Twin2Go

Coordinating twinning partnerships towards more adaptive governance in river basins

D. 2.3: Synthesis Report

Context-Sensitive Comparative Analysis of Associations between Water Governance Properties and Performance in Water Management

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1 Introduction

Water is a pivotal resource for ecosystems and for human societies. If water is temporarily or permanently not available in appropriate quantity or quality at a certain place, this will bring about severe consequences for affected human beings and nature, as can be seen in the case of devastating floods, droughts and water pollution incidents. Water-related disasters are wide-spread around the World. Global as well as climate change are expected to exacerbate existing water issues even further. The failure of water governance[1] has been identified as being one of the most important reasons for water-related problems (Pahl-Wostl, 2009). In other words, threats are often not posed by water resources per se, but by societal steering systems that are incapable to deal with (variation in) the natural water supply in an inappropriate way. One example of governance failures is corruption, which prevents water legislation from being effectively implemented on the ground. Another example is the lack of coordination between different sectors (e.g. agriculture, hydropower generation, nature protection), whereby activities within one sector can compromise the goals of other sectors.

The European Union has recognized the importance of water governance. For this reason, it has funded several research projects that have been addressing water governance in river basins in Europe and beyond. A central objective of Twin2Go is to compare, synthesize and consolidate the outcomes of EU projects that undertook research related to water governance in case studies around the world. A special focus of the Twin2Go investigation is on adaptive governance structures that allow an effective response to climate change.

In order to facilitate comparative analyses of case study results from other EU projects, Twin2Go developed a context-sensitive methodological framework. It allows analyzing properties of water governance regimes, the socio-economic and natural contexts, in which the regimes are embedded, as well as their performance (see deliverable 1.3). Data collection took place within the scope of a series of Case Study Review Workshops around the world (see deliverable 2.1). The workshops involved researchers of the projects as well as experts from the respective river basins. After the collection of data from 29 case studies, Twin2Go hosted a Synthesis Workshop to discuss analysis approaches with invited water experts and representatives of organizations that aim to bridge

[1] UNESCO and WWAP (2006, p. 47) state: *"The governance of water in particular can be said to be made up of the range of political, social, economic and administrative systems that are in place, which directly or indirectly affect the use, development and management of water resources and the delivery of water services at different levels of society"*. Water governance sets the rules under which the management of water operates. It refers to the kind of interplay how actors interact across different levels (from local to international) and how this inter-play is steered by various rule-sets, be it formal (e.g. water legislation) or informal (e.g. social norms).

science and water management practice (see deliverable 2.2). As a result, Twin2Go included further aspects in its analysis.

The Twin2Go project investigated, which governance properties are associated with high performance given different contexts. The document at hand documents the applied analysis approaches as well as the results of the comparative survey. Chapter 2 shows how the collected data were post-processed prior to data analysis. Chapter 3 reports the hypotheses that guided the comparative survey. The following three chapters document the analysis approaches applied, as well as their results: Chapter 4 deals with qualitative data analysis, chapter 5 with statistical investigation and chapter 6 with a cross-tab approach. The results of the analyses are summarized in chapter 7. Chapter 8 serves to draw conclusions with regard to the methodological approach.

Through its comparative analyses, Twin2Go adds empirical evidence to the current debate about how to make water management more adaptive. The main findings of the analysis on adaptive water governance in the light of climate change will be summarized in Policy Briefings (deliverable 4.3.3) for water policy-makers, in order to promote the implementation of adaptive water governance. All deliverables mentioned can be downloaded on the Twin2Go website (http://www.twin2go.uos.de/) after their release.

References

Pahl-Wostl, C. 2009. A conceptual framework for analyzing adaptive capacity and multi-level learning processes in resource governance regimes. Global Environmental Change 19 (3), 354-365. doi: 10.1016/j.gloenvcha.2009.06.001

United Nations Educational, Scientific and Cultural Organization (UNESCO) and United Nations World Water Assessment Programme (WWAP) 2006. Water: A shared responsibility. The United Nations World Water Development Report 2. UNESCO Publishing. [online] URL: http://unesdoc.unesco.org/images/0014/001454/145405E.pdf

2 Data Post-Processing

2.1 Need for post processing

Questionnaires were filled with the participation of more than a hundred experts at Case Study Review Workshops (Fig. 1) or by individual exerts and Twin2Go staff (see deliverable 2.1). This resulted in a variety of interpretations of the questionnaire's scoring scheme (see examples Fig. 2): In some cases the scoring scheme was not followed exactly, alternative options were added, multiple scores were given for the same indicator, indicators were not scored at all or only a comment was added. For a few indicators no scoring scheme had been given in the guidance document, which resulted in a large number of different values.

All scores were copied from the questionnaires to an excel workbook. The result is a matrix with 29 columns for the river basin-country pairs and – initially – eighty-six rows containing the indicator values. To allow synthesizing the results using any of the three approaches proposed by Twin2Go partners, some form of data processing was needed to deliver one final dataset to be used for further work under Twin2Go (Fig. 3).

Adjusted scoring schemes, methods to fill missing data, new data or updated sources and other actions taken for specific indicators are explained in chapter 2.3 of this document.

Comments (Fig. 4) made by experts together with the basin scores at this stage have not been coded and included in the database to be used in the synthesis. However these comments have been useful in the processing.

The final dataset is the result of an iterative process of analyzing filled questionnaires, updating of scores and adding new clarifications by experts and Twin2Go staff. The final data set also contains a number of new indicators, which were felt to be missing after having analyzed the preliminary synthesis results (August 2010) and after discussing the need for additional indicators at the Twin2Go Synthesis Workshop on September 1-2 2010 (see deliverable 2.2). These additional indicators, which primarily address environmental performance, have been scored by case study experts from September to October 2010.

The case studies questionnaires, including the addendum, have been uploaded to the Twin2Go website (http://www.twin2go.uos.de/downloads/35-basin-questionnaires). Note that the original

scores in the questionnaires have not been changed (in most cases), consequently you may find a discrepancy between the questionnaires and the final dataset table.

