the sole responsibility for climate change adaptation to the international community. The proposed analysis suggested that international organisations should hence start focusing on informing and generating dialogue horizontally across ministries and vertically with regional and local actors, while building their capacity to move towards more adaptive operating regimes. In parallel, Kyrgyzstan should move towards developing national adaptation plans that are free from the economic interest of increasing productivity at all costs, and instead aim at improving water use efficiency and agricultural crop diversification. Respondents discussed the importance of making national and local decision-makers understand the need to adopt an anticipatory and preventive attitude towards climate change. A substantial mind-shift in this sense could be achieved by investing in communication and awareness-raising directed at both administrators and the general public, for example by using the media to increase the accessibility and availability of information.

In order to avoid conflicts between water users within the country, it would be important to address the current fragmentation of the Kyrgyz water governance system. While the 2005 Water Code fundamentally delegated water management functions and responsibilities to a number of different authorities at different levels, it failed to identify a central body with coordination and monitoring tasks. In addition, there is a low level of integration especially of water and agriculture adaptation measures with other national programs, due to the high level of sectorisation that characterises the Kyrgyz political context. Conflict resolution mechanisms were reported to be largely absent, and WUAs are rendered ineffective by corruption and inadequate information about their mandate, functions and decisions. Nevertheless, the establishment of WUAs, providing for the participation of farmers in water-related decision-making processes, was identified as a useful way to facilitate the implementation of adaptive management practices at the local level. Furthermore, education and trainings were said to improve the relationships between water users, especially in cases of mixed ethnicity. The interviews highlighted that establishing relationships of trust between water users is key to reduce the risk of conflict.

More generally, this study stressed the importance of farmers and other water users at the community and local levels for effective and adaptive water resources

management. Indeed, since these actors are likely to have experienced similar situations in the past, they will know, at least to a certain extent, how to deal with current and future changes. The fact that their experience remains employed on an ad hoc basis and is not reflected in more institutionalised practices that could benefit other villages/regions/communities clearly represents a limitation. An additional barrier to users' participation in water resources management is posed by the many budgetary problems affecting WUAs.

Moreover, the present analysis highlighted that the international dimension plays a critical role in shaping the adaptation options of the Kyrgyz water sector. It also emphasises that most of the discussion in terms of whether and how Kyrgyzstan will be able to respond to the challenges identified by climate other models very much depend on the country's relationships with its Central Asian neighbours. The lack of an effective basin-wide agreement is obviously not helpful for assuring water availability in normal circumstances, and even more so in the context of climatic and socio-economic changes. This situation is exacerbated by the problems that the Syr Darya riparian states experience in terms of managing water resources in their own territories, which makes it very unlikely that they will ever succeed to fulfil international obligations, even if a perfect agreement was in place. One of the key legal mechanisms necessary for regulators to control demand in the face of variable supply is the ability to vary water use rights over time in such a way as to balance resource availability, investment planning and equity (UNESCO 2006). While the 2005 Kyrgyz Water Code allows for water use permissions to be modified in the public interest and in accordance with regularly reviewed basin plans, this power is only limited to short-term users and excludes larger projects (Kyrgyz Republic 2005, arts. 23 and 28). Faith in the system is further undermined by perceptions of corruption and lack of consistent implementation (UNECE 2009b).

In addition to changes in the legal framework towards a more integrated management of water resources across its different economic uses, policy-relevant adaptation measures should include consistent data collection and dissemination, cross-sectoral collaboration, promotion of responsibility and initiative, awareness-raising of climate change impacts among key stakeholders, and a regional strategy. In particular, effective data generation and sharing mechanisms are essential for the success of any transboundary agreement that may be reached between the Syr Darya states. In Kyrgyzstan, the lack of reliable statistics on socio-economic indicators, climate change vulnerability assessments, and data on climatic, weather and hydrological trends has greatly augmented the uncertainty that surrounds the discourse on climate change adaptation, simultaneously reducing the willingness of political actors to take action. All in all, it would seem that, while Kyrgyzstan's vulnerability to climate change is high, the barriers to climate change adaptation remain much more significant than the potential solutions, despite some first steps in the right direction have started to be taken. Any real attempt at introducing and implementing adaptation measures in the country will have to be matched with a comprehensive and integrated strategy aimed at increasing cooperation and trust between the Central Asian states. Ultimately, climate change adaptation in Kyrgyzstan is not a domestic issue, but an international one.

References

Abbink K, Moller L, O'Hara S (2010) Sources of mistrust: an experimental case study of a central Asian water conflict. Environ Resour Econ 45:283–318

Agrawala S, Carraro M (2010) Assessing the role of microfinance in fostering adaptation to climate change. OECD Environmental Working Papers, No. 15, 12 February

Alymbaeva A (2004) Institutional development of water users associations in Kyrgyzstan. Thesis submitted in fulfilment of the Masters in Public Policy at the Rochester Institute of Technology (RIT). Rochester, Feb

Autorità di bacino del fiume Po (AdbPo) (2010) Piano di Gestione del distretto idrografico del fiume Po. AdBPo: Parma, 24 Febbraio

Autorità di bacino del fiume Po (AdbPo) (2011) Valutazione globale provvisoria dei problemi relativi al bilancio idrico nel distretto idrografico del fiume Po. Incontro tematico "Scarsità e siccità – Cambiamenti climatici". Documento per la consultazione pubblica ai sensi dell'art.66, comma 7a del D. Lgs 152/06 e smi, AdBPo: Parma, 6 Ottobre

Autorità di bacino del fiume Po (AdbPo) (2012) "Valutazione Ambientale Strategica: Rapporto Preliminare: Documento per la fase di consultazione preliminare ai sensi dell'art. 13, comma 1 del D. Lgs 152/06 e smi", Piano di Bilancio idrico del distretto idrografico del fiume Po, AdBPo: Parma, 6 Febbraio

Bardelli L, Robotti L (2009) The water sector in Italy. Working Paper CIRIEC 2009/1

Bekkulova JE (2011) Aarhus convention implementation report: Kyrgyz Republic. Report submitted on behalf of the Kyrgyz Republic in accordance with decisions I/8 and II/10, State Agency for Environmental Protection and Forestry under the Government of Kyrgyzstan: Bishkek

Beniston M, Stoffel M, Hill M (2011) Impacts of climatic change on water and natural hazards in the Alps: can current water governance cope with future challenges? Examples from the European "ACQWA" project. Environ Sci Pol 14:734–743

Bichsel C (2005) In search of harmony: repairing infrastructure and social relations in the Fergana Valley. Central Asian Survey, Mar

Börzel TA, Risse T (2009) Diffusing (inter-) regionalism: the EU as a model of regional integration. KFG Working Paper Series, No. 7, September. Kolleg-Forschergruppe (KFG) The transformative power of Europe, Free University Berlin

Braun LN, Hagg W (2009) Present and future impact of snow cover and glaciers on runoff from mountain regions – comparison between Alps and Tien Shan. Assess Snow Glacier Water Resour Asia 8:36–43

Calise M (1994) The Italian partitocracy: beyond president and parliament. Polit Sci Q 109(3):441–460

Commissione Internazionale per la Protezione delle Alpi (CIPRA) (2011) Acqua e Cambiamenti Climatici. Relazione specifica della CIPRA, N.3/2011, Turin

Connolly B, Gutner T, Bedarff H (1996) Organizational inertia and environmental assistance to eastern Europe. In: Keohane RO, Levy MA (eds) Institutions for environmental aid. Pitfalls and promise. MIT Press, Cambridge, MA

Downing TE (2009) Experience and evidence: mainstreaming climate information into adaptation planning. In: World climate conference 3, Geneva

Engle NL, Lemos MC (2010) Unpacking governance: building adaptive capacity to climate change of river basins in Brazil. Glob Environ Chang 20(1):4–13

Folke C, Hahn T, Olsson P, Norberg J (2005) Adaptive governance of social-ecological systems. Annu Rev Environ Resour 30:8.1–8.33

Global Facility for Disaster Reduction and Recovery (GFDRR) (2010) Vulnerability, risk reduction and adaptation to climate change: Kyrgyz Republic. Global Facility for Disaster Reduction and Recovery (GFDRR). The World Bank Group, Washington DC, online: http://sdwebx.worldbank.org/climateportal/home.cfm?page=country_profile&CCode=KGZ

Global Facility for Disaster Reduction and Recovery (GFDRR) (ed) (2011) Vulnerability, risk reduction and adaptation to climate change: Kyrgyz Republic. Global Facility for Disaster Reduction and Recovery (GFDRR). The World Bank Group, Washington, DC

Herrfahrdt E, Kipping M, Pickardt T, Polak M, Rohrer C, Wolff CF (2006) Water governance in the Kyrgyz agricultural sector: on its way to integrated water resources management? German Development Institute, Bonn

Huntjens P, Pahl-Wostl C, Rihoux B, Schlüter M, Flachner Z, Neto S, Koskova R, Dickens C, Nabide Kiti I (2011) Adaptive water management and policy learning in a changing climate: a formal comparative analysis of eight water management regimes in Europe, Africa and Asia. Environ Pol Gov 21:145–163

Intergovernmental Panel on Climate Change (IPCC) (2007) Climate change 2007: the physical science basis. Contribution of Working Group I to the fourth assessment report of the Intergovernmental Panel on Climate Change, Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M, Miller HL (eds) Cambridge University Press, Cambridge/New York, 996 pp

International Crisis Group (ICG) (2012) Kyrgyzstan: widening ethnic divisions in the south Asia Report, No. 222, 29 Mar

Joint Country Support Strategy (JCSS) (2006) Kyrgyz Republic: joint country support strategy (JCSS) FY 2007–2010, Environment Assessment Working Group, Preliminary Thematic Note. Draft. Nov

Kyrgyz Republic (2005) Water code of the Kyrgyz Republic. Kyrgyz Republic, Bishkek

Levine S, Ludi E, Jones L (2011) Rethinking support for adaptive capacity to climate change. Overseas Development Institute (ODI), London

Moser SC, Dilling L (2004) Making climate hot. Communicating the urgency and challenge of global climate change. Environment 46:32–46

Mysiak J, Henrikson HJ, Sullivan C, Bromlyey J, Pahl-Wostl C (eds) (2010) The adaptive water resource management handbook. Earthscan, London/Sterling

Organisation for Economic Co-operation and Development (OECD) (2011) National policy dialogue on strategic financial planning for water resource management in Kyrgyzstan. Interim Report on the pilot project. November

Orolbaev E, Valentini K (2010) Final report on support to IWRM and tariffs and financial policy. EU-UNDP project (2009–2012) on "Promoting integrated water resources management and fostering transboundary dialogue in central Asia". UNDP, Bishkek

Ostrom E, Burger J, Field CB, Norgaard RB, Policansky D (1999) Revisiting the commons: local lessons, global challenges. Science 284:278–282

