

**A dissertation submitted to the Department of Environmental Sciences and Policy of  
Central European University  
in partial fulfilment of the  
Degree of Doctor of Philosophy**

**Transboundary water management and climate change adaptation: a comparative study  
of four European river basins**

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**November 2014**

**Budapest**

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# THE CENTRAL EUROPEAN UNIVERSITY

## ABSTRACT OF DISSERTATION submitted by:

Sonja KOEPPEL

for the degree of Doctor of Philosophy and entitled: Transboundary water management and climate change adaptation: a comparative study of four European river basins

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Many of the more than 276 transboundary river basins worldwide are affected by climate change which leads to higher flow variability. They need to be managed in a flexible and adaptive way. This dissertation aimed to identify which factors are conducive to strengthen the adaptive capacity of transboundary water management regimes in Europe. The concept adaptive capacity was operationalized as “Ability to cope with past flow variability without conflicts”. Adaptation activities in four European transboundary water management regimes were compared: the Rhine, Danube, Meuse, and Neman basins, complemented by short consideration of 9 additional basins worldwide. The research question was analysed in a qualitative way, using participatory observation, complemented by semi-structured interviews and document analysis. The analysis identified the following enabling factors for adaptive capacity:

1. Adaptive capacity of transboundary water management regimes can be promoted by flexible legal frameworks, flexible and well-working organizations such as river basin commissions, data and information exchange about climate change impacts, learning capacity and clarification of responsibilities between the national and transboundary levels. Usually, the transboundary level has a role to play in prevention, preparedness and reaction to flow variability, whereas responsibilities for all areas of the disaster risk management cycle and for implementation of measures lies at national level. These levels can motivate each other.
2. Legal frameworks should facilitate the other enabling factors, namely include provisions on data exchange, common monitoring and early-warning, stakeholder engagement, creation of river basin organizations, funding aspects. New legal treaties should be designed flexibly, which can however have transaction costs.
3. Flexibility in the organization responsible for ensuring implementation of the transboundary agreement, such as the river basin commission (RBO), is important for adaptive capacity and can overcome lack of flexibility in the legal framework, at least in water-rich European basins. To increase adaptive capacity flexible RBOs can set up expert groups or develop basin-wide adaptation strategies and plans. Thus, more efforts are needed for establishing and strengthening river basin commissions.
4. River basin organizations need an effective secretariat, a visionary and motivating leader, trust and understanding benefits of cooperation by the riparian countries, wide stakeholder engagement, human and financial resources for climate change adaptation and a mandate to address flow variability.
5. Exchange of data and developing basin-wide models, studies and vulnerability assessments facilitates reaching of common understanding and scientific consensus on climate change impacts, which is a precondition for increasing adaptive capacity.
6. Climate change impacts and the need for adaptation do not necessarily cause conflicts, but provide often even a motivation for cooperation.

**Keywords:** <transboundary water management, regimes, institutions, climate change, adaptive capacity, flow variability>

## List of abbreviations

AMICE	Adaptation of the Meuse to the Impacts of Climate Evolutions (project)
Cc	Climate change
CHR	Commission for the Hydrology of the Rhine
COP	Conference of the Parties
Coop.	Cooperation
DRBMP	Danube River Basin Management Plan
EC	European Commission
EFD	European Flood Directive
EU	European Union
EU WFD	EU Water Framework Directive
ICPDR	International Commission for the Protection of the Danube River
ICPR	International Commission for the Protection of the Rhine
IMC	International Meuse Commission
Inst.	Institution
IPCC	Intergovernmental Panel on Climate Change
ISRBC	International Sava River Basin Commission
IWRM	Integrated Water Resources Management
MEA	Multilateral Environmental Agreement
MOP	Meeting of the Parties
MOU	Memorandum of Understanding
MRC	Mekong River Commission
NGO	Non-Governmental Organization
RBO	River Basin Organization
Tb	transboundary
Tbwm	Transboundary water management
UNECE	United Nations Economic Commission for Europe
UN	United Nations
UNDP	United Nations Development Programme
UN Watercourses Convention International Watercourses	Convention on the Law of the Non-Navigational Uses of
UNFCCC	United Nations Framework Convention on Climate Change
Water Convention	Convention on the Protection and User of Transboundary Watercourses and International Lakes
WFD	Water Framework Directive of the European Union
WWF	WorldWide Fund for Nature

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# **1 Introduction**

## **1.1 *Background and relevance of the research***

This dissertation aims to analyze which factors enable transboundary water management regimes to adapt to climate change impacts on water resources while maintaining the regime's main aims, namely prevention of conflicts between riparian countries. Climate change impacts, such as increasing flow variability, floods and droughts, represent an additional challenge to water management and especially transboundary water<sup>1</sup> resources management, which is already complicated due to differences in interest, power, priorities, level of development and other problems between riparian countries. Thus, there is a risk that climate change will lead to conflicts over dwindling water resources, especially in shared basins.

### **1.1.1 *Climate change impacts on water resources***

The existence of human-induced climate change<sup>2</sup> is now recognized, especially since the fourth and fifth Intergovernmental Panel on Climate Change (IPCC) Assessment Reports. Most climate change impacts are transmitted through water and impacts are already visible today in some regions (UNECE 2009, Bates et al. 2008). Climate change impacts on freshwater resources mainly manifest themselves through changes in air and water temperature, changes in flow or discharge, precipitation, evapotranspiration and sea level change (Kundzewicz et al. 2007). However, climate change impacts differ significantly from region to region and the exact impacts on water resources in a particular basin are still much more uncertain than climate change impacts on temperature (Kiparsky et al. 2006). Projections become less certain when decreasing the spatial scales, e.g. to the level of basins.

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<sup>1</sup> The term “transboundary water” in this dissertation refers to transboundary rivers, lakes, inland water as a whole and aquifers; here, explicitly excluding open oceans, territorial seas and coastal waters (UN-Water 2008).

<sup>2</sup> A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (UNFCCC 1992).

Many climate models for the 21st century forecast precipitation increases in high latitudes and parts of the tropics, and decreases in some subtropical and lower mid-latitude regions (Bates et al. 2008). This may lead to an increase in annual average river runoff and water availability at high latitudes and in some wet tropical areas, and a drop in some dry regions at mid-latitudes, such as in Europe, and in the dry tropics. Many already semi-arid and arid areas such as the Mediterranean Basin are especially negatively affected by impacts of climate change and their freshwater resources are expected to decrease further (Bates et al. 2008). In addition, in many regions, a change in seasonality of precipitation is expected, for example more precipitation in the winter and less in the summer.

Increased precipitation intensity and variability will increase the risks of flooding and drought. The frequency of heavy precipitation events is likely to increase during the 21st century, which will affect floods and intensify erosion (Jimenez-Cisneros et al. 2014). At the same time, extreme drought is projected to increase (Kundzewicz et al. 2007, Bates et al. 2008, and UNECE 2009). Due to glacier and snow melting, water availability during warm and dry periods in regions dependent on melt water will be reduced (Bates et al. 2008).

Climate change also has positive effects on water resources in some areas, for example increased total water supply in some regions (Bates et al. 2008). However, globally, the negative impacts of future climate change on freshwater systems are expected to outweigh the benefits (Bates et al. 2008). By the 2050s, the area of land suffering from increasing water stress will greatly increase, with negative consequences for the ecosystems and other services provided by these areas. Fig. 1 shows changes in projected runoff based on a compilation of 12 models. According to this projection, some areas with transboundary rivers are expected to be particularly affected by reduction in flow such as Mexico-USA (Colorado, Rio Grande), the North of Latin America (Amazonas), Southern, Central and Mediterranean Europe (Guadiana (Spain-Portugal), Danube, Mestos-Nestos and many others), Southern Africa (e.g., Okavango and Orange rivers) and the Middle East (Euphrates and Tigris, the Jordan river).

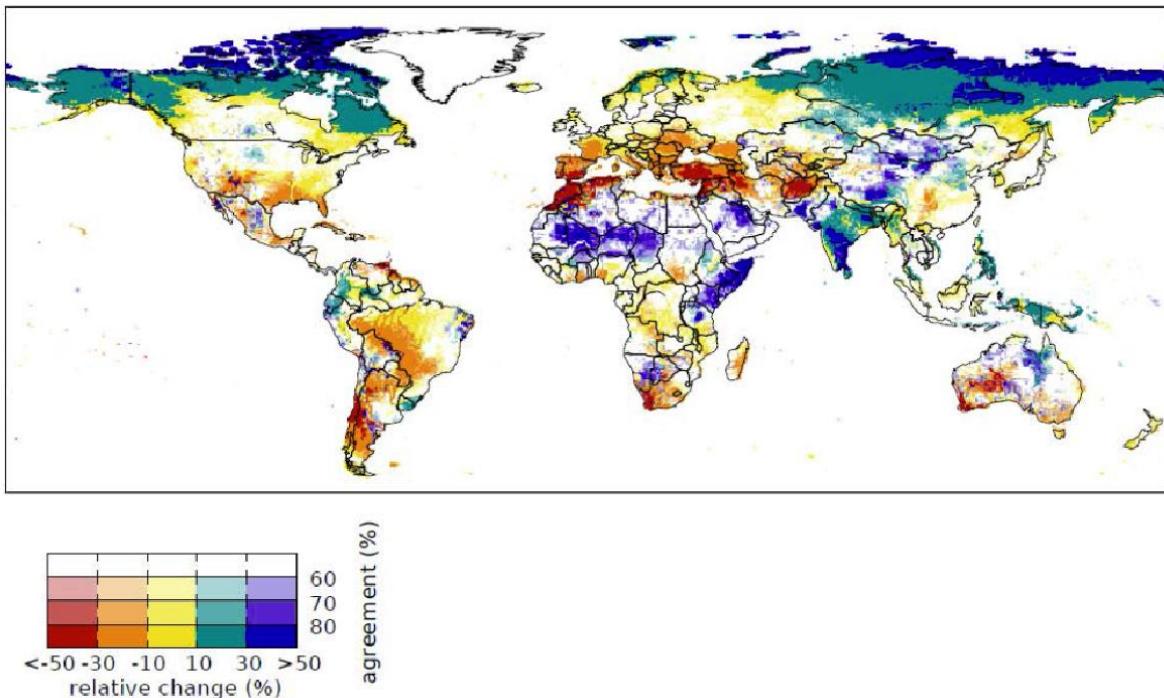


Figure 3-4: Percentage change of mean annual streamflow for a global mean temperature rise of 2°C above 1980–2010 (2.7°C above pre-industrial). Color hues show the multi-model mean change across 4 GCMs and 11 global hydrological models (GHMs), and saturation shows the agreement on the sign of change across all 55 GHM-GCM combinations (percentage of model runs agreeing on the sign of change) (Schewe *et al.*, 2013).

### Figure 1 Expected changes in annual runoff due to climate change

Source: Jimenez-Cisneros et al. 2014 figure 3.4

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#### 1.1.2 Transboundary water management

Transboundary watercourses are water bodies flowing at least through two or more countries. Approximately 40 per cent of the world's population is located in river and lake basins which comprise at least two countries (UN-Water 2008: 1). In addition, over 90 per cent of the world population lives in countries that share basins (UN-Water 2008:1). The existing 276 transboundary lake and river basins cover nearly half of the Earth's land surface and account for an estimated 60 per cent of global freshwater flow. One hundred forty-five States have territory within such basins, and 30 countries lie entirely within them. In addition, about 2 billion people worldwide depend on groundwater, which includes approximately 300 transboundary aquifer systems (UN-Water 2008: 1).

Less than half of the 276 transboundary basins are governed by joint management institutions or transboundary water management regimes. Regimes are institutions with explicit rules, agreed upon by governments, that govern for example the joint management of the transboundary basin (Keohane 1989, see also section 2.1). Many of these regimes lack certain provisions enabling them to adapt to climate variability and change.

## **1.2 Research aims and questions**

### **1.2.1 Research justification**

Transboundary water management can enable more effective climate change adaptation, but on the other hand, may itself be affected by climate change (UNECE 2009). Table 1 shows how many of the impacts of climate change on water resources complicate transboundary water management.

**Table 1: Climate-related observed trends of various components of the global freshwater system and possible implications for transboundary water management (TBWM)**

Cc impacts on	Observed climate-related trends	Implications for TBWM
Precipitation	Increasing over land north of 30°N over the period 1901–2005. Decreasing over land between 10°S and 30°N after the 1970s Increasing intensity of precipitation	Implications for tbwm depend on whether changes in precipitation are felt equally in the basin and whether data are exchanged regularly between the basin countries
Cyrosphere	Snow cover decreasing in most regions, especially in spring Glaciers decreasing almost everywhere Permafrost thawing between 0.02 m/yr (Alaska) and 0.4 m/yr (Tibetan Plateau)	Leads to a change in seasonal flow which can cause controversy with downstream regions/countries.
Surface waters	Streamflow increasing in Eurasian Arctic, significant increases or decreases in some river basins Earlier spring peak flows and increased winter base flows in Northern America and Eurasia Increased actual evapotranspiration in some areas Lakes warming, significant increases or decreases of some lake levels, and reduction in ice cover	Is positive for some basins and negative for others. Changes in seasonality can cause controversy between riparian countries. Requires consultations and joint/coordinated adaptation response at transboundary level
Floods and droughts	Damages are increasing Intensified droughts in some drier regions since the 1970s	Floods and droughts often have transboundary impacts and their management by one country can affect other basin countries

Source: Adapted from Kundzewicz et al. 2007

However, few transboundary regimes and institutions have actually started to assess climate change impacts and to prepare strategies or measures to reduce their vulnerability (UNECE 2011). While countries are currently elaborating national climate change adaptation strategies and plans, at the level of transboundary river basins climate change adaptation is so far still receiving limited attention, although extreme weather events clearly have transboundary impacts. Adaptation planning in shared basins requires transboundary cooperation in order to avoid or mitigate potential negative impacts of unilaterally decided adaptation measures in other riparian countries and in order to identify the optimal measures which might better be located in another riparian country (UNECE 2009). Thus, there is a risk of “mal-adaptation”, due to national adaptation measures with unintended consequences in other parts of the basin. In addition, climate change impacts, in particular increased water stress, and measures taken against these, might cause conflicts in shared basins. Little research has been done on how and under which conditions transboundary cooperation can help to adapt to climate change, which mechanisms and measures have worked in situations of past flow variability and how transboundary water management regimes and institutions need to be designed to increase their adaptive capacity<sup>3</sup>.

From the literature, it seems that many transboundary regimes (see section 2.2.5: especially regimes in Africa, Western Asia, Southern and Mediterranean Europe, Asia (Mekong and India-Bangladesh) as well as some others) are not well adapted to expected climate change impacts since many of them do not have the necessary flexibility for change and adaptation activities built in (de Stefano et al. 2012). There are several reasons for the lack of adaptation: political reasons (high political pressure for renegotiating agreements), the nature of agreements as package deals or vague provisions in agreements (Fischhendler 2004). One of the most important reasons for the lack of adaptation of transboundary water management regimes is probably the uncertainty about actual climate change impacts as well

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<sup>3</sup> “Adaptive capacity” in the context of this dissertation always means adaptive capacity to climate change.

as uncertainty about the most effective response mechanisms. Due to this large uncertainty, IPCC (1997), UNDP (2004), Stakhiv (1998) and many others argue that it is more important to reduce the current vulnerability since many systems and policies are not well-adjusted even to today's climate and climate variability resulting in increasing costs in terms of human life and capital, from foods, storms and droughts which demonstrate current vulnerability<sup>4</sup>. Making the water resources sector more resilient to contemporary conditions would help in adapting to future changes in climate (IPCC, 1997). This is similar to the concept of adaptive management, a new and emerging paradigm in water management (see chapter 2.7).

By analyzing the adaptive capacity and enabling factors for it in four transboundary basins, my dissertation addresses these difficulties and gives some indications on how they can be overcome. The present dissertation thus deals with climate change impacts on transboundary water management and aims to analyse how transboundary water management regimes need to be designed and be implemented to be able to cope with climate change impacts- and what role different enabling institutional mechanisms and characteristics play.

### **1.2.2 Knowledge gap addressed through the thesis**

Goulden et al. (2009: 823) examine adaptation to climate change in international river basins in Africa. They conclude their research with the following question for future research: “Research is needed to examine the factors and processes that are important for cooperation to lead to positive adaptation outcomes and increasing adaptive capacity of water management institutions”. And “For both African and other international basins there is a need to review the appropriateness of existing institutional structures and frameworks for treaties in the context of climate change and research new approaches that are better suited to nonstationary

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<sup>4</sup> Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC 2007).

hydrological conditions" (Goulden et al. 2009:824). My thesis contributed to fulfilling this identified research need by considering the need for flexibility in these agreements.

As chapter 2 shows, there is still significant uncertainty regarding how to implement adaptive management in a transboundary context, how to trigger institutional change and increase flexibility. In addition, questions remain to be answered such as: which kind and extent of flexibility is useful for countries and basins, for transboundary water management regimes in general? What does institutional flexibility mean, how can it be implemented? As shown in the literature review (chapter 2) the theories of institutional change and regimes do not give a clear answer to this. My dissertation aimed to fill this knowledge gap in chapters 4 (in detail for each case study) and chapter 5 (comparison and analysis) by analysing ongoing and past flow variability and the reactions to it, as well as adaptation efforts in four European transboundary basins, complemented by experiences from nine additional basins worldwide.

An appropriate framework for analysis includes structure (institutions, water management regime), process (adaptive water management) and outcome (sustainable water system) (Pahl-Wostl 2008). In this dissertation, all three elements were considered, the structure, i.e. transboundary water management regimes and institutions, the actual water management through the institutions and the outcome, the capacity to deal with flow variability, i.e. the adaptive capacity.

### **1.2.3 Research questions**

My dissertation dealt with climate change impacts on transboundary water management and specifically aimed to analyse enabling factors for adaptive capacity.

#### **Main research question:**

How are certain institutional characteristics of transboundary water management regimes in Europe related to strengthening their capacity to address climate variability and change, (using the examples of the Rhine, Danube, Meuse and Neman basins)?

#### **Sub-question:**

How are the transboundary water management (tbwm) regimes in the Rhine, Danube, Meuse and Neman river basins and river basin commissions adapting to climate change and why?

My dissertation aimed to answer these questions by enabling factors for addressing flow variability, as well as adaptation efforts in these four European transboundary basins, complemented by experiences from nine additional basins worldwide.

### **1.3 *Dissertation outline***

As usual, this dissertation starts with a review of available literature in the areas of climate change impacts on water resources, transboundary water management as well as climate change adaptation, adaptive management and adaptive capacity in order to identify the current state of knowledge and define the research gap to be addressed in the dissertation. As theoretical framework, theories of institutional change, institutional flexibility and adaptive management are presented. Chapter 2 also describes how different authors explain adaptive capacity of regimes and institutions in general and transboundary water management regimes in particular.

The methods used in this dissertation are presented in chapter 3. The research questions were answered with qualitative methods and four main case studies, i.e. four European river basins, whose adaptive capacity was analysed through participant observation, semi-structured interviews and document analysis. These four basins, namely the Rhine, Danube, Meuse and Neman basins are presented in chapter four together with the results of my field research in these basins. The findings for these four basins describe the possible enabling factors for adaptive capacity of tbwm regimes. The results are then compared and analysed in chapter five, complemented by insights from several basins worldwide, which were not analysed in detail. This chapter answers the research questions and describes limitations and further research suggestions, followed by conclusions and recommendations in chapter 6.

## **2 Theoretical framework and existing literature on transboundary water management and adaptive capacity to climate change**

The following chapter 2 provides an overview of the available literature regarding transboundary water management and climate change adaptation and also describes the theoretical background to the dissertation. Concepts such as “regimes” and “institutions”, “adaptive capacity” and “adaptive management” are defined and the theoretical framework presented.

### **2.1 *Definitions: Institutions and regimes***

#### **2.1.1 General definitions**

The concepts ‘regimes’ and ‘institutions’ are very similar since they both describe “the ‘established rules’ that structure human behaviour, by reducing the chaos of an endless amount of possible actions to a complex, but tangible set of possible actions” (Raadgever and Mostert 2005:3). However, the definitions used for these concepts vary significantly. For example, institutions are commonly defined as “rules or regularities of behaviour that are generally accepted by members of a social group, that specify behaviour in specific situations, and that are either self-policed or policed by external authority” (Rutherford 2001 in Raadgever and Mostert 2005:3). According to Keohane (1989: 3) institutions are "persistent and connected sets of rules (formal and informal) that prescribe behavioural roles, constrain activity, and shape expectations," which makes no overt reference to actual behavior. Alternatively, institutions can be defined as an “actor-created rule of behaviour, restricting and enabling actors’ behaviour” (North 1990 cited in Héritier 2007). North (1990:3) defines institutions as “rules of the game in a society, or more formally, the humanly devised constraints that shape human interaction”. They are made up of formal constraints (e.g. rules, laws, constitutions) or informal constraints (e.g. norms of behaviour, conventions, self-imposed codes of conduct). “Institutions reduce uncertainty by providing structure to daily

life” (North 1990:3). Keohane et al (1993:45) state that “institutions may take the form of bureaucratic organizations, regimes (rule-structures that do not necessarily have organizations attached) or conventions (informal practices)”.

There are institutions of transboundary water cooperation, for example the Helsinki Rules, which define general principles for transboundary cooperation, such as the “no significant harm” rule, the “equitable and reasonable utilization” rule and many others. These rules and principles are included in more formal constraints, namely in the international conventions for transboundary water management, such as the Convention on the Law of the Non-Navigational Uses of Transboundary Watercourses (UN 1997) or the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE 1992).

Krasner’s (1983:2) definition of a regime is today commonly recognized: “Regimes are explicit principles, norms, rules and decision-making procedures around which actors’ expectations converge in a given arena of international relations. Principles are beliefs of fact, causation, and rectitude. Norms are standards of behavior defined in terms of rights and obligations. Rules are specific prescriptions or proscriptions for action. Decision-making procedures are prevailing practices for making and implementing collective choice”. Thus, regimes can be considered as a set of institutions in a given area (Raadgever and Mostert 2005). Keohane (1989: 4) slightly simplified the definition and defined the concept of regime: “Regimes are institutions with explicit rules, agreed upon by governments, that pertain to particular sets of issues in international relations.”

The term “regime” should be distinguished from “organization” (Hasenclever et al. 1997) such as a river basin commission or a secretariat of a treaty in charge of monitoring the compliance with the regime’s provisions. Regimes and institutions often include an organization in order to fulfil all of their functions (Hasenclever et al. 1997). Organizations are structured and organized forms of institutions, “actors in social practices” and were

created as a legal entity by the countries through an act under international law (Desai 2010:12). As Hasenclever et al. (1997) explain, a regime cannot react as it is only a set of principles, whereas an organization can react for example to climate change.

### **2.1.2 Water management regimes**

In the context of this dissertation, transboundary water cooperation, when formalized through an agreement or Convention between states is considered as a regime. The organizations to implement the regime are the river basin commissions or joint bodies. They key aim of a water management regime is to allocate water among different users (or different countries) according to pre-determined criteria (Pahl-Wostl 2007). In the case of a transboundary basin, this usually means allocating water between the riparian countries. Transboundary water management regimes usually aim to protect transboundary waters and ensure their sustainable, reasonable and equitable use while preventing conflicts between users and riparian countries (UNECE 1992).

When the definition of Krasner (1983) is applied to a transboundary water management regime, principles of such transboundary regimes are usually the common understanding that the cooperation will be beneficial for all sides. The norms are the main rules of international water law such as the “no significant harm rule” or the “equitable and reasonable utilization” rule or the principle of consultation (see section 2.2.1). Rules are the specific provisions of transboundary agreements such as data and information exchange. Transboundary water management regimes can contain for example rules in relation to information exchange, joint monitoring and assessment, water allocations, water quality objectives, the creation of a joint body with secretariat or financial issues. Regimes are based on legal frameworks which can for example take the form of conventions, laws, directives, agreements, accords, treaties or other types of legally binding documents which governments sign and ratify. Similar, but weaker agreements can be for example memoranda of understanding such as in the Drin basin. Finally, the decision-making is usually happening in a river basin commission.

### **2.1.3 Institutions and organizations in environmental agreements**

In the literature on Multilateral Environmental Agreements (MEAs), there is substantial discussion about whether treaties require an organizational framework, i.e. an organization in order to reach their goals. Most authors believe that this is the case (e.g. Churchill and Ulfstein 2000, Beyerlin and Marauhn 2011) since such arrangements are needed to develop, update and adapt MEAs to changing environments, such as new knowledge, more ambitious commitments which states might be willing to take (Churchill and Ulfstein 2000). In the case of global MEAs, such an institutional framework usually comprises the Conference of the Parties and its subsidiary bodies, such as working groups, Implementation Committees, but also, in many cases, a secretariat. In the case of transboundary water management regimes, these organizations usually comprise a river basin commission or another form of joint body and frequently also a permanent secretariat. The highest level body of the river basin commission, usually the ministerial council, is acting like a Conference of the Parties and can take related decisions. The Conference of the Parties can amend the MEA, take decision on its implementation or clarify interpretation of the treaty. Whether its decisions can have a rule-making or even a law-making character (Churchill and Ulfstein 2000), when taken by consensus or the necessary majority of Parties, is debated by the literature on administrative law and by different scientists (see section 5.3).

## **2.2 Transboundary water management in the literature**

### **2.2.1 International water conventions and rules**

The 1997 United Nations Convention on the Law of the Non-Navigational Use of International Watercourses (United Nations 1997) and the 1992 UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE 1992, UNECE Water Convention) contain numerous principles relevant for managing shared watercourses. The most important ones are, among others, the principle of Equitable and Reasonable Use as contained in the Helsinki Rules, the principles of Avoidance of Significant

Harm or even the No Harm principle as included in the Berlin Rules adopted in 2004, and the principle of Prior Notification and Consultation between riparian countries when a project with significant transboundary impacts is planned (Phillips et al. 2006). From a legal perspective, states have an obligation to cooperate when using and managing transboundary waters which is, however, a soft obligation because of a lack of precision on what is required (Farrajota 2011). The duty to cooperate is operationalized in procedural obligations such as the obligation to exchange data, to notify planned measures, to enter into consultations and negotiate regarding joint measures as well as to settle disputes peacefully.

The principle of equitable and reasonable utilization is one of the main principles of international water law. The UN Watercourses Convention mentions climate, as one of the factors determining equitable and reasonable use and requires cooperation also when climate change causes a significant change in basin conditions (Leb 2013). States shall take all appropriate measures to prevent or mitigate harmful conditions whether resulting from natural causes such as flood, salt water intrusion, drought or desertification (Leb 2013). Also the UNECE Water Convention obliges its Parties to prevent such transboundary impacts due to flow variability for example (UNECE 1992).

The Helsinki Rules adopted by the International Law Association in 1966 constituted one of the first codifications of international water law and were focused on the principles of equitable and reasonable utilization, including explanation of factors or indicators defining such use (ILA 1967). They are widely accepted as customary international law. The Berlin Rules of 2004 (ILA 2004) were developed by the International Law Association as an update of the Helsinki Rules, but are more ambitious by focusing on environmental protection and sustainability. They include the “No Harm” rule and are therefore much more contested, i.e. not widely accepted as customary law. However, they also include articles on flood and drought management, requiring States to cooperate in preparing for and reacting to these extreme events through exchange of data, early warning and development of contingency and

response plans (ILA 1997 and 2004). Thus, they could be useful for basins for addressing water scarcity and flow variability, the subject of this thesis.

The implementation of international conventions is fostered and monitored through organizations such as river basin commissions or other forms of formal bodies charged with implementing a transboundary agreement. International water treaties “reduce uncertainty, can contribute to transparency, decrease the transaction costs and clarify expectations among Parties” (McCaffrey 2003: 157). Recent research has found that while an international water agreement may not necessarily prevent the emergence of tensions, these tensions usually result in negotiations (or peaceful management) when an agreement already governs the basin (Brochmann & Hensel, 2009, cited in de Stefano et al. 2012).

### **2.2.2 Definition of conflict and cooperation**

Conflict can be defined as “Two or more entities, one or more of which perceive a goal as being blocked by another entity, and power being exerted to overcome the perceived blockage” (Frey 1993 cited in Priscoli and Wolf 2009: xxiii). In a transboundary basin, this might mean that one (or more) riparian countries see their “share” of the basin water as threatened and therefore take action against the other riparian countries. Wolf et al. (2003) analyse basins at risk (BAR) worldwide and classify water-related events on a scale from -7 (conflictive events) to 7 (cooperative events) as it can be seen on table 2 below. In my dissertation, all those events between -7 and -2 are considered as water conflicts, i.e. ranging from formal declaration of war because of water to strong verbal expression displaying hostility in interaction. Similar, as cooperation are considered all those events between 2 and 7 of the same scale, namely ranging from “official verbal support of goals, values or regime” to “voluntary unification into one nation” (Priscoli and Wolf 2009).

<b>BAR scale</b>	<b>Event description</b>
-7	Formal declaration of war
-6	Extensive military acts
-5	Small scale military acts

-4	Political-military hostile action
-3	Diplomatic-economic hostile action
-2	Strong verbal expressions displaying hostility in interaction
-1	Mild verbal expressions displaying hostility in interaction
0	Neutral or non-significant acts for the inter-nation situation
1	Minor official exchanges, talks or policy expressions- mild verbal support
2	Official verbal support of goals, values or regime
3	Cultural or scientific agreement or support
4	Non-military economic, technological or industrial agreement
5	Military economic or strategic support
6	International freshwater treaty, major strategic alliance
7	Voluntary unification into one nation

Table 2 Conflict BAR event intensity scale

Source: Priscoli and Wolf, 2009.

Absence of conflict does not mean automatically well-established cooperation; many transboundary basins do not share their resources equitably and reasonably on the basis of international law and many either do not have any agreement at all or only an insufficient one, for example without joint organizations (Philipps et al. 2006). Conflict and cooperation often even occur simultaneously, since conflict is not only negative and not any type of cooperation is positive for all riparian countries (Zeitoun and Mirumachi 2008). Notably, uncritical acceptance of traditional forms of ‘cooperative’ arrangements can actually sustain the conflict which they should have transformed. Zeitoun and Mirumachi (2008) for example argue that if transboundary water management agreements are not implemented, if they are unfair or only very minimal, this may perpetuate an inequitable and unsustainable order. Yoffe et al. (2003) find that the most conflictive basins (those with the greatest number of conflictive events) also belong to the most cooperative ones. They also identify that conflict is more likely to occur bilaterally and that multilateral basins are rather regulated in harmony.

### 2.2.3 Occurrence of conflict and cooperation over shared waters

Transboundary waters create inter-dependence (Phillips et al. 2006) between countries and societies and are therefore a potential source of conflict and/ or cooperation. They also create numerous challenges, such as linguistic and cultural differences, institutional asymmetry, distance from decision-making loci, and frequently, a complex geopolitical

context, disparate institutional practices, sometimes conflicting political agendas, and possibly uneven technical and financial resources (Varady et al. 2012, Morehouse 1995; Ingram et al. 1994).

The allocation of water between riparian countries was one of the first areas of international law and treaty-making, probably because of the crucial importance of water for life (Beyerlin and Marauhn 2011). Some even argued that the organization of the state originates in water rights (Berber in McCaffrey 2007). These led to several doctrines such as absolute territorial sovereignty, absolute territorial integrity, limited territorial sovereignty and finally reasonable and equitable use. The earliest water treaty was concluded in app. 3100 BC between the Mesopotamian city states of Umma and Lagash (McCaffrey 2007). The number of water treaties concluded rose constantly and reached a peak in the 18<sup>th</sup> century due to the disintegration of empires, but also due to the increase in multiple uses of water, including for hydropower, irrigation etc. While many of the early agreements focused on navigation, the scope of water treaties was broadened in the 19<sup>th</sup> and 20<sup>th</sup> century and new treaties were concluded, covering also water allocation and later water quality aspects as well as IWRM. Organizations were created to ensure implementation of these agreements such as in 1909 the International (US-Canadian) Joint Commission or in the 1950s the International Commission for the Protection of the Rhine (McCaffrey 2007).

Different theories see the chances of cooperation between riparian countries in transboundary basins differently (Philips et al. 2006). In the 1980s and 1990s, pessimistic forecasts of water shortages caused fears of water conflicts and even wars among policy-makers so that many governments wanted to secure water supply for their countries at any cost (Philips et al. 2006). Researchers and media even published negative predictions of water wars (e.g. the Independent, 28 February 2006, cited in Zeitoun and Mirumachi 2008). In the first decade of the 21<sup>st</sup> century, the discussion moved from conflicts over water towards a more collaborative approach, towards the concept of benefit-sharing (Philips et al. 2006). This

was mainly due to the finding of Aaron Wolf and his team from Oregon State University that water wars have been very rare in history, based on an analysis of 1,831 water events (Wolf 1998). More than 400 agreements over transboundary waters are currently in force worldwide (Oregon State University 2009). Based on this database, many authors demonstrate that cooperation over transboundary waters has been much more frequent than conflict (for example Yoffe et al. 2003, Wolf 1997, Zentner 2012). It was also shown that countries, which cooperate in general, often also cooperate over water, and countries with overall unfriendly relations are also more likely to be non-cooperative over water issues (Yoffe et al. 2003). The concept of “hydrosolidarity” was developed and defined as: a full upstream/downstream integration of monitoring, stakeholder consultation, models and expert systems that can link basin pressure to transfers, across various administrative and/or political boundaries, and between the various land users, water users and other stakeholders.” (Gerlak et al. 2011: 256).

Even self-interested players, such as some upstream countries, can see a benefit in cooperation, which may lead to positive-sum outcomes (Philips et al. 2006). This can be explained by the concept of benefit-sharing which implies that sharing of benefits derived from the river (e.g. hydroelectricity) can be more politically feasible and therefore more likely than actual sharing of the transboundary resource itself (Zeitoun and Mirumachi 2008). According to some theories such as neo-functionalism, cooperation in low or technical policy areas such as water-sharing can spill over and even trigger cooperation in other more political areas, due to benefit-sharing (Philipps et al. 2006).. High regional interdependence in the Southern African region, for example, has driven cooperation beyond water (Philipps et al. 2006). However, overall problematic relations between riparian countries such as in the Middle East can also lead to a deadlock in cooperation over transboundary waters.

The degree of cooperation depends on numerous factors (Yoffe et al. 2003, for example, see below). The most relevant question for this dissertation is whether climate variability and water scarcity actually lead to conflict, which is a question highly debated by

different authors. Priscoli and Wolf (2009) in their analysis of water-related events find that the majority of cooperative and conflictive events are due to water quantity. Yoffe et al. (2003) do not find any relationship between water scarcity due to climatic conditions and water conflict/cooperation in a basin. Also Allouche (2011) argues that resource scarcity itself cannot explain entirely conflict, political instability and security, but the politics of inequality and allocation play a much larger role. Although international conflicts are sometimes explained by resource scarcity, the current data shows that most conflicts over water and food are much more local than international (Allouche 2011). On the other hand, Zeitoun and Mirumachi (2008) find that water scarcity is a source of conflict in several basins.

In a study by Yoffe et al. (2003), most of the commonly cited indicators linking freshwater to conflict were not confirmed by the data, namely spatial proximity, government type, climate, basin water stress, dams and infrastructure development, and dependence on freshwater resources for agricultural or energy needs (Yoffe et al. 2003). Instead, the most relevant indicators, which could indicate conflict in transboundary basins, seemed to be rapid or extreme changes in physical or institutional settings within a basin – large dams and/or internationalization – and the absence of institutional mechanisms, such as international freshwater treaties. The following indicators were found to contribute to conflictive water relations (Yoffe et al. 2003):

- high population density (higher than 100 persons/km<sup>2</sup>),
- low per capita GDP (<lower than USD 765/person),
- overall unfriendly relations,
- politically active minority groups that might lead to internationalization,
- proposed large dams or other water infrastructure development projects, and
- limitations or lack of freshwater treaties.

The last factor shows that regimes and institutions with legal frameworks are important for preventing water conflicts since they provide a mechanism for mitigating or managing the

uncertainty in the international arena and because they reflect a country's ability to understand and cope with stresses upon water resource systems (Yoffe et al. 2003). Wolf et al. (2003) come to similar conclusions, but underline the importance of institutional capacity in a basin: "The likelihood and intensity of dispute rises as the rate of change within a basin exceeds the institutional capacity to absorb that change".

#### **2.2.4 Climate change and transboundary water management**

On the one hand, as shown above, many transboundary rivers are projected to be significantly impacted by climate change impacts (see section 1.1.1). Climate change impacts and especially the expected changes in runoff and water availability as well as the increased water demand in future decades will represent an additional challenge to transboundary water regimes, increasing the potential for conflict between riparian countries. For instance, unilateral measures for adapting to climate-change-related water shortages can lead to increased competition for water resources and thus to tensions (UNECE 2009).

On the other hand, transboundary water cooperation is recognised as an effective policy and management tool to adapt water management to climate change in transboundary basins, (Bates et al. 2008). In particular, transboundary cooperation can help to enable more efficient and effective adaptation since some measures that support adaptation in one country can be more effective if they are taken in another country (UNECE 2009). Prevention of flooding, for instance, can be realized by creating retention areas and such areas may be located in the upstream country (UNECE 2009). In general, transboundary cooperation in climate change adaptation can widen the knowledge/information base, enlarge the set of available measures for prevention, preparedness and recovery and thereby help to find better and more cost effective solutions for climate change adaptation (UNECE 2009). In addition, enlarging the planning space enables measures to be located where they create the optimum effect from the basin perspective. In some instances, for example, it might be appropriate to make payments

to an upstream country for management practices of the basin that bring benefits downstream (e.g. reduced flooding and sediment loads, improved water quality) (UNECE 2009).

### **2.2.5 Vulnerability of existing transboundary water management regimes**

Certain transboundary agreements are not sufficiently adapted to climate change and other water stressors and therefore need to be revised, according to some authors such as Dellapenna (1999). Draper and Kundell (2007) analyze which transboundary water agreements are potentially most at risk due to climate change impacts, considering the regional IPCC climate projections (i.e. not based on the regime's institutional design, but based on their location and corresponding climatic vulnerability). They conclude that the following transboundary agreements are at high risk, so that they might need to be revised to take into account climate change impacts:

- 10 transboundary African basins, especially the Nile basin,
- 15 water sharing agreements in Western Asia (Middle East) because of projected estimates of reduced yields in the future,
- The agreements between India and Bangladesh,
- The agreements on the Mekong river,
- The agreements on rivers in Southern and Mediterranean Europe,
- The 1994 Convention on Cooperation for the Protection and Sustainable Use of the River Danube because the lower basin will be affected by climate change similar to basins in the Mediterranean area,
- The 1978 Treaty for Amazonian cooperation and the agreement on the La Plata,
- Transboundary agreements between the United States and Mexico as well as interstate water sharing agreements compacts in the south-western and Midwestern part of US states.

De Stefano et al. (2009 and 2012) find that the most vulnerable basins to climate change are in Africa, Latin America, Central Asia and Eastern Europe. While presently the most vulnerable basins are located in sub-Saharan Africa and in North Africa/ the Middle East, future vulnerability covers also more non-African basins (de Stefano et al. 2012). Among the European basins found to be most vulnerable are the Mesta, Kura/ Araks and the Neman basin- one of my case study basins which was also identified as having a low adaptive capacity in my research (see chapter 4.4).

### **2.3 *Explaining institutional change***

Institutional rules on the one hand shaped by human actors and on the other hand restrict and influence human behaviour (Héritier 2007). Thus, institutions can be a causal factor for institutional change or the object of explanation (Héritier 2007). In my case, institutions are the subject of analysis and explanations.

Transboundary water institutions and regimes are mostly fixed in terms of conventions or other legal contracts, however, as shown above, climate change requires them to be flexible and possibly change. Numerous authors such as Héritier (2007) and North (1990) explain the reasons for and process of institutional change; however, mostly referring to the breakdown of the former Soviet Union or the institutional change within the evolution of the European Union. Institutional change is important for the dissertation, but mainly to analyze under which conditions transboundary water management regimes can be expected to change under a changing climate.