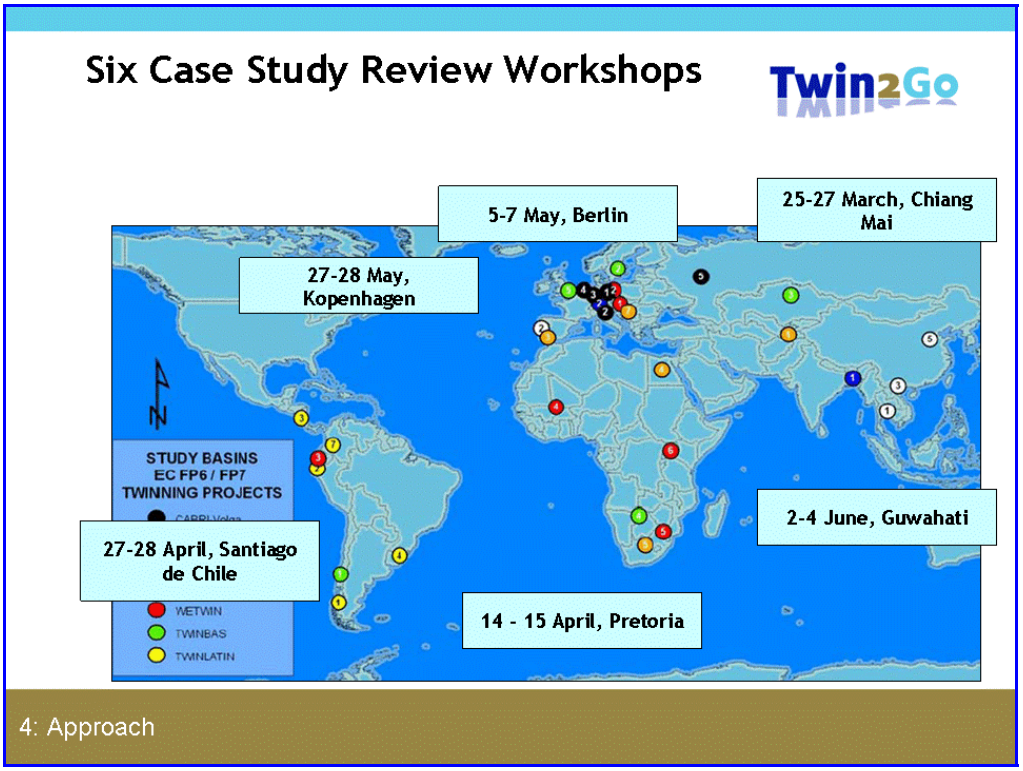


Fig. 1: Overview of the Twin2Go Case Study Review Workshops.

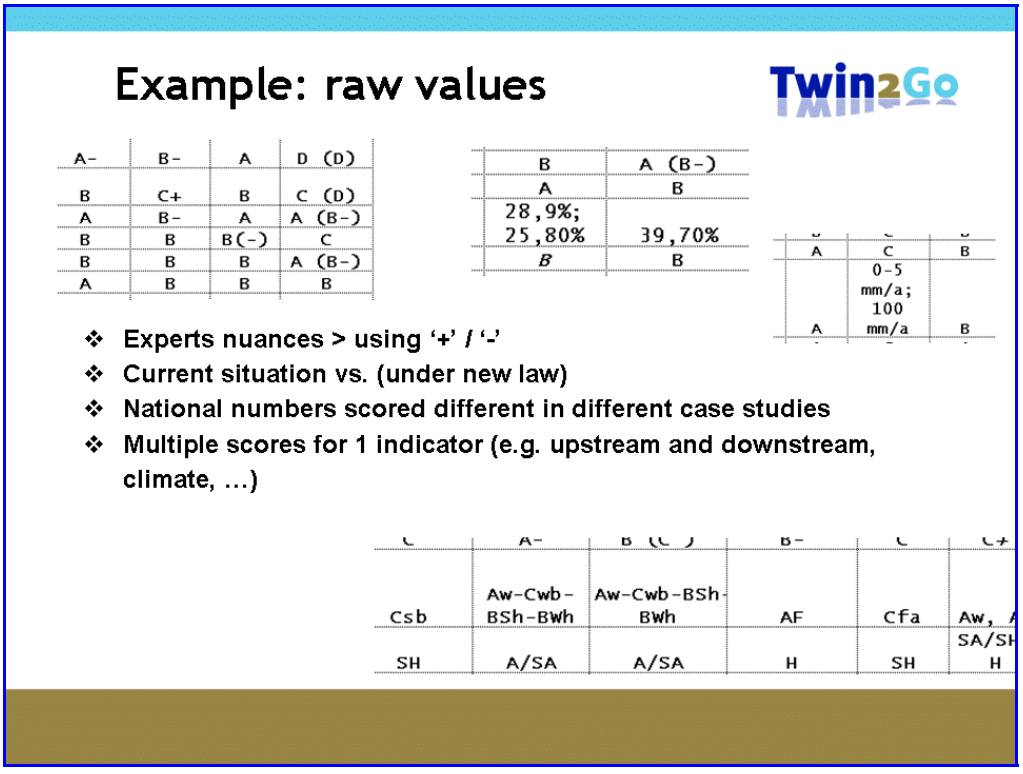


Fig. 2: Examples of raw values taken from questionnaires returned by experts.

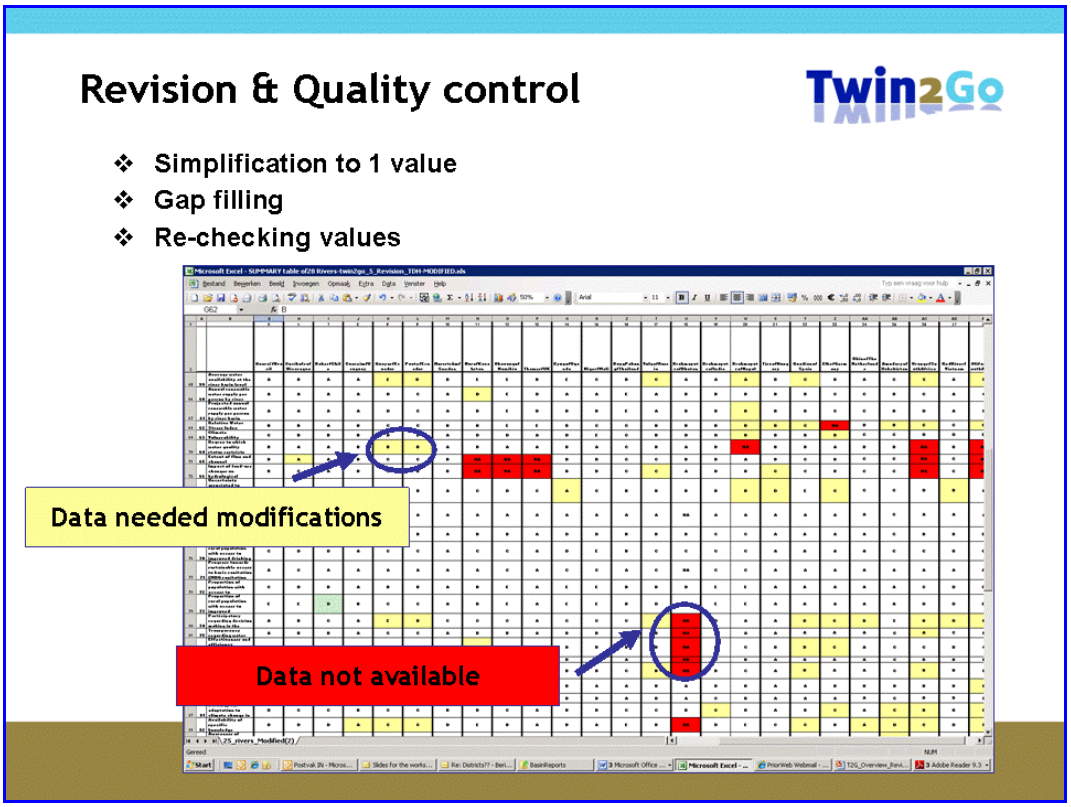


Fig. 3: Unprocessed data set for 29 river basins – country pairs.