Parry ML, Canziani OF, Palutikof JP (eds) (2007) "Climate change 2007: impacts, adaptation, vulnerability". Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge

Raggi M, Ronchi D, Sardonini L, Viaggi D (2007) Po Basin case study status report. Università di Bologna, Bologna

Riva M, Cucca C (2007) Gestione partecipata dei recenti eventi di crisi idrica in Lombardia. Working Paper No. 8, Istituto Regionale di Ricerca della Lombardia (IRER), Milan

Salvadori LM (2001) Storia d'Italia e Crisi di Regime: Saggio sulla Politica Italiana 1861–2000. Il Mulino (ed): Bologna

Scholz JT, Stiftel B (eds) (2005) Adaptive governance and water conflict: new institutions for collaborative planning. Resources for the Future, Washington, DC

Sgobbi A, Fraviga G (2006) Governance and water management: progress and tools in Mediterranean countries. Nota di Lavoro 151. Fondazione Eni Enrico Mattei, Venice

SHARE (2009) Project brief: balancing river ecosystems and hydropower requirements. SHARE – Sustainable Hydropower in Alpine River Ecosystems. Project reference number: 14-2-3-IT

Swanson DA, Hiley JC, Venema HD, Grosshans R (2009) Indicators of adaptive capacity to climate change for agriculture in the Prairie Region of Canada: comparison with field observations. Working Paper for the Prairie Climate Resilience Project Winnipeg: International Institute for Sustainable Development (IISD)

Timmerman J, Bernardini F (2010) Perspectives on water and climate change adaptation: adapting to climate change in transboundary water management. Co-operative Programme on Water and

Climate (CPWC), the International Water Association (IWA), IUCN and the World Water Council. Available at: http://www.worldwatercouncil.org/fileadmin/wwc/Library/Publications_and_reports/Climate_Change/PersPap_06._Transboundary_Water_Management.pdf

Triulzi, U (2004) The reform of the Italian water sector. Paper presented at the Water Week 2004 – Session 3 'How to engage with public and private sectors in urban WSS'. World Bank, Washington, DC, 24 February

United Nations Development Programme (UNDP) (2006) Beyond scarcity: power, poverty and the global water crisis. Human development report. United Nations Development Programme (UNDP). Oxford University Press, New York/Oxford

United Nations Economic Commission for Europe (UNECE) (2009a) Guidance on water and adaptation to climate change. United Nations Publications, United Nations, New York/Geneva

United Nations Economic Commission for Europe (UNECE) (2009b) Environmental performance reviews: Kyrgyzstan, second review, vol 28, Environmental performance reviews series. United Nations, New York/Geneva

United Nations Educational, Scientific and Cultural Organization (UNESCO) (2006) Water: a shared responsibility. The United Nations World Water Development Report 2. UNESCO/Berghahn Books, Paris/New York

United Nations International Strategy for Disaster Risk Reduction (UNISDR) (2010) In-depth review of disaster risk reduction in The Kyrgyz Republic. UNISDR: Sub-Regional Office for Central Asia and Caucasus, Almaty

Votrin V (2003) Transboundary water disputes in central Asia: using indicators of water conflict in identifying water conflict potential. Thesis submitted in partial fulfilment of the requirements for the Master in Human Ecology, Vrije Universiteir Brussel, Ixelles

Wegerich K (2000) Water user associations in Uzbekistan and Kyrgyzstan: study on conditions for sustainable development. International Water Management Institute, Colombo

World Bank (2009) Improving weather, climate and hydrological services delivery in central Asia (Kyrgyz Republic, Republic of Tajikistan and Turkmenistan). World Bank, Washington, DC

World Bank (2012) Political context and implications of change of government in Kyrgyzstan. Background document, Governance Thematic Working Group. World Bank, Washington, DC

World Wide Fund (WWF) (2003) Results overview for the Po river basin (Italy). WWF water and wetland index – critical issues in water policy across Europe. November. Retrieved 30 Jul 2014 from: http://www.cabri-volga.org/DOC/Cherepovets/EG5/wwfpoitaly.pdf

Chapter 7
Conclusions: Summing Up, Zooming Out, New Challenges Ahead

> *We receive water freely from nature. We owe it to nature to use this gift in accordance with our sustenance needs, to keep it clean and in adequate quantity. Diversions that create arid or waterlogged regions violate the principles of ecological democracy.*
>
> (Vandana Shiva 2002)

Abstract In this concluding chapter, we elaborate on the contributions of our study in terms of (i) understanding the multi-level dimension of water governance arrangements, and (ii) illustrating the interconnectedness of scales for assessing drivers and barriers of institutional adaptive capacities. We show that the multi-level dimension is crucial to define whether and how much a given governance arrangement in the water sector will be adaptive to respond to climate-related and socio-economic changes. Therefore, governance processes should address issues of fit and scale, particularly in light of uncertainty and unprecedented change. With respect to the interconnectedness, our finding is that determinants of adaptive capacity act in complex combination across scales to produce certain adaptive outcomes. In the second part of this chapter, we make use of the lessons learned from our study to suggest a number of policy recommendations. On the overall, for a political framework to be adaptive, we see the need for an integrated and coordinated approach, shaped around the river basin as the natural unit of reference within a national adaptation strategy formulated by the central state. In turn, the conceptualisation and implementation of such a strategy need to occur at interconnected vertical and horizontal governance scales, and by institutionalising participatory processes at the river basin level.

Keywords Po river • Syr Darya river • Multi-level dimension • Sustainability • Adaptive governance • Climate uncertainty • River basin management • Participatory processes

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7.1 One More Step Towards Understanding Institutional Adaptive Capacity?

In the first pages of his *The Wealth of the Nations* (1776), the notorious Scottish philosopher and economist Adam Smith wrote that although water has always been abundant in nature, it has become even more so since humans learned how to manage it to satisfy their needs through engineering and technology. However, just because of its copiousness, water has traditionally been given very little value, contrarily to other far less useful but scarcer resources like diamonds (see the "Diamond-Water Paradox" in Zetland 2011, p 5). Today, stories of increased water scarcity and droughts from all around the world suggest that the era of water abundance is coming to an end. And this comes not (only) as a consequence of climate change, but also (and especially) of the current global water management paradigm, which, being based on the assumption that demand can exceed supply, is simply no longer sustainable. In the words of economist David Zetland: "*In the 20th century, we had so much of this useful fluid that we found new ways to use it. Our notions of "enough" changed from enough to drink to enough to fill a pool, from enough to grow food to enough for the lawn, from enough for a bath to enough for a fishery. Until enough was not enough.* […] *The engineering triumph of increased supply was not accompanied by an economic triumph in retaining demand*" (Zetland 2011, p 5).

Thinking of water scarcity as a situation that results from governance failures rather than from mere natural causes has prompted scholars in the social sciences to start investigating water resources management as a collective action problem, and a source of instability and even war between states and human societies. Once a "technical" topic that belonged to engineers and hydrologists, today water brings together a colourful community composed of experts and scientists from disparate disciplines. Adding climate change to the equation magnifies the type and amount of knowledge that is needed to fully understand the future (and present) challenges that water systems – and the human societies that depend on them – face. The risk of "water wars" may be exaggerated, but water does have the potential to worsen already tense situations, especially at the local, but also at the international level. The case of the Syr Darya River is exemplary in this sense; it illustrates how future situations of climate-derived scarcity may strain the diplomatic relations between Kyrgyzstan and its downstream neighbours (Uzbekistan and Tajikistan). In turn, regional tensions, if distorted by politicians at their own convenience, can create conflicts locally between farmers and other water users sharing a vital resource that flows irrespective of administrative borders.

Climate change is admittedly not the only threat pending upon water resources, yet it acts as an accelerator and amplifier of already existing problems. For this reason, its impacts need to be addressed and contained, and societies will be required

to quickly learn how to live in a climatically-altered world. Even if the political will is found tomorrow to adopt the requisite measures to halt the rise of global emissions, the time lag in the climate system is likely to mean an increase in global temperatures by up to 4 °C by the end of the century (World Bank 2012). The associated shifts in climatological patterns translate into an imperative order for water managers to figure out how to continue operating in such a way as to balance competing economic, social and environmental interests.

Change is nothing new to history: human societies have always invented ways to react to modified situations and conditions (e.g. Diamond 2004; Orlove 2005). Oftentimes, the ability to respond to new threats or realities, what is known as reactive or autonomous adaptation, is so obvious that people take it for granted (Tompkins and Adger 2005). Nevertheless, large climate-induced changes in environmental conditions that lie outside the normal range of experience (be it at the level of personal, community or institutional memory) require an increased understanding of the factors that lead governance systems to adapt. In this sense, the present study has tried to ascertain and analyse the conditions that are (and will be) demanded to build and enhance the capacity of water governance systems to adjust to the impacts of climate change (including climate variability and extremes) by putting in place adequate measures that not only prevent and moderate damages, but also take advantage of emerging opportunities.

The research question underlying our work sought to identify the key components of adaptive capacity that were empirically observable in two case areas; the ways in which different governance regimes facilitated (or not) adaptive capacity in the water sector; and the major challenges involved in building adaptive capacity across different contexts and scales. Our primary objective was to better understand how the governance context contributes to the establishment of an enabling environment for adaptive capacity, and to describe the challenges of generating adaptive capacity across spatial scales. Moreover, the proposed typology of possible adaptive governance outcomes was designed to guide policy- and decision-makers through the complex choices required to mobilise and operationalise adaptation.

In order to meet these goals, we identified (drawing on different literature streams, including institutional theory and adaptive and multi-level governance) and developed a set of determinants of adaptive capacity. Subsequently, we used the interview method to understand what combinations of determinants best contributed to building and/or hampered the capacity of the considered water governance systems to respond to prospected climate and socio-economic changes. This conclusive chapter, drawing on the results of such analysis, will present a list of challenges and priorities to be addressed by policy- and decision-makers, water managers and users, as well as some suggestions for future researchers who wish to embark upon the exciting task of investigating institutional adaptive capacity in the water sector.

7.1.1 *Addressing the Multi-level Dimension of Water Governance Arrangements*

First and foremost, this book has revealed that the multi-level dimension is important to define whether a given governance arrangement in the water sector will be more or less adaptive to respond to climate-related and socio-economic changes. Accordingly, it was demonstrated that the identified determinants of adaptive capacity combined with each other and across scales, produce a specific adaptation outcome. This interaction occurred both horizontally (across institutions that are governmental and non-governmental, formal and informal) and vertically (across levels "below" and "above" the state). Proactive responses tended to be triggered particularly by top-down processes, whereby external actors, i.e. the EU for Northern Italy, and international organisations and donors for Kyrgyzstan, intervened directly by means of operational decisions, or indirectly by enacting policies and regulations. By contrast, reactive responses often happened in the form of concrete interventions at the local level: within communities and villages in Kyrgyzstan, and in regions, provinces and municipalities in the Po River basin.