When information regarding the environment is improved, this can lead to small incremental changes in institutional design if the transaction costs are not too high. (North 1990, cited in Héritier 2007). Since knowledge of actors is imperfect, new information and the gradual learning of actors represent the most important sources of institutional change. This view seems to be the most appropriate for climate change which is a gradual process and requires monitoring, learning, research and exchange of information. An exogenous shock

(such as extreme weather events due to climate change) can accelerate the process and exert pressure to redesign institutions (North 1990).

If actors do not know enough about a problem they hesitate to engage in cooperation (Snidal 2004). Given the high uncertainty due to climate change, Snidal's reasoning might explain why governments cooperate so little in climate change adaptation so far despite of the obvious benefits of cooperation demonstrated above. However, with gradual increase of knowledge, increasing trust in the counterpart and decreasing political uncertainty soft institutional rules of cooperation tend to be changed to constraining institutional rules (Snidal 2004). This could also be relevant for transboundary water management under climate change conditions which might be formalized with time according to this explanation.

Ostrom (1990) identifies as precondition for institutional change that most involved persons need to:

- 1) believe that they will be negatively affected if they do not adopt an alternative management,
- 2) be affected similarly by the changes,
- 3) appreciate the continuation activities from the common pool resources,
- 4) have low information, transformation and enforcement costs and
- 5) all share some level of reciprocity and trust.

For other authors (Majone 1989, Saleth and Dinar 2004), the role of individuals in institutional change is more important. They argue that the institutional change process starts with the perception of a need for change. This is followed by three other phases, namely procedural institutional change, substantive institutional change and actual performance impact. These phases are considered indirectly in my thesis, in particular the perception, procedural change and performance impact in relation to transboundary water management institutions having to adapt to climate change.

## **2.4 *Institutional flexibility***

As shown above, transboundary treaties or agreements facilitate cooperation in transboundary basins. However, while the conclusion of a treaty between riparian countries has many advantages such as increasing certainty for the user (McCaffrey 2003), it also has some disadvantages since change is frequent in freshwater systems, but treaties often are too rigid to adapt to such changes. “While the rules of customary international law, properly understood, are sufficiently flexible to permit adaptation to changed circumstances, treaties are in principle rigid instruments that are modifiable only pursuant to their terms or by mutual agreement, and that may not be suspended or terminated except under certain very limited conditions. Moreover, if a treaty lacks built-in flexibility, and an unforeseen event occurs causing asymmetric harm, the state harmed most may want to deviate from or even terminate the treaty, while the other state may not, because it continues to benefit from the agreement.” (McCaffrey 2003: 156). Several water-related conflictive events (as contained in the Oregon State University Database) and court rulings such as the ruling of the International Court of Justice on the Gabčíkovo case between Hungary and Slovakia demonstrate that it is very difficult for a state not to comply with its obligations under a treaty only because of changed external conditions, such as less available freshwater resources (McCaffrey 2003).

Since climate change is a gradual process with many uncertainties, it seems that increasing gradually the flexibility of existing transboundary water management regimes might be more appropriate than abrupt institutional change. Sound adaptive water management relies on functioning institutions that can cope with changes and adapt to new information, not only in meteorology and hydrology, but also the more rapid changes in the socioeconomic structure, demographics, technology and public preferences regarding strategies for sustainable development (Stakhiv 1998). Korenemos et al. (2001) even state that flexibility is one of the most important design features of international institutions as it enables to deal with the pervasive uncertainty in international politics, as well to address distributional issues. Korenemos (2005, cited in Héritier 2007) in her theory of “flexible

institutional design” argues that introducing flexibility provisions into a treaty allows to react to unanticipated exogenous shocks. She analyses the following flexibility provision: escape clauses<sup>5</sup>, renegotiation clauses and provision of limited duration of treaties.

The theory of institutional flexibility can be helpful for considering transboundary regimes under a changing climate. Koremenos et al. (2001) distinguish between adaptive and transformative institutional flexibility. Escape clauses such as the special provisions in some transboundary agreements regarding allocations in periods of drought are examples of adaptive institutional flexibility whereas stronger, less desirable elements such as renegotiation of treaties are examples for transformative flexibility. Koremenos (2001) argues that increasing regime flexibility also makes regimes more robust because such regimes are then better prepared for a wide range of possible futures. Koremenos et al. (2001) analyse the rational design of international institutions and find that higher uncertainty (for example due to climate change) will lead states to adopt more flexible international regimes.

However, is institutional flexibility actually beneficial for countries and, if yes, which kind of institutional flexibility? Not many existing studies and theories deal with this question. Kucik and Reinhardt (2008) analyse the positive and negative implications of flexibility arrangements using the antidumping mechanisms in the international trade regime as an example. They find that these flexibility mechanisms support adhesion to the global trade agreement by more countries since they give arguments to the government to withstand and overcome domestic pressures. Kucik and Reinhardt (2008) state that adaptive flexibility in treaties can be useful whereas transformative institutional flexibility can be problematic since renegotiation of treaties is very time-consuming and characterized by an open outcome. Adaptive institutional flexibility provisions have the following advantages (Kucik and Reinhardt 2008):

- they define legal standards which can limit the abuse of these provisions,

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<sup>5</sup> An **escape clause** is “any clause, term or condition in a contract that allows a party to that contract to avoid having to perform the contract under certain conditions” (Wikipedia 2009).

- they legitimate the use of such provisions when meeting the mentioned standards, which can prevent excessive retaliation from other Parties, and
- They provide a mechanism to assess and limit demands on the compensation due to the adversely affected Parties.

Kucik and Reinhardt (2008) also claim that treaties with flexibility provisions allow concluding deeper and more far-reaching treaties and more sustained levels of compliance but admit that this assumption has not yet been proven empirically.

However, flexibility provisions can also have disadvantages. Renegotiation and unilateral invocation of escape clauses is costly (Koremenos et al. 2001). States may need a highly sophisticated domestic institutional capacity for justifying the use of the flexibility provisions, for example for proving that a drought is occurring which justifies that they may deliver less water downstream. This requires allocation of resources and development of expertise (Kucik and Reinhardt 2008). There is also a risk of abuse of escape clauses: states can develop self-serving interpretations of escape clauses which run counter the original intentions. Such incentives increase with the number of Parties to an agreement. Koremenos et al. (2001) therefore assume that flexibility decreases with the number of Parties to an agreement. Empirical studies on the efficiency of these flexibility mechanisms are still rare. Kucik and Reinhardt (2008) find that the inclusion of flexibility provisions in the global trade regime has been overall effective, i.e. led to an increase in overall welfare. However, it is uncertain and not yet researched whether this also applies to transboundary water management regimes.

## **2.5 Flexibility mechanisms for coping with climate change**

According to several experts, the ability of a transboundary regime to cope with climate variability and climate change depends on its regime and institutional design (Goldenman 1990, Drieschova et al. 2008). Certain institutional characteristics and mechanisms are more likely to increase adaptive capacity of transboundary regimes, as

described in section 2.4. This section presents some of the mechanisms used in transboundary water management regimes, their use as well as advantages and disadvantages in addressing flow variability.

### **2.5.1 Institutional mechanisms for addressing flow variability**

Firstly, the general components of most transboundary water management regimes can be considered, namely sharing of data, joint basin management and development structures, including communication, dispute settlement procedures and legal texts, i.e. the underlying treaty (Goldenmann 1990). Regarding sharing and exchange of data, riparian countries should agree on a common definition of climate change and the expected impacts through elaborating joint scenarios and models, agree on meteorological and hydrological data to be monitored and on thresholds to decide on whether a parameter change is long-term or transient.

Treaties and legal agreements for transboundary cooperation are important, but often rigid and difficult to change (McCaffrey 2003). It is therefore recommended to include procedures for amendment of the agreement, for example integrating into treaties periodic review or provisions for adjustments, including specification of “triggers”, i.e. magnitudes of climate change indicating that a treaty should be adjusted or time schedules for reviewing of treaties (Goldenman 1990).

Improving communication between riparian Parties of the agreement helps to adapt to climate change since this contributes to building trust and enables joint climate change impact assessments (Drieschova et al. (2008), Cooley et al (2009) and UNECE (2009)), to solve possible water conflicts and to negotiate water allocations in case of changing climatic conditions, thus removing the need to rely entirely on inflexible rules on resource sharing (UNECE 2009). Communication channels can be established through meetings and negotiations, for example under a joint body (Goldenman 1990). Therefore, river basin commissions with a wide scope, competence and jurisdiction are very important for making

transboundary agreements “climate proof”. However, the existence of joint management structures such as joint bodies alone is not enough, their design and implementation also counts. For example, scrupulous recordkeeping, honest disclosure, obligations to notify and to consult in cases of reduced water availability, mechanisms for data exchange and joint monitoring are essential elements for adapting transboundary agreements to climate change (Goldenman 1990). In addition, conflict resolution mechanisms such as compulsory fact-finding, conciliation, inquiry or arbitration can provide a mean to solve conflicts between concerned parties (Goldenman 1990).

In some basins, following the theory of integrative bargaining, it can be helpful for addressing flow variability to broaden the scope of cooperation to go beyond water allocation and to include in the cooperation gains on matters they perceive of equal importance (Goldenman 1990). For example, simultaneous discussion on several related issues such as water and energy or food exchange can allow trade-offs as one possible mechanism for solving conflicts, for instance, over how to divide unexpectedly low flows in the implementation phase of the regime (Drieschova et al. (2008) as well as Cooley et al. (2009)). Integrated Water Resources Management provides such a framework for expanding the scope of many existing agreements since it seeks to balance interests of different water use sectors (Cooley et al. 2009).

These mechanisms, mainly those aimed at improving communication, can be considered as “no regret” mechanisms, which are useful for transboundary cooperation even if flow variability does not increase. However, communication measures are just a basis, creating a forum for negotiation, and usually need to be complemented by additional instruments defining how to deal with water quantity, i.e. water flow, and quality in the basin (Goldenman 2004). Therefore, Drieschova et al. (2008) recommend hybrid mechanisms and combination of flexibility mechanisms.

Changes in water flow, whether due to climate change or not, can be especially problematic and lead to conflicts in agreements with water allocations. 37% of all transboundary water management regimes include water allocations, but these are often only volumetric and not flexible allocations (Cooley et al. 2009). Therefore, they might need to be revised to address flow variability better. The various strategies for water allocation differ in their suitability for climate change adaptation (Draper and Kundell 2007, Drieschova et al. 2008):

- **Limitations for storing water for hydropower upstream**

If the transboundary agreement sets quantitative limitations on water storage by upstream parties, the downstream Party may be disadvantaged if the overall flow is reduced due to climate change, but the upstream country may still store as much water as before.

- **Water allocations by total amount of water**

If a specific quantity of water by the upstream party is mandated at a particular location on the shared resource, the upstream Party is disadvantaged, if the overall flow is reduced, but the amount of water to be delivered remains the same as before.

According to Drieschova et al. (2008), useful mechanisms for water allocations in times of a changing climate, which can increase the agreement's flexibility, include:

- **Prioritization of water uses in case of drought.**

An agreement can specify which water uses are considered as priority in case of insufficient water for all. However, if priorities of use are set in the transboundary agreement according to specific water demands, such as agricultural or municipal water use, it might be difficult to modify the agreement since modification may leave some users without the water necessary to meet their overall demand and thus attempts to replace the agreement may face significant political and economic opposition (Drieschova et al. 2008). This corresponds to

the doctrine of priority of uses which, however, was meant to be flexible, at least to some extent. Thus, it is preferable to keep this allocation mechanism somewhat flexible.

- **Allocation of water based on percentage of flow**

Dividing the overall water among the parties according to a certain percentage of the flow seems to be the best strategy to cope with climate change impacts (Drieschova et al. 2008). However, it takes some time to collect and agree on the hydrologic data and to translate this into permitted volumetric extraction, based on the fixed percentage withdrawal rate.

- **Periodic, for example annual review of water allocations**

This mechanism works best in basins with comprehensive basin management in which an independent commission, under supervision and policy control of the states involved, allocates water according to a predetermined objective function. The fairness of this strategy under climate change conditions depends on the fairness of the negotiations, the impartiality of the joint body and the predetermined objective function (Drieschova et al. 2008).

- **Special provisions**

Agreements can include special provisions, for example if total flow is lower than a specified percentage the upstream country can deliver less water (but still a minimum amount) during a limited number of years which has to be made up in the period following the drought (Drieschova et al. 2008).

- **Indirect allocation mechanisms**

Agreements sometimes do not specify actual allocations, but rather the procedures for agreeing on allocations, such as obligations to notify, prioritization of water use or obligation to consent.

## **2.5.2 Use of such mechanisms in reality**

Drieschova et al. (2008) analyse a sample of 50 transboundary cooperation treaties signed between 1980 and 2002 according to their incorporation of the above mentioned

mechanisms (see fig. 2) and display the results in a graph, ordering the mechanisms on a continuum of binding- non binding and flexible- inflexible. Among the flexibility mechanisms most often used in reality are those which provide a high degree of flexibility and have a low degree of enforceability such as conflict resolution, principles of allocation and broadening of cooperation (Drieschova et al. 2008). Many transboundary agreements include broadening clauses (in particular non-water and water linkages since such mechanisms contribute to the stability and longevity of treaties during their implementation phase (Fischhendler 2004)). On the other hand, the mechanism of percentage allocation, identified by Draper and Kundell (2007) as most effective for climate change adaptability, is only used in a minority of 6 cases within the sample of Drieschova et al. (2008). The graph also shows that those mechanisms with a high degree of enforceability and low flexibility such as fixed allocation are used less frequently than more flexible ones such as indirect allocation and data exchange.

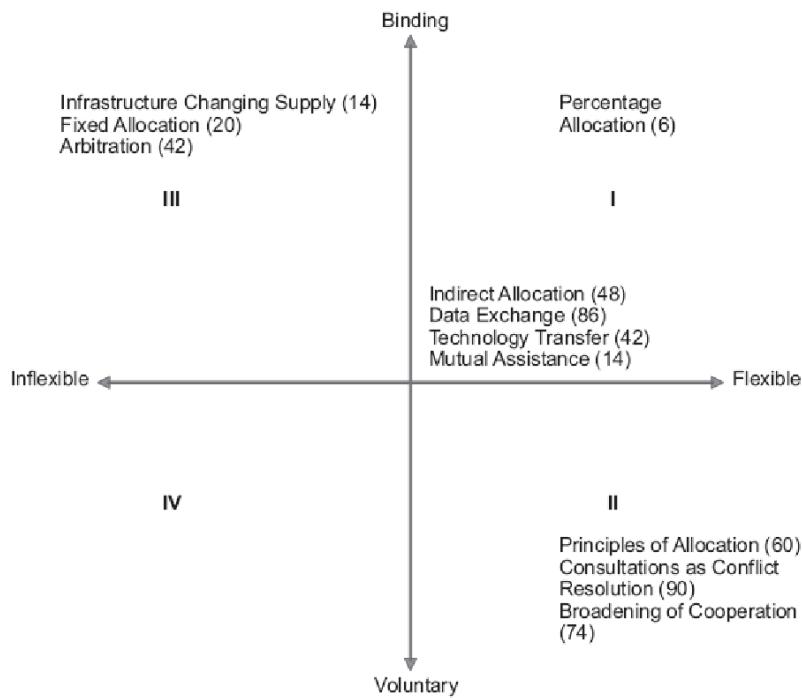


Fig. 2. Governance strategies and mechanisms in transboundary water law to address flow variability.

#### Figure 2 Matrix of mechanisms in transboundary water regimes to address flow variability

Source: Drieschova et al. 2008

In reality, some of the flexibility mechanisms recommended above have not helped the transboundary regime in addressing flow variability for different reasons such as climatic reasons (climate variability was higher than expected in the case of Mexico) or political reasons outside of the water field (Fischhendler 2004). It is thus necessary to examine in more detail which mechanisms have been used by states and why they were (or not) effective in order to assess which mechanisms are most useful for transboundary agreements under specific circumstances.

### **2.5.3 Advantages and disadvantages of such flexibility mechanisms**

All the flexibility mechanisms have advantages and disadvantages, such as political costs and uncertainty for riparian countries (Drieschova et al. 2008). For example, the flexibility provisions are often not exactly defined in transboundary agreements, which can lead to differing interpretation by riparian states (Goldenman 1990). There might be a trade-off for countries between flexibility and certainty about flows/ enforceability. Goldenman (1990) argues that the need for countries to have specificity and completeness in treaties is in contradiction with the requirement for flexibility in treaties to be better prepared to climate change. Annual negotiation of water allocations can have high political costs, can be affected by power asymmetries and changes in government, elections etc. This might be one of the reasons why some countries are hesitant to include such flexibility mechanisms in agreements. To be effective in increasing adaptive capacity, the presented mechanisms need to be very specific on how and when the provisions can be used, require compliance by all Parties as well as independent and mutually recognized data (Cooley et al. 2009). The mechanisms therefore have to be chosen according to local conditions. All agreements are different and require an individual assessment of their preparedness to climate change with recommendations for possible improvements (Cooley et al. 2009).

## 2.5.4 Explanatory mechanisms for treaty effectiveness

A recent example of such a study is provided by Zentner (2012) who analyses, as part of a larger World Bank funded project, the success of treaties in managing hydrologic stress and finds that treaty design plays a significant role in explaining the absence of conflict in situations of water stress and water scarcity in transboundary river basins. He finds that drought and water-stress **can** be a reason in some cases, but **is not the primary reason for water-related conflict or climate-related complaints**. He analyses seven explanatory mechanisms for resilience found in the literature:

- *Specificity*: describes the precision of rules and regulations guiding the stakeholders' actions, such as guidance for implementation of a transboundary water management treaty or agreement on common methods for measurement of water quantity or quality in a specific basin,
- *Uncertainty management*: this describes the recognition and planning for the possibility that available data may not accurately reflect current conditions or that the future may unfold differently than expected, such as preparation of alternative scenarios for the future, variability management for flood and drought etc.,
- *Enforcement*: mechanisms to ensure compliance with and adherence to the treaty, such as dispute resolution mechanism in times of disputes,
- *Communications*: this includes for example data and information exchange between the riparian countries, scheduling and holding of meetings, data validation etc.,
- *Flexibility*: this includes mechanisms to manage flow variability such as treaty amendment mechanisms, communication mechanisms for observing and communicating changes in flow,

- *Integrativeness*: this mechanism describes the extent to which the treaty includes other related policy areas, such as non-water exchanges or concessions linked to water issues,
- *Scale*: this describes policy directions for regional, national and local management, such as public participation provisions, linkages to the national and other policy levels etc.

Interestingly, his results indicate however that less robust treaties with fewer flexibility mechanisms tend to have the least amount of conflicts (Zentner 2012). Instead, political, economic and social influences seem to determine the effectiveness of transboundary water management regimes and the occurrence of water complaints. He also finds that flexibility, scale and enforcement indicate less conflict and climate-complaints (i.e. conflictive events between the governments of at least two riparian countries which can be explained by climatic reasons such as droughts or floods) whereas communications, specificity and integrativeness indicate the opposite. He however also recognizes the absence of a clear linearity between the inclusion of mechanisms and cooperation. He explains these surprising results with the fact that the importance of a treaty for each country is shaped by the country and depends on the political will of the country and attitude towards the treaty. Another explanation is that increased treaty capacity can lead to more complaints. Finally, he recognizes himself that climate complaints may not be an appropriate indicator for treaty effectiveness since it can actually sometimes illustrate that a treaty is functioning properly.

My research therefore used the ability to deal with past flow variability without conflict as well as development of climate change impact and vulnerability assessment and basin-wide adaptation strategy as indicator for adaptive capacity. Since Zentner (2012) cannot confirm his initial hypotheses, my dissertation considered different possible enabling factors which are more institutional and relate to the actual implementation and “life” of a treaty and the corresponding river basin organization.

## **2.6 Adaptive capacity of institutions**

Adaptive capacity<sup>6</sup> is an important concept in climate change adaptation. It is part of the larger concept of vulnerability which consists of exposure, sensitivity and adaptive capacity (Adger and Vincent 2005). Adaptive capacity includes, for example, the capacity to modify exposure to risks associated with climate change, to absorb and recover from losses due to climate change impacts, and to exploit new opportunities that arise in the process of adaptation, such as beneficial climate change impacts, e.g. a longer growing season due to high temperatures (Adger and Vincent 2005).

IPCC (2007: 727) defines adaptive capacity as “the ability or potential of a system to respond successfully to climate variability and change, and includes adjustments in both behaviour and in resources and technologies”. Pahl-Wostl (2010:355) adds in addition to this definition: “Adaptive capacity refers to the ability of a resource governance system to first alter processes and if required transform structural elements in order to better cope with experienced or expected changes in the societal or natural environment.”

Since adaptive capacity is one of the components of the concept of vulnerability which can more easily be influenced than for example exposure, indicators for adaptive capacity are very important, for example in decisions to allocate climate funding under the UNFCCC. However, adaptive capacity is very difficult to determine on a quantitative scale and therefore more often described qualitatively (Adger and Vincent 2005).

Factors influencing adaptive capacity are seen differently by different authors, also depending on which is the object of the study, i.e. the system which is adapting. Such determinants can include, for example, access to information, technology, infrastructure and equity. Networks, associations and capital also play an important role in adaptation (Adger 2003, Adger and Vincent 2005). According to Mosello (2013), adaptive capacity is determined by government and governance, human and social resources, information

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<sup>6</sup> In this dissertation, adaptive capacity is always to be understood as adaptive capacity to climate change even if climate change is not explicitly mentioned.

management, infrastructure and finances and risk. Multi-level governance between the international, national, sub-national and local level are also influencing adaptive capacity. The relative weight of each factor depends on the basin (Mosello 2013).

Gupta et al. (2010) analyse and build a comprehensive theoretical framework for assessing the adaptive capacity of institutions, especially in the water field. They find that the following characteristics of institutions increase adaptive capacity:

1. Variety,
2. Learning capacity,
3. Room for autonomous change,
4. Leadership,
5. Resources, and
6. Fair governance.

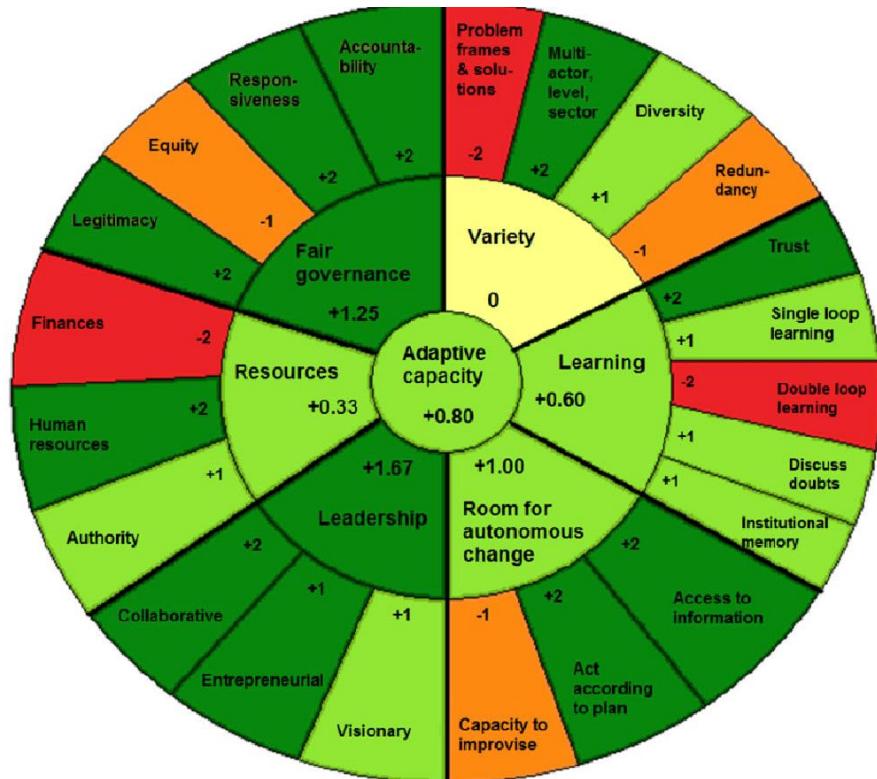
Each of these characteristics has at least 3 sub-dimensions. Table 3 below shows the different criteria and definitions of these dimensions which help to evaluate adaptive capacity. An additional column has been added to the table illustrating the relevance of the factors for transboundary basins and their cooperative management. The so called adaptive capacity wheel was developed by Gupta et al (2010) in order to visualize the outcomes of evaluations of institution's adaptive capacity. The different dimensions of adaptive capacity are included in the wheel while the results for the different dimensions of this analysis are then reflected in the colors. Gupta et al. (2010) applied this framework and analysed the adaptive capacity of different water management institutions such as the performance of institutions in the Dutch cities of Delft and Zaandam as well as other Dutch institutions. The results displayed in the adaptive capacity wheel (see fig. 3) helps the institutions and their representatives to understand how they could increase their adaptive capacity.

**Figure 3:** Adaptive capacity wheel and its application to Dutch water management institutions

Source: Brink et al. 2013, Gupta et al. 2010



Effect of institution on adaptive capacity	Score	Aggregated scores for dimensions and adaptive capacity as a whole
Positive effect	2	1,01 to 2,00
Slightly positive effect	1	0,01 to 1,00
Neutral or no effect	0	0
Slightly negative effect	-1	-0,01 to -1,00
Negative effect	-2	-1,01 to -2,00



<b>Dimension</b>	<b>Criterion</b>	<b>Definition</b>	<b>Transboundary aspects</b>
Variety	Variety of problem frames	Room for multiple frames of references, opinions and problem definitions	Involvement of stakeholder from all riparian countries
	Multi-actor, multi-level, multi-sector	Involvement of different actors, levels and sectors in the governance process	Transboundary-national-local relations and governance
	Diversity of solutions	Availability of many different policy options to tackle a problem	Different national solutions can be shared
Learning capacity	Redundancy	Presence of overlapping measures and back-up systems, not cost-effective	Adaptation measures taken by different riparian countries
	Trust	Presence of institutional patterns that promote mutual respect and trust	Equal chances and opportunities for all riparians
	Single loop learning	Ability of institutional patterns to learn from past experiences and improve their routine	Learning mechanisms at the RBO
	Double loop learning	Evidence of changes in assumptions underlying institutional patterns	
	Discuss doubts	Institutional openness towards uncertainties	Recognizing uncertainties in cc e.g. Danube
	Institutional memory	Inst. provision of monitoring and evaluation processes of policy experiences	
Room for autonomous change	Continuous access to information	Accessibility of data within institutional memory and early warning system to individuals	Exchange of data, early-warning systems at basin level
	Act according to plan	Increasing the ability of individuals to act by providing plans and scripts for action, esp in disasters	Flood risk reduction and Disaster risk reduction plans
	Capacity to improvise	Increasing capacity of individuals to self-organise and innovate, foster social capital	
Leadership	Visionary	Room for long-term vision and reformist leaders	Executive Secretary or lead country, president
	Entrepreneurial	Leaders that stimulate undertaking and actions, leadership by example	Executive Secretary or lead country, president
	Collaborative	Leaders who encourage collaboration between different actors, adaptive co-management	Very important for tb basins where mediation/conflict management is needed
Resources	Authority	Provision of accepted or legitimate forms of power	Legitimate and accepted RBO
	Human resources	Availability of expertise and knowledge and human labour	Sufficient staff members at RBO
	Financial resources	Availability of fin. resources	Fin. Resources for RBO
Fair governance	Legitimacy	Whether there is public support for a specific institution	Legitimacy of RBOs
	Equity	Are institutional rules fair?	Equal involvement of all countries
	Responsiveness	Do institutional patterns show response to society?	Stakeholder involvement
	Accountability	Do institutional patterns provide accountability procedures	

**Table 3: Adaptive capacity dimensions and criteria**

Source: Adapted from Gupta et al. 2010

Part of this framework was also applied to my research and the case studies, namely the following dimensions:

1. Learning capacity: did the transboundary regime/ organization actually learn from past experiences of flow variability and was it revised following these experiences?
2. Leadership: does the leadership by the head of the transboundary commission or the country chairmanship play an important role in the adaptive capacity?
3. Resources: do the financial and human resources of the transboundary commission influence the regime's adaptive capacity?

Both the approaches by Drieschova et al. (2008) and Goldenman (1990) as well as Gupta et al. (2010) consider flexibility as an important factor for adaptive capacity of institutions for transboundary water management as well as institutions in general. However, Drieschova et al. (2008) and Goldenman (1990) place emphasis on the legal provisions of the transboundary water agreement or convention. Gupta et al. (2010) follow a wider approach emphasizing the management and actual life of the institution and organization, including leadership (which could in my research refer to the head or the executive secretary of the river basin commission) and financial resources available. My dissertation helped to analyse the relevance and relation of these approaches, focused on the one hand on the legal agreement for transboundary cooperation and on the other hand on the organizational characteristics of the bodies and organizations responsible for transboundary water management.

## **2.7 Adaptive water resources management**

North's and Snidal's concept of gradual institutional change (North 1990, Snidal 2004) is similar to the concept of adaptive management, used in water and ecosystem management in general. The idea of adaptive management has been developed in the field of ecosystem management some time ago (Pahl-Wostl 2007). It is based on the understanding that it is nearly impossible to predict future key drivers influencing an ecosystem and the resulting

system behaviour and responses. Therefore, management should be adaptive and enable changes in management practices based on new experience and knowledge gained.

Adaptive management is more and more often highlighted as an approach to deal with the high uncertainty of climate change on water management<sup>7</sup>. Adaptive management describes a systematic process of steadily improving management policies and practices by learning from the outcomes of implemented policies and management strategies (Rijke et al. 2012). Learning requires research to improve discovery and understanding, capacity-building to increase the population's awareness and capabilities, and implementation to enhance practical progress (Rijke et al. 2012). Pahl-Wostl (2008: 1) defines adaptive management as “a systematic process for improving management policies and practices by learning from the outcomes of implemented management strategies and by taking into account changes in external factors.” Pahl-Wostl et al. (2007b: 4) suggest defining adaptive management as “learning to manage by managing to learn”.

Adaptive management is based on “experimentation”; however, instead of trial and error or casual observation; it should be structured and theoretically driven, so that new knowledge can be incorporated systematically into future management (Arvai et al. 2006). The added value of this concept lies in its ability to help policy makers who are faced with complex problems under high uncertainty. The concept explicitly recognizes uncertainty and complexity and may require major transition of systems to create an enabling environment. Pahl-Wostl (2008) argues that a new attitude towards uncertainty is needed: “Learning to live with uncertainty and being comfortable with it”. The concept of adaptive integrated water management involves replacing the current probability-based risk management styles with integrated risk management and robust policies. Adaptive governance systems require flexible institutional arrangements encouraging reflection, innovative responses, and some redundancy (Rijke et al. 2012). Rijke et al. (2012) underline the important role of different stakeholders

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<sup>7</sup> See for example the recent EU project NeWater funded by the European Union, which analyzed characteristics of adaptive institutions and regimes, as well as the position of a number of case studies, i.e. transboundary basins within their research framework (NEWATER 2009).

for example in adaptation to long-term structural changes, such as climate change adaptation and water allocation in large transboundary water systems. In these situations, networks with a lower degree of centrality and cohesion such as multiple communities and a higher density (i.e. interconnectedness) may be useful since a diverse knowledge base helps to find solutions to complex problems (e.g. Davidson-Hunt 2006).

Agrawal (2002) analyses transboundary protected areas and adaptive management and subsequently argues that adaptive management is based on learning from long-term experience, considering policy interventions as quasi-experiments and collecting and analyzing information about ecosystem response. Learning and feedback is essential for adaptive management as well as stakeholder and community participation. Table 4 provides more details on the characteristics of adaptive management.

**Table 4: Comparison of conventional management and adaptive management**

Based on Agrawal (2002) and Pahl-Wostl (2007)

	<b>Conventional management: prediction and control regime</b>	<b>Integrative Adaptive management</b>
Management paradigm	Prediction and control based on a mechanistic system's approach emphasizing short-term objectives, seek certainty and control	Learning and self-organization based on a complex systems approach promoting longer-run goals emphasizing learning and feedback
Governance	Centralized, hierarchical, narrow stakeholder participation	Polycentric, horizontal, broad stakeholder participation
Sectoral integration	Sectors separately analysed resulting in policy conflicts and emergent chronic problems	Cross-sectoral analysis identifies emergent problems and integrates policy implementation
Scale of analysis and operation	Transboundary problems emerge when river sub-basins are the exclusive scale of analysis and management	Transboundary issues addressed by multiple scales of analysis and management
Information management	Understanding fragmented by gaps and lack of integration of information sources that are proprietary	Comprehensive understanding achieved by open, shared information sources that fill gaps and facilitate integration
Infrastructure	Massive, centralized infrastructure, single sources of design, power delivery	Appropriate scale, decentralized, diverse sources of design, power delivery
Finances and risk	Financial resources concentrated in structural protection (sunk costs)	Financial resources diversified using a broad set of private and public financial instruments
Environmental	Quantifiable variables such as	Qualitative and quantitative

factors	BOD or nitrate concentrations that can be measured easily	indicators of whole ecosystem states and ecosystem services
Value of models and predictions	<ul style="list-style-type: none"> <li>- precise predictions</li> <li>- detailed models</li> <li>- promote scientific consensus</li> </ul>	<ul style="list-style-type: none"> <li>- elucidate range of possibilities</li> <li>- Model from experience and understanding aggregate response</li> </ul> <p>Highlight alternatives and trade-offs</p>

Firstly, adaptive management requires increasing the ability of a system to react to environmental changes, e.g. by reducing water demand instead of increasing water supply (Pahl-Wostl 2007). In the long-run, adaptive management involves more systematic changes such as switching to less water demanding crops. Adaptive management can help to address climate change since it operationalizes flexibility. However, there are numerous challenges to implement this concept (Arvai et al. (2006), such as short time horizons of policy-makers. Pahl-Wostl (2007) recognizes that most water management regimes are currently not adaptive since flexibility was not considered crucial during their construction.

Raadgeber and Mostert (2005) conclude that adaptive management regimes need to fulfil certain criteria in the following five areas:

- A. Actor networks
- B. Legal Framework
- C. Policy
- D. Information management
- E. Financing

Each of these areas contains a number of criteria to be fulfilled. Many of them are similar to the criteria used by Gupta et al. (2010) for analysing adaptive capacity of institutions.

According to the concept of adaptive management, successful adaptation to climate change requires adaptive institutions which can cope with complexity and as well as new challenges and possible surprises (Pahl-Wostl, 2002; Huntjens et al., 2011b and 2012; Pahl-Wostl, 2009). To achieve this, institutional arrangements need to be flexible and encourage experimentation, reflection, learning, trust-building and innovative responses. Thus, a

‘mechanism for facilitating social learning and policy ‘learning’ is needed (Huntjens et al., 2011b) which should include policy experimentation, conflict resolution mechanisms as well as monitoring and evaluation. Better integrated cooperation structures and advanced information management as well as adequate access and distribution of information, public participation and sectoral integration, flexibility and openness for experimentation can also help (Huntjens et al., 2011b).

While the governance structure is important, further research is required to assess the capacity of institutions to adapt to climate change and the way in which institutional arrangements can enhance that capacity (Huntjens et al. 2012) as well as to identify and assess the capacities of these institutional arrangements in diverse settings. My thesis made a contribution in this regard.

## ***2.8 Application of the theoretical framework to my thesis***

In this dissertation, transboundary agreements and the associated river basin commissions were considered as regimes with related institutions (see chapter 3). Based on the literature, it was assumed that climate change would require and possibly lead to some institutional change of these transboundary water management regimes. The adaptive capacity to climate change of these regimes was analysed (for operationalization of the concept adaptive capacity see chapter 3.1) using four European river basins as case studies. Through their analysis, enabling factors for adaptive capacity were identified, partly corresponding to those already described in the literature. These different factors from the literature were in fact used in the description, comparison and analysis of my case studies, namely those factors related to regime design (for example flexibility provisions as described in section 2.5), but also more process- and management related factors, such as those from the adaptive capacity wheel developed by Gupta et al. (2010, see chapter 2.6). The enabling factors from the literature considered in my research included legal and institutional frameworks of the transboundary water management regimes and their design, including flexibility provisions,

information and data exchange, stakeholder engagement, resources, learning capacity as well as leadership. These factors or criteria served as a framework for analysing the case studies (see chapter 4) which in turn was the basis for confirming and identifying general enabling factors for adaptive capacity.

Institutional change due to climate change, which is a long-lasting and gradual phenomenon, is usually not abrupt, but rather a long-term process, corresponding to the concept of adaptive management in these regimes. This concept has also helped in my analysis to understand the adaptive capacity of the transboundary water management regimes which are part of my study.

### **3 Research design and methods**

As demonstrated in the literature review above, while several authors have analysed transboundary regimes from a political scientific (e.g. Wolf 1997, Yoffe et al. 2003) and few from a legal perspective (e.g. McCaffrey 2007), little research has been done on whether and how these regimes, institutions and organizations are adapting to climate change and how their adaptive capacity can be explained and understood. The following chapter 3 describes the framework used to answer the research questions (see 1.2.3), the research design, selection of case studies as well as methods used, namely participatory observation, interviews and document analysis.

#### **3.1 *Operationalization of the research subject***

Considering the IPCC (2007: 727) definition of adaptive capacity (to climate change throughout this dissertation) as “the ability or potential of a system to respond successfully to climate variability and change” the adaptive capacity of transboundary water management regimes can be described as their ability to respond successfully to flow variability. While it is impossible to attribute a specific extreme weather event such as a particular flood or drought

to climate change, and climate change impacts on water resources are uncertain (IPCC 2013), especially at basin level, most transboundary basins have experienced different degrees of flow variability in the past (due to human and natural influences, such as floods and droughts) and the transboundary regime and institutions had to address it. Therefore, it can be assumed that ability to cope with past flow variability is an indicator for adaptive capacity to future flow variability as well (Drieschova et al. 2008, Fischhendler 2004).

In order to operationalize the word “respond *successfully*” in the IPCC definition, the main purpose of transboundary water management regimes should be considered, namely to allocate water between different users and thereby to prevent or to solve conflicts on the water quality and quantity between the riparian countries and water users (Pahl-Wostl 2007). Addressing future flow variability without conflicts is one of the major tasks of the transboundary regime. As flow variability is mainly due to extreme events such as floods or droughts, my study considered past examples of flow variability due to floods and droughts in order to analyze whether transboundary water regimes have been able to address such flow variability without conflicts or not. Other potential climate change impacts on water resources, such as on water quality, were not considered as they are more difficult to attribute to climate change. My research subject (i.e. adaptive capacity of transboundary water management regimes) was thus operationalized with the following indicator:

**Ability to cope with past flow variability in a transboundary basin without conflicts between riparian countries**

For the definition of “conflict” the concept by Priscoli and Wolf 2009 was used (see section 2.2.2) and all “events” below -2 on their scale (between -3 and -7) were considered as conflicts. Thus, in my case study basins, the occurrence of conflicts due to flow variability was analysed (Zentner 2012), through the interviews as well as using the BAR scale of conflicts (Priscoli and Wolf 2009).

Considering that flow variability might increase in the future due to climate change and my thesis analyses adaptive capacity **to climate change**, the actual adaptation activities under such regimes need to be considered. These can include, for example, the elaboration of a transboundary vulnerability and climate change impact assessment, the development of a transboundary adaptation strategy and the discussion, development and possible implementation of adaptation measures at the transboundary level as these activities can help the transboundary regime to prepare for future flow variability. These adaptation activities were thus analysed as secondary indicator for adaptive capacity.

### **3.2 Research design**

This research is a comparative study of transboundary water management regimes to assess their adaptive capacity through identifying different patterns across the cases helping to understand differences in adaptive capacity and possible enabling/ explanatory factors for it. Due to the interrogative word “how” in the research question I studied the process, implementation and design of transboundary water management regimes and institutions using a qualitative research approach. This allowed me to analyse in-depth the adaptive capacity of transboundary water management regimes in my case studies as well as the different enabling factors. I could also consider differing views regarding adaptive capacity by different persons, e.g. downstream countries might evaluate adaptive capacity differently than upstream countries and representatives of transboundary commissions differently than scientists and representatives of non-governmental organizations.