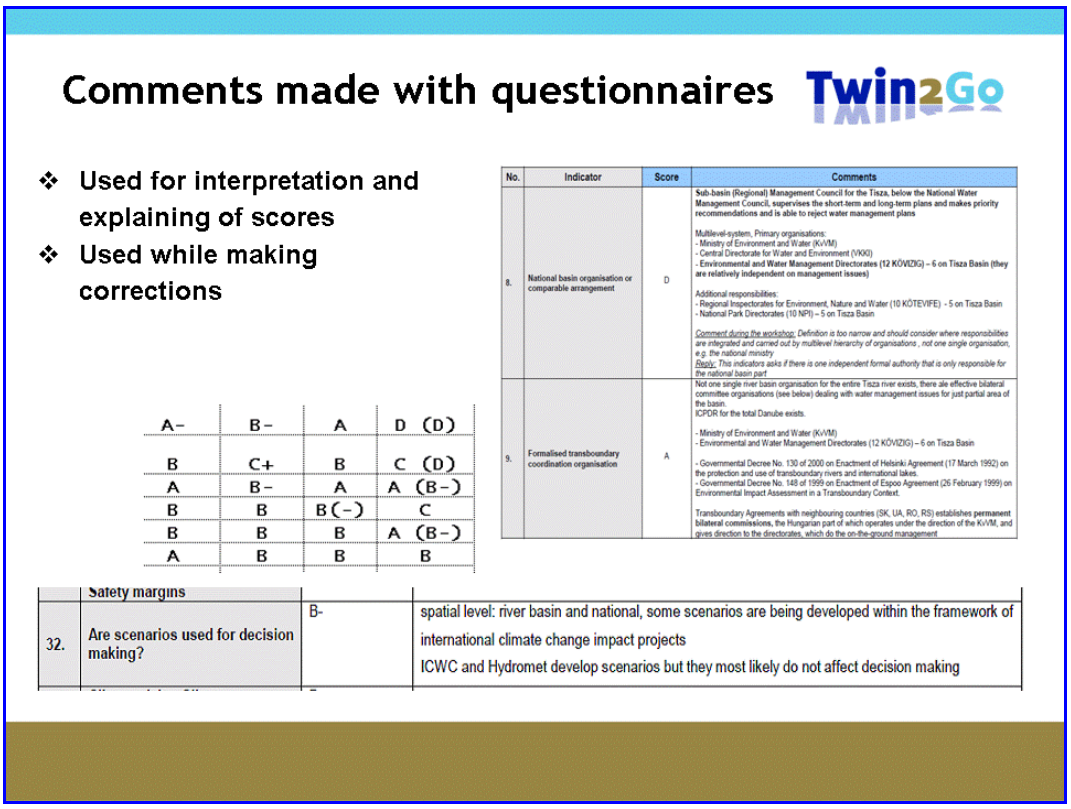


Fig. 4: Interpretation of scores and comments.

2.2 Overview of the case studies and Case Study Review Workshops.

Table 1: Case studies and Case Study Review Workshops

	Basin/Country	Workshop
1	Amudarya/Uzbekistan	Berlin, 05-07.05.2010
2	Baker/Chile	Santiago de Chile, 27-28.04.2010
3	BangPakong/Thailand	Chiang Mai, 25-27.03.2010
4	Biobio/Chile	Santiago de Chile, 27-28.04.2010
5	Brahmaputra/Bhutan	Guwahati, India, 03-04.06.2010
6	Brahmaputra/India	Guwahati, India, 03-04.06.2010
7	Brahmaputra/Nepal	Guwahati, India, 03-04.06.2010
8	Catamayo/Ecuador	Santiago de Chile, 27-28.04.2010
9	Catamayo/Peru	Santiago de Chile, 27-28.04.2010
10	Cauca/Colombia	Santiago de Chile, 27-28.04.2010
11	Cocibolca/Nicaragua	Santiago de Chile, 27-28.04.2010
12	Cuareim/Uruguay	Santiago de Chile, 27-28.04.2010
13	Elbe/Germany	Berlin, 05-07.05.2010
14	Guadiana/Spain	Berlin, 05-07.05.2010
15	Guayas/Ecuador	Santiago de Chile, 27-28.04.2010
16	Kyoga/Uganda	Loskopdam, South Africa, 14-15.04.2010
17	Niger/Mali	Loskopdam, South Africa, 14-15.04.2010
18	Norrström/Sweden	--
19	Nura/Kazakhstan	--
20	Okavango/Namibia	Loskopdam, South Africa, 14-15.04.2010
21	Olifants/South Africa	Loskopdam, South Africa, 14-15.04.2010
22	Orange/South Africa	Loskopdam, South Africa, 14-15.04.2010
23	Paute/Ecuador	Santiago de Chile, 27-28.04.2010
24	Quaraí/Brazil	Santiago de Chile, 27-28.04.2010
25	Red River/Vietnam	Chiang Mai, 25-27.03.2010
26	Rhine/The Netherlands	Berlin, 05-07.05.2010
27	Thames/UK	--
28	Tisza/Hungary	Berlin, 05-07.05.2010
29	Volga/Russia	Chiang Mai, 25-27.03.2010

2.3 Data processing - comments

Formalized transboundary coordination organization (Ind. 9)

Many basins have been scored 'NA', this is presumably because the basins are entirely national and not transboundary. A new score has been added;

(A) Transboundary coordination organisation and regular cooperation among countries existing
(B) Transboundary coordination organisation existing without sufficient support
(C) Transboundary coordination organisation currently in the planning stage
(D) No transboundary coordination organisation existing
(E) Basin is not transboundary (NEW SCORE ADDED)

Proportion of the population living in rural areas (Ind. 43)