The extent to which the river basin level was taken into account, and hence recognised as a natural unit characterised by hydrological interconnectedness, depended upon the system's capacity to coordinate multiple activities and resolve conflicts in order "*to make water use economically productive*, *socially equitable and environmentally sustainable*" (Mody 2004, p 8). To this end, processes of administrative decentralisation, delegating authority to lower levels of government, were initiated in both cases, and have resulted, *inter alia*, in the establishment of formal water users' associations (in the case of Kyrgyzstan) or a River Basin Authority (in the Po River basin). The choice of one organisational form over the other was determined by the particular features of each river basin in terms of its size, topography and hydrology, but also by the type of priorities to be tackled. Such priorities comprehend the traditional community structure, as well as other economic and social considerations, such as the region's economic affluence and the distribution of assets within it (in Northern Italy). Empirical evidence proved that there are certain conditions that enhance the capacity of these governance structures to enable integrated and decentralised decision-making, namely: (i) the political will to ensure a workable and agreeable framework; (ii) the administrative and financial autonomy of the organisation itself; (iii) an open information policy to guarantee communication with other actors at the river basin level; (iv) opportune scientific data and (v) strong and enforceable legal foundations to feed decision-support tools.

Some forms of horizontal governance, displayed particularly in the case of the Po River basin, were also shown to favour adaptive outcomes, for example by resulting in the creation of partnerships and networks. In turn, partnerships and networks built relationships of trust and collaboration between members of the group, thereby facilitating cooperation and the resolution of collective action problems, and rendering more economic, material, informational and social resources available for investments in adaptation. In this sense, it was demonstrated that the research sector

and the civil society are essential actors to reduce the uncertainty that surrounds climate change, and to change the erroneous perceptions of it that the general public and policy-makers may retain.

The fact that top-down processes were found to be particularly suited for enacting the legislation, policies and regulations that constitute the framework within which adaptation measures are planned, reinforces the empirical evidence according to which bottom-up governance and decentralisation reforms are not necessarily vital conditions for adaptive and integrative management approaches. Instead, transformative and adaptive measures are often driven by top-down policy and legislative frameworks. Bottom-up processes proved to be important for the implementation of operational adaptation decisions at more localised levels, and were only subsequently scaled up towards higher levels (e.g. the state or the international context). Interestingly, these two forms of vertical processes – top-down and bottom-up- converged at the national level, thus reconfirming the primary decision-making role that the state maintains in the environmental and related fields.

These conclusions highlight that decisions and actions should be framed within governance processes involving actors both horizontally and vertically in order to be effective. It is emphasised that they should address issues of fit and scale, which are important for the management of natural resources especially under conditions of increased uncertainty and unprecedented change deriving from both natural conditions and human impacts.

7.1.2 Studying Interconnections of Governance Scales to Assess Barriers and Bridges to Institutional Adaptive Capacity

In addition to understanding institutional adaptive capacity at multiple scales, this book proposed a typology of adaptive governance arrangements. Four ideal models were identified (resistant, incremental-reactive, incremental-proactive and adaptive) based on the specific nature of the measures (responsive, preparatory, and preventive) that governance systems in the water sector were adopting (or not) to respond to climate and socio-economic changes. The case of the Po River basin was associated with the incremental-proactive governance framework, while the water governance system in the Syr Darya River basin corresponded to the incremental-reactive type, and would have even been classified as fully resistant if the international dimension was not taken into account. More generally, the analysis of the two cases suggested that there are some particular conditions -and combinations thereof- that are more favourable to adaptation, while others tend to act as barriers.

Our analysis further highlighted the strong interdependence between the identified determinants of institutional adaptive capacity. Indeed, it was not one or the other determinant that led to a certain adaptive outcome, but their complex combination across governance levels. Such interdependence, however, was also one of

the reasons for the current inertia of water regimes and a barrier for change. Interestingly, while some of the identified bridges to adaptation were simply the reverse of barriers, others referred to entirely different determinants. To put it in other words, it was not necessarily the case that all the listed determinants were useful to build institutional adaptive capacity, whereas their absence automatically translated into obstacles. Indeed, there were some conditions that *predominantly* acted as barriers, and others that *predominantly* acted as bridges.

7.1.2.1 Barriers

As for barriers, it was demonstrated that the recourse to "hard" infrastructural adaptation, which tended to be the most common response to climate-related events in both cases, actually ended up reinforcing existing inequalities. In fact, it simply shifted risks away from the most powerful group of actors that initiated the adaptation measure towards the least powerful one that paid for its effects. Thus, it did little to alleviate underlying vulnerabilities. In addition, given the predictions for larger-scale changes in the climate system and the degree of uncertainty that still surrounds them, non-reversible responses may have adverse effects. The same consideration applies to the practice of planning present adaptation interventions on the basis of past experience. All in all, uncertainty clearly represented a barrier to the capacity of institutions in the water sector to formulate and operationalise sound adaptation strategies. It was further noted that uncertainty did not only derive from the increasing risks and hazards posed by a potentially warmer world, but also from the very nature of the knowledge system used to map out potential climate impacts. Especially in the case of Kyrgyzstan, innovation, generally equated with interventions that provide standardised new technology, resulted in being constrained by the dominant culture. At the same time, such interventions were hampered by other institutional factors such as the unwillingness to take financial risks and the limited access to information and ideas.

Oftentimes, and particularly when existing patterns of water resource allocation benefited some interest groups at the expense of others and when would-be losers had economic and political power, adaptation strategies could be strongly opposed. On the one hand, this may be because individuals have reduced incentives to shift from one technology and management practice to another, even more so if the change does not occur system-wide. On the other hand, it was found in the case of Kyrgyzstan that corruption in water resources management – combined with the lack of laws, frameworks, resources, awareness and capacity – causes policy failures and hence inhibits the system's capacity to plan and operationalise significant adaptation interventions. On a related point, it was noted that an unstable political system could hinder adaptation by reducing the prospects for long-term interventions. Frequent changes in administrative and political personnel within institutions not only doomed the governance system to short-termism but also caused a dramatic loss of expertise and institutional memory, which, in turn, reduced the potential for learning.

Since the Syr Darya is a transboundary river, its management as well as the adoption of a climate change adaptation strategy must take the international political context into account, given the strong interdependencies that exist between the ex-Soviet Central Asian Republics. Tense diplomatic relations were found to impede the definition of a common adaptation strategy, one that is based on institutionalised information-sharing, high-level cooperation, and a mutually-agreed and respected legislative and regulatory framework. An excessively bureaucratic legislative and institutional system that does not include provisions for flexibility (e.g. measures to temporally and spatially redistribute water resources, or to periodically review water allocation) was described as a further barrier to adaptive capacity. Introducing flexibility, however, can be a highly problematic endeavour, as it implies a system-wide modification of the prevailing mind-set of administrators and decision-makers.

Indeed, particularly in those river basins where users typically experienced water abundance, the perceptions of climate change-related issues represented a major obstacle to preparatory and preventive actions. In fact, the broader climate change and water discourse tended to remain focused on the scarcity dimension, so that people continued understanding climate change impacts mostly in terms of increased temperatures and decreased precipitations, and hence more frequent droughts. It is only very recently that also the connection between climate change and more intense and frequent extreme events started to be made, triggering at least some reactive responses in terms of disaster risk management. Moreover, the Kyrgyz case highlighted how more urgent and immediately understandable issues – such as poverty reduction, the improvement of the health and educational systems, and economic development- inevitably obscured climate-related risks and relegated them to the bottom of the national political agenda.

Another important barrier to institutional adaptive capacity was the lack of climate-specific legislation at the national and sub-national levels. In general, it was proved that a national adaptation strategy is required to establish the basic guidelines to plan and operationalise adaptation measures. Finally, the lack of adequate economic and social resources was described as an essential barrier to adaptive capacity. On the one hand, already-strained budgets were naturally allocated by national authorities to more salient and immediate concerns. For example, the Italian environmental budget was drastically curtailed as a consequence of the economic crisis. At the same time, within that narrow environmental budget, funds were preferably apportioned to issues such as pollution or interventions after the occurrence of natural disasters, while longer-term concerns were postponed to 'less difficult times'. In turn, this created a situation in which no funds are available to hire or keep competent and expert personnel, salaries are extremely low (and hence open the door to corruption), and opportunities for education and training are reduced to a minimum. Resorting to external donors to fill this vacuum can be a solution in the short term, but, if not coupled with adequate capacity building, it risks further reducing the adaptive capacity of domestic institutions.

7.1.2.2 Bridges

Moving to the identification of bridges, our analysis highlighted that attempts to create a national legislative and regulatory framework at the river basin level could be a way to improve the capacity of institutions to plan and operationalise adaptation measures. For example, the Po River Basin Management Plan (PBI) represented an important first step towards the transformation of the water governance framework in Northern Italy from a reactive and fragmented to a proactive and integrated one, which allocates water on the basis of its effective availability and takes into account the impacts of climate change. Generally speaking, national adaptation plans and policy frameworks in both developing and developed countries tended to be welcomed as positive progress. Regulations and directives that were compulsorily imposed on states in a "top-down" manner from higher governance levels (such as the international and/or regional one) were also considered as positive drivers of adaptive capacity. At the same time, however, communication and awareness-raising activities were said to be required to increase the understanding of the climate change-water nexus and to push adaptation to the top of national political agendas. Such activities tend to be primarily carried out by civil society organisations, suggesting that the presence of numerous and strong environmental NGOs can also be considered as a bridge to institutional adaptive capacity.

Technology and innovation were confirmed as important building blocks of adaptive capacity in the water governance system, and especially at more localised levels. The introduction of less water-consuming crop varieties and automatised drip irrigation systems, for example, was described as a positive move towards climate change adaptation. In the same way, investments in the operation and maintenance (or even the rehabilitation) of existing water-related infrastructure could help provide the system with the required material resources to face future climate-related challenges, although interventions should always be of a "soft" type, i.e., easily reversible. Interestingly, the management of complex adaptive systems would seem to benefit from the combination of different types of knowledge. In particular, it would gain from the integration of the cumulative body of knowledge as applied and developed by actors in the local context, including the use of new technologies and practices, into the accepted national paradigm for water resources management. The numerous references of interviewees to traditional knowledge pointed to the importance of reflecting on the ways in which land use occurs today. This links with re-thinking current urbanisation trends to ensure the adequate maintenance of hydraulic assets and the survival and health of natural areas. These results confirmed previous findings according to which "*the integration of local knowledge with additional scientific and technical knowledge can improve water resources management*, *disaster risk management*, *and adaptation*; *the self-generated knowledge can uncover existing capacity*, *as well as identify important shortcomings*" (CDKN 2012, p 11).