The research design can be described as a mix between inductive and deductive approach (Patton 2002). As shown in chapter 2, the literature already identified a number of enabling factors for adaptive capacity in general and adaptive capacity of transboundary water management regimes in particular, such as regime design variables, namely the existence of flexibility mechanisms in the design of the regime/ legal framework as well as several organizational variables such as leadership, resources, networks, learning capacity and

information management (based on e.g. Gupta et al. 2010, Raadgever and Mosert 2005). These enabling factors were used in my research, for example in the interview guide, and their relevance was analysed in my case studies. Additional factors were identified in the course of my study which corresponds to the inductive approach.

### **3.3 Sampling**

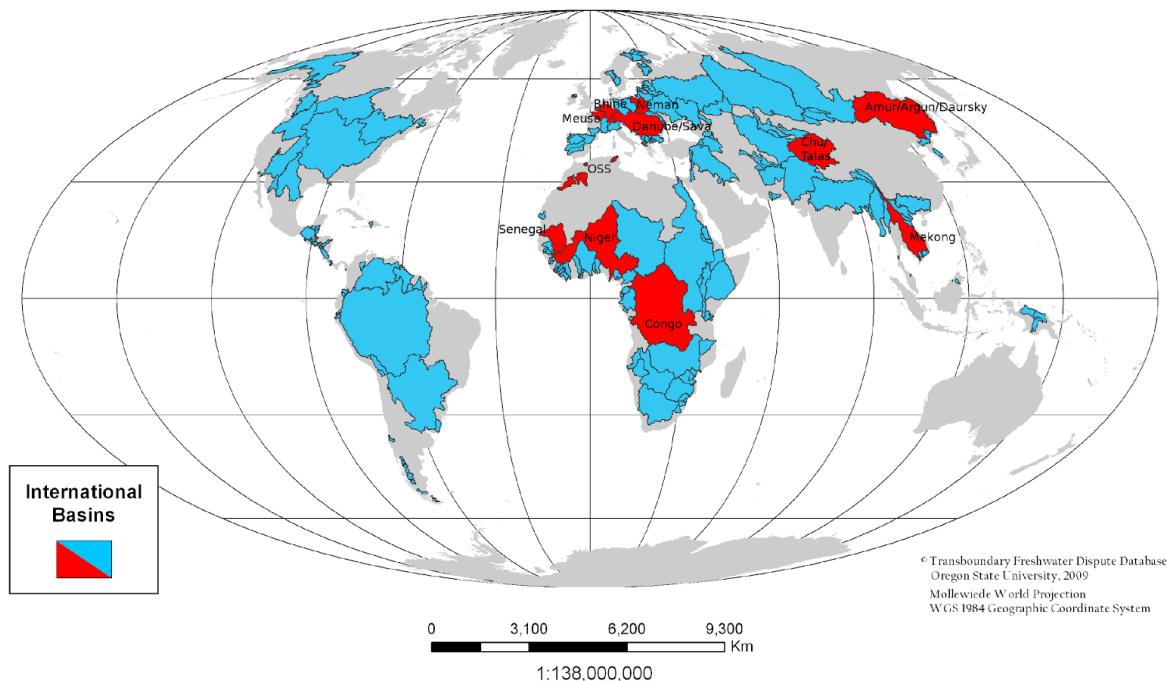
Four basins were selected for in-depth study among all the 276 transboundary basins worldwide with transboundary water management regimes, which are experiencing some flow variability and which are addressing climate change impacts to some extent. According to the concept of purposeful sampling (which means selecting information-rich cases, enabling in-depth understanding (Patton 2002)) I chose all my case studies from Europe due to accessibility of data and information for the research, for interviews and participatory observation, including aspects of language and contacts, but also since European basins have started addressing climate change adaptation and are thus more likely to have a higher adaptive capacity. All of the basins were part of the global network of basins working on climate change adaptation which I am coordinating at my workplace. As can be seen in table 5 and 6, the selected cases had at least some degree of variation, including at least one case where flow variability has led to conflict, as required by intensity sampling (Patton 2002). They also showed some difference in terms of geographic location and economic development, expected climate change impacts, existence and design of transboundary regime and its institutions, of a joint body or river basin commission, existence of flexibility mechanisms in the transboundary agreement as well as success of the basin in dealing with past flow variability. In addition to the four full case studies (see table 5 below) nine other basins were analysed only superficially, as additional evidence (see table 6) in order to support (or reject) findings from the four full case studies. Figure 4 shows the location of the case study basins on a world map.

The aim of the design was theoretical replication, i.e. the cases led to different results and had different adaptive capacity, which enabled analysing in detail the differences in regime and institutional design and other elements as possible enabling factors (Yin 2003). This method corresponded to the replication logic, not to the sampling logic, i.e. statistical generalizations were not possible based on this multiple case study research.

**Table 5: Selected basins for the case studies**

Basin	Riparian Countries	Status countries	Clim ate	Climate change impacts, adaptation activities and reasons for selection
<b>Rhine basin</b>	9: Austria, Belgium, France, Germany, Italy, Liechenstein, Luxemburg, Netherlands Switzerland	Developed EU countries	Moderate	More extreme events, also impacts on water temperature and quality  Chosen since a lot of basin-wide studies were done on climate change impacts and it is very advanced in terms of transboundary cooperation
<b>Danube basin</b>	13: Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Republic of Moldova, Romania, Serbia, Slovenia, Slovakia and Ukraine	EU and some transition and non-EU	Continental	More droughts, flood impacts unclear.  Chosen since it is the first transboundary basin in Europe and worldwide having elaborated a transboundary adaptation strategy. In addition, it includes very diverse countries in its basin, in terms of political, socio-economic development etc.
<b>Neman basin</b>	3: Belarus, Lithuania and the Russian Federation	EU/transition	Moderate	More droughts and earlier floods. Chosen since it is located in countries with economies in transition, but does not currently have a multilateral transboundary agreement in force, only bilateral agreements. It could thus help to analyse whether a formal multilateral transboundary agreement or treaty is necessary for adaptive capacity to climate change
<b>Meuse basin</b>	5: Belgium, France, Germany, Luxembourg, the Netherlands	all developed and EU countries	Moderate	More extreme events, also impacts on water temperature and quality.  Basin has a transboundary agreement and a river basin commission, which are rather weak. Chosen since it is expected to be significantly affected by climate change, leading to higher flow variability and water scarcity, affecting drinking water supply and other water uses

## International River Basins



**Figure 4:** Basins considered in the research (in red) and all other transboundary basins worldwide (in blue)

**Table 6 Basins included in the analysis**

Basin	Riparian Countries	Status of countries	Continent	Climate	Transboundary regime	Climate change impacts	Adaptation activities
<b>Full case study basins</b>							
Neman river basin	Belarus, Lithuania and the Russian Federation	EU/ transition	Eastern Europe	Moderate	No transboundary agreement/institution	Unclear, more droughts and earlier floods	Joint impact assessment, draft strategy
Rhine basin	Austria, Belgium, France, Germany, Italy, Liechtenstein, Luxemburg, the Netherlands and Switzerland,	All developed and EU countries	Western Europe	Moderate	Very advanced Commission and agreement exist	More extreme events, also impacts on water temperature and quality	Joint impact assessment, adaptation strategy under development
Meuse basin	Belgium, France, Germany, Luxembourg, the Netherlands	All developed and EU countries	Western Europe	Moderate	Commission and agreement exist	More extreme events, also impacts on water temperature and quality	Joint impact assessment, draft roadmap for adaptation prepared
Danube basin	Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Republic of Moldova, Romania, Serbia, Slovenia, Slovakia and Ukraine,	EU as well as some transition and non-EU countries	Central and Eastern Europe	Continental	Very advanced transboundary commission and agreement exist	More droughts, flood impacts unclear	Joint impact study, first transboundary adaptation strategy worldwide developed and adopted
<b>Additional basins included in the analysis</b>							
Dniester Basin	Republic of Moldova and Ukraine	Transition	Eastern Europe	Moderate	Bilateral treaty signed in 2012, not in force, Commission to be established	More extreme events, esp. floods	Joint impact and vulnerability assessment
Chu Talas Basin	Kazakhstan and Kyrgyzstan	Transition	Central Asia	Water scarce	Commission and agreement exist	Glacier melting, droughts	Project on adaptation
Sava river basin	Bosnia and Herzegovina, Croatia, Serbia and Slovenia, partly transition	Partly EU, partly transition	South-Eastern Europe	Moderate	Commission and agreement exist	Unclear, likely more extreme events	Project on floods
Amur/ Argun/ Daursky Bio-sphere reserve	Russian Federation, Mongolia and China,	Developing/ transition	Asia	Continental- dry	only agreement covering transboundary protected area	Climate cycling, more droughts	Joint studies, monitoring system enlarged
Drin	Albania, Former Yugoslav	Transition	South-Eastern	Mediterranean	Joint MOU signed in 2011	More extreme events	Adaptation project

	Republic of Macedonia, Greece, Montenegro	countries	Europe	- dry			just started
Niger basin	Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger and Nigeria	Developing countries	Africa	Tropical	Joint agreement and commission exist	More extreme events, floods especially	adaptation activities starting
Congo	Cameroon, Central African Republic, Democratic Republic of the Congo, Republic of the Congo, Equatorial Guinea and Gabon	Developing countries	Africa	Tropical	Joint agreement and commission exist	More extreme events, floods especially	adaptation activities starting
Mekong River	Cambodia, Laos, Thailand and Vietnam, (China and Myanmar not part of the transboundary agreement)	Developing countries	Asia	Tropical	Joint agreement and commission	More floods	Adaptation initiative working on impact assessment, strategy etc.
Senegal	Guinea, Mali, Mauritania, Senegal.	developing countries	Africa	Tropical	Very advanced agreement and commission	More drought	adaptation activities starting

## **3.4 Research methods**

### **3.4.1 Literature review**

As a first step, a detailed literature review was performed in order to identify existing research as well as my “niche”. This included searching for monographs and articles in databases such as “Science direct”, “JStor”, EBSCO and “Elsevier”. Journals searched included “Water policy”, “International Environmental Governance”, Environmental Policy” and many others. This literature review covered the theoretical background (regimes, institutions, institutional change, adaptive management), the research subject and related themes (climate change adaptation and transboundary water management regimes, adaptive capacity etc.), but also the case studies (existing research on the Danube, Rhine, Meuse and Neman river basins) as well as other basins with similar regimes. The literature review helped to focus my research, define my research questions, select the case studies etc. The literature review was done at the outset of the research and updated later during the research process.

### **3.4.2 Overview and justification of methods used**

Using different research methods, which is also called triangulation, generally increases the validity of the results (Patton 2002) since no single source can be trusted alone and provide a comprehensive picture of the situation. Instead, using different methods helps to use the strength of each method while minimizing the weaknesses. Therefore, different qualitative methods were combined, namely participatory observation and in-depth interviews, complemented with document analysis, where necessary or appropriate.

Participatory observation allowed experiencing first hand some crucial events of the transboundary regimes with regard to how they deal with climate change, such as stakeholder workshops or meetings of river basin commissions and their intergovernmental bodies (Patton 2002). Observing more than 10 such events also allowed seeing and understanding relations and interactions between actors and having informal conversations with them.

The 22 interviews permitted me to go beyond the external behaviour and explore the thoughts and feelings of actors from the different basins. This was especially important to better understand the situation, activities, perceptions and interests in my case studies, but also to hear how the actors themselves evaluate the performance and adaptive capacity of their transboundary river management regimes and why. However, interviews could also lead to possibly distorted results due to personal biases, anger, anxiety, politics, and lack of awareness. Therefore, these methods were complemented by document analysis.

A final reason for the selection of the above methods, in particular the interviews was my desire to complement my own, i.e. the researcher's interpretation of the adaptive capacity in the basins and their enabling factors with the interpretation of the participants, i.e. the representatives of the basins- as well as to realize and understand possible differences in interpretation between representatives of the same basin. Representatives of different institutions and different parts of the basin (upstream vs. downstream) often had different perspectives on the adaptive capacity of the regime and the enabling factors for it.

### **3.4.3 Participatory observation**

At least one climate-related event was observed for each of my four full case study basins and several meetings for the Neman basin. These included workshops, working meetings and commission sessions. In all these events field notes were taken and I contributed actively to the discussions and sometimes chaired a few sessions. The events are included in the annex:

In addition, through my work at the United Nations Economic Commission for Europe, secretariat of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE Water Convention) I am in daily contact with transboundary basins from the Pan-European region as well as worldwide. I have been working on the topic of climate change adaptation in transboundary basins for more than 5 years, since 2008. In this framework I was responsible for a programme of pilot projects and a

global network of basins working on climate change adaptation at the transboundary level (UNECE 2013). The network includes annual meetings of all basins, regular larger workshops with a larger audience and representatives of even more basins as well as a web-based platform. I have myself, in cooperation with colleagues, organized 5 global workshops on water and adaptation to climate change in transboundary basins in 2010 to 2014, with more than 100 participants each, as well as four smaller meetings of basins working on climate change adaptation with more than 10 basins represented (see the list of events in the annex). In addition, through my work I participated in at least 20 international meetings, workshops, conferences or sessions related to climate change adaptation and water management. At each of these meetings, usually at least 15 case studies, i.e. examples from different basins were presented. In addition to coordinating the network of basins I was also myself managing the climate change adaptation projects ongoing in two basins, namely the Dniester and Neman. My own involvement in some of the observed events, namely in the case of the Neman, for example as chair of sessions or even co-organizer, implied that I sometimes had to concentrate on other aspects and could therefore not always objectively observe the events. Regarding the Neman basin, language barriers made the observation more difficult since the events were held in Russian language and even with consecutive interpretation it was not possible to fully understand every aspect. Despite of these challenges, the events observed helped to better understand the situation in the respective river basin as well as the different actors involved and how they see and understand climate change, flow variability and adaptation, how they interact with each other, possible conflicts, disagreements and agreements etc. Managing the network as well as the pilot projects allowed me to collect unique first-hand experience and data from my interactions with these basins at the meetings as well as in field trips.

### **3.4.4 Secondary document/ data analysis**

#### *3.4.4.1 Types of documents and data collected and analyzed*

Document data was analyzed as a complement to the interviews and the participant observation primarily for the four full case studies and mainly (but not only) for variables which could not be analysed through other methods, such as the legal framework. For the four primary basins, if a river basin commission or other institutions for transboundary cooperation existed, their work related to climate change and/ or flow variability was analysed, using meeting minutes, reports, press releases or website information. The transboundary agreements in the case study basins were analyzed, including also different versions and revisions of the treaty and its related Protocols, if any. If such amendments of the transboundary agreement existed, the reasons and timeline of changes were analysed, in the document analysis as well as the interviews. In addition, information for example on financing, the river basin commissions' executive secretaries, changes in procedure, their structure, possible working groups, decision-making procedures etc. were searched for. Interviewees were also asked to suggest important documents to review and analyse. Among the documents studied were short annual reports which were submitted by the above mentioned basins yearly to the Water Convention secretariat on their climate change activities (UNECE 2014). The four case study basins were analysed for conflicts using the water events database hosted by the Oregon State University (OSU 2009) which contains conflictive and cooperative water events, however, only until 2008.

#### *3.4.4.2 Analysis of the documents and data*

The documents and especially the agreements for transboundary cooperation, but also other important documents, such as decisions of the river basin commission relating to climate change adaptation, were analysed through qualitative and quantitative content analysis i.e. through searching of underlying themes in the analysed material such as climate change

and flow variability, floods, droughts, water scarcity or extreme events. The following types of content analysis were applied, where appropriate and depending on the issues: word counting analysis, conceptual analysis and contextual analysis (Ahuja 2001). For example, I counted how often “floods, “drought” or “climate” was mentioned in a certain agreement. Documents and especially the legal frameworks were also compared between the case studies, especially with regard to the flexibility provisions they contain and changes in the institutions for transboundary cooperation.

### **3.4.5 In-depth Interviews**

22 in-depth semi-structured interviews were conducted with key actors of each of the full case study basins from different organizations. In-depth interviewing was important, in order to understand in detail the perspectives of different actors, such as staff members of the river basin commissions, national delegates, representatives of non-governmental organizations and academic experts. Through the interviews I gathered their understanding and opinion on flow variability, climate change impacts, adaptation activities, adaptive capacity, the transboundary regime, its design and effectiveness. For example, the performance of the latter and its adaptive capacity was partly evaluated quite differently by governmental and non-governmental experts. The interviewees also reported on a number of past events of flow variability and how the transboundary regime and its actors reacted to it. Thereby the interviews enabled comparing instances of flow variability and characteristics of transboundary regimes identified through secondary document and data analysis with how key stakeholders are talking about and perceive these issues, such as the flow variability, hence, how regimes and their actors interact. The interviews revealed different opinions on how key stakeholders with a lot of experience in managing water in their respective basins consider most appropriate to deal with flow variability and thus with potential climate change impacts and thereby to identify enabling factors for adaptive capacity.

### 3.4.5.1 Selection of informants

Around 4 to 5 persons per basin were interviewed for the four case study basins, and two international experts in addition (see the categories in table 6 below). Two interviewees were working on two of the case study basin and were therefore asked about these two basins. A non-random purposive sample of informants was taken using the snowball technique, which requests interviewees to suggest other potential interview partners. The literature review also helped me to identify a number of interview partners or at least their affiliations.

**Table 7: Categories of Interviewees**

Type of organization	Number and function of employee	Reasons for selection	Comments
River basin commission representatives	One staff member, in particular the staff member dealing with flow variability, with climate change adaptation and/ or with hydrological measurements	- Their knowledge on the regime design and its history, the past flow variability, the institutional characteristics and management and also their evaluation of the adaptive capacity of the tbwm regime. - Helped to identify other interviewees from the basin (“snowball technique”)	
Government representatives of different riparian countries	2-3 per basin, relevant persons in the ministries or water agencies/ institutes representing their country in the river basin commission	To compare views on the transboundary water regime and its adaptive capacity and effectiveness as seen by the different riparian countries.	In large basin where not every country could be interviewed, those particularly affected by climate change were prioritized e.g. Netherlands in the Rhine
Academic experts	1-2 per basin, e.g. from universities having studied cc impacts in the basin, natural scientists (hydrologists and climatologists) and social scientists	Because of their knowledge on the regime design and its history, the past flow variability, the institutional characteristics and management and also their evaluation of the adaptive capacity of the tbwm regime	
Non-governmental organizations	1-2 per basin, from NGOs working on cc in the basin	In order to get their perspective on the transboundary regime , the RBO, its performance, the current situation, difficulties and lessons learnt of cooperation etc.	

In addition, two international experts were interviewed who have knowledge and experience on the topic, know some of the basins and were therefore asked slightly different

questions compared to the others, focused more on their evaluation of adaptive capacity and its indicators. The final list of interviewed persons can be found in the annex. The number of interviews was determined by saturation: after 4 or 5 interviews for one basin, many respondents gave the same answers as previous interviewees from the same basin.

#### *3.4.5.2 Types of interviews and content*

Most interviews were conducted as telephone interviews, only two of them as face-to-face interviews. They lasted usually between 30 minutes and 1.5 hours and were recorded. While confidentiality was offered to interviewees, all of them agreed to be cited and citations were checked with them as much as possible. The interviews were “semi-structured”, i.e. using some pre-defined questions complemented by many individual ones depending on the progress in the interview. The interviews mostly covered the concepts and variables highlighted in the table 8 below. In these areas, informants were asked to give detailed explanations of their experiences and personal estimates of the future. The interviews included a general question on the respondents’ estimate of the adaptive capacity, i.e. whether and if yes why or why not the respondents thought that the transboundary agreement or transboundary cooperation helped to adapt/ was well adapted to climate change.

**Table 8 Categories of questions for the interview**

<b>Concepts</b>	<b>Indicators- Question items</b>
Introduction	General information about the basin, riparian countries, economic development, general interstate relations
Transboundary regime-object of study	Information about the agreement, date of entry into force, aims, content, its flexibility provisions, and other characteristics
Enabling factors	Information on learning capacity, resources, leadership of the institutions/ organizations for transboundary water management
Flow variability	Past experience of flow variability and the ability of the regime to react and cope with it
Conflictive events	Past conflictive “events” in the water relations between the , riparian countries
Exposure	Information about expected climate change impacts on the basin: (if available)
Personal opinion on adaptive capacity	Personal estimate of the respondent of the adaptive capacity of the regime
Personal opinion on independent variable	Personal opinion of the respondent on why the adaptive capacity is as estimated above

Adaptive capacity	Already implemented and planned measures in the basin to adapt to climate change at the transboundary level, including development of joint vulnerability assessments, joint adaptation strategy and/ or implementation of selected measures
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#### 3.4.5.3 *Interview Guide*

Based on my research question, as well as the observations and documents analysed an interview guide was established. The order and exact formulation of these questions depended on the progress of the interview and also on the affiliation of the interviewed person. Some additional follow-up questions were asked to the respondents depending on the interview process and depending on their affiliation, function, position etc. The interview guide is included in the annex. My interview guide evolved in the course of doing interviews. For example, some questions could not be answered by all respondents, such as questions about the river basin commission or the transboundary agreement could not be answered by scientists and experts. All interviewees were informed about the background of the study and how they can benefit from it, and they were offered to review the chapters dealing with their case study. During the interview I asked the respondent for any additional relevant documents and/ or data such as different versions of the transboundary agreements, data on discharge and climatological/ meteorological/ hydrological data as appropriate and needed.

A significant challenge was the language: I interviewed most persons in English, but some in French or German upon their request, which caused additional challenges in the interviews and their analysis. In the Neman case study, since some potential respondents spoke only Russian, I could not interview them, due to my unfortunately limited knowledge of this language.

#### 3.4.6 **Data analysis**

During the participant observation notes were taken and a database was created with all results, which included all data collected from the direct observation of events, documents analysed and the interviews as well as my own impressions and thoughts. The first interviews

and subsequently the most important sections of the following ones were transcribed and coded in order to facilitate their analysis. Notes from events observed as well as the interview notes were reviewed, ordered and analysed for certain terms, such as flow variability, floods, droughts, adaptation, adaptive capacity, data exchange, transboundary cooperation, resources etc. Relevant sections were highlighted and categories were created. The data analysis started already while I was still collecting data which allowed me to adjust for example the interview questions as well as pay attention to certain issues in the next event observed. Regular research memos were prepared. The conceptual framework, some elements of which were already identified in the literature review stage, was further developed and a model showing the research subject and the identified enabling factors was constructed (see chapter 5.3).

### **3.4.7 Quality of the research design and limitations**

In qualitative research, it is generally difficult to ensure validity and reliability (Richard and Lewies 2003). Validity was for example increased through considering deviant cases such as the Neman.

While my professional status gave me access to certain events and persons to whom I would not have had access otherwise, it also involved certain risks for my research, both during the interviews and in participatory observation. In particular, by working in this field, I could not assume the role of an invisible researcher, but might have influenced my research subjects, especially those who know me professionally, through my presence or actions, but also due to my professional role. For example, respondents might not have made certain critical remarks about their organization or my organization in my presence. I addressed this risk by using triangulation, i.e. by using other complementary methods, such as document analysis and participant observation, by separating as much as possible my professional and academic role and by selecting as many interviewees as possible with whom I had not interacted before in my professional role and to whom I introduced myself only as PhD student. In addition, when selecting my case study basins I gave priority to such basins where

I did not manage a project, except for the Neman basin. Furthermore, in order to broaden the data available and take into account basins not related to my work, nine additional basins were considered in my study without a detailed analysis, as explained above. Finally, my findings were checked with experts from the basin, my interviewees and external experts.

Chapter 3 described and justified the research design and methods. As the present study relied on a multi-case study design, the following chapter 4 describes and compares the four case study basins.

## **4 Transboundary cooperation and climate change adaptation in my four European case study basins**

As described in chapter 3, the research questions were answered by analysing in detail the transboundary water management regimes in four European river basins located in different parts of Europe: the Rhine, the Danube, the Meuse and the Neman. Each of these basins are presented in the following section according to the same criteria which , namely in terms of their geography and water use, legal and institutional framework for cooperation, climate and hydrology, ability to deal with flow variability, climate change activities, actor networks and stakeholder engagement, resources and data exchange and climate change studies. These criteria were selected based on the literature review and especially the framework by Raadgever and Mostert (2005). This descriptive part is followed, for each basin, by a section on unique features of each basin and conclusions, including recommendations for each basin.

### **4.1 Rhine- oldest European transboundary regime faced with new challenges of low flow**

**Table 9: Data sources used for the Rhine case study<sup>8</sup>**

<b>Interviews conducted</b>	<b>Institution</b>	<b>Date</b>
Adrian Schmid-Breton	ICPR	14 June 2013
Hans Nilson	Federal Institute of Hydrology, Germany	28 August 2013

<sup>8</sup> This table does not include literature, such as articles. The same applies to the tables for the other river basins (full case studies).

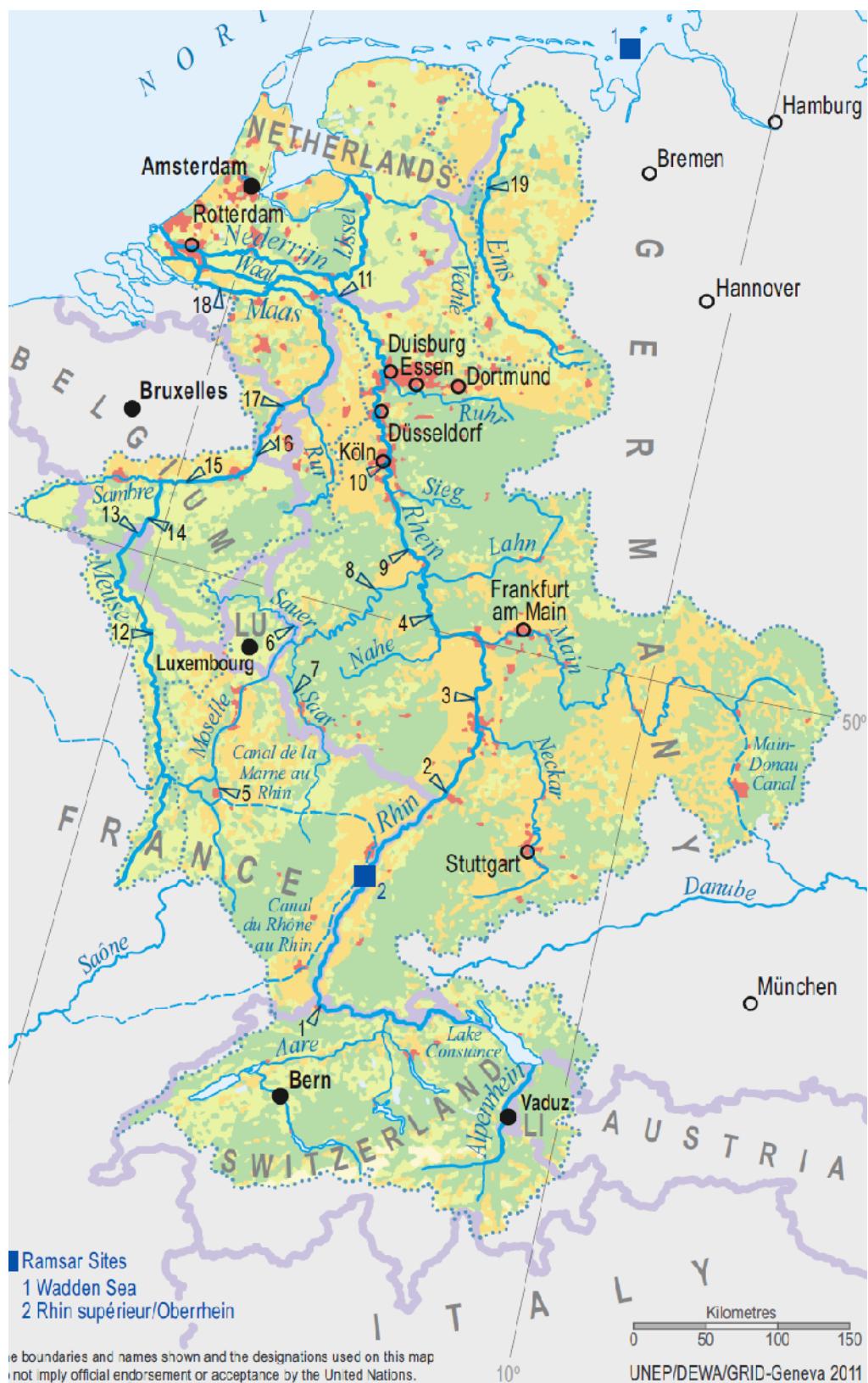
Hendrik Buiteveld	RWS, the Netherlands	29 Aug 2013
Koos Wieriks	Former Executive Secretary of ICPR	28 Nov 2013
Hugo Aschwanden	Swiss Federal Office for the Environment	6 May 2014
<b>Events observed</b>		
Workshop on climate change adaptation in the Rhine basin, Bonn, Germany, 30-31 January 2013		
<b>Documents analysed:</b>		
1999: Treaty on the Protection of the Rhine		
2007. Conference of Rhine Ministers. Communiqué. Living and linking Rhine- challenges of a watershed.		
2011. Report no 188: study of scenarios for the discharge regime of the Rhine		
2011b. Aktionsplan Hochwasser 1995-2010. Handlungsziele, Umsetzung und Ergebnisse.		
15th Rhine Ministerial Conference. Ministerial Communiqué, 28 October 2013		

#### 4.1.1 Geography and water use

The Rhine is located in the centre of Europe (ICPR 2013). It connects the Alps to the North Sea and represents the most important cultural and economic axis in Middle Europe. In its watershed, 58 million people are living in nine different states, as can be seen in table 10 and figure/ map 5 below, Austria, Belgium, France, Germany, Italy, Liechtenstein, Luxembourg, the Netherlands and Switzerland. As can be seen on table 10, the Rhine waters are used for many different purposes such as navigation, drinking water supply, industry, energy generation (nuclear power, hydropower etc.) as well as, to a lesser extent, agriculture.

**Table 10: General description of the Rhine basin**

Riparian countries	Austria, Belgium, France, Germany, Italy, Liechenstein, Luxemburg, Netherlands, Switzerland
Population in the basin	58 million
Water uses	Navigation, drinking water supply, industry, energy generation (nuclear power, hydropower etc.)
Regime	Rhine Convention (1999) and Commission (since 1950)
Years of cooperation	Since 1950



**Figure 5** Map of the Rhine, Ems and Meuse basins

Source: UNECE 2011

#### **4.1.2 Legal and institutional framework for transboundary cooperation**

The cooperation on the Rhine dates back to the 1950s (ICPR 2013). The International Commission for the Protection of the Rhine was created already in 1950. A first agreement was signed in 1963, followed by several technical agreements on pollution aspects in the following decades. Following a ministerial decision, a new convention or revised legal framework was negotiated in the early 90s in order to include aspects such as protection of ecosystems, flood management and water quality, and also to comply with international requirements and react to the Sandoz accident. The Convention on the Protection of the Rhine was signed on 12 April 1999 by representatives of the governments of the five Rhine bordering countries: France, Germany, Luxembourg, Netherlands and Switzerland and by the European Community, as a consequence of the Sandoz accident (ICPR 2013). The Convention aims to protect the Rhine, its banks and floodplains through increased cooperation (ICPR 1999). It also aims to maintain the quality of the drinking water, to improve the quality of sediments, to ensure flood prevention and protection and to protect the North Sea (ICPR 2013). The International Commission for the Protection of the Rhine (ICPR) has a small international secretariat (ICPR) with 13 staff members located in Koblenz, Germany, which promotes implementation of the Convention. The ICPR cooperates with two independent specialized commissions: the Commission for the Hydrology of the Rhine (CHR), located in the Netherlands (Lelystad) and the Commission for the Navigation of the Rhine (CCNR). In addition to the multilateral Rhine Convention, many of the riparian countries have concluded bilateral agreements on transboundary water management with their neighbouring countries.

As described above, it is important to note that the Rhine Convention includes flood prevention and protection as one of its objectives. This gives the Commission and secretariat the mandate to deal with floods, flow variability and related climate change impacts. Low flow is not covered in the Convention, probably because at the time of elaboration of the

Convention water scarcity was not yet so high on the agenda and until 2013, the Rhine has not faced as many problems with low flow as for example the Meuse or Odra (Schmid-Breton, ICPR; pers. comm.). The Rhine Convention text does not foresee any special mechanisms for addressing drought and low flow, i.e. does not include any flexibility provisions. However, through the mechanisms and institutional structure of the Convention, such as working and expert groups of the Rhine Commission, issues of low flows are being addressed and the climate change adaptation strategy under development in 2014 will have a special focus on low flows (Schmid-Breton, ICPR, pers. comm.). Thus, through decisions of the Commission new topics are being addressed which are not explicitly included in the legal framework.

#### **4.1.3 Climate and hydrology**

The Rhine is located in a moderate climate zone. Since it is fed by both glaciers and precipitation, flow variability during the year is not as high as in other basins such as the Meuse (Buiteveld, the Netherlands, pers. Comm). However, floods are a serious problem and droughts probably soon as well. For example, in 2011, low waters in the Rhine caused a serious problem for navigation which had to be interrupted, and other water uses, especially for the downstream country the Netherlands. In general, the Rhine is more frequently suffering from floods, e.g. in 2013, 2011, 2007, 2002, 1999, 1998 etc.

The Conference of Rhine Ministers charged the ICPR in 2007 to develop a “Study of Scenarios for the Discharge Regime of the Rhine” (ICPR 2007). According to this study, by the middle of the 21<sup>st</sup> century, up to 20 % higher water discharges are to be expected during winters in the Rhine catchment and up to 10 % lower discharges are expected during summers, while regional variations may occur (ICPR 2011, Nilson, pers. Comm.), but the discharges vary depending on the region.

#### **4.1.4 Ability to cope with flow variability**

The Rhine transboundary regime has generally been able to avert conflicts associated with flow variability. As the Swiss representative in the ICPR noted, "the Rhine is well able to cope with flow variability" (i.e. to overcome situations of low or high flow without significant conflicts between countries or users, such as the flood in June 2013). There have not been any significant conflicts over water in the past years, despite some, albeit limited, situations of flow variability, for example in 2003, 2009 and 2013. Still, the riparian countries want to be prepared for possible future climate change impacts, as the Swiss representative explains (Aschwanden, pers. Comm.):

*So far, we do not really see any climate change impacts yet and also the expected impacts are not so serious compared to elsewhere. Only low water after 2050 could be problematic according to the forecasts. Therefore, we want to scientifically analyse this scenario and are starting a study on what Switzerland can do, e.g. retain water in Alpine lakes which are regulated. We also prepared guidelines for our cantons on how to deal with low water, how to prioritize water uses etc.*

#### **4.1.5 Climate change adaptation activities**

The Rhine is very advanced in climate change adaptation: as described under section 4.1.3, numerous studies on climate change impacts, including impacts on water quality, water temperature and ecosystems as well as an extensive modelling exercise have been carried out. The "Study of Scenarios for the Discharge Regime of the Rhine" (ICPR 2011) presents discharge projections at representative gauging stations on the Rhine and its tributary, the Moselle, for the near future (up to 2050) as well for the remote future (up to 2100) (ICPR 2013). For the first time, this study is based on a common ground in terms of data and methods. The data are consistent for the whole catchment and a consensus was reached on the methods between many relevant institutes after long discussions. In addition to this study, several other studies have been developed, e.g. on climate change impacts on water quality and ecosystem, by the relevant working groups under the ICPR. On 30-31 January 2013, a workshop on climate change impacts was held in Bonn with numerous stakeholders from

authorities, other sectors, non-governmental and international organizations from all Rhine countries. Since 2013, a preliminary adaptation strategy is under preparation.

The original mandate to address climate change by the ICPR was given by the ministerial conference in 2007 in Bonn (ICPR 2007) and reiterated in 2013 (ICPR 2013). At that occasion, ministers recognized that flood management requires a coordinated approach in order to prevent that unilateral measures have a negative effect downstream or upstream (ICPR 2013b). They also requested the Commission clearly to develop an adaptation strategy and to mainstream climate change elements in its work (ICPR 2013b):

*“The Ministers and the Representative of the European Commission (...) ask the ICPR to draft a preliminary ICPR climate adaptation strategy for the Rhine catchment, based on the assessment of available studies/the diagnosis on the discharge regime (floods and low flow) and on the temperature regime and to check proposals for adaptation measures concerning the expected effects of climate change, based on management plans existing in the different states/regions. In the near future the ICPR will decide on further steps, eventually on an ICPR low water (management) plan; to take into account socio-economic developments (...) to include all actors concerned.”*

The adaptation strategy shall be complementary and not contradictory to those of riparian countries (many of which already have their own national strategies) and be adopted in 2016 either by a ministerial conference or the heads of delegation (Aschwanden, Switzerland, pers. Comm.).

#### **4.1.6 Data exchange and scientific studies**

There have been many research projects on the Rhine under climate change conditions partly under the International Commission for the Hydrology of the Rhine (CHR), such as RHEINBLICK or KLIWA as well as CAWAS. Due to the sufficiently high amount of resources for research, a multi-model approach was used by researchers in the Rheinblick project for climate change assessment. This enabled some sort of common understanding between the numerous involved scientists on possible future climate change impacts, even if a range of uncertainty is indicated for each finding, i.e. no clear projection is given. Scientists have decided to communicate this range of possible futures to the decision-makers. This

approach was first contested and criticized by decision-makers, but subsequently they accepted and appreciated it (Nilson, German scientist involved in the Rhine studies, pers. comm.). In 2014, the Commission for the Hydrology of the Rhine is preparing a study on possibilities for storing and releasing water, i.e. for regulating the lake Constance, as suggested by The Netherlands (Aschwanden, Switzerland, pers. Comm.). This could be a possible adaptation measure, even if regulating the lake is not permitted according to the constitution of several riparian Swiss cantons.

The Rhine countries are exchanging data on water quantity and quality and all collected data are stored in a database located at the CHR. In addition, some bilateral data exchange is happening, for example between Germany and Switzerland. There are also some suggestions for merging or at least more closely linking the Commission for the Hydrology and the International Commission for the Protection of the Rhine (Aschwanden, pers. Comm.).

#### **4.1.7 Stakeholder involvement**

Numerous NGOs participate as observers in the different meetings and working groups of the ICPR. This process started in the 90s: in 1996, when there was the first hearing where NGOs could bring forward their concerns, the Commission listened and promised to get back to them regarding the issues mentioned. Koos Wieriks, the executive secretary of the ICPR at that time explains:

*During the 90s, it was the time to bring in the public and NGOs. The secretariat pushed for it and there was a general environmental wave in the 90s, many Conventions on environmental issues were negotiated.*

Currently, more than 18 Non-Governmental Organizations are admitted as observers to the ICPR and actively contribute to the protection of the Rhine (ICPR 2014), including the activities on climate change adaptation and flood protection.

#### **4.1.8 Resources**

All Parties share proportionally the expenses for the functioning of the Commission, based on their share of the Rhine basin (ICPR 2013). The budget is negotiated annually at the plenary assembly. These resources are high enough to cover also the costs of special dedicated studies on climate change impacts from the Commission's budget. In addition, some studies are paid for by other sources, namely the International Commission for the Hydrology of the Rhine, international research projects etc.

#### **4.1.9 Unique features and conclusions for the Rhine**

Experience of flow variability and extreme floods in the 80s and 90s was one of the reasons for the negotiation of the new Rhine Convention in the 90s, which includes provisions related to flood management (Wieriks, former Executive Secretary of the ICPR, pers. Comm.). A crucial event for the Rhine, but also trigger for stronger cooperation was the accident in a chemical factory near Basel in Switzerland in 1986, the famous “Sandosz” accident. This disastrous accident destroyed life in the river, in particular fish, for years. On the other hand, it was an important trigger for further cooperation, demonstrating to all actors the need for it, as Koos Wieriks from the Netherlands explains:

*The secretariat of the Commission comprised only two persons before the accident and then grew to 13 staff members. German and Dutch were added as official languages of the Commission. The ministers decided subsequently to reduce pollution by 50%; it was up to the Commission to implement it. We had 100 meetings per year at this time, on water quality, flood protection, negotiation of the new Convention etc.*

Thus, the Rhine transboundary regime has been able to “learn” from past catastrophes, failures and deficiencies in its regime design (no flexibility provisions), among others due to the commission's sufficient budget, the trust between actors, the leadership, networks of water managers and scientists as well as the transboundary information management and data exchange. The Rhine Commission is even seen as a model for example by the Danube, Odra

and Elbe, and even other basins from the entire world. Delegations from basins worldwide are visiting the Rhine Commission (Wieriks, pers. Comm).