Table 2: Indicator 43 - Proportion of the population living in rural areas

No.	Indicator	Definition	Hypothesis/ statement on relationship	Scoring scheme	How to assign scores (i.e. on which basis are scores allocated)	Comment on data source
43.	**Proportion of the population living in rural areas**	Percentage of "[d]e facto population living in areas classified as rural" (United Nations Population Division, 2008).	Rural countries tend to have a lower performance of the water governance regime. This indicator serves to judge the Millennium Development Goals with regard to rural population (see performance section).	Percentage number Without categories	Proportion of the population living in rural areas in the national part of the basin. If no data are available for the basin and expert estimations are impossible, please refer to the entire national level.	National level: United Nations Population Division (2008): World Urbanization Prospects: The 2007 Revision Population Database, http://esa.un.org/unup/ => Choose value for 2005

The numeric scores have been transformed in categories using the following scheme:

(A) ≤ 100%
(B) ≤ 80%
(C) ≤ 60%
(D) ≤ 40%
(E) ≤ 20%

Values are also available for 2008 but show only very minor changes in %-values, which does not result in a changed score for any of the countries considered. (Source consulted: http://www.wssinfo.org/data-estimates/table/)

Human Development Index (Ind. 44), Gini index (Ind. 45) and GDP per capita (Ind. 46)

The indicators Human Development Index (Ind. 44), Gini index (Ind. 45) and GDP per capita (Ind. 46) have been checked against most recently published data. Occasionally, experts have reported deviating scores compared to the values available in global data sources. This is explained by regional differences within the country, i.e. Brazil, Peru, Russia and Vietnam. In the final data set only scores reflecting national values have been included.

The GDP per capita data for 2005 was used in most cases. The Human Development Report 2009 gives GDP data for 2007, whereas http://data.worldbank.org published data up to 2008. The changes in GDP per capita (PPP, $) between 2005 and 2008 do not move any of the studied countries in a new category.

The final data set only shows scores for the indicators 44-46 based on national values as published in the *Human Development Report 2009* (http://hdr.undp.org/en/media/HDR_2009_EN_Complete.pdf). The 2010 edition of this report has changed the HDI calculation method. This reduces comparability between older and later HDI values.

Trustworthiness (Ind.48)

The source, which had been proposed in the guidance document (Guardian article, 2009: http://www.guardian.co.uk/business/2009/may/22/recession-government-borrowing#zoomed-picture) did not contain data for all countries. The map published with the article show data provided by the

financial services company Standard & Poor's (S&P). S&P published a list of ratings per country on its site, this list however is not made for all developing countries.

The World Bank published a paper in 2007, where an attempt was made to predict sovereign ratings for developing countries that do not have risk ratings from agencies such as Fitch, Moody's, and Standard and Poor's. Values for the missing countries are listed in Table 3. The paper is available at: http://econ.worldbank.org/external/default/main?pagePK=64165259&theSitePK=469372&piPK=64165421&menuPK=64166093&entityID=000016406_20070621154413

Table 3: Predicted ratings for unrated developing countries (World bank, 2007)

Country	Predicted rating	Score (Twin2Go questionnaire)
Bhutan	BBB- to BBB+	C
Mali	B to B	C
Namibia	BB+ to BBB	C
Nepal	CCC+ to B	C
Uzbekistan	B to BB-	C

Köppen-Geiger climate classification (Ind. 55) and Climate Moisture Index (Ind. 56)

Table 4: Indicator 55 - Köppen-Geiger climate classification

No.	Indicator	Definition	Scoring scheme	How to assign scores (i.e. on which basis are scores allocated)	Comment on data source
55.	**Köppen-Geiger climate classification (river basin)**	The Köppen climate classification (1884) is one of the most widely used climate classification systems. Geiger collaborated with Köppen on changes to the system, resulting in the Köppen–Geiger climate classification system.	Köppen-Geiger code	Current climate type (1951-2000) Each particular climate type in this system is represented by a 2 to 4 letter symbol. Log the corresponding official multiple-letter Köppen-Geiger climate classification code for the river basin. If the basin covers more than 1 climate zone, then log all.	Kottek, M., J. Grieser, C. Beck, B. Rudolf, and F. Rubel (2006): http://koeppen-geiger.vu-wien.ac.at/present.htm#maps

The source resulted in a mix of scores, which were difficult to compare in the analysis. Therefore, the indicator was transformed in two new indicators derived from the Köppen-classification (Fig. 5).