The determinant of climate and scientific information was also deemed to be crucial for improving the adaptability of water governance systems. Accordingly, investments to build a solid knowledge base on climate change with relevant data

series are crucial. These can inform decisions and actions important to reduce the uncertainty that plagues current projections of climate change impacts on water resources. At the same time, they help establish the grounds for planning and implementing effective and sustainable adaptation actions in the mid- to long-term. The collection and analysis of climate and scientific data at different levels was often facilitated by the creation of partnerships and networks. Especially the research sector benefited from the possibility of accessing international projects and establishing collaborations aimed at releasing more resources and expanding the available information base.

Participatory processes and conflict resolution mechanisms were said to contribute to building the capacity of institutions to respond to climate change. As already observed, however, it was also important that they were adequately institutionalised, and not only implemented on an ad hoc basis, and opportunely coordinated and integrated at the river basin level. Indeed, the IWRM approach was indicated as an important first step to operationalise climate change adaptation in a given governance system, although only when combined with other important determinants of adaptive capacity, such as flexibility and long-term planning, information–sharing, leadership, and political willingness.

Interestingly, the intensification of extreme events, such as devastating floods and increasingly warmer summers leading to prolonged droughts, was found to have a positive impact on stakeholders' perceptions in terms of highlighting the need to address adverse impacts. While before these were once-in-a-lifetime events, they have recently become more and more frequent. As a result, they now enter institutional and social memory, and begin to instigate responses and adaptation actions. However, political leadership and willingness to address climate change were confirmed as critical to build the capacity of the institutional system to adapt. Both conditions were key to overcome the implementation hurdles arising from the application of the IWRM approach, including: (a) inadequate financing; (b) paucity in skills, particularly with respect to management and supervision, (c) resistance from those who benefited from the centralised structure; and (d) a lack of sustained interest in the participatory process in the long-term. In turn, climate and scientific information can magnify the impact of leadership on institutional adaptive capacity, in that, when opportunely translated into the language of decision-makers, they can help trigger and inform adaptation strategies and plans of action. In this sense, the operationalisation of a "*Trialogue Model*" (Turton et al. 2007) based on the balanced interactions between government, science and society, would seem to be ideal for adaptation purposes. The trialogue model actually accounts for the fact that adaptation does not only depend on decisions taken by governmental bodies, but also on actions taken at the community and individual level, assisted by scientific research.

Adequate budget and funding were confirmed to be important resources for climate change adaptation, although they were surprisingly not labelled as fundamental as one may have imagined. In fact, the analysis highlighted that budgetary requirements cannot be considered in isolation, but should be coupled with the creation of human and social capacity within institutions. In turn, this capacity is the

result of the education, training and political experience of administrators and water users at different levels on how to respond to and cope with climate change impacts.

Especially in the case of transboundary rivers, taking into account the political, economic, and geographic context at the international level proved to be a fundamental step towards building the capacity of the water governance system to respond to climate-related changes. This is because, first of all, transboundary river basins fall by definition within the administrative boundaries of multiple states that must learn to cooperatively manage their waters. Secondly, and this is true also for non-transboundary waters, the increasing interdependence of political entities at different levels, including the regional and international ones, no longer allows to consider the state and its sub-units as acting in isolation. In the case of the Po River basin – having minor transboundary characteristics- the European Union played a fundamental role in triggering adaptation actions and initiatives. In the case of Kyrgyzstan, the relationship with its Central Asian neighbours was essential for defining the country's strategy vis-à-vis water resources management.

Finally, ad hoc interventions were indicated as helpful to increase the system's capacity to adapt. Positive measures included investments in the construction, operation and maintenance of water-related infrastructure such as rehabilitating aqueducts in villages and cities, restructuring the observational network and hydro-meteorological infrastructure, cleaning clogged water canals, strengthening dikes, and building artificial reservoirs to store water resources. Similarly, the analysis highlighted that individual initiatives in villages and cities, also defined as "*autonomous adaptation*" (UNECE 2009, p 111), aimed at reducing water consumption ahead of future situations of scarcity, should be praised and encouraged.

7.2 Transforming Lessons Learned into Policy Recommendations

This study started from the assumption that institutions in the water sector will have to become increasingly adaptive to face the impacts of climate change in a rapidly-evolving socio-economic context. The underlying idea was that adaptive capacity improves the ability of governance systems to become resilient to shocks and longer-term changes by shaping positive responses in its institutional components, and even transformations if required. Different disciplinary fields have developed alternative interpretations and characterisations of adaptive capacity (Engle 2010), ranging from a focus on cooperation, resources and incentives in geography and political economy (Adger 2003) to an emphasis on poverty reduction and climate injustice in development studies (Dow et al. 2006). However, relatively little work has been done to more precisely investigate how to create a robust framework to characterise and foster the components of adaptive capacity, even though the latter is actually crucial to produce meaningful sets of choices for decision-makers.

In the introduction, a number of questions were presented: What conditions determine the evolution and learning of institutions towards responding to uncertain change? What needs to be modified in the current practices of water governance to make them adaptive to climate change? What is the most appropriate governance level for climate change adaptation to occur? Which actors should participate in decision-making on water resources management? And what is the 'magic formula' to ensure that human societies can efficiently and sustainably govern their water resources?

Far from claiming that our study has all the answers to these questions, we believe it quite clearly points to at least a number of firm conclusions. First of all, it is clear that the conditions promoting adaptive capacity are primarily of a political nature, and only subsequently touch upon human and social resources, finances, information and infrastructure. As a consequence, it is the political framework within which water resources management takes place that needs to become more adaptive – and eventually transformative – to face large-scale, long-term changes and increasing uncertainty. To this end, an integrated and coordinated approach, shaped around the river basin as the natural unit of reference (instead of mere administrative boundaries) should be adopted and inscribed within a national adaptation strategy formulated by the central state. In turn, the conceptualisation and implementation of such a strategy need to occur at interconnected vertical and horizontal governance scales, and by institutionalising participatory processes at the river basin level.

Therefore, it appears that the most appropriate governance level to ensure adaptive responses – and the consequent sustainable and effective management of water resources- is the river basin one. This being said, however, the legislative, policy and administrative contexts for climate change adaptation should continue residing within state authorities. At the same time, the implementation of adaptation actions should be left to more localised levels, perhaps in the context of partnerships and networks, and with the support of international or regional actors. All stakeholders need to be included, although to a different extent, in water resources management in order to increase the capacity of the institutional system to provide serious and useful responses to pending climate and socio-economic challenges. Of course, the degree and scope of involvement of certain user groups will depend on the specific tasks and functions to be performed and the objectives to be attained. Consequently, they will not rely on considerations based on political and/or economic power, corruption, or any other non-efficient or unfair practice.

Finally, we want to convey the important message that no magic formula exists to ensure that human communities can arrive at a sustainable, effective and peaceful way to govern their water resources. Simply, what is required is a different understanding of the concepts of risk and uncertainty, one that emphasises their *management* rather than complete control and elimination; an utopic goal anyway. This understanding should be combined with a more direct knowledge of the natural environment in which human activities take place, and of how its vulnerabilities can be optimally addressed.

7.2.1 Some General Recommendations…

From here, a number of recommendations for decision-makers and stakeholders in the water sector can be proposed. Despite calls for the greater integration of the climate change and water agendas in research and policy, institutional barriers in this sense continue to persist. In both case studies, and as is commonplace in other regions, water-related issues are approached from a technical and infrastructural perspective only and by individual ministries. Instead, it would be crucial to increase the dialogue between actors in different sectors in order to formulate an adequate response to climate change impacts. Thus, climate change adaptation in the water sector has the potential to serve as a bridge to create inter-linkages across political and (socio-)economic lines.

This study suggested that a focus on the institutional aspects of adaptation should come before infrastructure adaptation planning; without a robust and functioning social and institutional context, money and resources could easily be wasted. This could be the case, for example, with infrastructure investments that fail to resolve the real issues concerning water allocation and use. Furthermore, the integration of economics into considerations related to climate change adaptation in the water sector would help highlight that. Especially in cases of (expected) water scarcity, governments have a crucial role to play in improving water management by reallocating scarce water from low-valued to high-valued uses, provided that equity considerations are safeguarded. This can be done through pricing mechanisms, although in practice, making certain groups (such as farmers) pay for water can prove politically difficult. Economic models of water demand and supply bear the potential to guide public policy-making towards finding the most efficient allocation of water.

Similarly, international relations theory has useful indications to offer with regards to transboundary contexts, where riparian countries should focus on the generation of basin-wide benefits to be allocated in a manner that is agreed to be equitable and reasonable. The solidarity that is thus created in the basin may become an incentive for upstream countries to share some portion of the downstream benefits that their practices generate, and hence the costs of these practices. Payments for benefits (or compensation for costs) in the context of cooperative arrangements are becoming an interesting practice that has proved to lead to more sustainable natural resources management (Folke et al. 2005). Clearly, the same mechanisms could be applied in a non-transboundary context between users sharing water resources for different economic purposes. In this sense, the intervention of a central authority, enabling benefit-sharing to occur along some pre-established and regulated lines, would be a key requirement to avoid conflicts.

Water resources management would also widely benefit from a mind-shifting process that convinces decision-makers, i.e. politicians and administrators and the general public alike of the need to take measures to prevent, prepare for, and respond to the expected impacts of climatic and socio-economic changes. Modifying perceptions on the need to take climate adaptation measures takes time, especially if such a transition has to occur at the system-level and not in one organisation only.

Education can play a fundamental role in this sense, and should, therefore, benefit from substantial investments, especially directed towards the younger generations. The same is true for communication and awareness-raising activities, thereby stressing the fundamental role that civil society and research actors have to play in this domain.

7.2.2 … And Some More Specific, Country-Based Recommendations

This study also indicated that both the Italian and Kyrgyz cases are striving to build the adaptive capacity of their institutions in the water sector to respond to climate change impacts. However, while adaptive capacity in the Po River basin is being tailored to the planning and implementation of reactive, but also preparatory and preventive measures, adaptive capacity in the Syr Darya basin is conceived in an almost exclusively reactive sense. In the Po River basin, therefore, current challenges relate to the institutionalisation and full operationalisation of a more proactive dimension of adaptive capacity, or to the definition of a coherent and integrated approach to climate change adaptation that renders the system more flexible to accommodate uncertainty and risks. The efforts that are being made towards these goals are embedded within the Po River Basin Management Plan and the Draft Hydrogeological Risk Exposure Plan. These two documents have the potential to lay the basis for establishing participatory processes for decision-making on water allocation and use (potentially also serving a conflict prevention function), as well as a multi-level legislative and policy framework that is coordinated at the river basin level by the Po RBA and integrates all sectors related to water resources management. Further measures could include the production of data series to support decision-making by creating partnerships with and collaborations between political authorities, the civil society, the private sector and research institutes to leverage existing economic and social resources.