## **4.2 Danube – first transboundary adaptation strategy**

Table 11: Sources of data used for the Danube case study (excluding literature)

<b>Interviews</b>	<b>Institution</b>	<b>Date</b>
Raimund Mair	ICPDR secretariat	18 July 2013
Knut Beyer	German Ministry for the Environment	8 August 2013
Monika Pratsch	Ludwig-Maximilians Universitaet of Munich	27 August 2013
Elisabete Orpisan	Romania	27 August 2013
Branislava Vasiljevic	Serbia	3 October 2013
Camila Ionescu	WWF Romania	8 May 2014
<b>Events observed</b>		
Multistakeholder workshop in the Danube basin on 30-31 March 2012, Munich, Germany		
<b>Documents analysed</b>		
1994: Convention on Cooperation for the Protection and Sustainable use of the Danube River (Danube River Protection Convention)		
2010: Ministerial Declaration. Joint Waters, shared responsibilities.		
2010: Report on Achievements in Flood Protection in the Danube River Basin		
2012: Facts and figures.		
2013b: ICPDR Strategy on Adaptation to Climate Change,		

### **4.2.1 Geography and water use**

With more than 800,000 square kilometres or 10 percent of continental Europe, the Danube River Basin includes part of the territories of 19 countries (ICPDR 2013). It is considered the most international river basin in the world. 81 million people live within the basin, but the share of each country in the basin varies significantly (see table 12 as well as figure/ map 6 below). Those 14 countries having more than 2000 square kilometres of the basin are, together with the EU, contracting parties to the International Commission for the Protection of the Danube River Basin (ICPDR), as can be seen on table 12.

**Table 12: General information about the Danube basin**

Riparian countries	Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Republic of Moldova, Romania, Serbia, Slovenia, Slovakia, Ukraine
Population	81 million
Water uses	Navigation, drinking water supply, industry, energy generation (nuclear power, hydropower etc.)
Regime	International Convention for the Protection of the Danube River (1994) and Commission (since 1996)
Years of cooperation	Since 1992

Figure 6: Map of the Danube river basin . Source: ICPDR 2013

### Danube River Basin District: Ecoregions

MAP 2



Vienna, December 2009

#### **4.2.2 Legal and institutional framework for transboundary cooperation**

The “Convention on Cooperation for the Protection and Sustainable use of the Danube River (Danube River Protection Convention)”, generally referred to as the “Danube River Protection Convention” or “DRPC” (ICPDR 2013) commits the contracting parties Germany, Czech Republic, Austria, Slovakia, Hungary, Slovenia, Croatia, Serbia, Montenegro, Bosnia-Herzegovina, Bulgaria, Romania, Moldova, Ukraine, and the European Union to join their efforts in sustainable water management, including conservation of surface and groundwater, pollution reduction, and the prevention and control of floods, accidents and ice hazards (ICPDR 2013). The convention was signed in Sofia in 1994 and entered into force four years later, in October 1998. The Convention led to the creation of the International Commission for the Protection of the Danube River (ICPDR), which has a permanent secretariat based in Vienna. The ICPDR has developed into one of the most effective, professional and recognized river basin commissions worldwide (Schmeier 2013). In 2007, the basin won the International Thiess River Prize for its success in transboundary water cooperation as well as in river restoration.

The Danube Convention itself is rather general and does not cover flow variability in detail, nor does it mention climate change anywhere (ICPDR 1994), but it mentions floods several times. The ICPDR was given the mandate to deal with flood management- its specific role in this regard is to coordinate on the basin-wide level approaches for flood management, flood risk mapping and flood risk reduction measures, especially those with downstream impacts- i.e. where solidarity between the countries is required (Mair, pers. comm., ICPDR 1994). The ICPDR has a very developed institutional framework with many working groups, including a flood expert group.

#### **4.2.3 Climate and hydrology**

Flow variability in the Danube is not as high as in other basins, because it is fed by precipitation and by glaciers, but still it can be significant. Flooding is the most common natural disaster in the Danube basin and, in terms of economic damage, the most costly one (ICPDR 2012). There have been 78 significant floods along the Danube over the last nine centuries; 55 of them after extensive flood protection was built since the 18<sup>th</sup> century. Since then, significant areas of natural flood-plains have been lost through drainage for agriculture, city development and flood protection dykes, leaving only one fifth of the natural floodplains. This has made the basin more vulnerable.

Recent years have seen an increase in flood frequency, and record-high water levels were reached three times since 2002 (ICPDR 2012). Four of the most significant floods occurred during the last 10 years, namely in 2002, 2006, 2010 and 2013. The high damage was, among others, due to destroyed, not well-maintained or neglected levees/ dykes, as well as long winters and unusually heavy snow and rain (ICPDR 2012). Multi-annual averages for precipitation have been exceeded by 1.5 to 2.0 times recently in some parts of the basin (ICPDR 2012), a maximum never before observed since the start of systematic instrumental weather observations. Such trends could be due to climate change, but this is not certain.

Droughts have also become more frequent in the Danube basin. For example, there were serious droughts in 1992/3 in Bulgaria and Hungary, in 1996 in Bulgaria, and in 2003 a very serious drought affected the entire basin (ICPDR 2013). Such droughts are expected to increase due to climate change. The study carried out from 2010 to 2012 by the Ludwig-Maximilians-Universitaet Munich has led to the following expected climate change impacts (ICPDR 2013):

- An increase of the air temperature, particularly in summer in the south-eastern Danube region;
- Changes in the seasonal runoff pattern, triggered by changes in rainfall distribution and reduced snow storage and increasing evapotranspiration;
- More frequent droughts, low flow situations and water scarcity;

- Regarding floods, although local and regional increased heavy rainfall might occur, there is no clear picture for changes in flood magnitude and frequency;
- An increase of water temperature and increased pressures on water quality;

Source: ICPDR 2013

Thus, climate change is expected to lead to more low flows and droughts in the basin as well as an increase in air and water temperature, whereas future trends regarding flooding are not so clear. This will have consequences for water dependent sectors such as agriculture, forestry, navigation etc. As shown earlier (see chapter 2) some authors such as Draper and Kundell (2007) consider the Danube basin as one of the most vulnerable transboundary basins worldwide.

#### **4.2.4 Ability to cope with flow variability**

While there have been several floods and droughts in the last 20 years since the creation of the ICPDR, causing significant economic damage and sometimes also fatalities, the Danube basin has been able to cope with these extreme events for the majority without conflicts and the ICPDR is addressing them as much as possible through exchange of data, preparation of flood action plans etc. (Schmeier 2013). The last severe flood occurred in June 2013, with record flow levels, for example in Budapest, and severe economic damage as a consequence. As another example, the flood in the Austrian part of the Danube basin in 2002 caused 3.1 billion EURO damage (ICPDR 2013). In 2003, record temperature levels and lack of precipitation were observed and the drought in the Danube basin throughout the summer required ships to stop and nuclear plants to close down for months.

Most importantly, with the creation of the ICPDR in 1994, the number of conflicts according to Wolf's BAR scale was reduced and the number of cooperative events increased (Schmeier 2013) which shows the importance of the RBO for conflict prevention and resolution.

#### **4.2.5 Climate change adaptation activities**

The Danube basin is the first transboundary basin worldwide with a transboundary climate change adaptation strategy, which was developed by the ICPDR and officially adopted by the Danube countries in December 2012 (ICPDR 2013). The development of the climate change adaptation strategy goes back to the Danube Ministerial Conference in February 2010 where the River basin management plan was adopted and the Commission was requested to develop a climate change adaptation strategy (ICPDR 2010). Extract of the Danube Ministerial Declaration of February 2010: (ICPDR 2010: 8):

The Danube countries' ministers:

“ (29) *Emphasize* that the impacts of climate change will increase and develop into a significant threat in the Danube River Basin if the reduction of greenhouse gases is not complemented by adaptation measures. We *appreciate* that the DRBM Plan draws some first conclusions and identifies future tasks in this regard.

(30) Ask the ICPDR to develop until 2012 a Climate Adaptation Strategy in the Danube River Basin. This strategy should be based on a step-by-step approach and encompass an overview of relevant research and data collection, a vulnerability assessment, ensure that measures and projects are climate proof respectively “no regret measures” and ensure that climate adaptation issues are fully integrated in the second DRBM Plan in 2015.”

Subsequently, Germany took the lead in financing and organizing the preparation of the strategy (Knut Beyer, German ministry of environment, pers. comm.). As a first step, a climate change impact assessment was prepared, but not by doing additional modelling, but rather by reviewing, collecting and comparing different existing studies. More than 100 studies, many more than expected, were identified, compared and synthesized, including indication of uncertainties. The study was carried out by Ludwig-Maximilians-Universitaet Munich, but results were discussed and presented at the river basin management group meetings under the Commission and at the workshop in Munich at the end of March 2012. Based on the study and the workshop results, a draft adaptation strategy was prepared in 2012, under the leadership of the ICPDR secretariat together with Germany and the University of Munich. The strategy was developed, written and adopted in less than a year, which is very fast compared to other adaptation strategies, for example in the Rhine, which

usually take several years for development and endorsement. The strategy contains suggestions for possible general measures to be considered at basin-wide level, such as navigation or agriculture, as explained by the responsible ICPDR staff member (*Raimund Mair*): *The strategy contains an outline of possible adaptation measures of basin-wide importance as discussed at the stakeholder workshop in March 2012, addressing for instance sectors, such as agriculture and navigation.*

#### **4.2.6 Data exchange and scientific studies**

When preparing the climate change impact assessment for the Danube, results of existing studies were used and compared, which gave a certain authority to the results, especially when several studies had identified the same climate change impacts. It was also appreciated that the expert cooperation in the Danube worked very well and was not politicized (Vasiljevic, pers. comm).

The data exchange between the riparian countries in the Danube basin is working well, which is a precondition for scientific consensus (Prasch, Beyer, Mair pers. comm.). Data on water is exchanged between Danube countries through a special database located in Bratislava at the Slovak Hydrometeorological Institute. In addition, the ICPDR secretariat maintains the Danube River Basin Information System (DANUBIS) which collects data and information on different issues (Schmeier 2013), such as planned activities, water quality and quantity etc. These data are published on a public website, but also synthesized in regular reports by the ICPDR. In addition, regular joint surveys are carried out. The data-sharing system is often described as “one of the best in the world” (Schmeier 2013: 206).

#### **4.2.7 Stakeholder involvement**

Numerous stakeholders contribute to the work of the ICPDR as observers, from NGOs, business, etc. which is considered to contribute greatly to effective river basin governance (Schmeier 2013). Guidelines on observers were elaborated, a stakeholder conference was

organized and the ICPDR even has an expert group and a staff member working entirely on outreach, communication and public participation.

The preparation of the adaptation strategy as well as all activities under the ICPDR involve different relevant working groups of the ICPDR, government representatives as well as other stakeholders and NGOs (Mair, ICPDR, pers. Comm.). The river basin management expert group of the ICPDR oversaw the development of the adaptation strategy together with a special group of experts on climate change adaptation, which was created specifically for the purpose of supporting the adaptation strategy development. In addition, numerous representatives of NGOS and other water-related sectors participated in the stakeholder consultation workshop in March 2012 which aimed to collect feedback on the climate change impact assessment and the first outline for the strategy.

#### **4.2.8 Resources**

The ICPDR's annual budget amounts to a bit less than a million Euro per year and is equally paid for by the different Parties, except the EU (ICPDR 2014). There are also some exceptions for less wealthy Danube countries. In 2009, Parties were divided into three groups, according to their GDP and share of the basin, and contributions to be paid were fixed differently depending on these categories (Schmeier 2013). However, each party, even the poorest ones such as Ukraine and the Republic of Moldova pay a small contribution. In addition, the ICPDR has a number of projects and extrabudgetary contributions which are paid for by Parties and businesses, such as, in the case of the climate change activities, by Germany as lead country.

#### **4.2.9 Unique features and conclusions for the Danube**

It is surprising that the Danube transboundary regime, although it seems to be a complicated basin with so many and so diverse riparian countries (some EU members and some not) and the high vulnerability according to some authors (e.g. Draper and Kundell

2007), has elaborated the first transboundary adaptation strategy worldwide. According to my respondents, this can be explained by the positive history of cooperation, the effectiveness of the river basin commission and its secretariat, leadership, resources, a clever way used to demonstrate evidence for action and a scientific consensus, external pressure from the EU directives and many other factors. The Danube remains the most advanced basin with regards to transboundary climate change adaptation since, as of 2014, the ICPDR was already working to mainstream the climate change impacts in the new river basin management plan. In general, the ICPDR is often considered as one of the most advanced and most effective river basin organizations (RBOs) worldwide (Schmeier 2013).

#### ***4.3 Meuse- climate change as one of many pressures on an already challenging cooperation***

**Table 13: Data sources used for the Meuse case study (excluding literature)**

<b>Interviews</b>		
Hendrik Buiteveld	RWS, the Netherlands	29 August 2013
Maite Fournier	Former project leader, AMICE	29 May 2013
Martine Lejeune	Formerly AMICE	3 July 2013
William Schreurs	Executive Secretary of the IMC	8 August 2013
Paul Dewil	Walloonian Environment Agency	29 October 2013
Denis Besozzi	French water agency for Moselle, and Meuse	16 May 2013
<b>Events observed:</b>		
Final workshop of the AMICE project on the Meuse, 13-15 March 2013, Sedan, France		
IMC (International Meuse Commission) 2004. International agreement on the Meuse.		

##### **4.3.1 Geography and water use**

The Meuse is a transnational, navigable river, one of the largest in North Western Europe, with a catchment basin incorporating five Member States (UNECE 2013). The Meuse is starting in France and then flowing through Belgium and the Netherlands before ending up in the North Sea (IMC 2013, see also figure/ map 7 below). Several tributaries are discharging into the Meuse from Germany and Luxemburg. 9 Million persons are living in the Meuse basin and the river is one of the main drinking water sources for some of the major cities such as Liège and Brussels. Water is mainly used for domestic purposes, for industry, feeding of

different water channels and agriculture (UNECE 2011). The river is significantly hydromorphologically altered due to urbanization, agriculture and flood defense systems.

**Table 14: General information about the Meuse basin**

Riparian countries	France, Netherlands, Germany, Belgium, Luxembourg
Population in the basin	9 million
Water uses	domestic purposes, for industry, feeding of different water channels and agriculture
Regime	International Meuse Commission (since 1994), Accord de Gand (2002)
Years of cooperation	Since 1994



**Figure 7: Map of the Meuse basin**

Source: <http://www.socopse.se/casestudies/meuse.4.3d9ff17111f6fef70e9800050421.html>

#### **4.3.2 Legal and institutional framework for transboundary cooperation**

In 1994 some of the riparian countries signed an agreement, i.e. the Netherlands, Belgium and France, among others due to and based on the UNECE Water Convention (Schreurs, IMC, pers. comm) with the aim to address pollution and floods (Fournier, pers. comm). In the beginning of the year 2000, with the adoption of the Water Framework Directive, the cooperation was widened to the entire basin including new countries (Germany and Luxemburg) and new topics such as ecosystems and floods, thus water quantity issues. Subsequently in 2002, the International Meuse Agreement (Accord de Gand) was signed by France, the Walloon region, the Netherlands, Germany, the Flemish region of Belgium, the Brussels capital region, the federal Belgian government and Luxemburg (IMC 2013). The delay in setting up the new multilateral agreement with all riparian countries can be explained among others by the reorganization of the Belgian state, where the responsibilities for water management were not clear and passed from the national to the federal or states level in 1994 (Fournier, previous AMICE project manager pers. Comm.). The Meuse agreement entered into force in December 2006 and is therefore rather young, compared to the Rhine and Danube Conventions. The agreement includes the International Meuse Commission as well as a very small permanent secretariat. Its tasks are:

- Coordination of the obligations of the different EU directives (Water Framework Directive and Flood Directive)
- Alerting Meuse riparian countries in case of industrial accidents

The Commission has developed an action plan and meets once a year, while there are several working groups on thematic issues, meeting more frequently. Decisions and recommendations are taken in consensus.

The transboundary regime in the Meuse basin consists not only of the multilateral agreement, but also of bilateral agreements between some of the riparian countries, for example a bilateral agreement with flow allocations between Flanders and the Netherlands

(Buiteveld, The Netherlands, pers. comm.). Negotiations for this started already at the end of the 19<sup>th</sup> century, but were interrupted through the First World War (Bastings 2002). Negotiations restarted in 1963 and led to three treaties. One of them, however, which was elaborated in 1975 and should have guaranteed Belgium a flow of 50 m<sup>3</sup>/s as well as the construction of several reservoirs, was never signed and thus did not come into force. In 1995, Flanders and the Netherlands concluded the Meuse discharge treaty (*Maasafvoerverdrag*), an agreement about the amount of water flowing through canals and the Grensmaas (the stretch of Meuse river between Flanders and the Netherlands) (Arends 2005). It aims to ensure equal distribution of water between The Netherlands and Belgium especially during periods of low flow, so that the Grensmaas (stretch of the river forming the border between the Netherlands and the Flemish region) has a discharge of at least 10 m<sup>3</sup>/s. This agreement regulates all flows below 130 m<sup>3</sup>/s at the station Monsin according to the table 15 below:

<b>Undivided Meuse discharge(m<sup>3</sup>/s)</b>	<b>Average number of days per year with this flow</b>	<b>Allocation for the Meuse at Grensmaas</b>	<b>Allocation for Belgium</b>	<b>Allocation for the Netherlands</b>
130	>100	60	35	35
100	92	50	25	25
60	33	10	25	25
30	2	10	10	10
20	0.2	6.7	6.7	6.7

**Table 15: Water allocation between the Netherlands and Belgium at Monsin in the Meuse basin**

Source: Bastings 2002

To avoid conflicts between different water users, priorities are set and water uses for low priority functions is restricted during periods of water shortage (Wit et al. 2001). Different users should reduce their demand for water, for example by applying alternative solutions (such as using cooling towers instead of cooling with water), creating a buffer or reserve for drinking and industrial water use, using rain water in horticulture or households or storing water in the ground, e.g. for agriculture. This bilateral agreement enabled an increase in water in the Zuid-Willemsvaart Canal, the development of a common information system as well as a further development of the Meuse (Bastings 2002). This bilateral treaty has

brought some certainty to The Netherlands and Flanders on the amounts of water to be expected. The Dutch representative in the Meuse Commission considers this treaty as useful for addressing flow variability: (Buiteveld, pers. Comm.):

*After Liège, the water is going in two ways. There is an agreement on how to split: both get half. There is also an agreement on actions to take during low flows. There was actually a serious drought in 1976 and afterwards, we made this agreement which works very well now, especially for situations of low flow we had afterwards. It was operationally working. We had to do it in the right way, but with some direct contacts we can adjust it if needed.*

However, others highlight that even with this treaty it is difficult to predict the flow at certain locations such as Borgharen (Bastings 2002).

#### **4.3.3 Climate and hydrology**

The Meuse discharge fluctuates considerably with the seasons (UNECE 2013): for example, in the winter of 1993 it reached 3100 m<sup>3</sup> per second at the Dutch/Walloon border where normally it can fall down to only 10-40 m<sup>3</sup> per second in summer. As a rain-fed river, the Meuse has no glacier origin and little groundwater storage capacity to cope with precipitation variability (IMC 2013), which can be problematic for its economic activity, ecological status and cultural heritage. Low flow and water scarcity is already an issue in the basin and the basin has been experiencing flow variability for many years (M. Fournier, former AMICE project leader, and Mr. Schreurs, IMC, pers. comm.). Floods always pose a serious problem with high floods for example in 1993, 1995, 2000 and 2003. Climate change impacts are not yet clear, but the seasonal flow variability as well as extreme events are expected to increase (both in magnitude and frequency) with climate change, i.e. floods and droughts are increasing but more difficult to predict. It is expected that high and low flows will grow, that there will be wetter Winters and drier Summers and therefore more floods in Winter and Spring and more low flows in Summer and Autumn. In addition to climate change, many other pressures exist, such as land-use changes, population growth etc.

#### **4.3.4 Ability to cope with flow variability**

Flow variability has been significant as shown above, but it has not lead to any major conflicts in the last years, only smaller disagreements between water users, even at the national level according to interviewees (Schreurs, IMC, pers. comm). The Meuse basin has densely populated and built-up floodplains, which are some of the most vulnerable areas in Europe, at risk from storms, intense rainfall and flash floods (AMICE 2013, UNECE 2013). There are also industries, irrigated agriculture and an intense inland navigation, which are vulnerable to low water levels in the river and the channels it feeds. Therefore, several stakeholders consider that the preparedness of the regime to climate change is medium:

*Paul Dewil, Belgian representative in IMC, pers. comm:*

*I think our basin is moderately prepared for climate change, among others since the Meuse is flowing so fast and the floods usually arrive here downstream in one, two or three days.*

*Denis Besozzi, French representative in IMC, pers. Comm: We are not prepared today for climate change in the Meuse, not even in our minds. We have to continue.*

The IMC secretariat expects that soon a decision will be taken whether and how to deal with climate change, for example starting with an exchange of information and comparison of national adaptation activities (Schreurs, pers. Comm.). Subsequently, a strategy could be built, including some general principles. This would indicate that the regime is “learning”. Learning is also visible by the fact that the Meuse Commission recently added new areas of cooperation such as implementing river basin management plans, exchanging biological monitoring results, water quality data, water quantity data and the Floods directive (UNECE 2011).

#### **4.3.5 Climate change adaptation activities**

Compared to the other basins in my study, such as the Rhine or Danube, the Meuse basin is not yet very advanced in terms of addressing climate change through studies, assessments and adaptation strategies (Fournier, former AMICE project coordinator, pers.

Comm.) since the International Meuse Commission (IMC) has not yet addressed the issue, except for floods which were subject to the Meuse cooperation since the 90s. The only exception is the AMICE project, which was implemented in 2009-2013 as an Interreg project by 17 partner organisations, namely authorities from lower administrative levels such as regional authorities as well as cities and villages, which are located in the Meuse basin (six river basin managers, six universities and research centres, three public administrations, an environmental NGO and a crisis centre). The project was led by EPAMA (*Etablissement Public d'Aménagement de la Meuse et de ses Affluents*)<sup>9</sup>, a consortium of several French regions and departments, and aimed to minimise the economic, social and ecological impacts of climate change. Through the AMICE project, a preliminary basin-wide climate change impact assessment was prepared and several small-scale adaptation measures were implemented (AMICE 2013). At the end of the AMICE project in 2013, project partners expressed hope that the IMC would follow up on some of the results (final project workshop). However, some riparian countries believe that the result of the project first have to be validated before they can be officially accepted and used (final project workshop). In addition, the AMICE project did not reach its initial aim, to develop a strategy for climate change adaptation, but moved towards a roadmap. Some participants at the final AMICE workshop in March 2013 stressed that the Meuse Commission will see what to do with the AMICE results and that other climate change impacts needed to be analysed, e.g. on water quality, drinking water and biodiversity. These remarks show that, while the AMICE project was considered useful, its outcomes are not accepted by all and it did not reach all its aims. The networking, exchange of knowledge and experience was considered to be one of the most important project achievements.

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<sup>9</sup>EPAMA was created in the 90s as a regional organizations in order to better manage the frequent floods, i.e. high flow variability in the Meuse basin (EPAMA 2013).

#### **4.3.6 Data exchange**

Information and data exchange is generally working well in the Meuse and was further improved through the AMICE project (Dewil, representative of Belgium in the IMC, pers. comm.). The monitoring system is being harmonized throughout the basin in order to use the same parameters and methodologies. Flow and water quality data are exchanged and an early warning system exists, enabling cooperation in situations of flooding (Dewil, Belgium, pers. Comm). But there are a few exceptional problematic cases. For example, during a flood in 2010, a dam was operated without informing the downstream country the Netherlands, i.e. in this case flow variability was not well addressed (M. Fournier, AMICE project, pers. comm.).

#### **4.3.7 Stakeholder involvement**

Actor networks are considered very important in the Meuse for the transboundary cooperation in the basin, but also the adaptive capacity (M. Lejeune, former AMICE project staff, pers. comm.), such as networks of NGOs as well as the network of 17 partners of the AMICE project. A network of NGOs existed already before the AMICE project and played an important role in forming the partnership of the AMICE project since several of the network's NGOs joined the AMICE project. M. Lejeune, previously working on the AMICE project, pers. comm:

*17 partners were involved from 5 regions in the AMICE project, the partners got to know each other well, the combination of universities and water managers on the ground was a good team, some stakeholders talked to each other for the first time, it was an eyeopener for some people and the approach at different levels was a key to the success.*

Nine different organizations participate as observers in the activities of the Meuse Commission (IMC 2014).

#### **4.3.8 Resources**

As indicated before, resources allocated for the Meuse Commission are very low compared to the Rhine and the Danube regimes for example. The Commission secretariat

only has 2.5 professional staff members (and interpreters/ translators) and a yearly budget of 500,000 EUR (Schreurs, IMC; pers. Comm). With this, numerous working and project groups need to be serviced, both from the content and practical point of view. This leaves nearly no time for promotion or participation in international meetings- this situation is described by the Executive Secretary as “isolated existence” (Schreurs, IMC; pers. Comm). There are even threats of further reduction of this already very low budget.

#### **4.3.9 Unique features and conclusions for the Meuse**

All Meuse countries are stable countries with similar languages and access to EU funding (Schreurs, IMC, pers. Comm). However, the cooperation does not work as well as in the Rhine until today (Schreurs, IMC, von Buiteveld, the Netherlands, pers. Comm): it is difficult to find agreements and consensus and the trust and overall atmosphere of cooperation between the riparian countries is not as good as for example in the Rhine or Danube. Reasons for this might be the shorter period of cooperation, significant differences in economy, culture and practices of water management, but also the different status of countries: some countries such as the Netherlands (UNECE 2011) are more advanced in water management than the others and have more resources as well as more staff working on this topic than the other riparian countries. According to the Dutch representative in the Meuse Commission (Buiteveld, pers. comm), time was needed to get to know each other in the Meuse Commission and to build a common reference framework. These reasons might explain why the Meuse countries are only willing to give very limited human and financial resources to the International Meuse Commission secretariat, which is very small with only 2.5 staff members. The reasons might also explain that, while the IMC has addressed floods, climate change has not yet been tackled by the Meuse Commission, except for the project AMICE which is a unique feature of the Meuse basin and has triggered cooperation on adaptation.

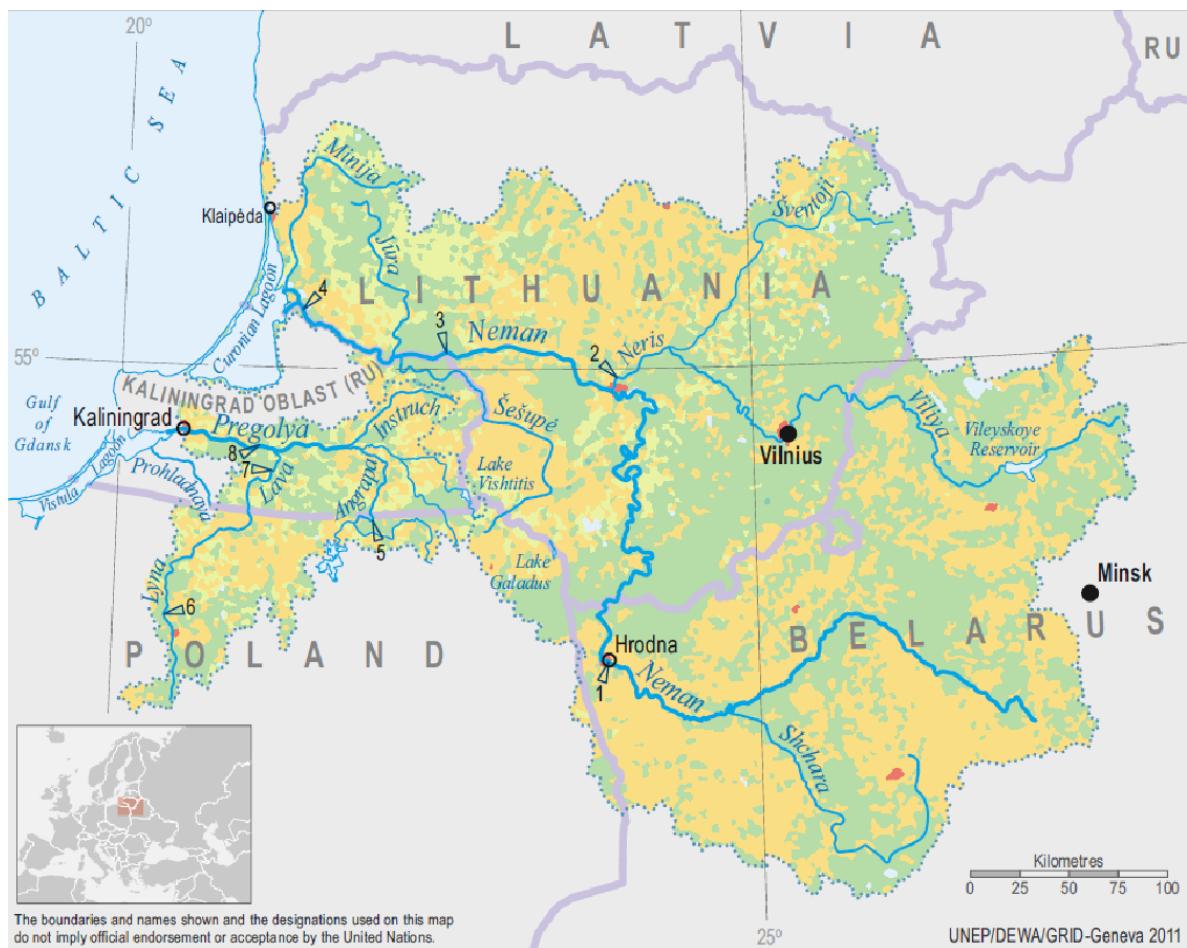
#### **4.4 Neman- climate change adaptation driving general cooperation**

**Table 16: Data sources used for the Neman basin (excluding literature):**

<b>Interviews conducted</b>		
Audrius Sepikas	Lithuanian Environmental Protection Agency	9 August 2013
Paul Buijs	Neman project consultant	26 October 2013
Vladimir Korneev	Institute for Complex Use of Water Resources Belarus	24 July 2013
Egidijus Rimkus	Vilnius University	8 January 2014
Nickolai Denisov	Zoi Environment Network	2 May 2014
<b>Events observed:</b>		
Multistakeholder workshop on the Neman basin on 16 May 2013 in Vilnius, Lithuania		
Multi-stakeholder workshop on climate change adaptation in the Neman basin, 19 March 2013, Minsk, Belarus		
Multi-stakeholder workshop on climate change adaptation in the Neman basin, 21 January 2014 Kaliningrad, Russian Federation		
Final project conference on river basin management and climate change adaptation in the Neman basin, 19-20 June 2014, Vilnius, Lithuania		
Expert meeting on the Neman basin cooperation, 30-31 October 2014 in Vilnius		

##### **4.4.1 Geography and water use**

The Neman River Basin flows through the Republic of Belarus, Republic of Lithuania and, for a small part of the basin, the Kaliningrad Region (Oblast) of the Russian Federation as well as Poland as can be seen on table 17 and on figure/ map 8. The river plays an important role in the socio-economic life of all riparian countries, especially Lithuania and Belarus, the countries sharing most of the basin's surface (UNECE 2013b). There is a high level of water use in the Neman River Basin due to a numerous industrial and agricultural activities and pipelines. Agriculture, industry and domestic water use are the highest water users in the basin (UNECE 2011).



**Figure 8: Map of the Neman basin**

Source: UNECE 2011

**Table 17: General information about the Neman basin**

Riparian countries	Belarus, Lithuania, Russian Federation (Kaliningrad), Poland
Population in the basin	5.4 million persons
Water uses	domestic purposes, industry, agriculture
Tbwm Regime	No river basin commission, no basin-wide agreement
Years of cooperation	Only sporadic cooperation

#### **4.4.2 Legal and institutional framework for transboundary cooperation**

While several bilateral agreements regarding environmental protection exist between Belarus, Lithuania and the Russian Federation (UNECE 2013 b), none of them is directly focused on water resources and the Neman basin in particular (Andersson et al. 2013):

- An agreement between the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus and the Ministry of Environmental Protection of the Republic of Lithuania about environmental protection cooperation;
  - A permanent working group between Belarus and Lithuania to discuss the results of surface water quality monitoring;

- A 2003 agreement between the Hydrometeorological Services of Lithuania and Kaliningrad for cooperation on monitoring and exchange of data on the status of transboundary surface water bodies
- A Technical Protocol between the Ministry of the Environment of the Republic of Lithuania and the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus for cooperation on monitoring and exchange of data on the status of transboundary surface water bodies, signed in 2008.

At the multilateral basin level, a transboundary agreement "Cooperation in the field of use and protection of the water bodies in the Neman River basin" was negotiated in 2000-2007 by Belarus, Lithuania and the Russian Federation for Kaliningrad. However, since the European Union then had to become a Party to the agreement, following the Lisbon treaty and a decision by the EU Council, which Belarus and the Russian Federation oppose, the basin-wide agreement is not likely to be signed and enter into force in the near future (Andersson et al. 2013).

Reasons for this slow progress in transboundary cooperation are multiple: lack of willingness at the high political level, lack of trust, differing interests between the riparian countries, e.g. in relation to the further development of the river (Lithuanian expert, pers. Comm.). As in many basins in Eastern Europe, the Caucasus and Central Asia, some technical cooperation mainly at the expert level takes place, but many essential elements of transboundary cooperation are missing, such as harmonization of monitoring, as an international project consultant explains (Paul Buijs, pers. Comm):

*The riparian countries of the Neman meet, but I did not get the impression that activities are adjusted thanks to the cooperation or an agreement. There is some joint sampling, but no real cooperation in that countries coordinate or adjust measures or so. There is nothing written in relation to cooperation, i.e. no agreement or so. A Commission should be established with a certain mandate.*

However, recent positive developments lead to some hopes for transboundary cooperation. At the final project conference on 19 June 2014 in Vilnius Belarus and Lithuania agreed to develop a technical agreement for transboundary cooperation. A draft technical protocol was negotiated on 30 and 31 October 2014, but still needs to undergo internal

approval procedures. It foresees the establishment of regular information and data exchange, elaboration of a joint river basin management plan or coordination of national plans and, most importantly, the creation of a commission for transboundary cooperation, with working groups etc. If this technical protocol will enter into force, it will represent a major breakthrough for transboundary cooperation in the basin.

#### **4.4.3 Climate and hydrology**

The overall annual flow in the Neman basin is not expected to seriously change on average due to climate change, but the annual distribution will change: peak of floods will likely occur earlier, winter discharge will increase and summer discharge will decrease in some parts of the river basin, especially in Belarus. The Neman basin will likely suffer from stronger droughts in summer (increased air temperature combined with reduced flow), and higher temperatures as well as higher water flows in winter (scientists Rimkus, Lithuania, and Korneev, Belarus, pers. Comm). The ice regime will change significantly and snow will melt earlier. This will lead to occurrence of earlier floods in the lower part of the basin. Some of these impacts are already happening, for example Summer droughts as well as local storms and heavy rains increased and the sea level in the Baltic Sea already raised by 15cm in the last century. It seems that climate change will have a stronger influence on runoff than expected changes in water use – at least in the Belarusian part of the Neman River Basin (Korneev, Belarus, pers. Comm). These trends may negatively affect especially small tributaries and their ecosystems. Climate change will also affect agriculture, industry, water quality and other sectors in the Neman basin. Some regions within the basin are especially vulnerable, such as the delta region in Kaliningrad (Russian Federation), which is located partly below sea level. The expected impacts may require revision or upgrading of flood protection measures and infrastructure.

#### **4.4.4 Ability to cope with flow variability**

Climate change has possibly already shown some first impacts on the Neman basin, such as changing patterns in extreme events, according to a representative of the Lithuanian environmental protection agency (pers. Comm) who explains that in a certain region of Lithuania, floods come earlier and stay longer, but are less severe. According to model calculations, 5-6 per cent of the changes in flow in the basin can be explained by water use changes, thus socio-economic effects, and 20% by climate change (Korneev, expert from Belarus, pers.comm).

However, other respondents (Denisov, Bujs, international experts, pers. Comm.) highlight that the Neman basin is less affected than other rivers in Europe by climate change. One of the project experts from Lithuania (Rimkus, pers. Comm.) judges the adaptive capacity of the river basin (but not of the transboundary regime) as “rather high” since expected climate change impacts are not very dramatic, both riparian countries have some, albeit limited financial resources and the required institutional capacities. An international expert has a similar opinion (Paul Bujs):

*Overall, I would not expect too drastic effects of climate change on the physico-chemical surface water quality; I doubt it will become a big problem of basin-wide importance. The projected 1 °C degree temperature increase is not so spectacular. However, we do not know how biological system responds. If we follow a precautionary principle, action should be taken mainly to take care of nutrients.*

In the past, water flow variability has caused some conflict between the riparian countries. For example, in the Summer of 2012, diplomatic tension emerged because of variations in water levels as a representative of Lithuania, explains:

*There was a lack of water in 2012 in the river, so a letter was sent to Belarus and they claimed that it was due to a dry Summer. Later it became clear that it was because Belarus started the filling of the Grodno hydroelectric power station's reservoir.*

Following this incident, letters of protest were sent by the Foreign Affairs Ministries of both countries and some planned cooperation activities were postponed. Such instances of tension between the riparian countries due to flow variability, which was actually due to

anthropogenic activities, i.e. the filling of the reservoir, indicates that the transboundary regime in the Neman basin might have difficulties to cope with climate change which affects negatively the adaptive capacity in this basin. On the BAR scale, developed by Wolf (see section 2.2.2) these events could be assigned the value -3 or -2.

#### **4.4.5 Climate change adaptation activities**

The first transboundary climate change impact assessment in the Neman basin was performed in the framework of the project “River basin management and climate change adaptation in the Neman basin”. The project aimed to improve integrated river basin management and transboundary cooperation in a changing climate (UNECE 2014), was implemented from 2010 to 2014 by UNDP and UNECE, and included the development of a joint climate change impact assessment, water balance modelling, assessment of climate change impacts on water quality, assessment of the monitoring systems and development of a transboundary adaptation strategy. The project led to a common understanding and scientific consensus among riparian countries on climate change impacts in the basin and enabled a renewal of cooperation between experts from the riparian countries on the shared river basin (UNECE 2014, Denisov, pers. Comm). A network of experts from the three countries was created which performed joint modelling. The success of the project was among others due to the personal engagement and motivation of several persons, namely the main project experts from Belarus and Lithuania, which shows that leadership is an important factor for adaptive capacity (Denisov, international expert, pers. Comm.). Experts from the riparian countries appreciated that the project helped them to improve cooperation with the neighbouring country not only on climate change, but also water management more general, such as in the framework of the river basin management plan, as a representative of Lithuania explains:

*Egidijus Rimkus, Lithuania, pers. Comm: The Neman project is very important because it started again the cooperation between the countries. Some links or projects existed before, for example related to flood forecasting and droughts, there was thus some communication but it has improved through the project. There is an increase in*

*awareness now. Not a lot will change, but better communication will solve some problems.*

#### **4.4.6 Data exchange and scientific studies**

At the multilateral or basin-wide level, information and data is not regularly exchanged between the Neman riparian countries. On a bilateral basis, under the 2003 agreement mentioned above, data on the hydrological and hydrochemical regime as well as on groundwater is exchanged monthly between the Kaliningrad oblast in Russia and Lithuania (UNECE 2011). Between Belarus and Lithuania, data exchange is very limited (Nickolai Denisov, international expert, pers. Comm). There is no accepted common information system, but first steps were made within the project for an information exchange improvement, as an expert from Belarus explains:

*We are exchanging this information and we have prepared draft common database in the project on Neman river basin on the web portal of my institute. Currently there is only informal information exchange between scientists and the information platform is not yet a public platform, but only a draft. We are working on improving it, especially for public access. I am not sure about good functioning of this platform.*

As described in the previous section 4.4.5, the involvement of scientists from all basin countries in the modelling and scenario development as well as regular discussion of the preliminary results with the authorities and involvement of stakeholders from other sectors in all riparian countries has facilitated achieving a common understanding or scientific consensus about expected climate change impacts. The organization of several national stakeholder workshops to discuss preliminary results was important for ensuring wide engagement and ownership.