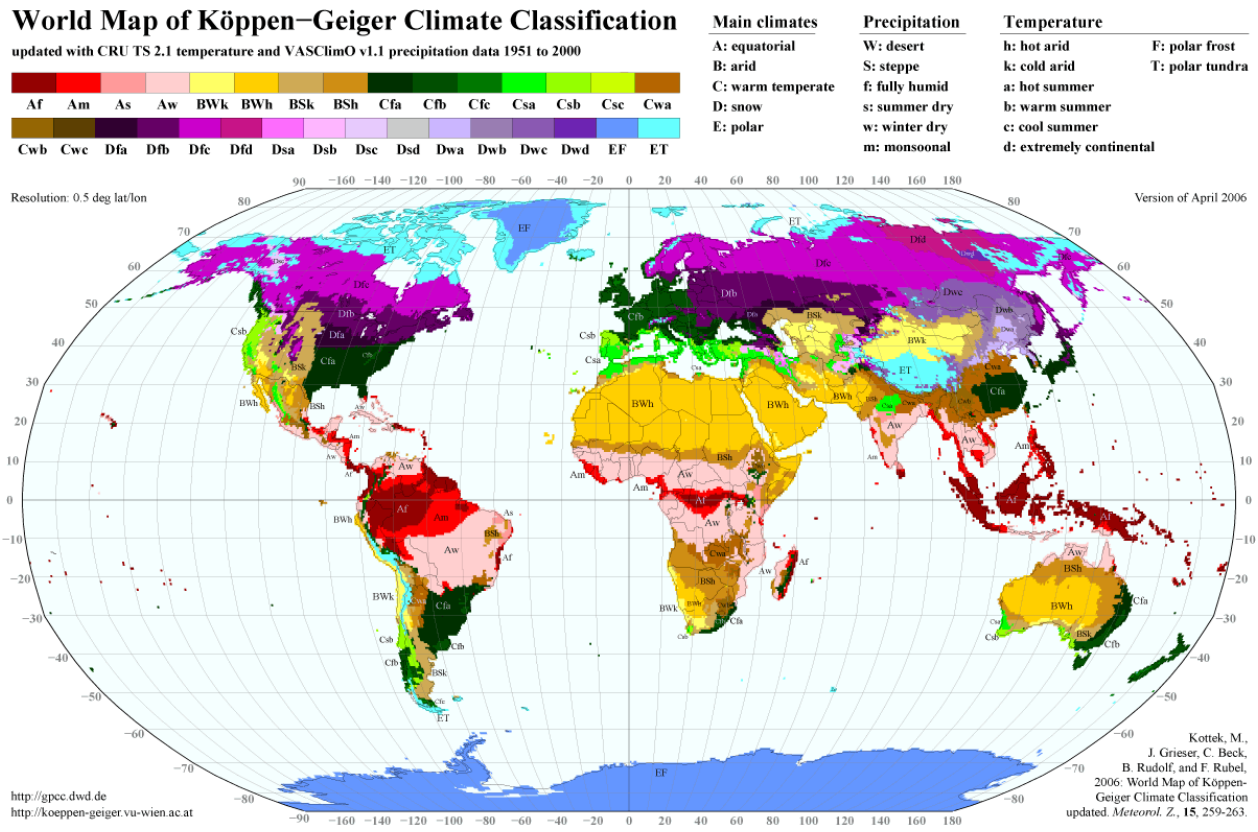


Fig. 5: World Map of Köppen-Geiger Climate Classification (Source: http://koeppen-geiger.vu-wien.ac.at/pics/kottek_et_al_2006.gif)

The new indicators are scored as:

Table 5: New scoring scheme of indicator 55

Nr.	Indicator	New Scoring
55a	**Köppen- Main Climate**	1st letter - main climate: A – E M for Multiple
55b	**Köppen- Main precipitation**	2nd letter – Precipitation (A) desert / steppe (W / S (B) fully humid (f) (C) s, w, m (D) multiple

Similar to the climate classification, also the climate moisture index (Ind. 56) has been transformed using a scoring scheme:

Table 6: New scoring scheme of indicator 56

Nr.	Indicator	New Scoring
56	**Climate Moisture Index**	(A) Arid, arid / semi-arid, semi-arid (B) Sub-humid / semi-arid, sub-humid (C) Sub-humid / humid, humid

Transboundary basins and basin sizes (Ind. 67)

An overview of all cases ranked on case study area or sub-basin size is given in Table 7. The roughly two thirds of the case studies - 20 out of 29 - are part of a transboundary basin (Table 8). The basins vary in size from less then 10,000 km² to over 1,000,000 km² with larger number of cases (12 out of 29) situated in the category between 10,000 to 50,000km (Table 9).

Table 7: Overview of basin sizes; total size, size of case study area (sub-basin), transboundary basins.

Sub-Basin Size (km²) (Ind. 67a)	Total basin (km²)	% of total basin consid-ered	Trans-boundary (Ind. 67b)	Case study	Case number
1.358.000,00	-	-	no	Volga/Russia	18
578.850,00	1.994.402,00	29,00%	yes	Niger/Mali	16
528.857,00	896.368,00	59%	yes	Orange/South Africa	27
200.000,00	534.764,00	37,40%	yes	Amudarya/Uzbekistan	26
153.783,00	413.550,00	37%	yes	Okavango/Namibia	13
147.181,00	500.000,00	0,29	yes	Brahmaputra/Nepal	21
96.932,00	148.268,00	65,83%	yes	Elbe/Germany	24
92.500,00	169.000,00	54%	yes	Red River/Vietnam	28
78.550,00	500.000,00	0,16	yes	Brahmaputra/India	20
59.680,00	62.361,00	95,70%	yes	Kyoga/Uganda	15
57.600,00	-	-	no	Nura/Kazakhstan	12
54.570,00	73.534,00	74%	yes	Olifants/South Africa	29
46.213,00	157.186,00	29,40%	yes	Tisza/Hungary	22
38.816,00	500.000,00	0,08	yes	Brahmaputra/Bhutan	19
34.000,00	-	-	no	Guayas/Ecuador	9
28.273,00	185.000,00	15,28%	yes	Rhine/The Netherlands	25
24.300,00	-	-	no	Biobio/Chile	1
23.000,00	-	-	no	Norrström/Sweden	11
20.850,00	26.726,00	78%	yes	Baker/Chile	7
19.317,00	23.844,00	81%	yes	Cocibolca/Nicaragua	6
18.670,00	-	-	no	BangPakong/Thailand	17
18.133,66	-	-	no	Cauca/Colombia	4
16.000,00	67.133,00	23,80%	yes	Guadiana/Spain	23
13.000,00	-	-	no	Thames/UK	14
9.986,81	17.199,18	58%	yes	Catamayo/Peru	2
8.258,00	14.800,00	55%	yes	Cuareim/Uruguay	8
7.212,37	17.199,18	42%	yes	Catamayo/Ecuador	3
6.660,00	14.800,00	45%	yes	Quaraí/Brazil	5
5.186,00	-	-	no	Paute/Ecuador	10

Table 8: Number of transboundary and not-transboundary rivers

Transboundary	Number of cases
no	9
yes	20

Table 9: Case studies categorized based on basin size

Size of basin	Number of sub-basins analyzed
< 10.000 km²	5
10,000 - 50,000	12
50,000 - 100,000	6
100,000 - 500,000	3
500,000 - 1,000,000	2
> 1,000,000	1

Progress on MDGs (Ind.68 – 73)

Scores related to the Millennium Development Goals (MDGs) – indicators 69, 70, 72, 73 – have been updated based on the 'Progress on sanitation and drinking water 2010 updated' by the WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation. This data has also been updated on http://mdgs.un.org/unsd/mdg/Data.aspx.

The source, which had originally been used for these indicators, contained information until 2006 for some countries and until 2008 for others. In certain cases, local experts participating in the basin reviews have contested the data available in international databases, either because they had more recent local data or because the national values do not reflect the basin value. Values at basin scale are hardly existing, although sub-national figures may exist on district or province level or comparable administrative levels.

In order to improve comparability only the 2008 data from the JMP-report (2010) has been kept in the dataset. Since actual %-scores are transformed to distinct categories, changes in the database are minimal (Table 15). Values and scores are included in Table 11, Table 12, Table 13 and Table 14.