In the Kyrgyz case, the first priority at present consists in teaching decision-makers and water managers about the need to adopt an anticipatory and preventive attitude towards climate change, since adaptation still occurs only reactively and at the initiative of international actors. A substantial mind-shift in this sense could be achieved by investing in communication and awareness-raising activities directed at policy-makers but also, and especially, at the general public, for example by intelligently using the media. In addition, in the Kyrgyz case, climate change adaptation in the water sector would benefit from an improvement in diplomatic relations with neighbouring countries, and particularly with Uzbekistan and Tajikistan. Given the interconnected nature of the hydrological system in Central Asia, as well as the Soviet legacy in the definition of a common water management paradigm, institutions can only become (and remain) adaptive after they adopt a mutually-agreed and shared regional strategy – one that is based on improved systems for

information and data-sharing. As such, water adaptation also bears the potential to improve cooperation on other matters (such as energy and trade) in the difficult region of Central Asia.

An issue that national policy-makers in both contexts should more carefully consider is how to better link their agendas and strategies to the local and community level, where most of the adaptation actions are currently being implemented. For instance, this could happen through the provision of technical and financial support, as well as the identification of creative strategies for establishing partnerships, always trying not to impose top-down control. In turn, the combination of top-down and bottom-up approaches could contribute to resolving the issue of scale that, according to some authors, is what hampers the capacity of socio-ecological systems to adapt to the expected impacts of climate change (e.g. Adger et al. 2005; Young et al. 2008). In both Italy and Kyrgyzstan, it would seem that an initial step for water managers and decision-makers is the optimisation of the use of existing institutional assets (e.g. the Po RBA in Northern Italy and WUAs in Kyrgyzstan) by enhancing their financial, social, and informational capacity. Given their inherent nature as multi-scale organisations, these bodies can serve as boundary elements between adaptation agents at different levels. This would allow shifting away from a status quo characterised by a high degree of rigidity and the one-dimensional management of water resources, to a more flexible one in which decisions are taken collectively by institutional actors at the river basin level.

Currently, the conceptualisation of climate change adaptation tends to be rather technical and path-oriented in both Italy and Kyrgyzstan. Accordingly, proposed measures heavily focus on infrastructural projects (e.g. dams, canal repairs, groundwater wells, irrigation), and not so much on the institutions that are required to enhance the ability of governance systems to agree on and implement efficient, equitable and sustainable solutions to mounting challenges. A policy shift towards incentivising better connections between economic actors in the river basin might open the doors for identifying alternative market-based solutions to restore degraded ecosystems and thus enhance their resilience to, *inter alia*, climate change impacts. More generally, adaptive governance would need to involve "*the evolution of new governance institutions capable of generating long-term*, *sustainable policy solutions to wicked problems through coordinated efforts involving previously independent systems of users*, *knowledge*, *authorities*, *and organised interests*" (Scholz and Stiftel 2005, p 6). Embracing this framework, the present book confirmed that institutional solutions are required to solve governance problems in rapidly-evolving climatic (natural) and socio-economic contexts, combined with more infrastructure-based interventions, which nevertheless cannot stand alone as adaptation measures.

Clearly, in low income/developing and/or transitional countries the challenges linked to climate change adaptation and mitigation are higher (from a financial point of view, but also in terms of human capacity and technology) than in more developed contexts. In fact, for example in the Kyrgyz case study, it was shown that climate change is still perceived as a peripheral 'add on' by decision-makers who are, as a consequence, not willing to allocate economic and financial resources to it.

Furthermore, the high levels of uncertainty that typically exist in assessing climate risks and opportunities represent a significant obstacle towards enacting legislation and policies in this field. To overcome such concerns, it could be useful to embrace a climate compatible development (CCD) approach rather than a low carbon development (LCD) one, as it has been the practice in the past. First of all, CCD allows merging the two streams of climate change mitigation and adaptation, which is an essential task if the threats posed by climate change are to be addressed coherently and comprehensively by the global community. CCD focuses on a combination of climate resilience, emissions-efficient growth and poverty alleviation, all within a focus on development (Mitchell and Maxwell 2010). Implementing such an approach in contexts like Kyrgyzstan could help change perceptions about climate change amongst policy-makers at the highest level, and make them understand that building institutional adaptive capacity represents an opportunity for positive change, even in development terms. As such, CCD could foster the political willingness and leadership that are required to introduce robust adaptive strategies and policies at different governance scales.

7.3 Looking Ahead: Embracing Uncertainty, Addressing Future Challenges

This work wanted and tried to identify some of the conditions that are hypothetically required to build the capacity of institutions – organised within an interconnected, complex and multi-scale governance system – to prepare for and respond to climatic and socio-economic changes and related uncertainties. More specifically, we focused on investigating those factors that influence institutional adaptive capacity, either as bridges or barriers. The study of two radically different river basins such as the Po (in Northern Italy) and the Syr Darya (partly in Kyrgyzstan) not only guaranteed that the analysis remained context-sensitive, but also allowed the findings to be generalisable and eventually transferable to a wider array of cases, including both developing and industrialised countries.

Thus, our conclusions reaffirmed the need to standardise and operationalise adaptive capacity across the various scales it involves, and that institutions and governance mechanisms are important for determining adaptive capacity to climate-induced challenges. We additionally identified a number of conditions that interact with each other and at different levels to define the capacity of governance systems to adapt to intense changes and increased uncertainty. Of particular importance were political factors, such as the stability of the political system, the role of political leaders and their willingness to implement change, power relations within groups, and the degree to which the legislative, administrative and policy frameworks are coordinated and integrate different sectors into decision-making.

It should be always kept in mind that, like in many other research fields, there are no Newtonian laws guiding the understanding of adaptation processes; theories of

economic growth, democratisation, globalisation and institutional change all point in different directions, and yet provide useful insights into the conditions that favour adaptation and those that hamper it. Uncertainty is not inherent only to climate change and the impacts it will have on future resource availability and the survival and wealth of human societies. Uncertainty is part of our daily life, and is definitely part of scientific research. Indeed, uncertainty is the motor of scientific research, the very motivation underlying all experiments, investigations and studies. Uncertainty must not be stored away, but adequately recognised through traceable theoretical accounts that portray its complex nature. This is an essential starting point from which to learn how to use the information and knowledge that research can offer to decision- and policy-making in the field of, *inter alia*, climate change adaptation.

We live in an era characterised by the "*end of abundance*" as far as water resources are concerned. This study emphasised that the end of abundance cannot be blamed on any specific individual or group, but results from good intentions gone bad, changing circumstances, and outdated practices. Climate change will make existing problems worse, not only by drastically reducing the availability and quality of water resources, but also by worsening the risk of devastating extremes such as floods and droughts. However, events like water shortages, droughts, floods and glacial melting will not necessarily have to result in crises, conflicts and wars. Today we have the knowledge, technology, and understanding to propose and implement solutions. In order to respond to climate change, we need nothing more than a change in the way in which we manage our water resources, and more generally we perceive and use the ecological systems in which we live and on which we inextricably depend. Water is a natural resource, but water resources management is a fundamentally political endeavour.

Change will not require water managers to develop new skills and competencies. Rather, it will necessitate a different attitude, one that is based on the fair allocation and effective and sustainable use of water resources, instead of their predation and distribution in accordance with the interests of powerful individuals and groups. Economic incentives need to be integrated into the management of finite waters. Infrastructure needs to be built, technology needs to be improved, and innovation needs to be promoted. The leadership and cooperation of political and social leaders will serve to neutralise those factions that benefit from the status quo and hence oppose change. Institutionalised mechanisms for ensuring coordination, the participation of interested stakeholders in the decision-making process, and the resolution of conflicts will all have to become functional parts of the 'normal' way of doing things in the water sector.

A more harmonised relationship between land and water resources will have to be developed, together with the acceptance that risk, like uncertainty, cannot be nullified but only understood, countered, and minimised through legitimate, credible and salient political actions at different governance levels, stretching vertically "up" and "down" the state, and horizontally through partnerships, networks and collaborations between formal and informal, public and private, governmental and non-governmental institutional actors. It is important that the demands of both individuals and groups that have insufficient capacity to adapt to climate change

(e.g., women in farming communities, or discriminated minority ethnic groups) are also considered and satisfied. Finally, it is essential to remember to involve young people in the current efforts aimed at climate change adaptation and mitigation specifically, and in the management and protection of the environment and natural resources more generally, for this is the only sure recipe for sustainability.

References

Adger WN (2003) Social capital, collective action, and adaptation to climate change. Econ Geogr 79(4):387–404

Adger WN, Arnell NW, Tompkins E (2005) Successful adaptation to climate change across scales. Glob Environ Chang 15(2):77–86

Climate and Development Knowledge Network (CDKN) (2012) Managing climate extremes and disasters in the water sector: lessons from the IPCC SREX Report, Retrieved 29 Jul 2014 from www.cdkn.org/srex

Diamond JM (2004) Collapse: how societies choose to fail or survive. Viking Adult, New York

Dow K, Kasperson R, Bohn M (2006) Exploring the social justice implications of adaptation and vulnerability. In: Adger N, Paavola J, Huq S, Mace MJ (eds) In fairness in adaptation to climatic change. MIT Press, Cambridge, MA

Engle NL (2010) Adaptation to extreme droughts in Arizona, Georgia, and South Carolina: evaluating adaptive capacity and innovative planning and management approaches for states and their community water systems. PhD dissertation, University of Michigan

Folke C, Hahn T, Olsson P, Norberg J (2005) Adaptive governance of social-ecological systems. Annu Rev Environ Res 30:8.1–8.33

Mitchell T, Maxwell S (2010) Defining climate compatible development. CDKN ODI Policy Brief November 2010/A

Mody J (2004) Achieving accountability through decentralization: lessons for integrated river basin management. World Bank Policy Research Working Paper 3346, June. World Bank, available at: http://elibrary.worldbank.org/doi/book/10.1596/1813-9450-3346

Orlove B (2005) Human adaptation to climate change: a review of three historical cases and some general perspectives. Environ Sci Policy 8(6):589–600

Scholz JT, Stiftel B (eds) (2005) Adaptive governance and water conflict: new institutions for collaborative planning. Resources for the Future, Washington, DC

Shiva V (2002) Water wars: privatization, pollution, and profit. South End Press, Cambridge, MA

Tompkins EL, Adger WN (2005) Defining response capacity to enhance climate change policy. Environ Sci Policy 8:562–571

Turton AR, Hattingh HJ, Marce CA, Roux DJ, Claasen M, Strydom WF (eds) (2007) Governance as a trialogue: government-society-science in transition. Springer, Berlin/Heidelberg

United Nations Economic Commission for Europe (UNECE) (2009) Guidance on water and adaptation to climate change. United Nations Publications, United Nations, New York/Geneva

World Bank (2012) Turn down the heat: why a 4°C warmer world must be avoided. A report of the World Bank by the Potsdam Institute for Climate Impact Research and Climate Analytics. World Bank, Washington, DC

Young OR, King LA, Schroeder H (eds) (2008) Institutions and environmental change: principal findings, applications, and research frontiers. The MIT Press, Cambridge, MA