#### **4.4.7 Stakeholder involvement**

According to the interviewees, some transboundary cooperation is happening at the expert, scientific and NGO-level, but to a very limited extent (Lithuanian expert, pers. comm.). Cooperation is made difficult by practical issues such as visa questions or differences in water management and monitoring systems. In 2014, new efforts were made by

environmental NGOs to create a network of NGOs in the basin, in order to revive transboundary cooperation at the grassroots level (Trombitsky, pers. Comm).

#### **4.4.8 Resources**

Financial and human resources for (transboundary) water management and climate change adaptation are not only limited in Belarus, but also in Lithuania: the number of staff in the ministries working on water is very low. At the stakeholder workshop in Vilnius on 16 May 2013, representatives of local authorities complained about the lack of funding to implement the different measures of the Lithuanian river basin management plan some of which would also help to increase adaptive capacity. Some resources are available for transboundary cooperation in climate change adaptation, but only through the above mentioned project. Resources are seen as important, as an expert from Belarus explains:

*I think our problem mainly relates to funds because in the framework of the project we cooperate well. Scientifically we cooperate well, but we need some funds. We have river basin management plan in Lithuania and complex scheme of water resources for the Belarussian side. This covers water quality, ecosystems etc. but not floods. Lithuania needs to implement the EU floods directive.*

#### **4.4.9 Unique features and conclusions for the Neman**

The project on river basin management and climate change adaptation increased the adaptive capacity of the Neman and is accepted and recognized by stakeholders and authorities who consider it as useful. However, the Neman regime has not been able to cope with flow variability without tension and it is uncertain what will happen after the end of the project. Due to the current tensions between the governments of Belarus and Lithuania due to the construction of several nuclear power plants close to the border, the cooperation between the Neman basin riparian countries is not expected to improve in the near future. Flow variability in the basin is not only due to climate change, but also anthropogenic influences, as an expert from Lithuania highlights:

*The large variability of the Neman is not only due to climate change, but also the building of hydropower stations. This changed the hydrological regime. I do not think however that the Hrodno hydropower station makes a big difference.*

A rapid finalization, signature and entry into force of the basin-wide Neman treaty or adoption of a bilateral technical agreement would certainly improve transboundary cooperation and adaptive capacity of the regime. Ideally, in the longer-term future, the infrastructure such as the hydropower stations in the basin could be managed jointly like in the Senegal basin, with the aim to regulate flow variability from a basin-wide perspective.

#### **4.5     *Overview of the other basins considered in the analysis***

In addition to the four basins analyzed in detail in this dissertation, 9 other basins from Europe and beyond were considered in order to answer my research questions (see table 18). They were not analysed systematically or in detail, i.e. no interviews were conducted for these basins and participatory observations of events occurring in the basin were done only for some of them, namely the Sava basin and the Chu Talas basin. Their analysis is therefore mainly based on document analysis and on participatory observations of the meetings of the global network of basins under the UNECE Water Convention, where representatives of these basins joined and presented their progress with regard to climate change adaptation. The objective of considering these basins is twofold: firstly, enlarge the range of evidence for certain findings of the present research and secondly, address some of the deficiencies of this dissertation, in particular to enlarge the focus beyond Europe.

Insights from these additional basins indicate that the institutional and legal transboundary cooperation regimes, priorities, climate change impacts and flow variability challenges differ from those in my four case study basins. For example, in Africa, climate change impacts are often already felt, at least in some basins, but the priorities in the basin and river basin commissions are different than in Western Europe: the main focus is on development and on increasing access to clean water and energy for the population (5<sup>th</sup> Africa Water Week, Dakar, 26-30 May 2014). Also in the Drin basin in South-Eastern Europe, the

Chu Talas basin in Central Asia and the Mekong in Asia, development is considered as highest priority, including exploitation of the hydropower potential in the basin. New hydropower stations are under construction for example in the Mekong, causing significant controversies among the riparian countries. Representatives of the Congo, Senegal and Niger basin underlined that the energy or hydropower sectors usually have the largest influence on water allocation decisions in their basins compared to agriculture, water supply and environment (Second meeting of the global network of basins working on climate change adaptation, Geneva, 13-14 February 2014). The energy sector determines how the dams and hydropower reservoirs are operated, thus how the water is managed in the basin. In the Senegal, one of the most advanced basins with regards to transboundary cooperation in Africa, the permanent water commission, which is in charge of all water-related decisions in the basin, includes mainly representatives of the energy, agriculture, but no representatives of the environmental sector (Ndiaye, pers. comm.).

In addition, aspects of climate change and resulting higher flow variability are often not taken into account in the construction of new hydropower stations and dams in these basins such as the Senegal (Ndiaye, pers. comm.). Mainstreaming climate aspects into already planned infrastructure, plans and strategies would be a way to increase adaptive capacity while respecting the understandable needs for developments in the basins.

All the additional basins considered in my dissertation experienced flow variability and have mostly, but not always, been able to address such situation of flow variability without major conflicts. Some of the transboundary basins in Africa have river basin commissions with strong leadership, for example the Senegal, high resources through donor funding and a long history of cooperation, except for the Congo where the Commission was only established a few years ago. However, many of them have not yet started to seriously address climate change impacts, to prepare a systematic impact and vulnerability assessment and subsequently an adaptation strategy. While many of the basin countries have developed

national adaptation plans and strategies, the topic climate change adaptation seems to be less prioritized at the basin level compared to development. The main exception is the Mekong River Commission, which set up a large climate change adaptation initiative already in 2009.

Chapter 4 presented the four case study basins, their natural conditions and transboundary water management regime according to common criteria. Some of these criteria will be used in the following chapter to identify enabling factors for adaptive capacity of transboundary water management regimes.

<b>Basin and reference</b>	<b>Riparian Countries</b>	<b>Status of countries</b>	<b>Continent</b>	<b>Climate</b>	<b>Transboundary regime</b>	<b>Expected climate change impacts</b>	<b>Adaptation activities</b>
Dniester Basin UNECE 2012	Republic of Moldova and Ukraine	Transition	Eastern Europe	Moderate	Basin-wide agreement signed in 2012, but not yet in force, Commission to be established, New Treaty identifies principles and provides a framework for cooperation on water pollution prevention and control, water flow regulation, conservation of biodiversity and protection of the Black Sea environment. It also addresses the monitoring of data exchange, public participation and cooperation in emergency situations, such as floods.	More extreme events, esp. floods. Severe floods in 2008 and 2010.	Project on climate change led to a joint climate change impact and vulnerability assessment and a draft adaptation strategy.
Chu Talas Basin UNECE 2000	Kazakhstan and Kyrgyzstan	Transition	Central Asia	Water scarce	Commission and agreement exist, covers joint management and joint financing of infrastructure, water allocations not included, no flexibility provisions, negotiations ongoing for revised broader mandate and scope. Agreement foresees cooperation in extreme situations, such as natural disasters (e.g. droughts)	Glacier melting, droughts	Project on adaptation led to a joint vulnerability assessment.
Sava river basin ISRBC 2002	Bosnia and Herzegovina, Croatia, Serbia and Slovenia,	Partly EU, partly transition	South-Eastern Europe	Moderate	Commission and agreement exist since 2006, no water allocations, no flexibility provisions, but joint monitoring, exchange of data, inst. Structure for transboundary coop. Additional Protocol on Flood management adopted in 2009	Unclear, likely more extreme events, very serious floods in May 2014	Project on floods, project by World Bank on adaptation plans
Amur/ Argun/ Daursky Bio-sphere reserve UNECE 11	Russian Federation, Mongolia and China,	Developing/ transition	Asia	Continental- dry	Only agreement over transboundary protected area. A joint Russia-China commission exists based on the 2008 agreement between the two countries	Climate cycling, more extreme events such as droughts and floods (big flood in 2013)	Joint studies, monitoring system enlarged
Drin UNECE 2011	Albania, Former Yugoslav Republic of Macedonia, Greece, Serbia; Montenegro	Transition countries	South-Eastern Europe	Mediterranean – dry	Joint MOU signed in 2011, establishes a core group, working groups and Meeting of the Parties, no allocations or other flexibility provisions, but structure for cooperation, GEF project is starting for the Drin.	More extreme events	Transboundary project on flood management and climate change adaptation
Niger basin UNECE 2011	Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger and Nigeria	Developing countries	Africa	Tropical	Joint agreement and commission (Niger Basin Authority, NBA) exist, convention mainly focused on its structure, aims, mandates, including on floods and droughts	More extreme events, floods especially	A climate risk assessment has been prepared
Congo	Cameroon, Central African	Developing countries	Africa	Tropical	Joint agreement and commission (CICOS) exist (between Cameroon, DRC, CAR and Republic of Congo), cooperation	More extreme events, floods	Climate change adaptation activities started

UNECE 2014	Republic, Democratic Republic of the Congo, Republic of the Congo, Equatorial Guinea and Gabon				originally focused on navigation, then widened up to include IWRM. Includes prioritization of water uses, but no fixed allocations	especially, higher variability between dry and wet season, diverging model results	
Mekong River MRC 1995	Cambodia, Laos, Thailand and Vietnam	Developing countries	Asia	Tropical	Joint agreement and commission. The treaty (MRC 1995) includes flood control as one area for cooperation in order to optimize multiple use and minimize harmful use. The treaty provides for the Joint Committee to "prepare and propose . . . Rules for Water Utilization and Inter-Basin Diversions. . . ." Wet Season: within-basin use requires notification of the Joint Committee. Inter-basin diversion requires consultation	More floods, High flow variability	Climate Change Adaptation initiative (MRC-CCAI) prepares a joint impact assessment and adaptation strategy as well as implementation of measures
Senegal OMVS 2002	Guinea, Mali, Mauritania, Senegal.	Developing countries	Africa	Tropical	Very advanced agreement and commission, shared management and financing of infrastructure, detailed regulations for different sectors, also has a "water charter"	More drought	Adaptation activities starting

Table 18: Overview of Additional Basins.

## **5 Analysis: Enabling factors for adaptive capacity of transboundary regimes**

Chapter 5 identifies and analyses enabling factors for adaptive capacity to climate change of transboundary water management regimes, based on the case studies results, such as legal frameworks, forums for discussion and decision-making, in particular river basin organizations, data and information on climate change and flow variability, multi-level governance and learning capacity. Following a description of each single identified factor, they are considered together, including linkages between them, with national level processes etc. Finally, the chapter concludes with a section on limitations and future research needs.

### **5.1 Adaptive capacity of the four transboundary water management regimes**

Table 19 compares the main case study basins according to the criteria in chapter 4.

Basin	Countries	Information and data exchange	Legal and inst. framework	Actor networks	Resources	Climate change impacts
Rhine	9, all EU	Regular Data exchange, scientific consensus through common studies	Very advanced, Commission and agreement exist since 60s	Very active participation	Regular contributions, sufficient for cc activities	More extreme events, impacts on water temp. and quality
Danube	13/19 EU/ non-EU	Data exchange through a common database, scientific consensus	Advanced RBO and agreement since 1994	Very active participation	Regular contribution, cc led and financed by DE	More droughts, flood impacts unclear
Neman	3, mix	Data exchange limited, cc studies through project led to common understanding	No transboundary agreement/ institution	NGO networks are being created	Project external donor funds	Unclear, more droughts and earlier floods
Meuse	5, all EU	Data exchange fine, common understanding through AMICE project	Commission and agreement exist since 90s	Very active e.g. AMICE project, doing tasks of RBO	Project external donor funds	More ext. events, impacts on water temperature and quality

Table 19: Comparison of the 4 case study basins according to my identified criteria

As written in chapter 3.1, adaptive capacity is defined in this dissertation as: Ability to cope with past flow variability in a transboundary basin without conflicts between riparian countries. The development of climate change impact assessment and adaptation strategies can support responding to extreme events and prevent conflicts in such situations.

As described in Table 20 below, out of the 4 case studies, the Rhine and Danube already have a transboundary climate change impact assessment and/ or climate change adaptation strategy and they have been able to cope with flow variability, especially floods, which usually did not result in major conflicts. In the Meuse, climate change activities are starting and the regime has usually been able to cope well with flow variability, with some exceptions however. In the Neman, the relations between riparian countries are more conflictive, and changes in flow, whether due to extreme weather events or to anthropogenic impacts, have led to tensions which might indicate a lower adaptive capacity. In the four case study basins, conflicts due to flow variability have been rare, except the Neman.

**Table 20: Overview of adaptive capacity indicators in the analysed basins/ case studies**

	Basin-wide cc impact/ vulnerability assessment	Basin-wide adaptation strategy	Capacity to cope with flow variability	River basin commission
<b>Rhine</b>	yes	in process	yes, high (e.g. recent floods, low flow in 2011)	yes strong
<b>Danube</b>	yes	yes	yes high (e.g. floods in 2013)	yes strong
<b>Meuse</b>	yes (through the project)	roadmap	rather high, some tensions	yes weak
<b>Neman</b>	Yes (through the project)	Draft available	rather low: low flow in 2012 led to political conflict	no

My preliminary results are in line with previous research (Raadgever et al. 2008): In a comparison of adaptive capacity of seven transboundary river basins, considering criteria such as actor networks, financing and information management, Raadgever et al. (2008) considered the Rhine as most adaptive of all basins, also due to its joint and participative information production, broad communication and consideration of uncertainty. Also some other actors evaluate the Rhine regime as most adaptive of all (e.g. Timmerman, Denisov pers. Comm).

My research was based on two indicators for adaptive capacity, namely ability to cope with variability in flow without conflict and secondly, the existence of joint climate change impact and vulnerability assessments as well as adaptation strategies. They were confirmed in my research through some interviewees, but also because they led to similar results. For example, those basins with a joint vulnerability assessment and adaptation strategy were

usually also able to cope with flow variability. Only in the Neman basin, the first indicator led to more negative evaluation of adaptive capacity than the second indicator since the Neman basin has a transboundary vulnerability assessment and draft adaptation strategy, but the transboundary regime is not well able to deal with flow variability.

## **5.2 *Enabling factors for adaptive capacity***

In the following section, enabling factors for adaptive capacity are analysed based on the case studies, including the literature review. They are divided into five main categories: legal frameworks, forums for communication and decision-making, namely river basin organizations, data and information, learning capacity and clear responsibilities of different governance levels.

### **5.2.1 *Legal frameworks for transboundary cooperation***

Existence of a legal framework for transboundary cooperation is very important for adaptive capacity of transboundary water management regimes, as indicated by many of my interviewees (for example Korneev, Mair, Schreus, pers. comm) and many authors (such as Goldenman (1990), Fischhendler (2004), Drieschova (2008), Zentner (2012), McCaffrey (2003)). Those basins which do not have such a legal basis for transboundary cooperation usually have a lower adaptive capacity, for example the Neman, Dniester and Amur/ Argun basins in the Far East. The following section will analyse the reasons for this and analyse the importance of a certain institutional design of these legal frameworks.

#### *5.2.1.1 Reasons for their importance*

Legal frameworks or transboundary water management treaties are crucial for communication, cooperation, security, data exchange, compliance and environmental protection in the basins. They determine rules for the cooperation in the basin regardless of government changes or financial constraints, oblige countries to fulfill certain requirements in relation to national and transboundary water management (Zentner 2012), to implement what

they committed to e.g. improving water quality (for example the Rhine Convention), ensuring a minimum flow in the river, even in times of government changes or lack of resources. For example, the Danube Convention obliges riparian countries to prevent, control and reduce transboundary impact, to exchange information and consult other riparian countries when planning measures with significant transboundary impact according to the Convention (ICPDR 1994). As another example, the bilateral Meuse treaty between the Netherlands and Flanders describes the allocation of water between them (see section 4.3.2). Representatives of Netherlands as downstream country in the Rhine also highlight the importance of legal frameworks for water supply, including drinking water: *However, it is extremely important that firm international agreements are made because in summer the Rhine is by far the largest source of fresh water for the Netherlands and because it is important to maintain a minimum water level in the Waal...*

Legal frameworks are also important for defining cooperation modalities in times of low and high water flow and generally flow variability, for example they often describe how to communicate, how to allocate water, how to warn and assist each other in times of extreme weather events. They can include provisions on prevention of, preparedness for and response to flow variability, such as floods, in the different areas identified as important in this dissertation, such as information exchange, learning capacity, resources etc. For example, the transboundary agreement between Finland and the Russian Federation specifies that Finland can deliver more water in flood situations and then compensate the Russian Federation for the loss of hydropower which enables both countries to share benefits. The legal frameworks in three of my case study basins include provisions on flood management: the Danube Convention refers to floods seven times (ICPDR 1994), the Meuse agreement six times (IMC 2004), and the Rhine Convention five times (ICPR 1999). As it can be seen on Table 18, the agreements on the Sava, Chu Talas, Mekong, Niger and Dniester include provisions on actions to take in emergency situations, e.g. countries should exchange data, perform joint

monitoring and forecasting, have a basin-wide early warning system, assist each other etc. The Danube Convention obliges Parties to prevent transboundary impacts, including impacts due to flood protection measures such as dams and dykes (ICPDR 1994). In addition, Parties shall make comparable as much as possible flood forecasts and elaborate and implement joint monitoring programmes in this area. Article 16 of the Danube Convention obliges Parties to inform each other about competent authorities as well as designated officials in the areas of floods and ice hazards (ICPDR 1994). Article 16 (4) asserts that:

(4) In order to control and reduce the risks originated from floods including ice-hazards, the competent authorities shall immediately inform the down-stream Danubian States likely to be affected and the International Commission on the occurrence and run-off of floods as well as on forecasts of ice-hazards.

The Meuse agreement, signed 10 years later, even goes a bit further obliging Parties to consult and coordinate flood protection measures taking into account ecological, spatial planning, nature protection and other sectoral aspects (IMC 2004).

Legal frameworks for transboundary cooperation thus provide some form of security and certainty at the national level and to the other riparian countries, which is very important in transboundary basins, since one of the highest challenges for transboundary water management is uncertainty about the other riparian countries' actions, in addition to the uncertainty about future precipitation and water flow caused by climate change and variability (UNECE 2009). One of the international experts pointed out the importance of a treaty for work in the transboundary Dniester basin (Denisov, pers. Comm.):

*The treaty for the Dniester basin, once in force, will help our work and the countries a lot. There would be a clear target and a clear client for our work. The treaty is an important mechanism for communication which can be used.*

Flow variability and specific extreme events can even be a trigger for the negotiation of a transboundary agreement by demonstrating the importance of transboundary cooperation in addressing the flood or drought. An expert, for example, asserted that two serious floods in 1993 and 1995 contributed to the development of the Meuse legal agreement (Schreurs pers. comm.). While flood management was not included in the 1994 Meuse agreement, flood

provisions were subsequently included in the text of the revised Meuse agreement adopted in 2004 (IMC 2004). The agreement stipulates, for example, that the Commission shall elaborate suggestions for coordination in the prevention and protection against floods (IMC 2004), coordinate the flood alarm systems and facilitate the exchange of data. Actually, any mentioning of floods in the agreement text refers to the Commission, underlining the importance of the river basin organization. Also the Danube Convention gives an important role to the Danube Commission with regards to flood management (ICPDR 1994). Thus, flow variability was even a reason in some basins for negotiation of the agreement and establishment of the Commission.

Those basins without a legal agreement usually express the need for elaborating and signing such an agreement. The Neman basin is the only basin within my case studies without a signed and functioning multilateral transboundary agreement and river basin commission since, as described above, an agreement was negotiated, but not finalized and ratified (see section 4.4.2). At the same time, the basin has difficulties to cope with flow variability which could indicate a lower adaptive capacity. Country representatives see the signature of the Neman treaty as important also for adaptive capacity, i.e. they believe that a more formal transboundary regime would be important for climate change adaptation since it will make the adaptation more effective and reduce vulnerability of the entire basin (*Representative of Belarus*: “*The draft agreement should be updated to include climate change issues*”). Also representatives of Lithuania are very interested in the conclusion of an agreement and explore all possible ways for moving it forward (Lithuanian representative: *the signature of the agreement needs to be included in the strategy of adaptation to climate change as an important measure*). At the final project seminar on 19-20 June 2014 in Vilnius, Lithuania promoted the idea of a technical agreement in order to move forward.

If a transboundary agreement does not address flow variability, this can be changed through an additional protocol. For example in the Sava River basin, the Sava agreement was

signed in 2002, when climate change adaptation and flood management did not yet play an important role or were not considered as a high priority by riparian countries (ISRBC 2014). Several years later, in 2010, when the importance of climate change adaptation and flood management became apparent, an additional Protocol on Flood Management was elaborated (ISRBC 2010) which is based on the EU Flood Risk Directive and aims to reduce flood risk from the transboundary perspective. It includes provisions such as preparation of flood risk assessment, flood maps, flood risk management plan, exchange of data and other activities, but ratifications by Sava countries took several years. When in force and properly implemented, this protocol may increase adaptive capacity of the transboundary regime.

#### *5.2.1.2 Implementation capacity*

The implementation of legal frameworks plays an important role for their adaptive capacity. As one of the experts pointed out “legal instruments are only as good as they are implemented” (*Nickolai Denisov, pers. Comm.*). Several transboundary water management agreements face implementation problems which affects their adaptive capacity. For example, countries might not notify and consult with other riparian parties when constructing major water infrastructure although such an obligation to notify is included in most transboundary agreements and part of international water law. This has happened in the Mekong, Neman, but even in the Rhine basin where one of the riparian countries decided not to implement commitments taken (McCaffrey 2007). Also in the Aral Sea basin, some existing treaties are not applied since water allocations are either not agreed upon or not implemented. The Albufeira Convention between Portugal and Spain is also facing implementation problems because of lack of funding by both governments (Afonso d’O, expert from Portugal, pers. Comm.). For example, joint monitoring and information exchange does not take place as required, public involvement is at stake etc.

Implementation problems can be more easily addressed if legal frameworks include an appropriate institutional framework i.e. an organization for their interpretation,

implementation, such as a river basin commission or other forms of joint bodies (see 5.2.2). Dispute resolution mechanisms provide an explicit mechanism for addressing conflicts and a predictable and clear procedure in the event of disagreements. Such procedures might involve an external mediator and/ or riparian countries can refer to the International Court of Justice such as Hungary and Slovakia did for the Danube River.

#### *5.2.1.3 Flexibility provisions in transboundary agreements*

How should transboundary agreements be designed in order to be able to address flow variability without conflict, i.e. which mechanisms, provisions and text should be included? The text of many older legal agreements such as for the Rhine, Danube, Mekong, Senegal etc. for example does not refer to climate change impacts on water because at the time of their adoption climate was not yet considered to be a major issue. In addition, the agreements e.g. on the Rhine and Danube do not include any water allocations. Should they be revised to address flow variability? As described in the literature review (see chapter 2.5), authors such as Drieschova (et al. 2008), Fischhendler (2004), Goldenman (1990) etc. argue that transboundary water agreements should include so-called flexibility provisions, which give some flexibility in the implementation, for example in dealing with flow variability. These include for example minimum water allocations or escape clauses. According to my research, flexibility provisions are useful, especially in water-scarce basins and in agreements with water allocations. However, having a flexible forum or organization for discussion of flow variability and for taking decisions on how to address it, seems to be more important for adaptive capacity than flexibility in the legal framework in my European case study basins.

If treaties do not include such flexibility mechanisms, amending treaties or adding additional protocols can be an option to better respond to flow variability. However, in general, legal frameworks are fixed and often difficult to change to adapt them to flow variability, since this would require a new negotiation and ratification of the amendment by all Parties, which can be a very lengthy process. The example of the Sava in the preceding

section shows that it can take several years for only four countries to ratify an additional protocol addressing, among others, flow variability.

Out of my 4 case studies, minimum water allocation and other flexibility provisions exist only in the legal framework of the Meuse basin transboundary regime, and even there not in the multilateral agreement, but only in the bilateral agreement between the Netherlands and Flanders (see chapter 4.3). One expert explains the water allocation scheme in this case:

*I do not exactly remember the figures, but if the discharge of the Meuse drops below 60 m<sup>3</sup>/sec then there are some procedures and they have to allocate 30 m<sup>3</sup> to the Albert canal and 10m<sup>3</sup> to the Meuse river and 20m<sup>3</sup> to the Juliana canal, so it is very precisely defined how much water goes where. (Maité Fournier, former AMICE project leader, EPAMA).*

These provisions in a bilateral agreement between Flanders and the Netherlands have helped to prevent conflict or tensions between the two countries in times of flow variability, but only for boundary waters and not on the entire basin since the basin-wide Meuse agreement does not include such provisions (Fournier, pers. Comm.). Although flexibility provisions or minimum flow allocations do not exist in the Rhine and Danube transboundary water management regimes, these regimes have been able to cope well with flow variability and flow change without conflict which indicates a high adaptive capacity (see chapters 4.1 and 4.2, R. Mair, K. Beyer, pers. comm.). Thus, this shows that flexibility provisions are **not** necessarily crucial for adaptive capacity, at least in my four case studies of European river basins, contrary to findings of other authors. The reason for this might be that the Rhine and Danube have already a well-working flexible river basin commission, which decides on measures to take during situations of flow variability, including low flow, such as preparing flood and drought action plans. An effective flexible river basin commission can thus assume some of the roles which flexibility provisions in an agreement might play.

This requires adequate procedures for negotiation and discussion. One of the interviewed experts highlights that in his view, treaties should define procedures for negotiations, but not allocations:

*In my view, rather than to have flexible allocation, it is important to have flexible mechanisms for negotiations, consultations and discussions. Such procedures can rely on Parties, joint bodies or transboundary committees in place etc. Rather than fixing allocations treaties should define procedures in order to take into account climate change and the huge uncertainty related to it. (Nickolai Denisov, project expert).*

The Rhine, Danube, Meuse, Senegal, Niger, Congo and many other basins in the world have such forums for communication where changes in water flow can be discussed, usually in the river basin commissions (see section 5.2.2 below). For example, during the drought in 2011, The Netherlands brought the problem of drought in the Rhine basin to the attention of the International Rhine Commission, i.e. they used the existing institutional structure, which then decided to prepare an analytic report as a basis for future actions (Buiteveld, pers. Comm). As another example, in the Chu Talas basin, located in a region characterized by water scarcity (Central Asia), the transboundary agreement does not foresee flexibility provisions, but the river basin commission is negotiating each year about the sharing of water infrastructure and allocations of water between the riparian countries Kazakhstan and Kyrgyzstan. These examples show that flexibility provisions in the legal design, for example flexible allocations, are useful, but not crucial for adaptive capacity- more important are flexible fora or organizations where the riparian countries can come together to agree on needed adjustments.

However, does this preliminary conclusion really apply everywhere? It seems that in water-scarce areas, flexible water allocations are much more important than in water-rich areas. The following section will consider recent examples from some other basins worldwide with regard to flexibility provisions.

Minimum water allocations are one of the most frequently used flexibility mechanisms. In several basins, discussions are ongoing about whether to introduce a minimum environmental flow which might be due to the increase in droughts and water scarcity in these basins. Even in the Rhine, such suggestions have been made, such as inclusion of water allocations into the treaty or regulation of the lake Constance in Germany so to address water quantity fluctuations in the Rhine etc. As a first step, a study is now being

carried out by the ICPR (Timmerman pers. comm., ICPR 2013 b). In the Amur-Argun and Neman basins, similar proposals have been made (Neman project field trip on 10-14 October 2012). In the Senegal basin, the water charter adopted in 2002 describes mechanisms and procedures for water allocation in the basin. The charter can be considered as flexible instrument as it prescribes only general principles, whereas more detailed decisions on water allocation can be taken each year (OMVS 2002).

In water-scarce regions, for example between Spain and Portugal, flexibility provisions exist more often and are more important for addressing flow variability than in water-rich regions (Fischhendler 2008). Spain and Portugal do not have a river basin commission with a permanent secretariat, but the legal framework for cooperation between Spain and Portugal has been made more flexible by amending the Convention on Cooperation for the Protection and Sustainable Use of the Waters of Portuguese-Spanish River Basins (The Albufeira Convention, 1998). It regulates the transboundary waters in the shared basins between Spain and Portugal, namely the Tagus, Minho, Duero/Douro, and Guadiana Rivers, and covers for example bilateral information exchange, public information, assessment of and dialogue on transboundary impacts, pollution control and prevention, water uses, droughts and resource scarcity, assignment of rights, and dispute resolution. Through the amendment in February 2008, the annual flow regime was divided into smaller integration time-steps (Otterman and Koeppel 2014b in Sanchez and Roberts 2014), thereby introducing additional flexibility provisions. This new regime determines a quarterly (Minho, Douro, and Guadiana), weekly (Douro and Tejo) and daily (Guadiana) discharge flow, depending on the rainfall conditions in each basin. Since then, the annual flow regime has been operating well, and difficult situations, such as water shortages in an exceptional drought period in 2004-2005 or a flood in 2013 were overcome without conflicts (Otterman and Koeppel 2014b in Sanchez and Roberts 2014).

These examples show that flexibility provisions are used more frequently recently. These recent changes, such as the revision of the Albufeira Convention might also be driven by external legal pressure, namely the EU Water Framework Directive which is described in the next section.

#### *5.2.1.4 External legal pressure or incentives*

External pressure and obligations, international water law, Conventions and EU directives can also promote adaptive capacity as shown in the Rhine, Meuse and Danube (Mair, Schmid-Breton, Dewil pers. Comm); however, such external pressure can also have negative impacts, as the following section will show. The relevant EU directives, mainly the EU Water Framework Directive (EU 2000) and the Flood Risk Management Directive (EU 2007) require riparian countries, among others, to cooperate in transboundary basins when developing river basin management and flood risk plans. Such EU directives oblige all riparian EU-countries to fulfil the same provisions in managing their river basins, they are legally binding, and non-compliance can be considered by the European Court of Justice. Therefore, countries need to allocate resources for their implementation, even in times of budget cuts, as a representative of Belgium in the Meuse Commission states (Paul Dewil, pers. Comm):

*In the Meuse, we all have the problem of budget cuts. This crisis will continue and here in Wallonie we need to limit ourselves to all what is imposed by the EU Water Framework Directive and cannot much address climate change. We need to always consider costs and benefits of any action.*

Even some neighbouring non-EU countries such as Ukraine and the Republic of Moldova are striving to implement the EU directives, at least partially, because this can help them in the process of EU accession and might open up new funding opportunities. In the Danube basin, all riparian countries, also those not part of the EU, contributed to the development of the basin-wide river basin management plan, which helped them to understand EU directives in practice (Mair, pers. Comm).

*The Danube has specific circumstances: a lot of countries and a high heterogeneity in the basin. It's sometimes a challenge to bring them in and together, there are EU and non-EU countries which is a huge challenge. But we are also very fortunate that all countries agree to coordinate in the EU directive implementation (Mair, ICPDR).*

Some experts consider the EU water framework directive as a useful instrument for climate change adaptation, as it requires preparation and regular revision of river basin management plans and thus corresponds to the principles of adaptive management (see chapter 2.7, Mair pers. Comm, Beyer, pers. Comm.). One expert highlights the value of the WFD in promoting a common vision and adaptive management:

*The EU Water Framework Directive stressed the need for a common approach on good ecological status, common environmental analysis as well as the obligation to define problems requiring transboundary cooperation. The directive thereby helped a lot also for transboundary cooperation and reporting (Schreurs, pers. Comm, IMC).*

Climate change impacts actually need to be taken into account in the revision of the river basin management plans, due in 2015 according to the Water Framework Directive, which should undergo a “climate-check” (EC 2008) as described in the Guidance document “River Basin Management under a changing Climate” (EC 2009). These climate checks need to identify the measures best suited to strengthening river basins’ capacity to adapt to climate change and those water management measures which may weaken that capacity or be counter-productive (EC 2008). Andre Schmidt-Breton, ICPR pers. Comm:

*All the countries except Switzerland have to implement these European directives, so the countries have to do this and they have also to cooperate on international rivers, so it is also in their interest to develop this transboundary cooperation. Another issue is the fact that, we cannot say this in the past, but for the flood directive they took as a model the Rhine Action Plan and also the flood plan.*

As it can be seen in the quote above, representatives of the Meuse and Rhine river basin commissions (Schmid-Breton and Dewil, pers. Comm.) even state the EU member states, when negotiating the EU Water Framework and the floods directive, took the Rhine and Meuse flood action plans as basis and model. On the other hand, a representative of the Danube River Basin Commission claimed that the EU Water Framework Directive is more important for their daily work than the Danube River Protection Convention (Mair, pers.

Comm.). This shows that the EU directives are stricter and more ambitious than the legal framework for transboundary cooperation in the Danube.

However, the EU directives are also criticized, as they are ambitious and demanding in certain areas, but not in others, such as climate change adaptation, which is highlighted by a representative of a non-EU country, namely Switzerland (Hugo Aschwanden):

*The implementation of the WFD has very much influenced the work of the ICPR. It involves many formal requirements and led to a focus of the Commission's work only on the WFD. The fact that member states need to report to the EU is a bit contrary to the basin management principle. Anything which is not required by the WFD is difficult to implement.*

Some experts even consider that the directive is hindering climate change adaptation since it is very prescriptive in certain areas and does not leave much room for any other innovative actions, e.g. on climate change adaptation (Schmid-Breton, ICPR, pers. Comm).

Compared to these EU directives the United Nations Economic Commission for Europe's Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE Water Convention) has even stronger obligations as it requires countries to conclude bi- or multilateral agreements for transboundary cooperation as well as to establish joint institutions for their management (UNECE 1992). Several interviewed persons state that the UNECE Water Convention played an important role for transboundary cooperation in their basin (e.g. Paul Dewil, Belgian representative in the Meuse Commission). The agreements of several of the above mentioned basins are based on or referring to the Convention (Meuse, Rhine, Danube) or were even supported by the Convention in its conclusion and establishment of river basin commissions (Chu Talas, Sava, Dniester etc.). The Convention also provides a framework for adaptation to climate change in transboundary basins, although it does not directly mention climate change and can therefore promote adaptive capacity (UNECE 2009).

In conclusion to this section, it seems that the existence of a legal framework for transboundary cooperation is crucial for adaptive capacity of transboundary water

management regimes, whereas its design and in particular the inclusion of certain flexibility provisions is useful, but not so crucial as some other authors claim, at least in my sample of European basins, which have been suffering rather from high than from low flow in the past. Legal frameworks should include the creation of an organizational framework, i.e. a river basin commission, which can then address issues of flow variability and flow change. However, short consideration of several other basins worldwide indicates that flexibility provisions play an important role in water-scarce river basins, such as between Spain and Portugal or Mexico and the United States. Thus, my initial finding (i.e. that the existence of a legal framework is more important than its design) might especially be valid in water-rich and not in water-scarce regions.

### **5.2.2 Basin-wide forums for discussion and decision-making**

Communication between riparian countries in transboundary basins is crucial in order to discuss and address flow variability and possible joint actions, but also to prevent conflict as the following section will show. Mechanisms and permanent fora for facilitating this dialogue, such as river basin organizations, are important, but require resources, leadership, stakeholder engagement and trust, as the following sections will show.

#### *5.2.2.1 River basin commissions*

The existence of a well-working river basin commission seems to be one of the most important enabling factors for adaptive capacity. Those basins that have a commission (Rhine, Danube, Meuse, Niger, Congo, Senegal etc.) tend to have a higher adaptive capacity while those that do not have such organizational structures (e.g. Neman, Amur-Argun) tend to have lower adaptive capacity because such institutional structures provide a forum for addressing flow variability and change, for overcoming conflicts and for taking measures against flow variability and change.

All my interviewees referred extensively to the river basin commission and its work in the interviews and usually consider the Commission and its secretariat as one of the most important enabling factors for adaptive capacity because they can take actions to address flow variability and reduce conflicts in such situations (Vasiljevic, Mair, Beyer, Korneev, Buiteveld, pers. comm). More than half of the text of the Rhine Convention (ICPR 1999) and the Meuse agreement (IMC 2004), is dedicated to the Commission. Similarly, when negotiating a new bilateral Protocol on transboundary cooperation, Belarus and Lithuania considered crucial the creation of a Commission for its implementation and devoted nearly half of the negotiation time to discussing the modalities of the Commission (Vilnius meeting, 30-31 October 2014). This shows how important Parties consider the role of the Commission for the implementation of the agreement. A river basin commission is usually created through a legal agreement (see section 5.2.1 before).

#### *Tasks of river basin commissions in addressing flow variability*

There are several reasons for the importance of river basin commissions: such a commission can evaluate adaptive capacity of the basin and the transboundary regime, assess climate change impacts and vulnerabilities as in the Danube and Rhine, enable and organize exchange of data (e.g. Meuse, Danube, Rhine, Mekong), bring together stakeholders, experts and scientists to reach scientific consensus (see chapter 5.2.3 below) and much more. Information and data exchange is often regulated, discussed and sometimes even implemented through the Commission (e.g. databases are sometimes located at and managed by the river basin commission such as in the Mekong or the Danube). The Meuse Commission issues flood warnings and warnings for low flow (MRC 2014). As another example, the International Commission for the Protection of the Rhine is considered as crucial for coping with flow variability as it is working well, prepares documents and meetings efficiently and is able to crystallize compromises between countries and experts (Nilson, pers. Comm.).

River basin commissions can also coordinate the development of a climate change **adaptation strategy** for the entire basin as in the Danube basin, implement concrete adaptation measures, ensure learning capacity, i.e. that experiences of extreme events are followed up and ultimately lead to improvements. Raimund Mair, technical expert at the ICPDR stresses that it was important to develop the climate change adaptation strategy by the ICPDR secretariat and not by an outside expert since it required knowledge of political processes. Thus, the river basin commission and/ or some of the secretariat's staff members are often a leader for climate change adaptation in the basin (see also section 5.2.2.2 on leadership). The river basin commission also plays an important role in implementing basin-wide adaptation strategies if they exist: for example, in the ICPDR adaptation strategy, the term "ICPDR" is mentioned more than 30 times (excluding references, titles etc.) (ICPDR 2012). One of the main aims of the strategy is to ensure mainstreaming of climate change impacts into the Commission's procedures, working and expert groups etc. The strategy also foresees a role for the ICPDR in reconciling different interests in relation to adaptation, thereby overcoming potential conflicts and in involving national experts on adaptation in order to ensure synergies.

One important function of any river basin commission is **dispute settlement** in cases of conflict between riparian countries about flow variability, such as the Senegal Commission (see section 4.5). A representative of the Senegal River Basin Organization, Mr. Ndiaye, explains how the Senegal River basin development organization had to resolve conflicts:

*Shortly before we wanted to start the preparations for a new hydropower reservoir in the Senegal last year, local farmers complained and threatened to sabotage the inauguration ceremony with the Presidents from all the four riparian countries since the new hydropower plant to be constructed would lead to a significant drop of water levels in the tributary of the river where they were located. We had to convene an emergency session of the permanent water commission and negotiate with the farmers in order to find a solution. The first temporary solution which we found was not accepted by the energy sector since it would have reduced the energy yield of the hydropower station. So we had to find another longer-term solution.*

This role of the river basin commission corresponds to the second part of the indicator of my research object adaptive capacity of transboundary water management regimes (see section 3.1,...”*without conflicts* between riparian countries”). The Neman basin, which does not have a transboundary commission, provides the opposite example since the disputes concerning the water levels in the Neman basin in Summer 2012 caused diplomatic tensions because of the absence of a joint body for transboundary cooperation which would have been the best organization to deal with such disagreements (see section 4.4, Denisov, pers. Comm.).