Table 10: Indicators 69, 70, 72 and 73 – Water-related Millennium Development Goals

No.	Indicator	Scoring scheme	How to assign scores (i.e. on which basis are scores allocated)	Comment on data source	New Source
69.	**Proportion of population with access to improved drinking water**	Percentage number and categories - A - B - C - D - E	Proportion of total population using an improved drinking water source, 2008 (A) 100% (B) 91 – 99% (C) 76 – 90% (D) 50 – 75 % (E) < 50%	UN statistics of MDG progress: http://mdgs.un.org/unsd/mdg/Data.aspx see goal 7 => target 7c => 1st item (total) => 3rd item (rural)	*JMP Report (2010). Progress on drinking water and sanitation. Joint Monitoring Program by WHO and UNICEF. Statistical Table pp. 39-51.* www.unwater.org/downloads/JMP_report_2010.pdf *- Use of sanitation facilities: Rural-improved. (Ind. 73)*
70.	**Proportion of rural population with access to improved drinking water**	Percentage number and categories - A - B - C - D - E	Proportion of rural population using an improved drinking water source, 2008 (A) 100% (B) 91 – 99% (C) 76 – 90% (D) 50 – 75 % (E) < 50%		

No.	Indicator	Scoring scheme	How to assign scores (i.e. on which basis are scores allocated)	Comment on data source	New Source
72.	**Proportion of population with access to improved sanitation facilities**	Percentage number and categories - A - B - C - D - E	Proportion of total population using an improved sanitation facility, 2008 (A) 100% (B) 91 – 99% (C) 76 – 90% (D) 50 – 75 % (E) < 50%	UN statistics of MDG progress: http://mdgs.un.org/unsd/mdg/Data.aspx see goal 7 => target 7c => 4th item (total) => 6rthitem (rural)	*- Use of sanitation facilities: Total-improved. (Ind. 72)* *- Use of drinking water sources: Rural-improved.(Ind. 70)* *- Use of Use of drinking water sources: Total-improved.(Ind. 69)*
73.	**Proportion of rural population with access to improved sanitation facilities**	Percentage number and categories - A - B - C - D - E	Proportion of rural population using an improved sanitation facility, 2008 (A) 100% (B) 91 – 99% (C) 76 – 90% (D) 50 – 75 % (E) < 50%		

Table 11: Proportion of the population using improved drinking water sources, total (Source: http://mdgs.un.org/unsd/mdg/Data.aspx; 29/09/2010).

Proportion of the population using improved drinking water sources, total						2008
Country	**1990**	**1995**	**2000**	**2005**	**2008**	**Ind. 69**
Bhutan			91	91	92	**B**
Brazil	88	91	93	95	97	**B**
Chile	90	92	94	96	96	**B**
Colombia	88	90	91	92	92	**B**
Ecuador	72	79	86	92	94	**B**
Germany	100	100	100	100	100	**A**
Hungary	96	97	99	100	100	**A**
India	72	76	81	85	88	**C**
Kazakhstan	96	96	96	96	95	**B**
Mali	29	36	44	51	56	**D**
Namibia	64	73	81	88	92	**B**
Nepal	76	80	83	86	88	**C**
Netherlands	100	100	100	100	100	**A**
Nicaragua	74	77	80	83	85	**C**
Peru	75	77	79	81	82	**C**
Russian Federation	93	94	95	96	96	**B**
South Africa	83	84	86	89	91	**B**
Spain	100	100	100	100	100	**A**
Sweden	100	100	100	100	100	**A**
Thailand	91	94	96	98	98	**B**
Uganda	43	50	57	64	67	**D**
United Kingdom	100	100	100	100	100	**A**
Uruguay	96	96	98	100	100	**A**
Uzbekistan	90	90	89	88	87	**C**
Viet Nam	58	68	79	88	94	**B**

Table 12: Proportion of the population using improved drinking water sources, rural (Source: http://mdgs.un.org/unsd/mdg/Data.aspx; 29/09/2010).

Proportion of the population using improved drinking water sources, rural						2008
Country	1990	1995	2000	2005	2008	Ind. 70
Bhutan			88	88	88	C
Brazil	65	70	75	81	84	C
Chile	48	57	66	75	75	D
Colombia	68	70	71	73	73	D
Ecuador	62	70	78	86	88	C
Germany	100	100	100	100	100	A
Hungary	91	94	98	100	100	A
India	66	71	76	81	84	C
Kazakhstan	92	92	91	91	90	C
Mali	22	28	34	40	44	E
Namibia	51	62	72	82	88	C
Nepal	74	78	81	85	87	C
Netherlands	100	100	100	100	100	A
Nicaragua	54	58	62	66	68	D
Peru	45	50	54	58	61	D
Russian Federation	81	83	86	89	89	C
South Africa	66	67	71	75	78	C
Spain	100	100	100	100	100	A
Sweden	100	100	100	100	100	A
Thailand	89	92	95	97	98	B
Uganda	39	46	53	60	64	D
United Kingdom	100	100	100	100	100	A
Uruguay	79	81	88	95	100	A
Uzbekistan	85	85	83	82	81	C
Viet Nam	51	62	74	85	92	B

Table 13: Proportion of the population using improved sanitation facilities, total (Source: http://mdgs.un.org/unsd/mdg/Data.aspx; 29/09/2010).

Proportion of the population using improved sanitation facilities, total						2008
Country	1990	1995	2000	2005	2008	Ind. 72
Bhutan			62	64	65	D
Brazil	69	72	75	78	80	C
Chile	84	88	92	96	96	B
Colombia	68	70	72	74	74	D
Ecuador	69	76	83	90	92	B
Germany	100	100	100	100	100	A
Hungary	100	100	100	100	100	A
India	18	21	25	28	31	E
Kazakhstan	96	96	97	97	97	B
Mali	26	29	32	35	36	E
Namibia	25	27	29	31	33	E
Nepal	11	16	23	28	31	E
Netherlands	100	100	100	100	100	A
Nicaragua	43	46	48	50	52	D

Peru	54	59	62	66	68	**D**
Russian Federation	87	87	87	87	87	**C**
South Africa	69	71	73	75	77	**C**
Spain	100	100	100	100	100	**A**
Sweden	100	100	100	100	100	**A**
Thailand	80	86	93	96	96	**B**
Uganda	39	42	44	47	48	**E**
United Kingdom	100	100	100	100	100	**A**
Uruguay	94	94	96	99	100	**A**
Uzbekistan	84	85	91	97	100	**A**
Viet Nam	35	47	57	68	75	**D**

Table 14: Proportion of the population using improved sanitation facilities, rural (Source: http://mdgs.un.org/unsd/mdg/Data.aspx; 29/09/2010).