Zetland D (2011) The end of abundance: economic solutions to water scarcity. Aguanomics Press, Amsterdam/Mission Viejo

Appendices

Appendix 1: List of Interviews

Region	Institution	Department	Position of interviewee	Date and time of interview	Interview type
Piemonte	Regional Administration, Piemonte	Environment Directorate	Engineer, Planning and Soil Defence Department	Turin, 6/12/2010, h.12.00	Face-to-face (IT)
Piemonte	Farmers' cooperative "Il Glicine"		Farmer	Omegna, 17/07/2010, h.16.00	Face-to-face (IT)
Piemonte	Municipality of Craveggia		Mayor	Craveggia, 26/07/2010, h.14.30	Face-to-face (IT)
Italy	Civil Protection Department	Environmental Monitoring Department	Dr. Forestry and Ecology, Commissioner for Civil Protection	Rome, 21/06/2011, h.12.00	Face-to-face (IT)
Aosta	Regional Agency for Environmental Monitoring and Protection, Aosta Valley		Project Manager EU-project "SHARE"	Geneva, 15/12/2010, h.17.30	Skype (IT)
Bacino Po	Interregional Agency for the Po River (AIPO)		Director	Geneva, 18/01/2011, h.13.00	Skype (IT)

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B. Mosello, *How to Deal with Climate Change?,*
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Region	Institution	Department	Position of interviewee	Date and time of interview	Interview type
Lombardia	Regional Administration, Lombardia	Civil Defence and Risk Monitoring Department	Engineer, expert in risk assessment and monitoring	Milan, 15/02/2011, h.12.00	Face-to-face (IT)
Lombardia	Regional Administration, Lombardia	Water Management and Sustainable Development Department	Dr. Hydrologist	Milan, 15/02/2011, h.13.00	Face-to-face (IT)
Aosta	Regional Administration, Aosta Valley	Infrastructure, Soil Defence and Water Management Office	Director	Aosta, 21/‘01/2011, h.14.30	Face-to-face (IT)
Aosta	Operational Centre for Risk Monitoring, Aosta Valley Regional Administration	Climate change department	Dr. Hydrologist	Aosta, 21/‘01/2011, h.15.30	Face-to-face (IT)
Piemonte	Restaurant-hotel “Da Sciolla”		Owner	Domodossola, 20/06/2010, h.14.30	Face-to-face (IT)
Italy	Italian-Swiss Commission for Fishery		Director	Geneva, 30/06/2010, h.10.30	Skype (IT)
Aosta	Comunità Montana [mountain community] Grand Paradis	Office for farmers’ association	Programme manager	Geneva, 29/07/2011, h.9.00	Skype (IT)
Piemonte	Regional Agency for Environmental Monitoring and Protection, Piemonte	Provincial Department (for Verbania Province)	Director	Omegna, 10/06/2011, h.9.30	Face-to-face (IT)
Italy	Institute of Ecosystem Studies		Researcher	Verbania, 10/07/2011, h.12.00	Face-to-face (IT)
Italy	Institute of Ecosystem Studies		Researcher	Verbania, 10/07/2011, h.11.00	Face-to-face (IT)
Italy	WWF Italy	Water Programme	Director	Milan, 07/07/2011, h.11.00	Face-to-face (IT)

(continued)

Region	Institution	Department	Position of interviewee	Date and time of interview	Interview type
Italy	Referendum Campaign "Water as a Public Good"	–	Organiser and contact point in Verbania Province (Piemonte Region)	Domodossola, 04/07/2011, h.18.00	Face-to-face (IT)
Italy	Ministry of Environment		Responsible for water resources management	Rome, 09/07/2011, h: 11.00	Face-to-face (IT)
Italy	Legambiente (NGO)		Programme officer on climate change and water resources	Rome, 09/07/2011, h: 13.00	Face-to-face (IT)
Italy	Idrablu s.p.a.		Director	Domodossola, 06/07/2011, h.11.30	Face-to-face (IT)
Italy	Municipality of Domodossola		Mayor	Domodossola, 06/07/2011, h.16.00	Face-to-face (IT)
Piemonte	Natural Parc "Veglia devero"		Director	Geneva, 22/08/2011, h: 10.30	Skype (IT)
Bacino Po	Po River Basin Authority (AdbPo)	Territorial Monitoring and Planning Department	Director	London, 07/12/2011, h: 14.45	Skype (IT)
Bacino Po	Po River Basin Authority (AdbPo)		Secretary General	London, 15/12/2011, h: 8.30	Skype (IT)
Piemonte	ENEL S.p.a.	Energy Management Department (Hydroelectricity Unit)	Director	London, 16/12/2011, h: 16.30	Skype (IT)
Italy	Associazione Nazionale Autorità e Enti di Ambito (ANEA) [National Association for Optimal Territorial Areas]		Director	Domodossola, 20/12/2011, h: 14.00	Skype (IT)
Lombardia	Regional Administration, Lombardia		Department for Public Services and Sustainable Development	Londra, 12/01/12, h: 8.30–9.30	Skype (IT)

(continued)

Region	Institution	Department	Position of interviewee	Date and time of interview	Interview type
Lombardia	Regional Administration, Lombardia		Environment and Energy Department, Unit on water resources management and planning	London, 12/01/12, h: 8.30–9.30	Skype (IT)
Piemonte, Bacino Po	Legambiente	Water Department	Programme manager, Regional Rivers (Piemonte, Aosta Valley)	Domodossola, 26/02/12, h:16.30–17.15	Skype (IT)

Region	Institution	Department	Position of interviewee	Date and time of interview	Interview type
Kyrgyzstan	Zoï Environment Network	CAREWIB Project	Senior Associate, PhD Geography and Mathematics	Geneva, June 1st, 2011	Face-to-face (EN)
Bishkek	World Bank	ECA Sustainable Development Department	Water Resources Specialist	Bishkek, October 6th, 2011 h:15.00–15.45	Face-to-face (EN)
Bishkek	National Center for Mountain Regions Development of Kyrgyz Republic	Bishkek Office, Sustainable Land Management in the High Pamir and Pamir-Alai Mountains (GEF/PALM) Project	Head of Planning Department, GEF/PALM National Administrative Project Officer in the Kyrgyz Republic	Bishkek, October 5th, 2011 h: 14.00–15.00	Face-to-face (EN)
Bishkek	Institute of Ecology and Applied Sciences/Osh Technological University	GEF/PALM Project	Director of Institute of Ecology and Applied Sciences / Field Facilitator for the PALM Project in SDU 1 (Lenin)	Bishkek, October 5th, 2011 h: 15.00–15.30	Face-to-face (RUS)
Kyrgyzstan	CAREC	Regional Environmental Center for Central Asia (CAREC)	Programme Manager, Climate Change and Sustainable Development Programme	Bishkek, October 10th, 2011 h: 11.50–12.20	Skype (EN)

(continued)

Region	Institution	Department	Position of interviewee	Date and time of interview	Interview type
Kyrgyzstan	Helvetas	On-Farm Water Management Project – Efficient Use of Water (SEP)	Project Manager, Efficient Use of Water Project (SEP)	Bishkek, October 10th, 2011 h: 14.50–16.00	Face-to-face (EN)
Kyrgyzstan	Swiss Development Cooperation (SDC)	National Program Officer	Bishkek, October 11th, 2011 h: 11.00–11.45	Face-to-face (EN)	
Kyrgyzstan	World Bank	Central Asia Hydrometereology Modernization Program	Operational Officer for Disaster Risk Reduction Programs	Bishkek, October 11th, 2011 h: 15.00–15.45	Face-to-face (EN)
Kyrgyzstan	State Committee on Water Economy and Amelioration		Deputy Chair of the State Committee on Water Economy and Amelioration	Bishkek, October 11th, 2011 h: 09.30–10.15	Face-to-face (RUS)
Kyrgyzstan	State Agency on Environmental Protection and Forestry		Director	Bishkek, October 7th, 2011 h:10.00–10.45	Face-to-face (RUS)
Kyrgyzstan	OECD	OECD National Policy Dialogue on financing WRM in the Kyrgyz Republic	Consultant team leader (WS Atkins International Ltd)	Bishkek, October 13th, 2011 h:20.00–20.45	Skype (EN)
Kyrgyzstan	Civic Environmental Foundation UNISON		Coordinator on Climate Change Projects	Bishkek, October 14th, 2011 h: 16.00–16.45	Face-to-face (EN)
Osh	Osh BDWI	Office of Environmental Protection	Inspector	Osh, October 17th, 2011 h: 9.30–10.15	Face-to-face (RUS)
Osh	Osh BDWI	Water Management "Regulation of Osh basin and Water Resources"	Executive Director	Osh, October 17th, 2011 h: 10.30–11.00	Face-to-face (RUS)
Osh	ACTED	ACTED Kyrgyzstan	Program Development Manager	Osh, October 17th, 2011 h: 13.00–13.45	Face-to-face (EN)
Osh	UNICEF, WASH Project (Project on Water, Sanitation and Hygiene)	WASH in Schools – Equity Study	Research Fellow, Center for Global Safe Water	Osh, October 17th, 2011 h: 18.00–19.15	Face-to-face (EN)

(continued)

Region	Institution	Department	Position of interviewee	Date and time of interview	Interview type
Jalal-Abat	Rural Advisory Services Jalal-Abat		Deputy Manager	Jalal-Abat, October 18th, 2011 h: 9.00–10.00	Face-to-face (KYR)
Jalal-Abat	Rural Advisory Services Jalal-Abat		Specialist on pilot projects	Jalal-Abat, October 18th, 2011 h: 10.00–11.00	Face-to-face (KYR)
Jalal-Abat	Water User Association (WUA), Jalal-Abad		WUA Director and local farmers	Jalal-Abat, October 18th, 2011 h: 11.30–13.00	Focus Group (KYR)
Nookat	Water User Association (Abshyr Tany)		WUA Director	Bazar-Korgon, October 19th, 2011 h: 9.00–10.30	Face-to-face (KYR)
Nookat	Water User Association (Abshyr Tany)		Local farmers	Bazar-Korgon, October 19th, 2011 h: 10.30–11.00	Focus group (KYR)
Nookat	Rural Advisory Services		Director	Bazar-Korgon, October 19th, 2011 h: 11.00–11.40	Face-to-face (RUS)
Kyzyl Kia	Public Foundation "Taian"		Founder and Director	Kyzyl Kia, October 19th, 2011 h: 12.20–12.50	Face-to-face (RUS)
Ferghana Valley	Central Asian Alliance for Water	Sanitation and Hygiene Program	Program Coordinator and WASH Sector Coordinator for the South of Kyrgyzstan	Osh, October 19th, 2011 h: 14.50–15.30	Face-to-face (EN)
Kyrgyzstan	UNDP	Disaster Risk Management Programme	Programme Manager	Bishkek, October 25th, 2011 h: 15.30–16.00	Face-to-face (EN)
Kyrgyzstan	USAID	Local Development Programme	Marketing Specialist	Bishkek, October 28th, 2011 h: 15.00–15.45	Face-to-face (EN)
Kyrgyzstan	OSCE	OSCE Centre in Bishkek	Senior Programme Assistant	Bishkek, November 1st, 2011 h: 9.30–10.00	Face-to-face (EN)