In addition, the river basin commission plays an important **coordinating role** for ensuring coherence between activities of different riparian countries in addressing flow variability considering that in most countries many adaptation activities are also ongoing at the national level which might be contradictory: For example, at the Danube climate change workshop in March 2012, the ICPDR was described as “*a captain leading a group of small vessels*” (Beyer, pers. Comm.). The ICPDR secretariat described its own role as follows at the workshop:

*The ICPDR provides the forum for addressing the conflicts between countries and sectors and for organizing potential measures, which should be done on national and/or basin-wide level.*

#### *Design and effectiveness of the river basin commission in addressing flow variability*

Whether the river basin commission can fulfil the described functions for addressing flow variability depends on different factors and its design: the first condition for effectiveness is that the treaty and the river basin commission should cover the entire basin. If it only includes some, but not all riparian countries, there is a significant risk of conflict in times of flow variability (but not only). For example the Mekong river commission does not include the upstream countries Myanmar and China, which undermines its potential in effectively addressing the natural and man-made flow variability in the basin, caused especially by the numerous infrastructure projects in these upstream countries.

The ability of the river basin commission to improve adaptive capacity of the regime also depends on its organizational set-up (Schmeier 2013), whether it has a permanent secretariat, on its resources (financial resources and number of staff members, see section 5.2.2.5), the mandate given by the riparian countries (relationship between countries and the commission, see section 5.2.4.1), competence (knowledge/ professionalism), and recognition. Mr. Buiteveld, Dutch representative in the ICPR, compares the Rhine and the Meuse Commission and underlines that the former is more effective which he explains with the fact that the ICPDR has more human resources than the IMC.

River basin commissions without the mentioned provisions are less effective in increasing adaptive capacity, but are still “better than not having any forum at all”, since, for example compared to projects such as the AMICE project, river basin commissions are longer-term and more sustainable organizations. For example, in the Meuse basin, even if the International Meuse Commission is not always considered as effective (see chapter 4.3), all actors underlined its importance and called for its strengthening at the final AMICE project workshop. The workshop recommended maintaining the AMICE network in the future and that the IMC (International Meuse Commission) could be the coordinator of such partnership, in order to make use of the existing momentum. An agreement was signed with the Meuse Commission to maintain the AMICE website and data. The Meuse Commission secretariat is very small and dependent on its member states, which could be one of the reasons for the rather moderate adaptive capacity of the transboundary water management regime in the basin (Fournier, former AMICE project leader, pers. Comm.). Some experts explain this with a lack of resources:

*The International Meuse Commission is political and not progressing very fast. It refrains from decision-making. The staff and financial resources are not enough. Most important decisions are not taken inside the commission, but bilaterally by the countries (Lejeune, former AMICE project, pers. Comm.)*

As shown by the Danube, Rhine, Senegal, Sava, Niger, Mekong and, to a certain extent the Congo, the existence of an organization or institutional structure for transboundary

water management cooperation and its regime, such as a river basin commission with a strong secretariat, seems to be one of the most important enabling or supporting factors for adaptive capacity. Such river basin organizations need to be able to act flexibly, in order to address new challenges such as climate change; they need to be able to take decisions, e.g. to develop a flood or drought risk management plan or to develop a climate change adaptation strategy. This may also include changes in infrastructure. Mr. Nilson (pers. Comm, 2013), scientific expert in the Rhine, for example suggests adding a safety margin by constructing dams a little bit higher in order to get better prepared for possible climate change impacts. Procedures for negotiating water allocations should be flexible (Mr. Denisov, pers. Comm.). Such flexible decisions can be taken in a well-working commission, even if the actual legal framework, i.e. the agreement itself, is not flexible, but when there is willingness by all riparian countries to interpret the agreement in a flexible way. Thus, adaptive capacity requires flexibility and openness on the side of the river basin commission, the authorities and the persons implementing the agreement. Nilson explains that such flexibility exists in the Rhine:

The Rhine is well able to deal with flow variability due to the flexibility of the people and of the management system. Although in the situation of extreme low flow in 2003 navigation stopped, there was no system failure. It is possible to handle such situations by being flexible (e.g. shifting navigation by one month), exchanging information etc.

#### *Other fora for discussing flow variability*

Instead of a river basin commission, some basins without a transboundary legal agreement have other fora for discussion, such as informal working groups where representatives of the riparian countries meet and discuss issues of common concern, such as flow variability. In the Meuse, following the serious floods in 1993 and 1995, a separate working group was set up by the countries specifically for this issue, serviced by the Meuse Commission, which elaborated a flood action plan considered as effective as it allowed data exchange between the riparian countries (Schreurs, IMC, and Dewil, Belgium, pers. comm.).

In the Neman basin, for example, through the project on river basin management and climate change adaptation such an informal group has been created and also in the Dniester basin, a working group on flood management and climate change adaptation exists.

Informal fora are less effective in increasing adaptive capacity since they meet less regularly (for example, the plenipotentiaries<sup>10</sup> between Ukraine and Moldova have not met for two years from 2011 to 2013), their composition is often not fixed and they often cannot take decisions (except plenipotentiaries in the Dniester) and usually do not have a secretariat. Such groups often highlight the need for a formal institution for transboundary cooperation, such as a real commission, as it was requested at the Neman project workshop in January 2014, i.e. such groups understand their own limitations when it comes to flow variability. However, in the absence of any transboundary agreement and any official organizational structure like a commission such informal forums can enhance cross-country dialogue on flow variability.

This section has shown that the existence of appropriate organizations for transboundary cooperation, combined with some other aspects described in the following sections is crucial for adaptive capacity in the analysed European river basins and likely also beyond that. This confirms results of previous research (Goldenman 1990, see chapter 2.2).

Climate change and the resulting flow variability is a “new topic”. As described earlier, river basin commissions can discuss and potentially add new topics to the transboundary cooperation such as drought management, which is now being discussed in the Rhine, Meuse and Danube Commissions. Taking such decisions requires leadership, learning capacity, political willingness, resources and flexibility in the interpretation of the agreement and by the bodies implementing it. These factors are analysed in the following sections.

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<sup>10</sup> Plenipotentiaries are governmental representatives appointed to facilitate the implementation of the agreement;

### 5.2.2.2 Leadership

Leadership can facilitate adaptive capacity to climate change especially since climate change is a new and complicated phenomenon. Leaders are important in the case of the Senegal, Danube, Neman, Mekong and certainly other basins. Leaders can play a visionary and innovative role in the river basin commission (Gupta et al. 2010), especially if climate change adaptation requires some difficult adjustments and possibly even overcoming opposition, such as relocations in flood-prone areas. Leaders are important for showing personal commitment and thereby motivating others to adapt to an uncertain future, organizing adaptation processes with many actors, and ensuring that the transboundary water regime “learns” and improves after an extreme weather event. For example, in the Danube, the lead country Germany together with the relevant expert at the ICPDR secretariat have been instrumental for drafting and ensuring acceptance for the climate change adaptation strategy. Leaders should also have creative ideas in order to find solutions to difficult problems as is climate change, and have sufficient knowledge and experience for difficult tasks such as drafting the first transboundary adaptation strategy worldwide, the Danube strategy. For example, the AMICE project leader up to March 2013 can be considered a leadership figure due to her convening power, engagement, and knowledge of the issue, vision and creativity, as highlighted by her former colleague responsible for communication Martine Lejeune: *We were a very good team with the project leader of the AMICE project. It is really about people, the project success depends on this.* After the former project leader left in Spring 2013, due to a small technical problem, which she might have been able to solve, the project partners could not finalize on time an application for an extension of the project in autumn 2013, although there were numerous ideas available and a general willingness to extend the project or start a follow-up project (pers. comm. Linsen, the Netherlands).

Leadership can take different forms: the head of the river basin commission such as in the Rhine, the lead country such as Germany in the Danube, an individual person such as the

project leader in the AMICE project in the Meuse or a certain national expert in the Neman basin. It can also be a tandem of two persons or organizations driving the process. The ICPDR representative highlights the important role by Germany as lead country for climate change activities. Raimund Mair, ICPDR, pers. comm:

*The leadership and financing provided by Germany for the adaptation strategy development in the Danube was an important factor for the success of the strategy development. Germany provided full support for the climate change impact study as well as the actual strategy development.*

High-level political involvement can be very helpful, but is not indispensable. In the Senegal, for example, the presidents of the four riparian countries themselves are leading the cooperation and are usually signing new agreements and projects personally, opening new joint infrastructure projects etc. This presidential-level commitment is probably one of the reasons for that fact that the Senegal is often as a very advanced basins worldwide in terms of transboundary cooperation. However, cooperation does not have to be high-level to be effective. For example, the seventh Rhine Ministerial conference, held in Basel, Switzerland in October 2013 was only attended by ministers from Switzerland and Liechtenstein whereas the other riparian countries sent heads of delegations at the level of deputy minister or head of department (Aschwanden, pers. Comm.). The former Executive Secretary of the ICPR does not see this as a major problem: *Koos Wieriks pers.comm:*

*This could mean that the Rhine cooperation is not as high any more on the political agenda as in the past. It could also mean that the cooperation is running smoothly and thus there is no need for high-level involvement.*

In fact, national representatives were generally satisfied with the outcomes of the ministerial conference, such as the Swiss representative in the ICPR and host Hugo Aschwanden:

*The functioning and outcome of the Ministerial Conference were successful, from the Swiss point of view, at least. For us, most important outcomes include the measures decided to reduce micropollution and the measures for salmon.*

A “real” leader who can improve adaptive capacity, is not a leader because of his/ her position, but because of his characteristics: he must be treating everyone (in a river basin commission setting all countries) fair and equal, take on board views of all countries and actors and find a compromise, not favour anyone, must be knowledgeable, be able to supervise and empower others. According to Gupta et al. (2010), leaders in climate change adaptation should be visionary, collaborative and entrepreneurial which also applies to transboundary basins. For example, the leadership in the climate change area provided by Germany in the Danube was accepted by the other riparian countries and therefore successful since Germany ensured transparency and involvement of an expert group with representatives of all riparian countries (Beyer, pers. comm.). In addition, leaders should motivate others in the basin, such as countries which are reluctant to adapt to climate change.

### **5.2.2.3** *Trust and understanding benefits of transboundary cooperation*

Why is the cooperation in the Rhine and Danube working so well, including on issues of flow variability, whereas it is more difficult in other basins such as the Meuse, for example? Perceived importance of the river (in terms of economic, environmental, financial and other factors), trust and a good atmosphere in working together in a transboundary basins, for example in the river basin commission, can support adaptive capacity in such complex settings as transboundary basins. For example, the Dutch representative in the International Meuse Commission considers the size and economic importance of the river Rhine as one of the reasons for countries to engage in transboundary cooperation in climate change adaptation (Buiteveld, 2013, pers. comm). Several interviewees highlighted the very good and trustful cooperation in the Rhine and Danube, which is sometimes described as “like in a family” (Orpisan, pers. comm.). Another respondent (Vasiljevic, pers. comm) from Romania highlights issues such as importance of the river for economy and life:

*The Danube is so important for all countries and all have their interests, but they understand that they have to cooperate. The ICPDR also helps to coordinate activities of different institutions at the national level. Another reason why cooperation is*

*working so well is that people love the river and ordinary people are aware of the need for cooperation, of the need to protect the Danube. This is due to the promotion activities of the ICPDR but also in Serbia. We even have songs about the Danube and its tributaries.”*

This might be due to the fact that all Danube countries have some economic interests in the Danube and some are mainly located in the basin, e.g. Austria and Hungary for more than 90% of their territory (Schmeier 2013). Also the Rhine is seen as “a connecting factor for a long time already” (Wieriks, pers. comm.). This can enable understanding of the needs for and benefits of cooperation (Timmerman, expert from the Netherlands, pers. comm) as well as understanding of the need for changing some procedures, e.g. due to climate change.

Trust also entails empathy with other riparian countries, e.g. upstream or downstream countries, and trying to understand their situation and interests. In such an atmosphere, possible disagreements and conflicts can be openly discussed and a solution can be found, including on climate change adaptation measures and in situations of flow variability. For example, in the Rhine, there are disagreements about how to adapt to climate change, (van Buiteveld, Timmerman, the Netherlands, and Aschwanden, Switzerland, pers. Comm) since the Netherlands would like to regulate lake Constance in times of low water so to increase water flow in the Rhine in times of low water. While upstream Switzerland does not agree with this suggestion, it understands the difficult situation of downstream Netherlands and is therefore carrying out a study on a possible alternative, namely on the potential for using upstream lakes in Switzerland as storage reservoir which could benefit also downstream Netherlands (Aschwanden, pers.comm.). On the contrary, in the Meuse basin, such solidarity is rare and differences between the countries are always deplored. As the French representative in the Meuse Commission states:

*In the Meuse, cooperation is advancing very slowly because of different interests. Ambitions are high and there are 8 million persons living in the Meuse basin, but it is not the same river everywhere because of the high differences.*

These examples show that disagreements and tensions can even appear in advanced basins such as the Rhine, but their transboundary water management regimes are usually able to overcome such difficulties.

But what are the reasons for a certain level of trust and understanding of the benefits of cooperation? While the history and duration of working together plays a role, wide participation and inclusiveness are very important (see the next section 5.2.2.4), i.e. whether all riparian countries, but also experts from science, non-governmental organizations etc. are involved, as it is the case in the Rhine. A representative of the Rhine Commission, Mr. Schmidt-Breton, highlights:

*The first reason (for the high adaptive capacity) in the Rhine is the good cooperation and the history of the Commission. And maybe the last point on this is that we also have not so many countries, so it is maybe easier to find a solution, an agreement, we also have quite a good working level, not so big like the EU but also not the local level. This helps to move things forward. But the willingness by the countries on the Rhine and that they think it is a very important issue.*

Hendrik Buitenveld who is involved in both the Rhine and the Meuse Commissions as well as their respective climate change adaptation processes explains the differences between the river basin organizations in the two basins with reasons like resources, inclusiveness of cooperation or wide participation, but also economic stakes since the Rhine is economically more important than the Meuse (used for navigation, drinking water, agriculture etc.).

*In the Rhine, there is already a lot of information. The cooperation in the ICPR works very well, which has a lot to do with the Commission. One advantage is that more people are involved in the Rhine, it is better equipped and the economic interests are bigger in the Rhine than in the Meuse. Of course, there are always difficulties as well, but in the Rhine you can communicate on issues and problems, you can disagree, but a solution is usually found.*

*Maybe they are not so open there in the Meuse and the international cooperation on the Meuse is not as old as in the Rhine. In general cooperation is more difficult on the Meuse, also in the basin commission.*

When countries do not trust each other, they are afraid that the other riparian country could take measures without consultation, e.g. build reservoirs for water storage, e.g. in Central Asia, and could not implement commitments taken. One Dutch representative for

example regrets that it was not possible to negotiate and sign a bilateral agreement on flow allocations with the Walloon region of Belgium on the Meuse basin, whereas such agreement was signed with Flanders which now helps to address flow variability (Buiteveld, pers. Comm.). He sees the reasons for this failure partly on the Dutch, i.e. his side, since they gave Wallonia the impression that they might construct infrastructure without consulting them (van Buiteveld, pers. Comm.):

*We would have liked to have a similar agreement on flow allocations with the Walloon region, but from the Dutch side we probably asked too much. There was a discussion on an additional storage basin in the Netherlands at that time which is a delicate point since it would reduce water availability for the Walloon region. The Walloon partners do not trust us, they are always afraid that we come up with the question of the storage basin which would have many disadvantages for them. Our opinion now is anyway that such storage basin is not a good option. It is better to look at the existing infrastructure and see how to improve it. In the AMICE project, such a study on the Ruhr basin has been carried out analysing scenarios of high and low flow.*

This example shows that pushing individual country interests at the expense of other countries' interests can jeopardize trust in the cooperative effort to address flow variability jointly. An inclusive and transparent approach addressing concerns of both sides could have led to a mutually beneficial solution in allocating waters between The Netherlands and Walloonia. Different riparian countries have their own interest, but need to be able to negotiate and make compromises. This depends, among others, on which benefits the riparian countries see in the cooperation, but also on internal pressure and the perceived importance of the transboundary river for them. Finally, trust can be promoted by wide stakeholder engagement which will be analysed in the next section.

#### 5.2.2.4      *Wide stakeholder engagement*

Wide engagement by all relevant stakeholders in the basin is important for adaptive capacity as my four case studies and the following section shows. This includes organizations with official observer-role in the river basin commission, NGOs and NGO networks, IGOs, networks of local authorities, international projects, scientists as well as business actors

(Schmeier 2013). Their role is to involve, in addition to the formal authorities, other stakeholders as well as the population in the climate change adaptation process, but also to raise awareness about climate change impacts and extreme events, possible individual adaptation measures as well as the activities of the transboundary regime and thus facilitate their acceptance. In addition, they can implement adaptation measures, test innovative approaches such as ecosystem-based adaptation, and even sometimes take over some roles of the Commission. The value of stakeholder engagement is recognized in the text of some transboundary treaties, which foresee participation of officially accredited NGOs as observers in the Commission's and working groups' meetings (IMC 2004, ICPR 1998, ICPDR 1994). The staff member of the ICPR responsible for climate change adaptation clearly links stakeholder engagement to adaptive capacity:

*The first reason (for the high adaptive capacity) in the Rhine is the good cooperation, the working groups are very operational and discuss a lot, and we also have a good NGO participation (Schmidt-Breton 2013)*

Inhabitants of many basins, such as the Rhine, are often not well aware of extreme events and climate change impacts, especially those who live behind dykes and therefore feel secure (Schmid-Breton, ICPR, pers. Comm.). Groups of NGOs have played an important role in raising awareness on climate change, for example in the Meuse and Dniester basins, by preparing films, brochures, contests, boat tours etc., in order to transmit in an easily understandable way information about climate change impacts.

Informal networks can also exert pressure on governments regarding transboundary cooperation and climate change adaptation, such as the NGO ECO-TIRAS in the Dniester basin which was instrumental in the negotiation of the Dniester treaty. In addition, informal networks can facilitate information and data exchange in extreme weather events, such as floods and droughts, in particular if data are not officially or not sufficiently exchanged, as the Dutch representative in the ICPR, H. Buiteveld stresses:

*You need information and need to know whom to contact in a crisis situation. The International Commission for the Protection of the Rhine is too formal for that. You need to have your own good network.*

Climate change adaptation requires cooperation with other sectors such as agriculture, energy and hydropower for example (UNECE 2009). In addition, climate change adaptation also requires in many basins ecosystem-restoration which can affect other water users. In the Rhine, Meuse, Danube, Dniester but also the Neman basin, stakeholder workshops were organized in the process of developing climate change impact assessments and adaptation strategies with representatives from other sectors and of the regions of the basin. These workshops were considered important for the successful development of the strategies, for including views from important actors in the draft adaptation strategy and ensuring acceptance of the climate change impact and vulnerability assessment as well as eventual implementation of adaptation strategies (e.g. Schmid-Breton, ICPR, pers. comm.). For example, in the final declaration of the Rhine Commission's ministerial conference in 2013, the need for stakeholder engagement in the adaptation strategy development is stressed (ICPR 2013b). In addition, the positive cooperation with observers (e.g. stakeholders and NGOs) is highlighted at the end of the declaration. Also the Danube adaptation strategy mentions observer organizations in the section on implementation of the strategy as they can bring in sector-specific knowledge and data (ICPDR 2012).

NGO and stakeholder involvement is even more important for increasing adaptive capacity in basins where no river basin commissions exists, or where the official river basin commission is not so strong, such as in the Meuse (M. Fournier and M. Lejeune, formerly AMICE project, pers. comm.). In such cases, NGOs can assume part of the tasks of river basin organizations, such as preparing of joint models, scenarios, impact assessment studies and even draft adaptation strategies. In the Meuse basin, for example, in 2008-2013 the AMICE partner network played an important role in increasing adaptive capacity which

was, among others, due to the wide variety of partners and the positive relation between them, as stressed by the previous AMICE project communication expert:

*17 partners were involved in the AMICE project from 5 regions, the partners got to know each other well, the combination of universities and water managers on the ground was a good team, some stakeholders talked to each other for the first time, it was an eye-opener for some people and the approach at different levels was a key to the success (M. Lejeune, pers. Comm).*

However, the importance of informal networks is perceived differently by different interviewees: stakeholder and NGO representatives often considered themselves as more important than representatives of authorities do. For example in the Meuse basin, the role of environmental NGOs for adaptive capacity was estimated much higher by their own representatives than by representatives of the authorities from the riparian countries as well as the Meuse Commission (Lejeune, Besozzi and Dewil pers. Comm). All interviewees highlighted the role of the AMICE project, but some considered it as a project by authorities and others as NGO project.

In conclusion, stakeholder involvement, strong networks of stakeholders and public participation can promote adaptive capacity. In addition, if there is no river basin commission or the existing one is weak, other structures such as projects on the topic of climate change and strong networks of NGOs or research institutes can even partly and temporarily (depending on their design, management etc. ) take on the joint body's role and provide a framework for increasing adaptive capacity. Such projects or networks can also help in times of limited funding and take over some of the roles of governments. However, NGO networks cannot replace a river basin commission in the medium term and are usually limited in time whereas official organizations for transboundary cooperation are more long-lasting.

#### 5.2.2.5      *Resources*

Resources and financing play an important role in the analysed basins in increasing adaptive capacity because preparing climate change impact as well as vulnerability

assessments and adaptation strategies requires funding for the studies, for organizing consultation meetings with stakeholders and experts as well as for eventual implementation of measures aimed at increasing of adaptive capacity, such as ecosystem restoration, improvement of the monitoring and data exchange system and awareness-raising. Resources are also important for realizing and implementing some of the other enabling factors for adaptive capacity, for example data exchange. Producing and exchanging data depends, among others, on the organizations and the time and staff members they can invest in organizing the exchange of data (Buiteveld, The Netherlands, pers. comm.). Preparing joint climate change studies also requires resources. In the Dniester, Neman and Meuse basins, the preparation of vulnerability assessments and adaptation strategies is financed through international projects (i.e. with financial resources from outside) which have led to a common understanding on climate change impacts and thus increased adaptive capacity to a limited extent (Denisov, international expert, pers. Comm.). Successful projects can then also motivate funding for other projects, as an expert from Belarus states:

*The Neman project helps to look for other funds from the government to apply the project methodology in other transboundary cooperation of Belarus, for example Dnieper and Pripyat basin with Russian Federation. We can have a similar project there, if we find funds.*

While externally funded projects can improve adaptive capacity, achieve scientific consensus etc., they are usually short-term and the sustainability of the results after the project's end is not secured. For example, the results of the AMICE project are not further used and maintained after the project's end, including the website. Adaptive capacity is more likely to be increased if funds for adaptation are received by the river basin organization or any other permanent forum, body or organization in charge of transboundary cooperation in the basin. The river basin commission with the most activities on climate change adaptation is probably the Mekong River Commission, which has a Climate Change Adaptation Initiative (MRC-CCAI) with a budget of over 10 million USD and around 10 staff members dedicated

to it (MRC 2013). This initiative has led to a limited improvement of adaptive capacity in the Mekong basin, by implementing some pilot projects and sharing experience, by working on common climate change impact assessments and scenarios and by starting to develop a basin-wide transboundary adaptation strategy to be finalized by the year 2015 (Heikkila et al. 2012).

As an opposite example, some European basins have difficulties even to finance small river basin commissions and their secretariats which also then affects their adaptive capacity. For example, in the Meuse basin, Meuse basin countries have difficulties to pay their annual contributions to the International Meuse Commission and thus, the already stretched resources of the Commission might be further reduced. For this reason, there are no resources for addressing climate change impacts, as the Belgian representative in the IMC states:

*In the Meuse, we all have the problem of budget cuts. First, there were cuts here in Walloon region, but now also in the Netherlands. Therefore, we cannot implement even planned projects and cannot give more resources to the Meuse Commission. This crisis will continue and here in Wallonie we need to limit ourselves to all what is imposed by the EU Water Framework Directive and cannot much address climate change. We need to always consider costs and benefits of any action (Paul Dewil).*

Also the Albufeira Convention between Spain and Portugal, which was amended in 2008 as described in section 5.2.1.3, is facing implementation challenges due to lack of funds by the two countries (d'O, pers. Comm.). Meetings are held less frequently, data are not regularly exchanged, joint monitoring is done less frequently, public information is limited etc. Thus, while the adaptive capacity of the legal framework was increased through the above mentioned amendment, the organizational framework is not very adaptive due to lack of resources. The two examples from the Meuse and the Albufeira Convention demonstrate the importance of human and financial resources for increasing adaptive capacity to climate change.

There are many different sources of financing, for example donor funding, human resources support etc. Ideally, financial resources for the climate change adaptation activities are allocated from the regular budget of the river basin commission, as in the Rhine, i.e. the

mandatory contributions by member countries. Alternatively, extrabudgetary resources can be provided earmarked for the climate change adaptation activities. They can also be “outsourced”, i.e. be carried out or financed by lead parties such as Germany in the case of the Danube basin (see section on leadership). Funding needs for actually implementing adaptation measures and reducing flow variability, such as constructing flood protection infrastructure, preparing emergency plans or early warning systems are usually so high that the resource needs have to be mainstreamed into other strategies and plans, as explained by the project leader of the Danube delta project:

*The adaptive capacity of the population in the Danube delta is low due to their low income and low financial level. Our strategy of the Danube delta should be mainstreamed into other policy documents which will be developed soon, such as the river basin management plan for the Danube delta, to be developed by the ICPDR and a wider strategy to be developed by the World Bank which will be linked to EU financial instruments. The final implementation of the strategy depends on the financial resources which differ from country to country. For adaptive capacity financing is crucial. The local people need to have sufficient resources.*

Apart from financial resources, human resources are also important, i.e. sufficient and well-qualified staff members of the commission’s secretariat. They can prepare or implement some of the activities needed to increase adaptive capacity, for example organize stakeholder meetings to reach scientific consensus, hire and supervise experts who perform impact and vulnerability assessments, collect studies and information and even draft parts of the adaptation strategy themselves such as it was the case in the Danube basin. The Rhine Commission for example has more than 13 staff members, allowing the performing of detailed studies (A. Schmid-Breton, ICPR, pers. comm.). On the other hand, some river basin commissions have clearly insufficient resources available, for example the Meuse Commission only has 2.5 staff members thus not enough for increasing adaptive capacity of the regime.

While sufficient staff resources are important, the size and resources of a river basin commission and its secretariat does not automatically determine its effectiveness in

addressing flow variability and preventing conflicts, since the latter also depends on how the resources are spent, which experts are used, whether there is a good leader etc. Recognition of this fact has led to a process by the Mekong River Commission (MRC) aimed to reduce the number of its currently more than 100 staff members by giving more responsibilities to the member countries. Jos Timmerman, expert from the Netherlands compares adaptation activities in the Rhine and Mekong basins:

*The good thing of the MRC is that it has many smart people with a high technical capacity to be adaptive. However, it is staff of the Commission which does the work on climate change adaptation while in the Rhine Commission which is much smaller and certainly not less effective when it comes to adaptive capacity, the work is done by the riparian countries.*

But what are the reasons for a certain level of resources given to the river basin organization? In transboundary river basin commissions, which are created by national governments and where resources and financing are decided by the riparian countries represented in the commission, the financing available depends on their political willingness, prioritization of the transboundary cooperation and climate change adaptation, advancement of the riparian countries in terms of economic development, general financial situation and also knowledge and awareness of climate change. In the Rhine basin, for example, all riparian countries are quite wealthy and there is a high environmental awareness, which, among many other factors, explains the higher adaptive capacity of the basin. The climate change expert of ICPD explains that Rhine countries can “afford” to think about and to tackle climate change:

*Then of course we also have some countries in the Rhine which are very aware and advanced. And the countries are also so developed that they can think about this problem, so for example you know in Africa when you have problems of access to food and water you cannot think about climate change. But in the Rhine we have so developed and also so rich countries that we have time and resources to work on this problem of climate change (Schmidt-Breton 2013).*

This section has shown that resources are important as a basis for most other enabling factors, such as forums for discussion, data exchange, implementation of measures etc. The amount does not necessarily need to be large and different sources of funding are available.

This long chapter 5.2.2 has demonstrated the importance of fora for communication, deliberation and decision-making for adaptive capacity to climate change. Organizations can provide a regular, reliable and supportive role for this, namely river basin organizations and other joint bodies for transboundary cooperation. However, they require a certain design, leadership, resources, stakeholder participation and wide engagement as well as trust and realization of the benefits of cooperation by the riparian countries in order to increase adaptive capacity of the regime.

### **5.2.3 Data, science and information**

As described in chapter 2.4, according to theories of institutional change, new information is one condition for institutional change which can be necessary due to climate change. However, new information also needs to be accepted. Snidal (2004) even argues that actors only engage in cooperation if they know enough about a problem such as climate change. The following chapter will show how information and data need to be exchanged and used in studies in a transboundary basin so that they can facilitate transboundary cooperation for addressing flow variability.

#### *5.2.3.1 Data exchange*

Availability of information and data about current flow, short-term predictions of extreme weather events and projections of future flow in the basin support adaptive capacity in my case study basins since information about the current flow situation as well as forecasts for the future help to get better prepared for future flow variability. For example, in order to decide whether and which population needs to be evacuated during a flood, it is necessary to know the expected water levels. In transboundary basins, this requires exchange of information and data between the riparian countries on water flow and discharge, velocity and precipitation as well as water quality as an expert from Lithuania explains:

*A common forecasting system would be very useful for water levels. We do not have such a system at the moment, but it would be good to have it during extreme events. The information platform installed during the project is a good first step.*

Transnational monitoring including data on water quality but also discharge is seen as “absolutely essential” for climate change adaptation, but also day-to-day water management in the Danube (Mair, ICPDR, pers. comm). For example, Switzerland as upstream country of the Rhine shares its data and forecasts with Germany in times of floods, so that water managers there can decide whether to open up polders just after the border (Aschwanden, Switzerland, pers. Comm). This can help to prevent conflicts in times of extreme events.

How timely data about floods or droughts is exchanged determines, among others, the effectiveness of the early warning and the response since measures such as evacuations etc. need a certain time to implement. The timeliness of information exchange which depends on the flow velocity, the length of the river basin, but also the system of data exchange in the basin, is considered crucial for coping with such extreme events, i.e. for adaptive capacity-. Paul Dewil, national representative from Belgium, compares the Meuse and Rhine basins in this regard: *I think the Meuse is more vulnerable to climate change than the Rhine since in the Meuse, forecasts of flows can only be given 1-2 days in advance, whereas on the Rhine, this can be done 10 days before. I think the Meuse is medium prepared for climate change.* Provisions for exchange of data are usually included in the legal framework of the transboundary water management regime and the river basin commission often facilitates the monitoring and information exchange the process. Data exchange is working well in the case of Danube and the Rhine (Schmid-Breton, pers. comm.) where the Commission for the Hydrology of the Rhine has set up a common database with data on discharge, temperature and precipitation (Buiteveld, Nilson, pers. comm.). However, a representative from Switzerland claims that even in the Rhine, water use data are less openly exchanged than water quality data probably because riparian countries refrain from publishing information on water use by industry, water supply and agriculture (Aschwanden, pers. Comm.).

In periods of low flow, data exchange is even more important in order to prevent controversy on use of the already limited resources and to agree on the amount of water available and its allocation. This is also planned in the Meuse basin which has a well-working data exchange and alarm system for industrial accidents and for flood situations, as the French representative in the Meuse Commission explains:

*The data exchange and warning system in flood situations in the Meuse works well, we are now discussing about low water situations. In France, we have an information exchange system for droughts- it brings certain water use restrictions. This could be also useful for the entire Meuse basin (Besozzi, pers. Comm).*

Those basins where data is not effectively exchanged, like the Dniester and Neman, consider it a priority to initiate such exchanges, which shows how important data exchange is for adaptive capacity (Experts from Lithuania and Belarus, pers. Comm.). For example, in the Dniester basin, information and data are exchanged to a limited extent only between Moldova and Ukraine and therefore, the riparian countries see it as a priority to improve the infrastructure for information exchange in order to be better prepared for flow variability, mainly floods. At the seventh meeting of the Working Group on Flood management and climate change adaptation on 10 July 2013 in Chisinau all participants asked for improved monitoring, i.e. more and better automated monitoring stations, but also improved exchange of data, in particular between Ukraine and the Republic of Moldova. Also in the Neman, improving information exchange and the setting up of a web platform for this is seen as a priority. A participant at the Stakeholder workshop in Vilnius on 15 May 2013 expressed: “*The information platform is one of the most important achievements of the project*”. *The main problem will be to update this platform in the future every year.*

As this quote shows, there are concerns about the sustainability of a database set up only through a project which might end at the end of the project. The lack of a more regular data exchange in the Neman basin is explained by a lack of common understanding, of a legal or otherwise agreed framework or mechanism for data exchange by the international project consultant Paul Bujs:

*Information exchange in the Neman only happens mainly thanks to projects, there is no constant data exchange, although the countries have a lot of data. There is no mechanism agreed, there should be recognition, a common understanding of the problem that there is a need for exchanging data. Currently, there is no common perspective, view or mechanism for cooperation. Therefore, there is no incentive to exchange data.*

Thus, information management/ data exchange seems to be an important factor for adaptive capacity as it facilitates communication and subsequently reaching a common understanding between riparian countries on the current and future water availability, which is a precondition for them to cope with flow variability without conflicts.

#### **5.2.3.2        *Joint climate change studies***

Information about past and future expected climate change impacts and flow variability is a necessary condition for preparing to cope with it. Therefore, in the Danube, Rhine, Neman, Dniester, Meuse and Sava as a first step in the adaptation process, climate change impact studies have been elaborated either through new modelling or by compiling existing studies. This process for elaborating the adaptation strategy, i.e. first to develop a study compiling results of all already existing climate change impact assessments, followed by the adaptation strategy development, was considered logical and appropriate, which probably contributed to its acceptance as a representative of the ICPR states:

*The first reason (for the high adaptive capacity) in the Rhine is also the fact that we did this always like this: we first wanted to know the problem we are facing before taking action, so we do some studies ourselves, so for example after 1995 there was an inventory of flood protection measures and based on this we looked at how to improve it. So always the approach that we first have to know the problem and then try to find solutions at all levels in the Commission. So for the climate change we are ahead but also behind, so the Danube already has a strategy but we don't because we first wanted to do detailed studies (Schmidt-Breton, ICPR, pers. Comm.).*

Such studies can then provide evidence for action and for reviewing any water management measures in the face of climate change. Common studies can also help in finding mutually beneficial solutions accepted by all riparian countries. Information is also seen as a crucial prerequisite for institutional change by North (1990, cited in Héritier 2007, see section 2.4).

On the other hand, preparation of numerous endless studies can also be considered as an excuse for not taking action. For example, the fact that the Rhine Commission took much longer to start developing an adaptation strategy than the Danube Commission can be explained, according to one of my interviewees (Timmerman, Netherlands, pers. Comm.) by the existence of some climate sceptics in some of the Rhine riparian countries, who questioned whether climate change is happening and therefore required preparation of numerous studies until enough evidence was available for developing the strategy. Studies can thus help to reach a common understanding and then, once enough evidence is available, they can be useful to overcome lack of political will.

#### 5.2.3.3      *Common models and scenarios*

A common problem in transboundary basins is the use of different climatological and hydrological models by the riparian countries which can lead to different expected flows and climate change impacts and thus different adaptation strategies, as it happened in the Danube delta where different riparian countries predicted different developments (Ionescu, Danube delta project manager, pers. Comm):. *It was difficult to put together the knowledge and predictions for the vulnerability assessment of the Danube delta. For example, Ukraine predicted an increase in temperature and Romania a decrease.* Also in the Caucasus, one country predicted an increase in the levels of the Caspian Sea and another one a decrease (UNECE 2009). Therefore, bringing together scientists and their studies from all the different riparian countries is important in order to be able to use more data from the entire basin, more models and scenarios and also to ensure acceptance by all riparian countries of the results (UNECE 2009). Ideally, countries work together from the beginning in order to develop a basin-wide impact assessment using the same models and scenarios, as it was done for example in the Dniester and Neman basin. This enlarges the data available, enables the pooling of knowledge and resources and may lead to more reliable forecasts. In addition, such technical cooperation can then spill over to more political topics as it happened in the Neman.

However, why is it much more frequent in reality that countries develop their own models and scenarios? Developing common models and scenarios is often not considered realistic since adaptation is usually considered more a national rather than basin-wide endeavor and responsibility. A Dutch representative in the Rhine Commission argues that governments have traditionally considered climate change modelling and adaptation as a national task.

*Every country in the Rhine has its own responsibility for climate change adaptation towards the citizens. However, it is strange that every country uses its own scenarios although different predictions can lead to a contradictory situation. Therefore, an agreement is needed on some issues, but it is difficult. In the Rhine we are going in the right direction and developing a transboundary adaptation strategy. This requires first an agreement on the basis, i.e. on the scenarios. And we need to be cautious and realistic in what we are proposing in the strategy. Therefore, it takes time (Buiteveld, pers. Comm.).*

Different scientific structures and traditions also make the development of common models and scenarios difficult, as the project leader of the Danube delta project explains:

*Ionescu, pers. Comm.: Also the different structure of the scientific community made it difficult to agree on a common forecast. In Romania, there is a central scientific institute dealing with climate change whereas it is much more decentralized in Ukraine.*

Another reason might be that governments mostly trust their own scientists and prefer to use their own models and scenarios. For example, the German representative in the Meuse basin was not satisfied with the results of the AMICE modelling exercise for the Meuse, probably since a different model compared to the one used in Germany had been applied (AMICE project stakeholder workshop on 13-15 March 2013). Even in the Rhine, where transboundary cooperation is very advanced and a common modelling exercise was done for climate change impact assessment, riparian countries prefer using their own models for flood forecasting, but were able to reach a compromise after long discussions, as the Dutch representative, H. van Buiteveld, explains:

*The flood forecasting model we use in the Netherlands starts in the middle of Germany. The German länder (regions) were against developing a common model since it is their own responsibility to forecast water flow. There were lots of talks*

*resulting in the agreement that the forecast would only be done for the Dutch part and the Germans would do their own forecast. It is only partly realistic to have a common model. In the Rhine, we have some common models, for example we agreed on a hydrodynamic model. We also agreed where to use which model. In the Meuse basin it is more difficult to get an agreement. I would prefer to have a common model and common data. In the Meuse we are now making efforts to exchange more information for flood forecasting.*

In this situation, at least the results of different models can be compared, as it was done in the Neman basin and in the Danube climate change study, or harmonized at the border as it was done in the Meuse basin (Fournier, previously AMICE project, pers. Comm.).

A final reason for the reluctance by some governments against common models might be that, while developing basin-wide scenarios and models can increase adaptive capacity, it also has some disadvantages, e.g. that not all basin countries are correctly reflected in the model outputs. For example, in the Danube basin, the results of the climate change models based on the IPCC scenarios did not correspond to the observed trends in precipitation and discharge during the last years in Hungary and Serbia (Prasch, Munich University, pers. comm). Still, the two countries finally accepted the forecasts, recognizing the uncertainties and limits even of IPCC models. Recognizing uncertainty can thus facilitate mutual cooperation. Monika Prasch, Munich University, pers. comm:

*The observed evolution of precipitation by Serbia and Hungary did not match the scenarios in our study, so there were some disagreements and controversies. But this is due to the scenarios which are being used, the IPCC scenarios which we cannot change. There will be new scenarios in the new IPCC report, to be published next year, but they will not change very much. But finally Hungary and Serbia accepted and cooperated in the study and strategy development.*

This section has shown that mutual engagement /participation of scientists from all riparian countries is challenging, but can facilitate cooperation. In particular it can lead to scientific consensus and common understanding which will be shown in the next section.

#### *5.2.3.4 Scientific consensus and common understanding*

Climate change impacts are very uncertain and scientists often disagree on them. Common models and scenarios can facilitate the finding of a scientific consensus. As shown in the Danube, Rhine, but also the Dniester and Neman, a scientific consensus or at least a common understanding between riparian countries on approximate expected climate change impacts is necessary for joint actions to improve adaptive capacity, such as adaptation strategy development or implementation of measures.