Proportion of the population using improved sanitation facilities, rural						**2008**
Country	**1990**	**1995**	**2000**	**2005**	**2008**	**Ind. 73**
Bhutan			54	54	54	**D**
Brazil	35	35	36	37	37	**E**
Chile	48	59	71	83	83	**C**
Colombia	43	46	50	53	55	**D**
Ecuador	48	59	70	81	84	**C**
Germany	100	100	100	100	100	**A**
Hungary	100	100	100	100	100	**A**
India	7	10	14	18	21	**E**
Kazakhstan	97	97	97	98	98	**B**
Mali	23	25	28	31	32	**E**
Namibia	9	11	13	15	17	**E**
Nepal	8	13	19	24	27	**E**
Netherlands	100	100	100	100	100	**A**
Nicaragua	26	29	32	35	37	**E**
Peru	16	22	27	33	36	**E**
Russian Federation	70	70	70	70	70	**D**
South Africa	58	59	61	64	65	**D**
Spain	100	100	100	100	100	**A**
Sweden	100	100	100	100	100	**A**
Thailand	74	83	92	96	96	**B**
Uganda	40	43	45	48	49	**E**
United Kingdom	100	100	100	100	100	**A**
Uruguay	83	84	90	96	99	**B**
Uzbekistan	76	78	87	96	100	**A**
Viet Nam	29	40	50	61	67	**D**

Table 15: Table compares the values available in the international data sources (WHO) used to the values provided by experts (EXP).

	Basin/Country	69 WHO	69 EXP	70 WHO	70 EXP	72 WHO	72 EXP	73 WHO	73 EXP
1	Amudarya/Uzbekistan	C	UZB: C (88%)	C	UZB: C (82%)	A	UZB: B (96%)	A	UZB: B (95%)
2	Baker/Chile	B	C	D	D	B	B	C	D
3	BangPakong/Thailand	B	B	B	D	B	B	B	B
4	Biobio/Chile	B	B	D	C	B	B	C	D
5	Brahmaputra/Bhutan	B	C	C	C	D	D	D	D
6	Brahmaputra/India	C	C	C	C	E	E	E	E
	Assam		*D*		*D*				
7	Brahmaputra/Nepal	C	C	C	C	E	E	E	E
8	Catamayo/Ecuador	B	95%	C	91%	B	84%	C	72%
9	Catamayo/Peru	C	84%	D	63%	D	72%	E	36/72%
10	Cauca/Colombia	B	89%:C	D	68%:D	D	68%:D	D	39%:E
11	Cocibolca/Nicaragua	C	C	D	D	D	E	E	E
12	Cuareim/Uruguay	A	A	A	A	A	A	B	A
13	Elbe/Germany	A	D: A (100%)	A	D: A (100%)	A	D: A (100%)	A	D: A (100%)
14	Guadiana/Spain	A	(A): 100% total; (A): 100% rural	A	(B): 91-99% total; (B): 91-99% rural	A	(A): 100% total; (A): 100% rural	A	(B): 91-99% total; (B): 91-99% rural
15	Guayas/Ecuador	B	95 = B	C	91 = B	B	84 = C	C	72 = D
16	Kyoga/Uganda	D	D	D	D	E	E	E	E
17	Niger/Mali	D	D	E	E	E	E	E	E
18	Norrström/Sweden	A	A (100%)	A	A (100%)	A	A (100%)	A	A (100%)
19	Nura/Kazakhstan	B	B	C	B	B	B	B	B
20	Okavango/Namibia	B	C	C	C	E	E	E	-
21	Olifants/South Africa	B	ZA: B (93%)	C	ZA: C (82%)	C	ZA: D (59%)	D	ZA: E (49%)
22	Orange/South Africa	B	ZA: B (93%)	C	ZA: C (82%)	C	ZA: D (59%)	D	ZA: E (49%)
23	Paute/Ecuador	B	95 = B	C	91 = B	B	84 = C	C	72 = D
24	Quaraí/Brazil	B	B	C	E	C	B	E	B
25	Red River/Vietnam	B	E	B	E	D	E	D	E
26	Rhine/The Netherlands	A	NL: A (100%)	A	NL: A (100%)	A	NL: A (100%)	A	NL: A (100%)
27	Thames/UK	A	A	A	A	A	A	A	A
28	Tisza/Hungary	A	H: A (100%)	A	H: A (100%)	A	H: A (100%)	A	H: A (100%)
29	Volga/Russia	B	B	C	E	C	C	D	D

Also indicators 68 and 71 have been updated using the same data sources. The figures are presented in this report Fig. 6 and Fig. 7.

Table 16: Progress towards water-related Millennium Development Goals

No.	Indicator	Scoring scheme	How to assign scores (i.e. on which basis are scores allocated)	Comment on data source	NEW Source
68.	**Progress towards sustainable access to safe drinking water (MDG drinking water target)**	- A - B - C	Progress towards the MDG drinking water target, 2008 (A) On track (B) Progress but insufficient (C) Not on track	WHO & UNICEF (2010): Progress on Sanitation and Drinking Water: http://www.wssinfo.org/download.php?id_document=1289 => figure 9 on page 10	*JMP Report (2010). Progress on drinking water and sanitation. Joint Monitoring Program by WHO and UNICEF. Statistical Table pp. 39-51.* www.unwater.org/downloads/JMP_report_2010.pdf *- Fig.8 (p. 8): ind.71* *- Fig.10 (p. 9): ind.68*
71.	**Progress towards sustainable access to basic sanitation (MDG sanitation target)**	- A - B - C	Progress towards the MDG sanitation target, 2008 (A) On track (B) Progress but insufficient (C) Not on track	WHO & UNICEF (2008): Progress on Drinking Water and Sanitation: Special Focus on Sanitation: http://www.wssinfo.org/download.php?id_document=1289 => figure 8 on page 8	