(continued)

Region	Institution	Department	Position of interviewee	Date and time of interview	Interview type
Kyrgyzstan	Ministry of Natural Resources		Head of the Kyrgyz Complex Hydro Geological Expedition	Bishkek, November 3, 2011 h: 9.00–9.45	Face-to-face (RUS)
Kyrgyzstan	Ministry of Emergency Situations	Monitoring Department	Executive Director	Bishkek, November 4, 2011 h: 9.00–9.45	Face-to-face (RUS)
Kyrgyzstan	United Nations in the Kyrgyz Republic	Disaster Response Coordination Unit	Humanitarian Coordination Specialist	Bishkek, November 11, 2011 h: 15.00–15.30	Face-to-face (EN)
Kyrgyzstan	UNDP	Climate Risk Management Project in Kyrgyzstan	Project Manager	Bishkek, November 14, 2011 h: 10.00–10.30	Face-to-face (EN)
Kyrgyzstan	Institute for Water Problems and Hydropower, National Academy of Sciences of the Kyrgyz Republic		Director	Bishkek, November 16, 2011 h: 10.00–11.00	Face-to-face (RUS)
Kyrgyzstan	State Agency on Environmental Protection and Forestry	Working Group on Strategies and Adaptation to Climate Change	Lecturer at Slavic University; Consultant and Head of the Working Group on strategies and adaptation to climate change	Bishkek, November 18, 2011 h: 11.00–11.45	Face-to-face (RUS)
Ferghana Valley	International Committee of the Red Cross	Delegation in the Kyrgyz Republic	Water and Habitat Coordinator	Bishkek, November 22, 2011 h: 15.00–15.30	Face-to-face (FR)
Kyrgyzstan	OECD	OECD Environment Directorate. Environmental Performances &Information Division	Senior Project Manager	London, December 9, 2011 h: 8.45–9.15	Skype (EN)

Appendix 2: Interviews Guideline

Part of the interview	Question/s	Related determinant/s assessed with the question
Introduction	Thank you for your willingness to be interviewed and for your time, presentation of the researcher: name, institutional affiliation, PhD student status; objectives of the research; practical details: length of the interview, data treatment (confidentiality, anonymity if the respondent asks for it), and permission to record the conversation	
Section 1: General questions	Description of organisation and role of person within it	
	What are your specific tasks and functions in relation to water resources management/CC?	
Section 2: Questions specifically related to the determinants	1. Does your institution take part in the decision-making process concerning the issues that are part of your mandate?	Participatory processes
	2. Do you think the interests of the various stakeholders are adequately represented in the decision-making process?	Group relations/ representation of interests
	3. How do you resolve conflicts when they arise?	Conflict resolution mechanisms
	4. Within your role, do you have regular involvement with other water managers/ water stakeholders? If so, can you give examples of how do you engage with them?	Partnerships and networks
		Coordination
		Leadership
	5. Did any of these groups/individuals particularly block or drive progress?	Group relations
	6. How do you transfer/share information across different stakeholder groups?	Information and data sharing
	7. Do you think the existing legislative and administrative framework, as well as current policies, enable you to adequately perform your tasks and complete your mandate?	Legislative, administrative and policy measures
		Leadership and political will
	8. Do legal provisions/guidelines exist for the management of water supply during periods of high demand/water stress, or flooding events?	
	9. Is climate change integrated into your sectoral planning process or within any committees you are involved in at the local/ regional level?	Integration
		Experience
	10. Are there any training/workshop/ educational activity/program in relation to climate change?	Education and training
	11. Was there any adjustment/change in the system following extreme events?	Flexibility, planning
	12. Lessons learned? Incorporated into the system?	Experience

(continued)

Part of the interview	Question/s	Related determinant/s assessed with the question
	13. Are you more a user or a producer of information in your sector of competence? What kind of information?	Climate and scientific information
	14. Do you think the level of access to information is satisfactory?	
	15. What are the main sources of uncertainty, and how do you address uncertainty?	Uncertainty
	16. Do you have monitoring systems in place?	M&E
	17. In general, do you think that there is enough awareness about climate change, both among policy-makers and the general public? If not, are you aware of any activity that is being conducted to fill this gap, e.g., awareness-raising campaigns, and education in schools?	Communication and awareness-raising
		Perceptions
	18. Generally speaking, do you think your organisation is equipped with adequate financial and material resources to perform the tasks it is mandated with? If not, what are the main gaps?	Budget (and costs)
		Material resources and infrastructure
	19. Do you have access to financial mechanisms, e.g., insurance? Or do you receive support from external donors, for example in the framework of projects?	Financial mechanisms
		External donors
	20. Do you judge the infrastructure and material resources that are available to your organisation as sufficient, and in good condition?	Material resources
		Technology
	21. Do you receive useful technical assistance? If so, in what field?	Technical assistance
Closing: General	(a) In general, do you think the water management/governance system will be able to respond to the future challenges posed by climate change?	
	(b) What do you see as being the main impediments (legal, policy, political, social) for the system to cope with climate and socio-economic changes?	
	(c) Any final thoughts/questions/recommendations?	

Appendix 3: Results of Interviews

Table 1 Summary table: total number of references (and % of total references) to categories in association with adaptation responses and measures at different governance levels for the two research sites: the Po River basin (IT), and the Syr Darya River basin (KZ)

Governance level/Category of determinants		Finances + adaptation		Government + adaptation		H&S resources + adaptation		Info management + adaptation		Infrastructure + adaptation		TOT
		N. ref.	%	N. ref.	%	N. ref.	%	N. ref.	%	N. ref.	%	
Local level	*IT*	2	10	4	20	5	25	4	20	5	25	**20**
	KZ	0	0	1	7.7	4	30.8	2	15.4	6	46.2	**13**
Sub-national level	*IT*	4	6.2	25	38.5	11	16.9	14	21.5	11	16.9	**65**
	KZ	2	15.4	4	30.8	4	30.8	2	15.4	1	7.7	**13**
National level	*IT*	0	0	24	57.1	6	14.3	7	16.7	5	11.9	**42**
	KZ	0	0	3	33.3	2	22.2	0	0	4	44.4	**9**
International level	*IT*	0	0	0	0	0	0	0	0	0	0	**0**
	KZ	9	12.3	20	27.4	14	19.2	12	16.4	18	24.7	**73**
Civil society	*IT*	1	9	6	54.5	2	18.2	1	9	1	9	**11**
	KZ	1	11.1	3	33.3	2	22.2	2	22.2	1	11.1	**9**
Water users	*IT*	1	25	2	50	0	0	1	25	0	0	**4**
	KZ	0	0	0	0	0	0	0	0	0	0	**0**
Research sector	*IT*	0	0	0	0	0	0	1	100	0	0	**1**
	KZ	0	0	0	0	0	0	0	0	0	0	**0**
Multi-level governance (general)	*IT*	0	0	6	54.5	2	18.2	3	27.3	0	0	**11**
	KZ	0	0	3	42.8	4	57.1	0	0	0	0	**7**
Projects	*IT*	0	0	0	0	1	33.3	2	66.7	0	0	**3**
	KZ	0	0	1	33.3	2	66.7	0	0	0	0	**3**
Decentralisation	*IT*	0	0	2	66.7	1	33.3	0	0	0	0	**3**
	KZ	0	0	0	0	0	0	0	0	0	0	**0**
River basin level	*IT*	0	0	3	100	0	0	0	0	0	0	**3**
	KZ	0	0	0	0	0	0	0	0	0	0	**0**
Vertical governance (+top-down)	*IT*	0	0	4	100	0	0	0	0	0	0	**4**
	KZ	0	0	2	50	1	25	0	0	1	25	**4**
Horizontal governance	*IT*	0	0	0	0	0	0	0	0	0	0	**0**
	KZ	0	0	0	0	0	0	0	0	0	0	**0**
TOT	*IT*	***8***	***4.8***	***76***	***45.5***	***28***	***16.8***	***33***	***19.8***	***22***	***13.2***	***167***
	KZ	***12***	***9.2***	***37***	***28.2***	***33***	***25.2***	***18***	***13.7***	***31***	***23.7***	***131***
	tot	**20**	**6.7**	**113**	**37.9**	**61**	**20.5**	**51**	**17.1**	**53**	**17.8**	**298**

Source: Author

Table 2 Summary table: total number of references (and % of total references) to categories in association with barriers at different governance levels for the two research sites: the Po River basin (IT), and the Syr Darya River basin (KZ)

Governance level/Category of determinants		Finances + barriers		Government + barriers		H&S resources + barriers		Info management + barriers		Infrastructure + barriers		TOT
		N. ref.	%	N. ref.	%	N. ref.	%	N. ref.	%	N. ref.	%	
Local level	*IT*	4	16.67	4	16.67	9	37.5	4	16.67	3	12.5	**24**
	KZ	4	30.77	3	23.08	2	15.38	4	0.31	0	0	**13**
Sub-national level	*IT*	10	12.98	28	36.36	23	29.87	12	15.58	4	5.2	**77**
	KZ	4	26.67	3	20	3	20	5	33.33	0	0	**15**
National level	*IT*	4	10	15	37.5	11	27.5	6	15	4	10	**40**
	KZ	9	24.32	15	40.54	10	27.03	3	8.11	0	0	**37**
International level	*IT*	0	0	0	0	0	0	0	0	0	0	**0**
	KZ	38	20.21	54	28.72	64	34.04	32	17.02	0	0	**188**
Civil society	*IT*	3	17.65	6	35.29	6	35.29	1	5.9	1	5.9	**17**
	KZ	2	18.18	5	45.45	3	27.27	1	9.1	0	0	**11**
Water users	*IT*	1	11.11	4	44.44	4	44.44	0	0	0	0	**9**
	KZ	0	0	0	0	0	0	0	0	0	0	**0**
Research sector	*IT*	4	26.67	1	6.67	6	40	4	26.67	0	0	**15**
	KZ	0	0	0	0	0	0	0	0	0	0	**0**
Multi-level governance (general)	*IT*	2	11.76	8	47.06	5	29.41	1	5.89	1	5.89	**17**
	KZ	5	31.25	6	37.5	4	25	1	6.25	0	0	**16**
Projects	*IT*	1	33.33	0	0	0	0	1	33.33	1	33.33	**3**
	KZ	0	0	0	0	0	0	0	0	0	0	**0**
Decentralisation	*IT*	1	33.33	1	33.33	1	33.33	0	0	0	0	**3**
	KZ	0	0	0	0	0	0	0	0	0	0	**0**
River basin level	*IT*	0	0	0	0	0	0	0	0	0	0	**0**
	KZ	0	0	2	100	0	0	0	0	0	0	**2**
Vertical governance (+top-down)	*IT*	0	0	0	0	0	0	0	0	0	0	**0**
	KZ	0	0	0	0	0	0	0	0	0	0	**0**
Horizontal governance	*IT*	0	0	0	0	0	0	0	0	0	0	**0**
	KZ	0	0	0	0	0	0	0	0	0	0	**0**
TOT	*IT*	***30***	***14.63***	***67***	***32.68***	***65***	***31.7***	***29***	***14.14***	***14***	***6.83***	***205***
	KZ	***62***	***21.99***	***88***	***31.21***	***86***	***30.49***	***46***	***16.31***	***0***	***0***	***282***
	tot	92	18.9	155	31.83	151	31.01	75	7.19	14	2.87	487

Source: Author

Appendix 4: Statistical Analysis Results

CHI-TEST 1: Barriers and bridges to institutional adaptive capacity, difference between multiple governance levels in the case of the Po River basin.