Communication and common studies generate common understanding and reveal common or mutual interests which can facilitate cooperation and the development of joint strategies and measures. For example, when preparing the climate change impact assessment for the Danube, more than 100 already existing studies were collected and compared. The fact that the research results of all riparian countries and scientists were taken into account and compared gave the resulting climate change impact assessment study a certain credibility and legitimacy (Mair, ICPDR, pers. comm.). In the Rhine basin, through the project “Rheinblick 2020” a network of researchers was created which elaborated common studies and thereby enabled some sort of scientific consensus (Nilson, Rhine expert, pers. comm.). In the Neman basin, scientists from Belarus and Lithuania compared and put together their climate and hydrological models, thus creating more reliable results in the face of uncertainty caused by climate change which were provisionally accepted by the riparian countries. On the contrary, in the Dniester basin, one of the governments contested some of the results of the climate change impact assessment carried out within the project because their national scientists had not been sufficiently involved in the project and the preparation of the study according to them (Dniester basin workshop July 2013 in Chisinau, Republic of Moldova). In all these basins, cooperation by scientists and common modelling enabled reaching a scientific consensus or common understanding as a basis for development of a basin-wide strategy.

But what determines whether a scientific consensus is reached? The severity of flow variability which might be potentially due to climate change and therefore provides evidence of the need to act, plays a role as an expert from Belarus explains:

*Our project results were supported by scientists from Kaliningrad because the level of blue Lagoon was increased seriously during the last 20-30 years not because of Baltic Sea-level rise, but because of more extreme hydrometeorological events in the Summer.*

In addition, whether the forecasted effects correspond to the observed ones, the willingness of scientists and policy-makers to cooperate and wide engagement by all relevant scientists contributes to reaching a scientific consensus.

Still, scientific consensus is seen differently by different actors, especially the question when a scientific consensus is reached. Researchers usually stress remaining uncertainties and the need for further research to identify exact climate change impacts, even in the Rhine basin (Nilson, scientific expert pers. comm.), for example due to new models and scenarios from IPCC which would necessitate new modelling. Although in the Danube more than 100 studies about climate change impacts have been summarized in the climate change assessment report and widely discussed with experts, scientists etc. leading to some sort of a scientific consensus, some scientists argue that this is not enough and a comprehensive, self-standing basin-wide vulnerability assessment would be necessary, as it was done for example in the Rhine (Prasch, Munich university, pers. comm):

*With the available funds it was impossible to do a detailed hydrological modelling for the entire basin, there was not enough time and money for this. Such a study does not yet exist, although our assessment has revealed existence of more than 100 studies covering part of the basin. It would be good to model the entire Danube basin and we are trying to do such a project.*

Thus, it seems that scientists are more critical towards reaching a scientific consensus since they always believe that models can be improved while water managers and policy-makers are interested in agreed and reliable forecasts as the next section will show.

### 5.2.3.5 Communicating uncertainty

Decision-makers and water managers are usually interested in clear predictions of future temperature, precipitation and water flow; however, such clear predictions are not possible in the face of climate change due to the high uncertainty, confirmed also by the latest report of the IPCC (2013, 2014) and stressed for example by Ms. Orpisan from the Danube basin (pers. comm): *It is very difficult to predict precipitation and runoff whereas temperatures are easier to predict. There can be drastic change in flow in one year or no sign of change in another year. The degree of uncertainty of models is too high to have concrete results.*

In basins with high adaptive capacity, scientists are more likely to cooperate and then to agree on the magnitude of the uncertainties, to find a convincing method for displaying such uncertainties and subsequently to convince policy-makers of it. For example, as explained above, in the Danube basin, it was agreed to build the adaptation strategy based on a simple climate change impact assessment and even those countries where the final projected climate change impacts did not seem realistic, accepted the study (see section 5.2.3.3). Agreement or disagreement of results in certain areas among several studies was clearly analysed and then compiled in a graph showing uncertain and certain trends (Mair and Beyer, ICPDR and German ministry of environment, pers. comm.). This approach helped to reach a common understanding among the different relevant actors on the future climate and flow situation in the basin although there were some disagreements in the process. In the Rhine, despite different methods used by different scientists, the authors of the climate change impact assessment study, i.e. researchers, could find a consensus and communicated ranges of possible climate change impacts in order to demonstrate the uncertainty (ICPR 2011). This method was finally accepted by policy-makers who then need to decide which part of the range to base their decision on (Nilson, pers. comm).

In basins with lower adaptive capacity, on the contrary, policy-makers may sometimes use uncertainty or insufficient scientific results as pretext or excuse for not deciding upon any concrete climate change adaptation measures. For example, in the Meuse, the studies carried out within the Meuse project are not considered sufficient by certain policy-makers who argue that more research is needed before any clear actions can be taken, even if low or no regret measures are always possible (Dewil, Buiteveld, pers. Comm., AMICE project final workshop March 2013). While the AMICE project has greatly advanced knowledge on climate change impacts in the basin and created some common understanding, this knowledge is contested by some water managers and decision-makers who stress that the results still need to be politically validated:

*But in AMICE there was only one year to do the modelling, so they did it in a practical way and not as detailed as in the Rhine. Now we see when we want to transfer it to the IMC some say that AMICE is not enough. We are therefore trying to do a similar project as RHEINBLICK for the Meuse basin, but outside of the IMC (Buiteveld, pers. Comm).*

Finally, as indicated earlier, since climate change will always bring many uncertainties, the main question is the level of risk societies are willing to accept which can also vary between the riparian countries in a basin. These risk acceptance choices subsequently influence the choice of adaptation measures, the political willingness and the financing provided. For example, The Netherlands are one of the most vulnerable countries in the world and therefore have a lower risk tolerance than many other countries, as Mr. Buiteveld, Dutch representative in the ICPR explains:

*Our safety levels in the Netherlands are quite high. For the design discharge it is crucial for us to have information from upstream countries on retention areas. After several talks we found an agreement with Germany on this. This was done on a bilateral level, outside of the ICPR.*

In conclusion, data and information about current and future flow variability which can be used for the preparation of climate change impact assessments and influence adaptive capacity, since they provide the basis for any adaptation activities. Such data need to be

exchanged and used for elaborating studies and, if possible, joint basin-wide scenarios and models. This may facilitate a common understanding on current and future water availability in the basin and the development of joint adaptation strategies and measures. In order to make informed decision, policy-makers usually would like to have a “scientific consensus about future water levels” which is however difficult to reach, especially in a transboundary basin.

#### **5.2.4 Clear responsibilities of the national and transboundary levels**

Climate change has local and basin-wide impacts and requires responses at all these levels (UNECE 2009). Ensuring consistency, coherence and synergies between adaptation at these levels is thus important for adaptive capacity of the transboundary regime. In large basins, such as the Danube and Rhine, vulnerability and adaptive capacity of the basin population vary throughout the basin (Prasch, Munich university, pers. Comm), i.e. some riparian countries are usually more affected by climate change than others and some are better prepared than others. For example, the Danube delta, shared by Romania, the Republic of Moldova and Ukraine is very vulnerable, among others due to expected sea-level rise and due to the low adaptive capacity of the population. WWF is therefore implementing a project there aimed at developing a vulnerability assessment and a climate change adaptation strategy for the biodiversity and water sectors in the Danube delta (C. Ionescu, project manager from Romania, pers. Comm).

##### *5.2.4.1 Mandate to address flow variability*

The adaptive capacity of the transboundary regime also depends on the riparian countries' positions and whether they entrust the river basin commission to deal for example with flow variability. As a first step, riparian countries need to decide whether and in which way the transboundary water management regime should address flow variability. If they see transboundary cooperation as important for coping with extreme events, they can give a mandate (if possible high-level) to the river basin commission to address climate change

impacts, as did the Rhine and Danube ministers at the respective ministerial conference in 2007 and 2010 (ICPDR 2010 and ICPR 2007). Thereby, the Danube and Rhine riparian countries realized the importance of transboundary cooperation in adaptation instead of considering, as many other governments, that adaptation is mainly a national issue, to be addressed through national strategies.

In contrast, in other basins, the need for basin-wide adaptation is less understood. For example, at the Dniester workshop in July 2013, the need for a transboundary adaptation strategy for the entire Dniester basin was questioned with the argument that a national adaptation strategy already existed in the Republic of Moldova. Another example is the Meuse basin, where the Meuse Commission is not yet dealing with climate change and instead, problems of flow variability are discussed at the bilateral or local, but not multilateral level, as one Meuse expert explains:

*Because as I said the Meuse Commission (IMC) can only do what is decided by member states, one country can block all and there are long, long discussions. For example, I participated in the flood working group and there are no joint actions from the start, they only compared what is done at the national level, and if there is a real problem then we cooperate very locally to solve the problem. But there is no joint action; it is just a summation of the member states plans. Maybe if they see that there is a real problem then they start discussing but then this is discussed outside the IMC and then the IMC is informed.*

In such situations, with lacking political will and understanding, adaptive capacity of the basin is more difficult to enhance.

But why do certain basins cooperate in climate change adaptation and others not? Ideally, countries understand that by cooperating at the transboundary level in climate change adaptation they can pool their knowledge and resources, use more models and thereby achieve more reliable climate change impact predictions, include more data from the basin and share their knowledge and experiences (UNECE 2009). This can in turn then also help at the national level. In the Rhine basin, the riparian countries understand these benefits of a transboundary approach in climate change adaptation as the representatives of the ICPR and of the Netherlands in the ICPR explain:

*But the advantage of the ICPR is that we have the flood action plan with some goals and there are some models developed to evaluate these goals which we can use in our own national analysis (Buiteveld, The Netherlands, pers. comm.):*

Schmidt-Breton, pers. comm:

*And of course also the scientific knowledge is very advanced in the Rhine. Switzerland is very advanced in natural risk management, the Netherlands in water management in general. So the countries are very advanced themselves and when they bring their knowledge and lessons together in the Rhine Commission then it can be very efficient, we can make big steps forward.*

These quotes show that the transboundary cooperation in climate change adaptation should demonstrate some clear benefits for the riparian countries, such as better water quality and quantity, more certainty about actions of neighbouring countries, pressure on national institutions or additional knowledge for national processes. This can increase the priority given by the riparian countries to the transboundary regime in addressing flow variability and the political willingness to cooperate with other riparians, including their readiness to allocate time and resources to the river basin commission and its secretariat for climate change adaptation. In the Danube basin, for example, countries welcomed the development of the transboundary adaptation strategy since they could also use part of it for their national strategies (Mair, ICPR pers. Comm.).

Cooperation in climate change adaptation can promote transboundary cooperation in general as well as support other aspects of water management. For example in the Neman basin, the need to adapt to climate change has become a driver for transboundary cooperation as a representative of Lithuanian Ministry of Environment explains:

*This project on climate change adaptation is also helping us (Lithuania) to better cooperate with the neighbours and update our river basin management plan. Transboundary cooperation has progressed in the framework of the project. The transboundary agreement is stopped now since the European Union needs to become a Party to the agreement which requires a rearrangement.*

In the Danube, climate change adaptation is an incentive for better water management in general, as a representative of ICPDR explains:

*The adaptation strategy of the Danube contains an outline of possible adaptation measures of basin-wide importance as discussed at the stakeholder workshop in March 2012, addressing for instance sectors, such as agriculture and navigation. However, climate change is a driver for better water management in general; many measures such as ecosystem restoration and reconnection of floodplains will help other topics as well such as biodiversity.*

#### 5.2.4.2 *Developing and implementing joint adaptation strategies*

Developing and implementing basin-wide climate change strategies and plans can increase adaptive capacity because such documents usually describe how to reduce or react to flow variability at the basin level. They define a common understanding on climate change impacts as well as a common vision for adaptation in the basin and are usually prepared in a participative process. If developed and agreed upon at the basin level by all riparian countries, they can also prevent conflict between the riparian countries. The only adopted transboundary climate change adaptation strategy existing as of 2014 within my full case study basins is the Danube strategy (ICPDR 2013b). It contains a part focusing on the knowledge base, including expected climate change impacts and vulnerabilities, possible adaptation measures, and a second part on guiding principles, integration and next steps. Other transboundary water management regimes, such as the Mekong, Rhine, Dniester and Neman are currently in the process of preparing a transboundary strategy. In addition, the Rhine, Meuse and Danube Commissions develop flood action plans according to the EU flood risk directive at the transboundary level. The Nile basin also has a climate change strategy which is very general.

As they usually contain measures on how to address flow variability, developing such strategies and plans can be considered as sign of flexible treaty implementation and can be an alternative to the more complicated treaty amendments, i.e. revisions of the legal framework, which might take years to negotiate and then usually needs to be ratified by all riparian countries' parliaments. In some cases, decisions of river basin commissions can be a first step towards treaty revisions. For example, as described in chapter 4, both for the Rhine and Meuse in the 90s new legal agreements were negotiated widening up the cooperation both

from the geographical scope as well as the content. New topics such as flood management were included (Schreurs, IMC, Buiteveld, Netherlands, pers. comm.).

Developing a basin-wide adaptation strategy is a complicated and lengthy process which can take several years. In the Neman and Dniester basins, for example, the process has taken more than a year. In those basins, the title of the strategy had to be changed into “Strategic framework for basin adaptation” in order to avoid intergovernmental procedures for approval normally required for any strategic documents. In the Meuse basin, it was not possible at all within the AMICE project to develop a transboundary adaptation strategy since country representatives could not agree on the content of the strategy, but only on a roadmap for its development (Fournier, former AMICE project manager, pers. Comm), which reflects the general difficulties in transboundary cooperation in this basin. In the same way, the Meuse Commission IMC plays mainly a coordinating role and focuses on comparing national strategies for example in the flood risk group instead of preparing a transboundary flood risk management or adaptation strategy (Fournier, former AMICE project, pers. comm). Some external observers explain this with the politicized role of the Meuse Commission.

Whether riparian countries agree on a common strategy seems to depend, among others, on the aims of the strategy as well as the clarification of responsibilities between the different levels.

#### **5.2.4.3        *Responsibilities***

Responsibilities with regard to climate change adaptation need to be clarified between the national and the transboundary spatial levels. At the basin-wide level, usually the general principles for adaptation are defined and the overall structure and location of adaptation measures, whereas the actual implementation of measures happens at the local level. For example, the Danube strategy is very general (ICPDR 2013b) and defines mainly principles and categories of adaptation measures, but does not include prioritization of measures, which made it easier for the Danube countries to agree upon the strategy (Mair, pers. Comm, ICPDR

2013b). General strategies are certainly easier to agree upon. The Danube, as the most international river in the world, has for example, defined responsibilities in the basin as A-requiring basin wide action, B- sub-basin action and C-national and local action. The adaptation strategy is focused on level A, but highlights the importance of linking the other levels, e.g. by regular exchange, by involving experts from the other levels into the basin-wide activities etc. Concrete adaptation measures are supposed to be decided and taken by sub-basins or the countries and to be included in the river basin management plan. The strategy aims to guide adaptation in the basins, but more detailed planning is the tasks of lower levels:

*The focus of the Strategy is clearly on issues relevant at the Danube basin-wide scale (level A), being in line with the mandate of the ICPDR, while at the same time paying attention to the different levels of river basin management (level A, B and C) as requested by the WFD and EFD. Hence, further detailed planning on adaptation has to take place at the sub-basin, national and/or sub-unit level. The main objective of the Strategy is to guide the way to fully integrate climate adaptation into the 2nd DRBM Plan and the 1st DFRM Plan. The Strategy therefore does not include a jointly agreed Programme of Measures on adaptation (ICPDR 2013:10).*

In addition, the goal of the strategy is very specific, namely to “guide the way to fully integrate climate adaptation into the 2nd DRBM Plan and the 1st DFRM Plan” (ICPDR 2013: 10). On the contrary, the adaptation strategy for the Danube delta, prepared and adopted in 2014, i.e. a sub-basin of the Danube, is more practical and more detailed, suggesting actual measures and their location (C. Ionescu, project manager, pers. Comm.). Also the draft strategies for the Neman and Dniester rivers are more concrete and detailed than the one for the Danube proposing concrete adaptation measures (UNECE 2014 b and c).

This distinction of responsibilities can be crucial for ensuring acceptance and implementation of the strategy. For example, the mandate of the ICPDR is very specific and narrower than for example the one of the Senegal and Mekong River Commissions, yet, the ICPDR is considered more effective than the other basin organizations (Schmeier 2013). It seems that national governments want to have the main responsibility for climate change

adaptation themselves and consider the basin level's role in enabling a common understanding on climate change impacts, defining a vision for addressing climate change and flow variability as well as overall principles.

Consequently, the funding of the adaptation measures' implementation should be normally covered from national sources, which prevents the Danube Commission from having lengthy discussion on distribution of funding. The former Executive Secretary of the ICPDR, Koos Wieriks, underlines the importance of this principle of self-payment:

*All agreements in the Rhine, like the action plan on floods, are non-binding, except the Convention itself. In addition, implementation of the decisions is in the responsibility of the Parties. Everybody pays his or her own activities. This is important since this way; we avoid difficult discussions on financing.*

Any strategy is only effective and can only increase adaptive capacity if implemented. In 2013, reflections about the implementation of the Danube-wide adaptation strategy have started (UNECE 2014). The principles and measures included in the strategy should be mainstreamed into the new Danube river basin management plan and the first Danube flood risk management plan, both under development and to be finalized by 2015 (Mair, ICPDR, pers. comm). All working groups under the ICPDR were tasked to integrate climate change aspects and an analysis was done which elements of the strategy are relevant for which working group as well as which section of the new river basin management plan and the flood risk management plan (UNECE 2014, Mair ICPDR, pers. comm). Thus, since implementation of the adaptation strategy already started, the Danube is one of the most advanced transboundary basin worldwide with regard to the development and implementation of a transboundary adaptation strategy.

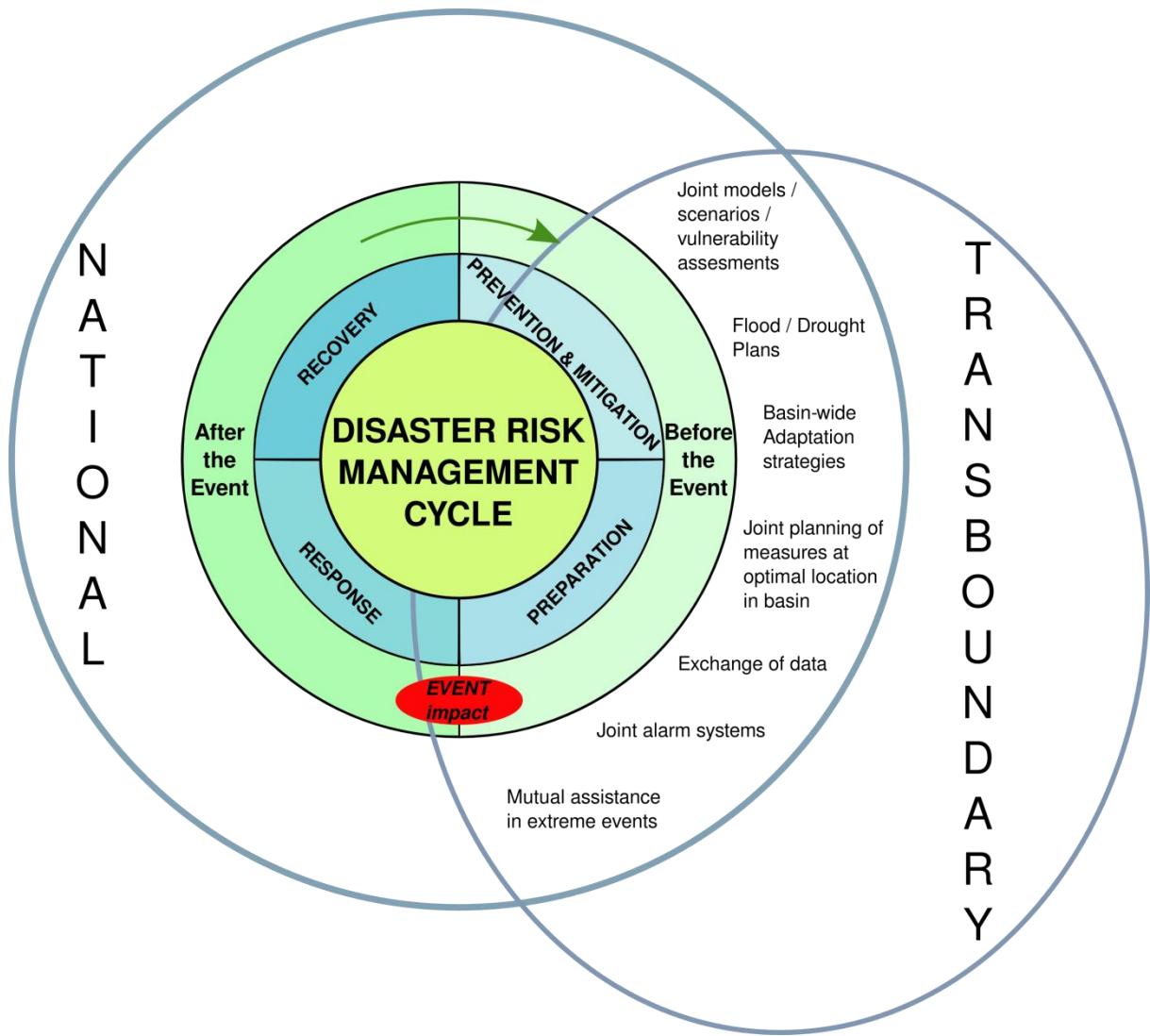
Since implementation of measures happens at the local level, representatives of those more local levels, who will have to implement adaptation measures, should be taken into account already in the development of the transboundary strategy, e.g. by inviting them to consultation workshops. The President of EPAMA, a local French water agency in the Meuse,

Mr. Bachy criticizes that the International Meuse Commission plays an important role, but includes only national representatives, not always closely involved at the local level. In contrast, the AMICE project also involved regional and local authorities.

Consequently, the indicator for adaptive capacity in this dissertation, i.e. “ability to cope with flow variability without conflict” cannot be fulfilled by the transboundary regime or the river basin commission alone, but also depends on the national, regional and local authorities and their adaptive capacity, who are in charge of emergency responses in times of high or low flow. This distinction was stressed by many of my interviewees indicating that emergency response measures cannot be taken by the river basin commission, but by local authorities. Some interviewees underlined that decisions on adaptation measures as well as their implementation should happen at the lowest possible level (Orpisan, Romania, pers. Comm.). For example, during the high flood in the Danube basin in June 2013, emergency measures such as evacuation and protections were implemented by national and local authorities (ICPDR 2014) of the different riparian countries which sometimes cooperated with the neighbouring countries. However, the ICPDR prepared afterwards an overview report summarizing the key events and lessons learned, with experiences from the different riparian countries. Thus, the river basin commission has in this case an analytical role promoting adaptive management, since it can integrate the lessons learned from the severe flood into the Danube flood Risk Management Plan which is under development in 2014 (ICPDR 2014).

Considering the different stages of the risk management cycle (see fig. 9), the transboundary water management regime usually mainly focuses on prevention, mitigation and preparedness to extreme events, with some exceptions, such as data exchange in times of extreme events (response), and on coordinating the actions of the countries in these areas. The national and subnational level is involved in the entire risk management cycle, including reaction and response to extreme events (see fig. 9 below). For this reason, the adaptive capacity of the transboundary regime is always related to the one of the riparian countries and,

possibly, even lower administrative levels such as sub-basins, regions or localities (Mair, ICPDR, Schmid-Breton, ICPR, pers. comm). As fig. 9 shows and as previous chapters have demonstrated, the transboundary water management regime can ensure exchange of data, prepare joint scenarios and vulnerability assessments, plans and strategies, operate joint alarm systems and facilitate mutual assistance during extreme events.



**Figure 9 Responsibilities of the national and transboundary level in different stages of the disaster risk management cycle**

Based on: FLOODSITE 2014 (revised)

However, since adaptation activities are also ongoing at the national level and many countries have already or are in the process of developing their national adaptation strategies, coherence, coordination and cooperation between these different governance levels needs to be ensured as a representative of the Danube Commission stresses:

*In the development of the Danube adaptation strategy countries wanted to ensure that there were no contradictions to their national activities and data on climate change projections. Overall, it was a constructive exchange. We tried to build the strategy as much as possible on already agreed documents and information in place, such as the CIS and ECE Guidance documents (Mair, pers. Comm).*

Coherence can be strengthened by exchanging information on national and sub-national adaptation activities, strategies and plans at the river basin commission level. The Mekong Climate Change Adaptation Initiative (MRC-CCAI) for example organizes basin-wide adaptation fora, among others for this purpose (MRC 2014). In addition, national policies, strategies and plans need to be analysed and taken into account in the development of transboundary strategies, as it is currently done in the Rhine basin (UNECE 2014).

If impact assessments and adaptation strategies are developed at the national and transboundary level, they can motivate and stimulate each other. For example, the political willingness to address climate change at the transboundary level in the Danube and to develop a transboundary adaptation strategy was also due to the fact that representatives of several countries, such as Serbia, which were at that time developing their own national strategies, thought that the Danube adaptation strategy could give them information and motivation also for their national processes and obligations (Mair, ICPDR, Beyer, Germany, Orpisan, Danube expert pers. Comm). Therefore, these national governments were very interested in the process of developing the Danube adaptation strategy, including the preparation of joint scenarios and vulnerability assessments (Knut Beyer, Germany, pers. comm.). The representative of the Danube Commission explains (R. Mair, pers. Comm.):

*Both, EU and non-EU countries were interested and participating in the strategy development; there was no major discussion about the need for it. There was especially high interest from those countries developing their own strategies who understood that they could learn and take some elements from the basin-wide strategy- so the Danube strategy development was seen as important since also helping the national level.*

This section has shown that adaptive capacity of the transboundary water management regime is always linked to the national level as well and the two influence each other. Ideally, the two can support each other and increase synergies as it is happening in the Danube basin. In this way, the overall adaptive capacity can be increased in a sustainable way.

### **5.2.5 Learning capacity**

Experience of extreme weather events leading to flow variability, such as floods and droughts, can play an important role in increasing adaptive capacity of transboundary water management regimes by providing evidence of the need to act and adapt - but only if the experience of such events leads to learning and improvements which happens usually if the transboundary water management regime or more specifically the river basin commission has sufficient learning capacity. According to the concept of adaptive management (Pahl-Wostl 2008, see also chapter 2.7), but especially the theories of institutional change exogenous shocks such as extreme events can be a precondition for change (North 1990, cited in Héritier 2004). Extreme events and resulting flow variability often represent an important incentive for cooperation, like in the Meuse after the floods in the 90s or in the Danube, where the low flow in the year 2011 has led the ICPDR to consider dealing with water scarcity, starting with a survey among Danube countries (see the Danube chapter 4.2 and the Meuse chapter 4.3). Also in the Rhine basin, the floods experienced led to significant learning, to an improvement in actions, goals, such as the development of the flood action programme in 1996 and even the risk culture as a representative of the Rhine Commission explains (Schmid-Breton, ICPR pers. Comm.).

But how does learning happen? As a first step, an extreme event needs to be perceived as extreme and as requiring preventive action, and this throughout the basin, i.e. awareness needs to be raised, for example through the media, on the seriousness of the , e.g. economic or even human life damage, also among those not affected directly. This is especially important in transboundary basins which are often large and thus, not the entire basin is affected by the

extreme event to the same extent. In addition, countries need to understand that the flow variability requires preventive and not only reactive measures. For example, in the Rhine, the low flow in 2011 was put on the agenda of the Rhine Commission by the Dutch delegation, resulting in a basin-wide study, as the Dutch representative H. Buiteveld explains:

*The last low flow in the Rhine was in 2011. At that moment, we had some problems in the Rhine and we put it on the agenda of the International Commission for the Protection of the Rhine. Then a research was made, an inventory of the sites and measures taken. But the most upstream countries did not have problems, only the Netherlands had. The conclusion of the research was that water temperature was problematic since it exceeded 25C. This posed a problem for some countries and some species, so climate change is differently affecting the riparian countries. And the other countries could not do much to help us at that time.*

Thus, the river basin commissions can help countries addressing the flow variability e.g. by collecting data and information from the entire basin and promoting communication between the riparian countries. For example, the Mekong River Commission collects and publishes data on water levels during floods and issues flood warnings.

Secondly, there needs to be an understanding of the need to address the flow variability, caused by the extreme event, through preventive action and at the basin-wide scale. The river basin commission plays an important role in raising awareness of the entire basin, but also the most affected riparian countries, such as the Netherlands in 2011 (see citation above). The Executive Secretary of the International Meuse Commission explains how the floods in the basin have led to a revision of the Meuse treaty:

*In the first period of the IMC the focus was on water quality. Time was needed to get to know each other. Then there were two heavy floods in 1993 and 1995, but flood management was not included in the Meuse treaty. Therefore, the ministers organized a working group on floods and hydrology separately from the treaty but using the facilities and services of the Meuse Commission. Important steps regarding floods were realized such as the elaboration of an action plan. Later on this issue was integrated in the new Meuse treaty. (W. Schreurs)*

Learning from and reacting to extreme events can take different forms, e.g. putting the issue on the agenda of the river basin commission, analysing the situation, as the ICPR did after the drought in 2002, and damage caused, as the ICPDR did after the 2006 Danube

floods, developing flood or drought action plans as in the Meuse and Rhine basin in the 1990s, elaborating climate change adaptation strategies or even implementing measures for risk reduction such as ecosystem restoration. Interestingly, in this case, the countries were taking measures, but outside of the Meuse Commission, i.e. outside of the formal transboundary cooperation regime because the transboundary regime and its legal text did not foresee addressing such issues (Dewil, pers. Comm). However, still they allowed the Meuse Commission to informally service the group. In 2002, the transboundary agreement for the Meuse River was revised, to address officially also floods and low flow situations as well as to include the other riparian countries of the basin. This can be considered as proof of learning capacity or adaptive management and was due to several extreme events, but also probably due to the adoption of the EU Water Framework Directive (external pressure, see chapter 5.2.1.5).

Learning needs to be officially reflected and can lead e.g. to treaty revisions or negotiations. The riparian countries or the river basin commission need to react to the issue, reflect the new situation by changing the agreement or procedures, such as in the Meuse basin in 1993 and 1995. For example, in the Rhine basin, a new transboundary agreement, the Rhine Convention, was adopted in 1999 in order to address several emerging issues, including floods (ICPR 2013). Since 2006, the EU Floods Directive details activities to be taken by countries and at the river basin level to prepare for floods, such as flood risk mapping, development of response plans etc.

Extreme events and resulting flow variability can even lead to the negotiation of new or revised treaties. For example, the transboundary cooperation treaty between Mexico and the United States of America was amended in 2013 making it more flexible. The treaty includes one important flexibility provision: the possibility to revise or complement the treaty by adding “minutes” (Fischhendler 2008). After a 5-year long period of negotiations, Mexico and the USA agreed on adding minute 319 which specifies, among other issues, measures to

take in the Colorado River basin in situations of water quantity fluctuations which might be due to climate change (Varaday 2013, Lopez-Perez, Mexico, pers. comm). This shows the flexibility of the regime, signed in 1944, and the willingness of the riparian countries to prepare transboundary agreements to climate change. According to Mario Lopez-Perez, Mexico (pers. comm), reasons for this significant progress in the transboundary regime, increasing its adaptive capacity, were the sense of urgency through several extreme events, such as floods and droughts in the recent years, the approaching change of government on the Mexican side and the relative trust between the two countries which has developed during the decade-long cooperation.

In recent years, low waters have come to the agenda of many European river basins, however, instead of creating a new legal framework or a new working group to deal with a new issue, it can be integrated into the mandate of existing institutions. The Rhine Convention text for example does not foresee any special mechanisms for addressing drought and low flow, i.e. does not include any flexibility provisions, but through the mechanisms and institutional structure of the Convention, such as working and expert groups of the Rhine Commission, issues of low flows are being addressed and the climate change adaptation strategy currently being developed has a special focus on low flows (Schmid-Breton, ICPR, pers. comm.). The Rhine, Meuse and Danube river basin organizations for example are addressing this new topic by first preparing a survey of country experiences and opinions on how the commission should address the new topic. Subsequently, they might develop a plan with concrete actions. At the same time, scientific studies are under preparation on the new problem and on possible solutions, such as the study currently carried out by Switzerland on the possible use of Swiss hydropower reservoirs for alleviating floods and droughts downstairs. The process of institutional change is not official or formal in this case, but rather informal since there is no expectation for a change in the legal framework. In the Rhine, the new emerging issue of drought was first brought up by one most concerned country, the

Netherlands, subsequently discussed in the Commission and then explored in more detail. Some Dutch representatives even believe that a water allocation agreement would be needed also for the Rhine (i.e. saying that the Commission is not enough):

*However, it is extremely important that firm international agreements are made because in summer the Rhine is by far the largest source of fresh water for the Netherlands and because it is important to maintain a minimum water level in the Waal, the main distributary of the Rhine and a heavily trafficked shipping lane.(PBL 2012.*

Thus, through decisions of the Commission new topics are being addressed which are not (yet?) directly included in the legal framework. This shows that the Commission, i.e. the organization, is acting flexible and is overcoming a deficiency in the Convention's provisions (lack of flexibility).

As a conclusion to this section, extreme events provide evidence for action which can lead to learning and learning can happen. However, for an extreme event to actually lead to a change, the issue needs to be brought to the agenda of the transboundary regime or river basin commission through a concerned country, social protests, media, EU directives, leaders etc. This is even more important, since the primary responsibility to respond to emergencies lies with national authorities, whereas the transboundary regime is mainly responsible for ensuring basin-wide communication, coordination, exchange of information and prevention of conflicts (see section 5.2.4.3). Finally, the transboundary regime itself cannot "learn" (Hasenclever et al. 1997), but the different actors can, such as the river basin commission.

### **5.3 Summary of the enabling factors**

The following section summarizes the research results demonstrated in the previous section and compares them with other similar literature, such as those authors presented in chapter 2.

Adaptive capacity of transboundary water management regimes is more complex than adaptive capacity of other water management systems or regimes, for example at the national level, due to the multitude of actors involved (e.g. governments, but also stakeholders from the different riparian countries), the different interests and alliances of the riparian countries

as well as sometimes conflicts or controversies. In addition, transboundary water management regimes involve numerous levels of coordination, such as the basin-wide level where usually multilateral agreements are concluded, but also bilateral agreements between two riparian countries as well as the national governments, which adds to the complexity.

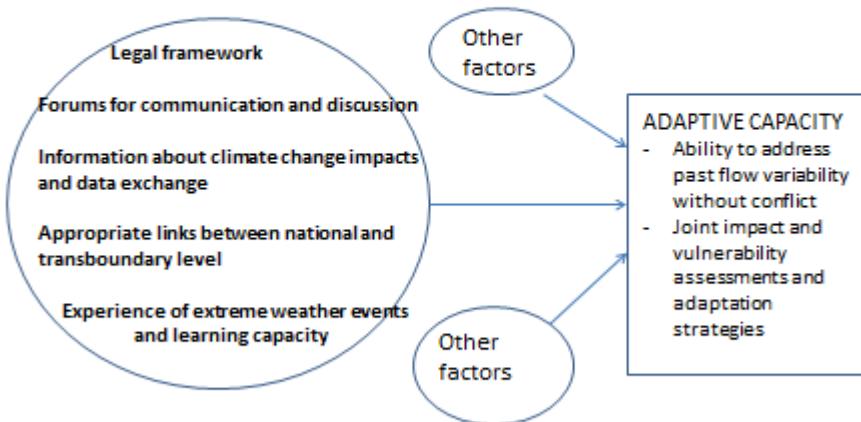
Many transboundary agreements and regimes have even been driven by the need and desire to address flow variability, in particular floods, such as the Meuse and the Rhine. These legal frameworks then usually contain specific provisions e.g. for information exchange in times of floods. In fact, hydrologic variability was one of the reasons for treaty regulation of shared waters by riparian countries (Leb 2013). Whether they can address flow variability without conflicts depends on the provisions in the transboundary agreement and especially on the institutional framework for implementing them, as well as on the other enabling factors identified through my and other research.

The previous sections have shown that many factors are influencing and enabling adaptive capacity of transboundary water management regimes in Europe. Enabling factors include a combination of flexible legal frameworks, flexible well-working forums for communication, discussions and decision-making such as river basin commissions with visionary and motivating leadership, resources, wide stakeholder engagement, trust and understanding of benefits of cooperation by the riparian countries enabling political willingness to cooperate etc., but also data and information about current and expected future water flow, learning capacity and development of adaptation strategies. A common understanding on the current and expected future situation, especially in terms of expected future water flow and data exchange is necessary to be able to react jointly to situations of flow variability. Ability to learn from past extreme events and improve the preparedness to future extreme events is crucial for adaptive capacity. Also the relationship between the transboundary and the national level needs to be clarified, including the responsibilities in situations of low and high flow. The transboundary level usually focuses on prevention,

preparedness to and, to a limited extent, on reaction to extreme events or flow variability.

Figure 10 displays the different enabling factors for adaptive capacity of transboundary water management regimes identified through my study, but also leaves open space for additional factors which my research might not have identified (see section 5.5 on limitations), as it was limited to only four case studies from Europe. These additional factors, such as those in the framework by Gupta et al. (2010) not considered in my research such as variety of problem frames, certainly also play a role for adaptive capacity,

## Adaptive capacity of transboundary water management regimes



**Figure 10 Research results: Framework for enabling factors for adaptive capacity of transboundary water management regimes in Europe**

Table 21 provides an overview of all enabling factors ordered according to the major categories identified in chapter 5.2. These include legal frameworks, forums for communication and decision-making such as joint bodies, information and data exchange, governance (clarification of responsibilities) and learning capacity. All other identified enabling factors can be related to one of these issues, for example resources are needed by the river basin organization to fulfill their functions regarding flow variability. In fact, many of the indicators in the right column of the table specify or facilitate the main enabling factors in the left column. The table also specifies the outcomes of each category of factors and how

they relate to flow variability and thus adaptive capacity. For example, communication is needed in situations of flow variability to agree on how to address the low or high flow.

**Table 21: Non-exhaustive list of enabling factors for adaptive capacity identified in my research**

<b>Adaptive and reliable legal frameworks for transboundary cooperation</b>	Existence of transboundary agreements Provisions regarding flow variability: data exchange, assistance, dispute settlement, plans Flexibility provisions Legal pressure from other levels such as EU
<b>Enable:</b>	<b><i>Specific rules for the transboundary cooperation under flow variability, provides certainty to riparians</i></b>
<b>Flexible forums for communication, discussion and decision-making</b>	Appropriate well-working organizations for transboundary cooperation such as a river basin organizations with the following characteristics: flexibility, inclusiveness, strong secretariat, mandates, resources Other fora for discussing flow variability such as informal working groups, projects etc. Motivating, innovative and visionary leadership Trust and understanding benefits of cooperation by the riparian countries Wide engagement: informal networks and stakeholder involvement of local and regional authorities, NGOs, scientists etc. Adequate human and financial resources for the river basin commission and adaptation activities
<b>Enable:</b>	<b><i>Communication e.g. on actions to take during flow variability, facilitate common understanding, common vision, common strategy for addressing climate change</i></b>
<b>Regular reliable data and information about climate change and flow variability</b>	Regular data exchange at basin-level Developing studies: climate change impact and vulnerability assessments Developing common models and scenarios Scientific consensus and common understanding Agreement on and communication of uncertainty to decision-makers
<b>Enable:</b>	<b><i>Common understanding on current flow situation and future cc impacts</i></b>
<b>Multilevel governance of climate change adaptation- clear responsibilities of the transboundary and national level</b>	Clear mandate to the river basin organization to address flow variability Developing and implementing joint strategies and plans for climate change adaptation Clearly defined responsibilities of the different levels in adaptation Transboundary cooperation facilitating national adaptation
<b>Enable:</b>	<b><i>Incentive for action, clear tasks, no overlapping tasks</i></b>
<b>Learning capacity</b>	Learning and improving after extreme events Reacting to new developments
<b>Enable:</b>	<b><i>Willingness to change and improve, evidence for action</i></b>

Some of the enabling factors influence each other, for example river basin organizations are set up through the legal framework but can also in return modify it as explained above. Table 22 displays some interactions between the enabling factors and shows that none of them can be seen in isolation and adaptive capacity can be really strengthened only if several conditions are fulfilled. For example, RBOs, if designed in a clever way, can facilitate data exchange, learning and clarification of responsibilities.