H0: In the Po River basin, determinants behave equally at each governance level in terms of contributing to/hampering institutional adaptive capacity.

H1: In the Po River basin, determinants behave differently at each governance level in terms of contributing to/hampering institutional adaptive capacity.

BRIDGES	Finance	Government	H&S resources	Info management	Infrastructure	TOT
Local level	2	4	5	4	5	**20**
Sub-national level	4	25	11	14	11	**65**
National level	0	24	6	7	5	**42**
Civil society	1	6	2	1	1	**11**
Water users	1	2	0	1	0	**4**
Research sector	0	0	0	1	0	**1**
Multi-level governance general	0	6	2	3	0	**11**
Projects	0	0	1	2	0	**3**
Decentralisation	0	2	1	0	0	**3**
River basin	0	3	0	0	0	**3**
Vertical governance	0	4	0	0	0	**4**
TOT	**8**	**76**	**28**	**33**	**22**	**167**

BARRIERS	Finance	Government	H&S resources	Info management	Infrastructure	TOT
Local level	4	4	9	4	3	**24**
Sub-national level	10	28	23	12	4	**77**
National level	4	15	11	6	4	**40**
Civil society	3	6	6	1	1	**17**
Water users	1	4	4	0	0	**9**
Research sector	4	1	6	4	0	**15**
Multi-level governance general	2	8	5	1	1	**17**
Projects	1	0	0	1	1	**3**
Decentralisation	1	1	1	0	0	**3**
TOT	**30**	**67**	**65**	**29**	**14**	**205**

P (BRIDGES): 0.424686522
P (BARRIERS): 0.695234935

BRIDGES: P = 0.42 implies that the null hypothesis cannot be rejected at a 5 % significance level. The different ways in which the categories of determinants contribute to building bridges at multiple governance levels in the Po River case is not statistically different at a 5 % significance level

BARRIERS: P = 0.69 implies that the null hypothesis cannot be rejected at a 5 % significance level. The different way in which the categories of determinants contribute to hampering adaptive capacity at multiple governance levels in the Po River case is not statistically different at a 5 % significance level

CHI-TEST 2: Barriers and bridges to institutional adaptive capacity, difference between multiple governance levels in the case of the Syr Darya River basin.

H0: In the Syr Darya basin, determinants behave equally at each governance level in terms of contributing to/hampering institutional adaptive capacity.

H1: In the Syr Darya basin, determinants behave differently at each governance level in terms of contributing to/hampering institutional adaptive capacity.

BRIDGES	Finance	Government	H&S resources	Info management	Infrastructure	TOT
Local level	0	1	4	2	6	**13**
Sub-national level	2	4	4	2	1	**13**
National level	0	3	2	0	4	**9**
International level	9	20	14	12	18	**73**
Civil society	1	3	2	2	1	**9**
Multi-level governance general	0	3	4	0	0	**7**
Projects	0	1	2	0	0	**3**
Vertical governance	0	2	1	0	1	**4**
TOT	**12**	**37**	**33**	**18**	**31**	**131**

BARRIERS	Finance	Government	H&S resources	Info management	Infrastructure	TOT
Local level	4	3	2	4	0	**13**
Sub-national level	4	3	3	5	0	**15**
National level	9	15	10	3	0	**37**
International level	38	54	64	32	0	**188**
Civil society	2	5	3	1	0	**11**
Multi-level governance general	5	6	4	1	0	**16**
River basin	0	2	0	0	0	**2**
TOT	**62**	**88**	**86**	**46**	**0**	**282**

P (BRIDGES): 0.503185383
P (BARRIERS): 0.381636916

BRIDGES: P = 0.50 implies that the null hypothesis cannot be rejected at a 5 % significance level. The different way in which the categories of determinants contribute to building bridges at multiple governance levels in the Po River case is not statistically different at a 5 % significance level

BARRIERS: P = 0.38 implies that the null hypothesis cannot be rejected at a 5 % significance level. The different way in which the categories of determinants contribute to hampering adaptive capacity at multiple governance levels in the Po River case is not statistically different at a 5 % significance level

CHI-TEST 3: Significance of cross-case comparison, with reference to multi-level governance and barriers and bridges to adaptive capacity.

H0: Determinants behave equally in the two cases in terms of contributing to/hampering institutional adaptive capacity at specific governance levels.

H1: Determinants behave differently in the two cases in terms of contributing to/hampering institutional adaptive capacity at specific governance levels.

BRIDGES	IT	KZ	TOT
Local level	20	13	33
Sub-national level	65	13	78
National level	42	9	51
International level	0	73	73
Civil society	11	9	20
Water users	4	0	4
Research sector	1	0	1
Multi-level governance general	11	7	18
Projects	3	3	6
Decentralisation	3	0	3
River basin	3	0	3
Vertical governance	4	4	8
TOT	167	131	298

BARRIERS	IT	KZ	TOT
Local level	24	13	37
Sub-national level	77	15	92
National level	40	37	77
International level	0	188	188
Civil society	17	11	28
Water users	9	0	9
Research sector	15	0	15
Multi-level governance general	17	16	33
Projects	3	0	3
Decentralisation	3	0	3
River basin	0	2	2
TOT	205	282	487

P (BRIDGES): 0.000000

P (BARRIERS): 0.000000

BRIDGES: P = 0.000000 implies that the null hypothesis should be rejected at a 5 % significance level. Kyrgyzstan and Italy are statistically different in terms of how determinants behave in contributing to/hampering adaptive capacity at a 5 % significance level

BARRIERS: P = 0.000000 implies that the null hypothesis should be rejected at a 5 % significance level. Kyrgyzstan and Italy are statistically different in terms of how determinants behave in contributing to/hampering adaptive capacity at a 5 % significance level

CHI-TEST 4: Significance of cross-case comparison, with reference to categories and barriers and bridges to adaptive capacity.

H0: The categories of determinants contribute/hamper to an equal extent to adaptive capacity in the two cases.

H1: Different categories have different impacts on adaptive capacity in the two cases.

BRIDGES	KZ	IT	TOT
Finances and risk	15	8	23
Government	34	63	97
H&S resources	29	25	54
Information management	19	28	47
Infrastructure	31	22	53
TOT	128	146	274

BARRIERS	KZ	IT	TOT
Finances and risk	12	2	14
Government	11	12	23
H&S resources	11	7	18
Information management	5	4	9
Infrastructure	4	6	10
TOT	43	31	74

P (BRIDGES): 0.01023549
P (BARRIERS): 0.1457272

BRIDGES: P = 0.01 implies that the null hypothesis should be rejected at a 5 % significance level. Kyrgyzstan and Italy are statistically different in terms of bridges at a 5 % significance level

BARRIERS: P = 0.15 implies that the null hypothesis should not be rejected at a 5 % significance level. Kyrgyzstan and Italy are not statistically different in terms of barriers at a 5 % significance level

CHI-TEST 5: Significance of cross-case comparison, with reference to determinants and barriers and bridges to adaptive capacity.

H0: The determinants contribute/hamper to an equal extent to adaptive capacity in the two cases.

H1: Different determinants have different impacts on adaptive capacity in the two cases.

BRIDGES	KZ	IT	TOT
Budget	15	4	19
Economic development	5	0	5
External donors	6	0	6
Financial instruments	2	5	7
Individual and market incentives	4	0	4
Conflict resolution mechanisms	0	3	3
Coordination and integration	3	9	12
Flexibility, planning	7	24	31
Legislation, administration	13	17	30
Participatory processes	3	12	15
Political stability	3	0	3
Risk and emergency management	9	26	35
WRM paradigm	8	12	20
Education and training	8	0	8
Experience	1	5	6
Group relations	0	10	10
Leadership	2	1	3
Partnerships and networks	5	6	11
Perceptions	10	5	15
Social and institutional capacity	6	3	9
Climate and scientific information	10	11	21
Communication and awareness-raising	4	9	13
Information and data sharing	2	0	2
M&E	1	2	3
Traditional knowledge	3	4	7
Uncertainty	1	4	5
Innovation	16	8	24
Investments O&M	3	3	6
Material resources	9	12	21
Technical assistance	4	0	4
Technology	7	2	9
TOT	170	197	367

BARRIERS	KZ	IT	TOT
Budget	36	61	97
Economic development	11	17	28
External donors	22	28	50
Financial instruments	1	4	5
Individual and market incentives	12	18	30
Conflict resolution mechanisms	1	4	5
Coordination and integration	22	15	37
Flexibility, planning	13	14	27
Legislation, administration	7	7	14

(continued)

BARRIERS	KZ	IT	TOT
Participatory processes	0	6	6
Political stability	20	4	24
Risk and emergency management	14	16	30
WRM paradigm	25	16	41
Education and training	5	2	7
Experience	7	6	13
Group relations	11	19	30
Leadership	13	5	18
Partnerships and networks	4	0	4
Perceptions	30	25	55
Social and institutional capacity	40	22	62
Climate and scientific information	14	11	25
Communication and awareness-raising	5	11	16
Information and data sharing	4	0	4
M&E	7	4	11
Traditional knowledge	19	5	24
Uncertainty	3	6	9
Innovation	1	1	2
Investments O&M	11	4	15
Material resources	20	12	32
Technical assistance	1	1	2
Technology	7	2	9
TOT	386	346	732

P (BRIDGES): 0.0000000141
P (BARRIERS): 0.0000203474

BRIDGES: the resulting P-value means that it is possible to reject the null hypothesis at a 5 % significance level. The different contribution of the identified determinants to adaptive capacity in Kyrgyzstan and Italy is statistically significant at a 5 % significance level

BARRIERS: the resulting P-value means that it is possible to reject the null hypothesis at a 5 % significance level. The different degree to which the identified determinants act as barriers to adaptive capacity in Kyrgyzstan and Italy is statistically significant at a 5 % significance level