**Table 22: Links between the different enabling factors identified in my research**

	Legal framew.	Organizations for transboundary coop (e.g. RBOs)	Information and data	Learning capacity	Multi-level governance
Legal framew.		RBOs can revise legal framework		Can require revisions in legal framework	Legal framework is created by national representatives
River basin Organisation (RBO)	Legal framework sets up RBOs			Learning can change RBOs	RBOs are directed by national reps.
Information-and data	Legal framework can facilitate sci. consensus	RBOs can facilitate info exchange e.g. platforms			
Learning capacity	Legal frame should enable learning	RBOs can facilitate learning	Info is required for learning		Can facilitate (or hinder) learning
Multi-level governance	Legal frame should specify links with other levels	RBOs help in clarifying multi-level governance			

Among the most important enabling factors identified are the existence of an appropriate legal basis for transboundary cooperation, i.e. an appropriate transboundary agreement, and the existence of a well-working organization to implement the agreement, for discussion and for making decisions on the joint management of the river under conditions of flow variability, such as a river basin commission. Those transboundary water management regimes with functioning transboundary cooperation, an effective legal framework, and especially with a well-working river basin commission such as the Rhine, Danube, Mekong and Senegal river basins can usually cope with flow variability and flow change without conflicts and are more likely to develop vulnerability assessments and adaptation plans, the two indicators for adaptive capacity used in my study.

As it can be seen in table 22, legal agreements for transboundary cooperation are crucial for coping with flow variability, since many of the other enabling factors identified in my research should be fixed through the agreement, such as cost-sharing in the commission and exchange of data. The transboundary agreement therefore needs to include certain provisions, for data exchange, dispute settlement, procedures for amendment, early warning, mutual assistance, joint monitoring, equitable and reasonable use of the resources also in the face of climate change as well as prevention of transboundary impacts, including those of any adaptation measures such as major infrastructure projects (UNECE 1992). In negotiations of new agreements, these elements should be as much as possible taken into account. If existing functioning agreements do not include such provisions, they can sometimes be added by the River Basin Organization (RBO), e.g. through a decision of the governing body or an amendment of the Convention.

Inclusion of flexibility mechanisms into the transboundary agreement as argued by Fischhendler (2004) and Drieschova et al. (2008) (see section 2.5) is useful, especially when the basin is faced with water scarcity, but can have some transaction costs, e.g. during negotiation, which might explain why many transboundary regimes do not have flexibility provisions. In fact, transboundary treaties are negotiated by countries in order to achieve a certain level of predictability and stability (Leb 2013). Therefore, governments may be hesitant to designing treaties very flexible.

In my four European case study basins, a very important enabling factor for adaptive capacity is the existence of a flexible organization for discussion and decision-making, such as a river basin organization which is able to learn and to address new emerging topics such as climate change. Effective river basin commissions can address issues which are not included in the legal agreement, such as water flow variability and climate change impacts, for example by elaborating protocols, plans or strategies for climate change adaptation or by taking flexible management decisions. Such decisions, e.g. to interrupt navigation and restart

it one month later due to low flow, can be taken by the river basin commission, as it happened in the Rhine in 2003, and do not necessarily require a flexible legal framework. Such decisions rather correspond to the concept of adaptive management (see section 2.7), which seems to be a useful approach, with some adjustments, also for transboundary water management regimes in order to enable learning and incremental improvements of the regime.

Numerous examples exist where river basin organizations have improved their regime's ability to address flow variability without conflict. For example, in the Rhine basin, the flood damage or calculated water levels in times of high floods have been significantly reduced since the adoption of the Rhine Action Plan on floods in 1998 under the ICPR, i.e. the ability to deal with flow variability was improved (ICPR 2011b). Through renaturation of the river basin, restoration of floodplains and polders as well as other measures, the vulnerability of the basin was reduced and the adaptive capacity increased. This was mainly possible because of the existence of the river basin commission in the Rhine. In the Danube basin, a flood action plan was elaborated as well as a climate change adaptation strategy whose elements are now integrated into the revised river basin management plan for the Danube (ICPDR 2013). In addition, since the establishment of the ICPDR, the conflict intensity as well as number of conflictive events according to the so called-BAR scale has dropped (Schmeier 2013). Similarly, also in the Mekong basin, the ratio between conflictive and cooperative events has improved since the establishment of the MRC (Schmeier 2013). Table 23 below summarizes this and additional evidence for the role of river basin organizations in successfully addressing flow variability.

**Table 23: Concrete achievements of river basin organizations in addressing flow variability and climate change**

<b>Basin</b>	<b>Activity with regards to flow management</b>	<b>Impact with regard to flow variability and reference</b>
Rhine	ICPR Flood Action Plan	Reduced flood levels during flood situations (ICPR 2011b)
	Rhine Convention of 1999	Improved water quality, reintroduction of the salmon in the river (ICPR 2007)

Danube	Climate change adaptation strategy	Common vision for adaptation in the basin (ICPDR 2012)
	Danube Convention of 1994	Improved water quality (Schmeier 2013)
	Danube Commission	Reduced conflict intensity (Schmeier 2013)
Mekong	Flood management and mitigation programme, flood alert system	Reduced damage in times of floods (Schmeier 2013)
	Mekong Commission	Reduced conflict intensity (Schmeier 2013)
	Climate change adaptation initiative	Increased capacity to adapt to climate change
Meuse	Early warning system for floods, basin-wide flood hazard maps	Improved capacity to react to floods and exchange of information
Sava	Protocol for flood management adopted	Common vision on how to address floods, also among non-EU riparian countries
Senegal	Senegal River Basin Organization (OMVS), with jointly managed and financed infrastructure	Reduced conflict intensity Better management of droughts, improved social conditions, Improved energy supply

However, in regimes with water scarcity and water allocations and/ or in bilateral agreements where often no secretariat and permanent institutional structure for cooperation exists, flexibility provisions play a higher role in addressing flow variability without conflicts. Additional research of such basins worldwide is therefore needed.

Finally, it should be recognized that basins are different and their regimes' adaptive capacity as well as enabling factors may vary. Basins differ in size, climate, location, water use, etc. For example, in smaller basins, climate modelling or basin-wide adaptation strategies might not be needed or river basin commissions often do not have a secretariat. Still, these regimes might have a high (or low) adaptive capacity. The enabling factors for adaptive capacity identified in my research should not be considered as necessary conditions for adaptive capacity, but as supportive factors. An individual analysis is needed for each basin.

## **5.4 Discussion**

My research results build upon and confirm some, but also give some additional insights compared to some of the findings by other researchers as described in the literature review chapter (chapter 2). Many factors which are found to indicate adaptive capacity of

water management institutions according to the framework by Gupta et al. (2010) are also identified in my research, namely learning, resources, trust and access to information and data. However, since my study considered the specific case of transboundary water management regimes, it identified additional enabling factors for adaptive capacity such as adaptive transboundary agreements and well-working organizations for transboundary cooperation. Thus, the factors identified in my research should be seen as additional to the ones by Gupta et al. (2010, see section 2.6).

Many other authors also find that river basin organizations matter (Schmeier, 2013, UNECE 1992 etc.). Schmeier argues that RBOs matter through their institutional design and highlights that “ill-designed RBOs are counter-productive to effective basin governance” (Schmeier 2013: 270). Factors determining the effectiveness of RBOS include membership, structure, functional scope, financing, data and information management environmental monitoring and dispute-resolution mechanisms. These factors are similar to those identified in my research.

This finding is also reflected in international water law: the UNECE Water Convention requires its Parties to set up basin-wide agreements and joint bodies and describes in detail which tasks they should fulfill (UNECE 1992). Parties should also include in their transboundary agreements provisions on joint monitoring systems, common research, exchange of data, fixing of common water quality objectives etc. The 1997 UN Watercourses Convention recommends to Parties to conclude transboundary agreements (UN 1997).

The relevance, role and importance of organizational structures for transboundary cooperation analysed in my study relates to the discussion in the literature about Multilateral Environmental Agreements (MEA, see section 2.1.3), which are usually often more effective in reaching their goals if they have an institutional structure such as a Meeting of the Parties (MOP), a secretariat etc. (Beyerlin and Marauhn 2011, Wettestad 2000). The MOP can even take decisions to reverse, review or make amendments to the legal text (Beyerlin and

Marauhn 2011). It can give specificity to the MEA, complement it through amendments or Protocols (Cullet 2013), take decision on its scope and interpretation of the provisions, e.g. decide to develop a flood action plan, to start addressing low flow, and give the mandate to develop a climate change adaptation strategy. Most transboundary agreements worldwide actually do have an institutional framework, including an organization for its implementation.

However, the law-making power of decisions by the Conference or Meeting of the Parties to Multilateral Environmental Agreements is debated (Brunee 2002, Churchill and Ulfstein 2000). Determining the binding nature of decisions by the Meeting of the Parties depends on the provisions in the actual agreement regarding the COP/ MOP and on how the decision was taken, e.g. by consensus or not. Often, procedures are specified in MEA texts on procedures and legal status for amendments and protocols, but not for normal COP decisions so that their legal status is “at best ambiguous” (Brunee 2002:32). The status of decisions can be analysed according to concepts of transparency, mutual understanding and consent and customary practice (Makagon 2012). To overcome this problem, the supreme organ of the transboundary water agreement, usually the Meeting of the Parties or Council of Ministers should be clearly empowered to take decisions on the further implementation and development of the transboundary water management treaty, including addressing of new areas of cooperation such as floods, droughts and climate change. Such important decisions should be taken by consensus. MOPs can be empowered to take such decisions ideally through a provision in the text of the agreement. The agreement text should be flexible in a way so that new areas of cooperation can be added. Making the legal framework of transboundary water management regimes flexible in this way corresponds to the principles of adaptive management.

Transferring decision-making power to international organizations such as RBOs can be considered as a trend towards administrative law where legislative and judicial functions are transferred to intergovernmental organizations and river basin commissions are performing

administrative rule-making (Dellapenna and Gupta 2009). While this trend to administrative law might have some disadvantages, it somehow reflects the global nature of problems such as climate change and transboundary water management and states still keep the decision-making power as they are taking the decisions and controlling the work in the RBOs. Possible disadvantages of such trends could be addressed, as described above, through clarification of procedures (e.g. need for consensus), responsibilities between the national and transboundary level and limits, ideally in the legal text of agreements.

My research results are confirmed by Leb (2013) who argues that, as climate change may have larger impacts than foreseen, several treaties providing flexibility for typical hydrological variability may not be able to withstand future flow variability due to climate change. Instead, she argues that treaties providing for regular data exchange can better address flow variability without conflicts. To address climate change, such data exchange can be made more frequent. Most preferable according to Leb (2013) is coordination within the framework of joint bodies as described by the UNECE Water Convention. She stresses that joint bodies need a mandate to address flow variability or a mandate which can be widened without renegotiating the entire agreement which is also confirmed by my research.

My research results also correspond to those of Raadgever and Mostert (2005) who identified enabling factors for adaptive capacity in the areas of legal frameworks, actor networks, policy, financing and information management. However, on the contrary, my research results contradict those by Zentner (2012, see section 2.5.4) who finds that flexibility, scale and enforcement indicate less climate complaints.

As a summary, different water management systems or institutions have differing adaptive capacity determinants, but some common areas of enabling factors identified in several studies include information, laws, organizations for communication, means for action, including resources and learning capacity. In the special case of transboundary water management regimes, the link between the national and transboundary level, clarification of

governance and responsibilities between these levels also play a role (Zentner 2012, Mosello 2013). Institutions and organizations can change or adapt when new information is available and actors are willing to learn, as described in chapter 2.3. In transboundary regimes, such change is more difficult since all riparian countries need to have a common understanding of the changes and be able to learn.

## **5.5 *Limitations and further research needs***

My research was performed in four European river basins, complemented by additional insights from nine other basins worldwide. Williams (2002) underlines that generalizations in qualitative research are possible only as “moderatum generalizations”, i.e. where aspects of the studied case(s) can be considered as instances of a broader set of recognizable features. This requires a sample which reflects the relevant characteristics of the wider group. Thus, while my research design does not allow generalization to non-European basins and even not to basins in Europe in water scarce regions, the value of my research lies in having studied four cases in detail, which enabled me to find out how representatives of transboundary water management regime evaluate adaptive capacity and why and, based on this, to identify general enabling factors for adaptive capacity. These identified enabling factors could then in the future be tested in a larger study for other basins worldwide in order to be able to detect generalizable trends. More basins would need to be analysed, possibly with a quantitative methodology or a mixed one.

The difficulties of forecasting future climate change impacts affect also the adaptive capacity. Especially in relation to forecasts for precipitation and water flow, it is possible that climate change might have different impacts than expected on water resources in specific basins and that these changes do not resemble to current and past flow variability, which I used as indicator for future climate change impacts. Thus, it is possible that not those transboundary water management regimes which are most able to deal with current and past flow variability today, will be best prepared to these future climatic changes. It should thus be

recognized that my indicator for adaptive capacity "ability to deal with past flow variability without conflicts" is only a proxy. Depending on the definition of the term adaptive capacity, the ability to plan, design and actually implement adaptation measures should also be taken into account, as requested for example by the "adaptive capacity wheel" (Gupta et al. 2010). However, ability to plan, design and actually implement adaptation measures could not be included as an indicator in my study, since none of the analysed basins and, to my knowledge, nearly no transboundary basin worldwide has so far actually implemented any adaptation strategy and related measures.

Future research could also take into account vulnerability of the transboundary basin from the physical, social and economic point of view. For example, rivers in Western Europe such as the Meuse, Danube and Rhine are often considered vulnerable since they are greatly hydromorphologically altered due to human influence: in many river sections they do not flow in their original river bed, most of the floodplains have been destroyed and many ecosystems are damaged or destroyed, as a staff member of ICPR highlights:

*As you might know, almost 85 % of the natural floodplains of the Rhine disappeared because of different regulation of the water streams, we have still 15 % left, we have different retention basins built or planned, but still we know that we didn't reach our goal to renature the planes of the Rhine, they are still very artificial, also floodplains are not connected to the arms. Also in terms of food protection we could look at new places where the Rhine could overflow (Andre Schmid-Breton, pers. Comm.).*

Thus, from a physical and ecological perspective these basins are certainly more vulnerable to climate change than others in Eastern Europe, for example, such as the Neman, which are still closer to their natural state. My analysis has not taken into account these geophysical factors, but only institutional and sociological factors since it was focused on the transboundary water management regime as unit of analysis and not the basin overall. However, for a comprehensive analysis, biological, geological and geophysical factors should also be considered.

Future research should also consider better the perspective of other levels than the transboundary level, such as the local and national levels, as indicated in chapter 5.2.4, since they play an important role for adaptive capacity of the transboundary regime. My definition of “transboundary water management regime” considered mainly the national and intergovernmental level and took into account only to a very limited extent other administrative levels below the national level such as provinces, regions, local and other authorities, which might implement adaptation activities and cooperate at the transboundary level as well. Especially in federal countries, such as Germany, such lower levels play an important role, also in the management of transboundary rivers even if the formal transboundary agreements are usually concluded between national governments. For this reason, and also since a comparative study between four European river basins did not allow studying in a lot of detail each single basin, my dissertation was focused on the transboundary, but not lower territorial levels.

## **6 Conclusions**

### **6.1 *Summary and research contribution***

This dissertation attempted to identify enabling factors for adaptive capacity of transboundary water management regimes and to answer the question which institutional flexibility is useful for transboundary water management regimes to respond to climate variability and change. It led to the finding that flexibility or adaptive management in the organization responsible for transboundary water management, such as the river basin commission can overcome a possible lack of flexibility in the legal framework of the regime, at least in water-rich European basins (see 5.2.3).

This research contribution was made by analysing and comparing the ability to address flow variability and currently ongoing climate change adaptation activities in four European river basins, including brief consideration of such activities in nine other basins around the

world. Given my research question “How are certain institutional characteristics of transboundary water management regimes in Europe related to strengthening their capacity to address climate variability and change (using the examples of the Rhine, Danube, Neman and Meuse basins)? “ the results of this research contribute to better understanding enabling factors for adaptive capacity of transboundary water management regimes, especially in Europe. Since my research was limited to Europe, the relevance of these results for other basins worldwide would need to be tested with a larger sample of basins from other continents.

Adaptive capacity of a transboundary water management regime was defined as “ability to cope with past flow variability without conflicts between riparian countries” (see 3.1). In my case study basins, but also elsewhere in the world, flow variability does not always lead to conflict, but in many cases to cooperation, as it happened in the Neman basin where technical cooperation spilled over to more political cooperation. In fact, natural and man-made flow variability is one of the main motivations for developing legal and institutional arrangements for transboundary cooperation, e.g. in the Rhine and Meuse (see 5.2.1). But which factors influence this process?

In general terms, adaptive capacity of transboundary water management regimes requires a common understanding of the hydrological situation as well as rules for cooperation and a common vision and strategy by riparians on how to address it. According to my research, enabling factors include a combination of flexible legal frameworks for transboundary cooperation, flexible and well-working organizations such as river basin commissions with visionary and motivating leadership, financial and human resources for the organization and adaptation activities, trust and wide engagement by all stakeholders, including civil society actors, information and data exchange, clear definition of responsibilities between different levels and learning capacity. These factors are described in more detail in the following paragraphs.

Legal frameworks for transboundary cooperation such as treaties or agreements usually contain specific rules for actions to take in situations of flow variability and thus provide some certainty to the riparian countries. They should include and specify some of the other identified enabling factors (see section 5.2.1), such as information and data exchange, joint monitoring, joint early-warning systems, stakeholder involvement and public participation, clarification of responsibilities between the national and transboundary level, creation of a river basin commission with secretariat. Legal frameworks can also facilitate development of policies and plans such as transboundary flood risk management or drought management plans. Flexibility provisions such as percentage water allocations enable them to adapt to uncertain future climate changes. Many legal agreements do not contain all recommended provisions for addressing flow variability, for example flexible water allocations, but amending them to add such mechanisms can be a very lengthy process. At least in my four case study basins (which do not include water allocations), most important seems to be the existence, adequate design, flexibility and effectiveness of an organization, such as a river basin commission, responsible for the implementation of the treaty. Such channels for communication incl. and especially during flow variability provided by the RBO, can facilitate a common understanding, a common vision and/ or a common strategy for addressing climate change and flow variability at the basin level.

Several factors can positively influence the ability of such an institution or organization for transboundary cooperation, usually a river basin commission, to address flow variability. These factors may include a well-working secretariat and resources to prepare climate change assessments and strategies and implement measures, a mandate given by the Parties to address climate change and variability, trust by the Parties resulting in respect and legitimacy of the RBO as well as stakeholder participation (see section 5.2.2 and Schmeier 2013). Stakeholders play a crucial role in raising awareness of the population on climate change, but also in supporting the RBO in addressing flow variability, especially if the RBO's

resources are limited like in the Meuse, and in suggesting and testing innovative approaches to address flow variability such as ecosystem restoration. When these conditions are fulfilled, it is more likely that the river basin commission can be flexible so that it can address new challenges such as climate change.

Making legal agreements flexible can be very useful for preparing them to climate change, but also can have significant transaction costs, especially in negotiations of such agreements. As shown in chapters 4 and 5, those river basins in Europe with the most effective river basin commissions, namely the Rhine and Danube, have been able to cope with flow variability without conflicts, even if their legal frameworks do not include many flexibility provisions. Thus, there needs to be flexibility in the agreement's implementation, in the organizations and institutions and the actors which manage them. Ideally, the supreme bodies of the Commission such as the Council of Ministers have an explicit mandate defined in the agreement's legal text entrusting them to take decisions by consensus to interpret the text of the agreement and add new emerging areas of work, if needed, such as climate change adaptation and drought management. Such provisions facilitate institutional change, but also represent a shift towards administrative law and rule-making. Thus, procedures, conditions and limits of this trend need to be clearly defined (see section 5.4).

Gradual institutional change and adaptive capacity in more general terms requires information, data about flow and climate and a common scientific understanding or a scientific consensus about climate change impacts- especially due to the high uncertainty associated with climate change. Data exchange can bring the riparian countries to the same "level-playing field" in terms of knowledge about the flow and impacts and thus the same basis for adaptation. In particular, data exchange can help downstream countries to better prepare for situations of flow variability such as floods and droughts and thereby help to prevent loss of life. However, data exchange is often difficult to implement due to confidentiality of data, incompatible data collection systems or lack of political willingness.

Developing common basin-wide climate change models, scenarios and thus joint vulnerability or impact assessments as in the Neman or Rhine can enable a common understanding about climate change impacts, but may face difficulties if the riparian countries already have their own models. In such cases, the national model results can be compared and harmonized.

Assessment of climate change impacts needs to be followed by development and actual implementation of adaptation strategies and measures which can reduce vulnerability on the ground. At this stage, responsibilities need to be specified between the national and transboundary levels in order to avoid overlapping actions, make most efficient use of limited resources, but also to avoid a situation where no level feels responsible. The Danube provides a good example of clear definition of responsibilities. While the national level is usually responsible for all stages of the disaster risk management cycle, activities of the transboundary level, i.e. the river basin commission usually focus on prevention, preparedness and only to a limited extent on reaction to extreme events and acute flow variability, mainly early warning and data exchange.

Learning capacity is an essential component for adaptive capacity and adaptive management (Gupta et al. 2010). Specific extreme events such as floods, droughts or other “external shocks” can accelerate the learning process of the regime and should be used as a justification for taking measures for increasing adaptive capacity. Agenda-setting at the right political moment (i.e. when there is momentum such as 2009 when the 15<sup>th</sup> Conference of the Parties to the UNFCCC took place) can also help to increase adaptive capacity. Existing transboundary regimes, instead of revising their legal framework to make it more flexible, can increase their adaptive capacity for example by preparing climate change impact assessments, strategies or plans for climate change adaptation or specific aspects of it, such as flood or drought management. This can be achieved by ministerial mandates or creation of specific expert groups, while taking into account the limits of this trend to administrative rule-making

described above. However, it should be noted that such conclusions mainly apply to transboundary agreements without water allocations.

Many of the enabling factors for adaptive capacity are actually explanatory factors of effective transboundary cooperation regimes, i.e. regimes which prevent conflicts in general, not only in times of flow variability. Thus, successful and effective transboundary regimes are usually also more likely (to be) adaptable to climate change and variability- if certain conditions are fulfilled (see above).

However, also basins without transboundary agreements and regimes can increase their adaptive capacity, for example through projects, informal working groups on climate change or floods etc. Basins differ significantly in scope, size, economic level etc and therefore also in adaptive capacity. The enabling factors might therefore not all apply to the same extent to all basins. They can support and increase adaptive capacity, but none of them is by itself a condition for such capacity.

Finally, this research shows the linkages and interdependencies between adaptive capacity at the transboundary, national and local level. In effect, since immediate reaction to extreme events such as floods is usually in the responsibility of national or local authorities, adaptive capacity of transboundary regimes is always also related to and influenced by adaptive capacity of the national and local level institutions in the basin.

The enabling factors for adaptive capacity identified in this research can potentially help those basins, especially in Europe, where new transboundary water management regimes are currently being negotiated, but also basins with existing transboundary water management, regimes which consider how best to evaluate and increase their adaptive capacity and whether a revision of the agreement is necessary.

As indicated before, my results do not allow statistical generalization, among others since my sample was deliberately limited to four European basins. However, some research conclusions and possible policy recommendations can be made. These recommendations,

contained in the next section, should be considered as suggestions or motivation for further investigation, but not as prescriptions or guarantees for success.

## **6.2 *Policy recommendations***

**Climate change adaptation can be a driver for transboundary water cooperation in general: i.e. transboundary basins are not automatically more vulnerable to climate change, but such basins can even be the connecting factor for riparian countries in a changing climate. Therefore, countries should engage in transboundary cooperation in climate change adaptation.**

Contrary to a perception and fear that climate change will lead to more water scarcity and thus to water wars (see sections 1.1 and 2.2), in many cases, the need to adapt to climate change at the basin-wide level and the obvious benefits of transboundary cooperation can revive transboundary cooperation, such as in the Neman basin where the common work on climate change adaptation has revived general cooperation. However, for this, certain support or incentives are needed, such as international projects, mediation from outside or external pressure, e.g. by EU directives. Transboundary cooperation in adaptation can make adaptation more effective by enlarging the knowledge base, and by enlarging the space for implementing adaptation measures, which might enable a larger increase in adaptive capacity when located in another riparian country.

**Climate change adaptation in transboundary basins should start by building common models and scenarios in order to achieve a common understanding and if possible, a scientific consensus for the entire basin on climate trends as well as expected climate change impacts.**

Common understanding of climate change impacts achieved through information (exchange) about already ongoing and visible climate trends as well as possible future climate change impacts, but also about possible adaptation measures is a precondition for jointly increasing

adaptive capacity in a transboundary basin. In transboundary regimes, some agreement about ongoing flow variability, expected climate change impacts and future trends should be built between the riparian countries through common modeling, scenario-building, through creation of joint transboundary working groups or networks of experts. All riparian countries and their experts need to be involved in this process in order to ensure support by all the governments for the climate change predictions and to avoid contradictory adaptation measures being taken by riparian countries based on different forecasts. Data exchange is also crucial for a common understanding and joint response in times of climate change. Provisions for data exchange should be included in the transboundary agreement.

**Transboundary water management regimes should have flexible organizations for cooperation, such as river basin commissions with adequate structure and functional scope, resources, leadership, mandate to address climate change and wide stakeholder engagement.**

Organizations ensuring implementation and further development of the transboundary agreement need to be designed in a certain way to increase adaptive capacity of the regime. In particular, river basin commissions should be flexible and ready to address new circumstances, such as the increasing flow variability. Such flexibility can be fostered by giving a clear mandate to the commission in the legal framework to decide upon new areas of work and to take related decisions, for example, by setting up bodies under the Commission for dealing with flow variability such as expert groups on climate change. Adequate scope and structure of the RBO adapted to the problems, provisions for data management, environmental monitoring and dispute resolution also influence the effectiveness of the RBO (Schmeier 2013). Therefore, more efforts are needed for establishing and strengthening existing river basin commissions. In transboundary basins where no treaty currently exists, other more informal institutions or organizations can temporarily also increase adaptive

capacity, such as projects with transboundary working groups for example in the Neman basin.

**Not only appropriate regime design promotes adaptive capacity of transboundary water management regimes, but also other enabling factors such as stakeholder engagement, leadership, resources, data and studies on climate change impacts enabling a scientific consensus and learning capacity. They should therefore be promoted.**

Contrary to some results of other authors identified in the literature review, enabling factors for the adaptive capacity of transboundary water management regimes include not only the existence of appropriate legal frameworks and the importance of flexible regime design, such as incorporation of flexibility provisions, e.g. percentage flow allocations. Other enabling factors such as wide engagement of actors (stakeholders, NGOs, scientists, experts, etc.), motivating and visionary leadership and human and financial resources also play an important role for adaptive capacity. Therefore, stakeholder involvement in transboundary water cooperation needs to be strengthened, such as NGO networks, which can complement the RBO's activities and resources in addressing flow variability.

**Addressing new emerging issues such as increased flow variability does not always require a revision of the regulatory framework, but can be done through elaboration of policies or strategies, such as flood or drought management plans or adaptation strategies.**

Even transboundary water management regimes without flexibility provisions in the legal framework (such as the Rhine and Danube) can increase their adaptive capacity, because flow variability can be addressed by different means, such as through mandates to address flow variability given by the river basin commission or the ministerial conference, preparation of an assessment study, creation of working groups on the emerging topic, preparation of action plans for floods or droughts and adaptation strategies or adoption of additional protocols on

flood management as in the Sava basin. Thus, most important is the flexible implementation of the agreement which usually however requires political willingness by the riparian countries in the regime. Formally amending the transboundary agreement or treaty instead can be a long and complicated process. However, new transboundary agreements under negotiation should, where possible, include some flexible provisions, in particular flexible water allocation rules, as well as the creation of a river basin commission in order to be prepared for possible flow variability. They should also take into account lessons from those basins with a longer experience.

**Experience of extreme events should be taken as an opportunity to improve and learn and thereby increase adaptive capacity of the transboundary regime.**

Extreme weather events causing high flow variability, such as floods in the Rhine and Danube basins, can lead to an increase in adaptive capacity, but only if the regimes are able to react to it, to improve preparedness and reduce overall vulnerability through action plans and strategies, better information exchange as well as implementation of concrete adaptation and risk reduction measures. Therefore, extreme events and the response to them should be analysed with a view to identifying options for preventing such events and limiting their impact in the future as well as for improving preparedness. For this, a well- working river basin commission or other institutional structures for cooperation, a certain amount of resources, leadership and political willingness are necessary.

**Responsibilities for climate change adaptation should be clearly defined between different levels, namely the transboundary, national and local ones. Certain aspects of climate change adaptation, such as water allocations, might be agreed upon at bilateral level.**

Since adaptation is traditionally considered as a national task, first, the need for transboundary cooperation in climate change adaptation needs to be understood by national governments.

Secondly, responsibilities should be clarified between the levels. Implementation of measures usually happens at the national and local level. However, the transboundary level plays an important role in prevention, preparedness and to some extent in response to extreme events, mainly by coordinating actions, sharing information and enabling data exchange.

### **6.3 *Recommendations for the four case study basins***

In the **Neman basin**, it is recommended to finalize, sign and ratify the basin treaty and establish a river basin commission. Only if the agreement is being revised anyway, the possibility of making it more flexible to address water scarcity and flow variability in general could be considered. In addition, an improved and automatic exchange of data in the basin would be important through some kind of an online platform. In the medium term, i.e. in a few years, it is recommended to prepare a joint river basin management plan, also including measures for climate change adaptation and flow variability, or at least coordinated national plans. Additional adaptation measures could include reviewing whether the water infrastructure in the basin, namely the reservoirs and dams can be operated in a beneficial way for all riparian countries. Wastewater management in the basin should be improved and sources of diffuse pollution identified and eliminated as much as possible.

The **Rhine basin** is very advanced in climate change adaptation at the transboundary level. The already ongoing development of a transboundary adaptation strategy is very positive and should be followed by its subsequent implementation. At the same time, new trends, whether due to climate change or not, such as low flow and high water temperatures need to be addressed. In this regard, prioritization of water uses for situations of low flow could be agreed upon, a drought management plan could be elaborated and a drought monitoring system established. Other recommended adaptation measures include further restoration of ecosystems and floodplains and awareness-raising of the population in the basin. Ensuring coherence and synergies with national adaptation strategies as well as ensuring their coherence is also necessary to avoid duplication.

Similar recommendations are valid for the **Danube**, where a transboundary adaptation strategy already exists, which was adopted in December 2012 and should now be implemented. Its principles as well as some adaptation measures are to be mainstreamed into the revised Danube river basin management plan under discussion in 2013-2015 as well as the flood risk management plan. Since the Danube basin has so many riparian countries, special attention should be given to linkages with national adaptation strategies and plans, including a regular exchange of information about these in order to ensure that no measures are taken at the national level, which might increase vulnerability in another part of the basin. Other recommended adaptation measures include restoration of some additional floodplains in the basin, creation of additional retention areas for flooding, as well as consideration of measures for low flows.

Finally, the **Meuse basin** benefitted from the AMICE project and while a potential successor project is under discussion and not yet financed, the issue of climate change adaptation needs to be taken up in the longer term under the Meuse Commission itself and be integrated into its regular work programme, the river basin management and flood risk reduction plan. Flow variability is a serious problem in this basin, including low flow and water scarcity. In this regard, a transboundary drought management plan could be developed for the entire basin and the early warning system for droughts already existing in the French part of the basin could be extended to the entire basin (Besozzi, France, pers. Comm.). In addition, improved management of the existing water infrastructure in the basin should be considered, including optimizing the system from the transboundary perspective, e.g. operating a dam also for the benefit of the other riparian countries. Managing water infrastructure jointly could mean for example operating dams and water reservoirs on the German side in a way which would allow using the water also for drinking water supply in the Netherlands. Ecosystem-based adaptation measures, such as restoration of wetlands would also increase adaptive capacity and reduce vulnerability. The AMICE project has successfully

implemented some relatively low-cost low-regret adaptation measures, which could be scaled up and replicated elsewhere in the basin. Such measures could be integrated into a transboundary adaptation strategy which however would probably take several years to elaborate.

Finally, on a more general level, since climate change adaptation is still very new and challenging as well as characterized by high uncertainty and requires considering very long time horizons, many river basins around the world still struggle to address it, even the most advanced ones. Therefore, **exchange of experience between the basins on climate change adaptation is crucial, those included in my dissertation as well as others**. For example, the Rhine Commission is currently developing a tool to assess the effectiveness of different measures for flood risk reduction which could be potentially very useful for other basins (Schmid-Breton, pers. comm.). Several forums for such exchange of experience already exist such as the International Network of Basin Organizations (INBO), the global network of basins working on climate change adaptation managed by the UNECE and INBO as well as others. In addition, regular fora such as the World Water Week, the World Water Forums and many other conferences provide venues for exchanging methodologies, experiences, lessons learnt as well as good and bad practices. Twinning programmes could also be useful. The Rhine and Mekong basins, for example, started exchanging experience on issues of common concern, such as impact and vulnerability assessments in transboundary basins.

Finally, the need for increasing adaptive capacity of existing and new transboundary water management regimes can be seen as an opportunity for strengthening their institutional structure and improving the cooperative management of shared waters worldwide which may have positive impacts on sustainable development, peace and security and human well-being.

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## **Annex I. List of interviews conducted**

### **Rhine**

Adrian Schmid-Breton, International Commission for the Protection of the Rhine River, 14 June 2013

Hans Nilson, Federal Institute of Hydrology, Germany, 28 August 2013

Hendrik Buiteveld, RWS, the Netherlands, 29 August 2013

Koos Wieiks, Former Executive Secretary of the International Commission for the Protection of the Rhine, 28 November 2013

Hugo Aschwanden, Water Unit, Swiss Federal Office for the Environment, 6 and 16 May 2014

### **Danube**

Raimund Mair, ICPDR secretariat, 18 July 2013

Knut Beyer, German Federal Ministry for Environment, Nature Protection and Nuclear Safety, 8 August 2013

Monika Pratsch, Ludwig-Maximilians Universitaet of Munich, 27 August 2013

Elisabete Orpisan, Romania, 27 August 2013

Branislava Vasiljevic, Serbia, 3 October 2013

Camila Ionescu, Worldwide Fund for Nature, Romania, 8 May 2014.

### **Meuse**

Hendrik Buiteveld, RWS, the Netherlands, 29 August 2013

Maite Fournier, Former project leader AMICE project, 29 May 2013

Martine Lejeune, Former communication officer, AMICE project, 3 July 2013

William Schreurs, Executive Secretary of the International Commission for the Meuse Basin, 8 August 2013

Paul Dewil, Walloonian Environment Agency, 29 October 2013

Denis BESOZZI , Water Agency for Moselle Amont and Meuse, France, 16 May 2014.

### **Neman**

Audrius Sepikas, Lithuanian Environmental Protection Agency, 9 August 2013

Vladimir Korneev, Institute for Complex Use of Water Resources, Belarus, 24 July 2013

Paul Buijs, Neman project consultant, 26 October 2013

Egidijus Rimkus, Lithuanian expert, Vilnius University, 8 January 2014

Nickolai Denisov, Zoi Environment Network, 2 May 2014.

### **International experts**

Jos Timmerman, Alterra, 8 May 2014

Nickolai Denisov, Zoi Environment Network, 2 May 2014

## **II. Additional personal conversations (no formal interviews)**

Lamine Ndiaye, Organisation pour la Mise en Valeur du Fleuve Senegal, 13 February 2014

Mario Lopez-Perez, Mexican National Water Authority, 14 October 2013, Geneva

Max Linsen, Netherlands, February 2014

Eugene Stakhiv, US Army Corps of Engineers, 16 January 2014

## **III. Interview guide**

### **1. How would you characterize the transboundary relations in the basin?**

- a. What is your role in it?
- b. How did the transboundary cooperation and agreement evolve in the past?
- c. What has worked and what has not?
- d. What were difficulties and challenges?
- e. When there is a problem how do you deal with it?
- f. How about the transboundary agreement in all this?
- g. Which different actors are involved, what is their role? How is the cooperation between them working?
- h. And how about the river basin commission?
- i. Can you tell me about water allocation in the basin?

### **2. How would you characterize flow?**

- a. What do you do in case of an extreme event?
- b. Have there been any changes in flow and how did you handle these?
- c. How did you deal with any low or high flows in the past? Can you tell me about past examples and what was done then by different institutions and actors? How did people react and work together?
- d. What should have been done?
- e. Did the river basin commission play a role in all this? And the agreement? How would you characterize the role of the agreement in such problematic situations?
- f. How should it be improved?
- g. Do any changes in flow have to do with climate change?
- h. Are things better or worse now?
- i. How do you think flow will evolve in the future? What are you and other people in the basin doing about it? Otherwise how do you think you will deal with it?

### **3. How would you characterize the Commission (if any)?**

- a. Can you tell me about its staff, resources etc.? Is it enough?
- b. How would you characterize its leaders?

### **4. How would you characterize the information exchange?**

- a. How is information being produced, used and managed?
- b. How is the information exchange working?

### **5. Adaptation activities**

- a. Are any adaptation activities ongoing at the transboundary level in terms of vulnerability or impact assessment, adaptation strategy development?
- b. Have any transboundary adaptation measures been discussed, planned or implemented?

## **IV. Participatory observation- Events observed**

**Rhine:** Multistakeholder workshop on climate change adaptation in the framework of the Rhine basin on 30-31 January 2013 in Bonn, Germany,

**Meuse:** Final multistakeholder workshop in the framework of the AMICE project on 13-15 March 2013 in Sedan, France,

**Neman:** 1) Multistakeholder workshop in the framework of the Neman project on 19-20 March 2013 in Minsk, Belarus; 2) second multistakeholder workshop of the Neman project on 16 May 2013 in Vilnius, Lithuania; 3) third workshop on 21 January 2014 in Kaliningrad, Russian Federation; 4) Final project conference of the Neman project, 19-20 June 2014, Vilnius

**Danube:** Multistakeholder workshop on climate change adaptation in the Danube basin on 30-31 March 2012 in Munich, Germany

### **Other events:**

First meeting of the global network of basins working on climate change adaptation in transboundary basins, 20-21 February 2013, Geneva, Switzerland

Multistakeholder workshop in the Sava basin on 4-5 June 2013 in Zagreb, Croatia

Global workshop on water and adaptation to climate change in transboundary basins, on 25-26 June 2013 in Geneva, Switzerland

Multistakeholder workshop on the Dniester basin on 9-10 July 2013 in Chisinau, Republic of Moldova

Multi-stakeholder workshop and meeting of the working group and climate change adaptation, 12-13 December 2013, Kiev, Ukraine

Multi-stakeholder workshop in the Neman project, 21-22 January 2014, Kaliningrad, Russian Federation

## **V. Workshops organized related to the topic (all in Geneva)**

Third meeting of the Task Force on Water and Climate (12 May 2010) and workshop on water and climate change: how to develop an adaptation strategy in transboundary basins (10 - 11 May 2010)

First meeting of the Core Group on pilot projects on climate change adaptation (15 - 16 February 2011)

Fourth meeting of the Task Force on Water and Climate (14 April 2011) and second Workshop on adaptation to climate change in transboundary basins: challenges, progress and lessons learnt (12 - 13 April 2011)

Fifth meeting of the Task Force on Water and Climate (27 April 2012) and Third Workshop on water and climate change adaptation in transboundary basins (25 - 26 April

2012)

Sixth meeting of the Task Force on Water and Climate (27 June 2013) and Fourth Workshop on Adaptation to Climate Change in Transboundary Basins (25 - 26 June 2013)

Meeting of the core group of pilot projects and global network of basins working on adaptation to climate change (20 - 21 February 2013), Geneva, Switzerland

Second meeting of the global network of basins working on climate change adaptation, 13-14 February 2014, Geneva

Seventh meeting of the Task Force on Water and Climate and fifth workshop on water and adaptation to climate change in transboundary basins, 13-15 October 2014, Geneva.