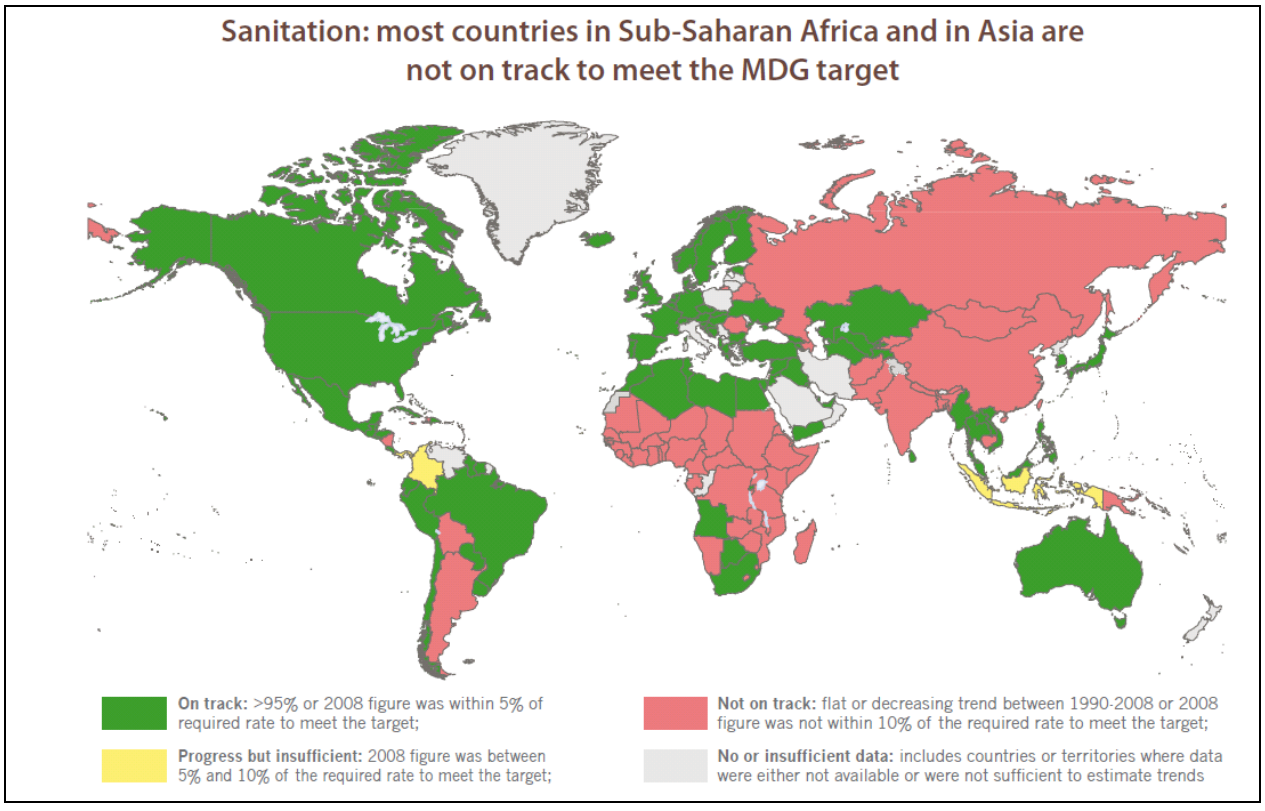


Fig. 6: Sanitation: Progress towards the MDG target, 2008 (Source: WHO/UNICEF, 2010)

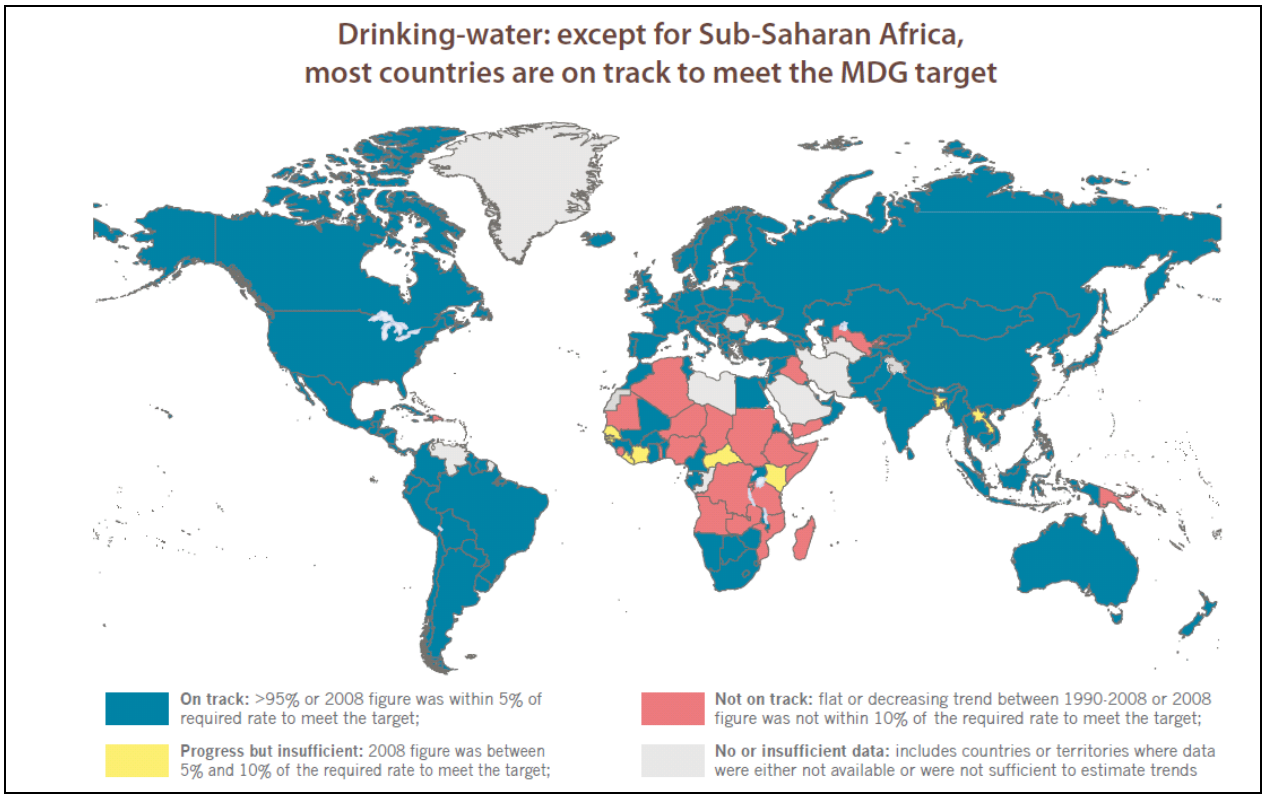


Fig. 7: Drinking water: Progress towards the MDG target, 2008 (Source: WHO/UNICEF, 2010)

Water Exploitation Index (Ind. 91)

(Source for information on WEI: EEA Report No 2/2009 - Water resources across Europe — confronting water scarcity and drought. EEA, Copenhagen, 2009)

The Water Exploitation Index (WEI), which is calculated annually as the ratio of total freshwater abstraction to the total renewable resource, is a relatively straightforward indicator of the pressure or stress on freshwater. A WEI value above 20% implies that a water resource is under stress and values above 40% indicate severe water stress and clearly unsustainable use of the water resource (Raskin et al., 1997).

National estimates showed Cyprus (45%) and Bulgaria (38%) to have the highest WEI scores in Europe, with high values also apparent for Italy, Spain, the former Yugoslav Republic of Macedonia and Malta. National estimates of this sort do not, however, reflect the extent and severity of water scarcity in sub-national regions. For example, while Spain's national WEI is approximately 34%, the southern river basins of Andalusia and Segura have extremely high WEI values of 164% and 127%, respectively.

In 2007, as part of the European Commission's assessment of water scarcity and drought, thirteen Member States submitted information on river basin WEI values (EC, 2007b). These data (Fig. 8) indicate that several river basins in southern Europe have extremely high WEI values and that a number of river basins in more northerly regions have WEI values of roughly 20%, indicating a stress on the water resource.

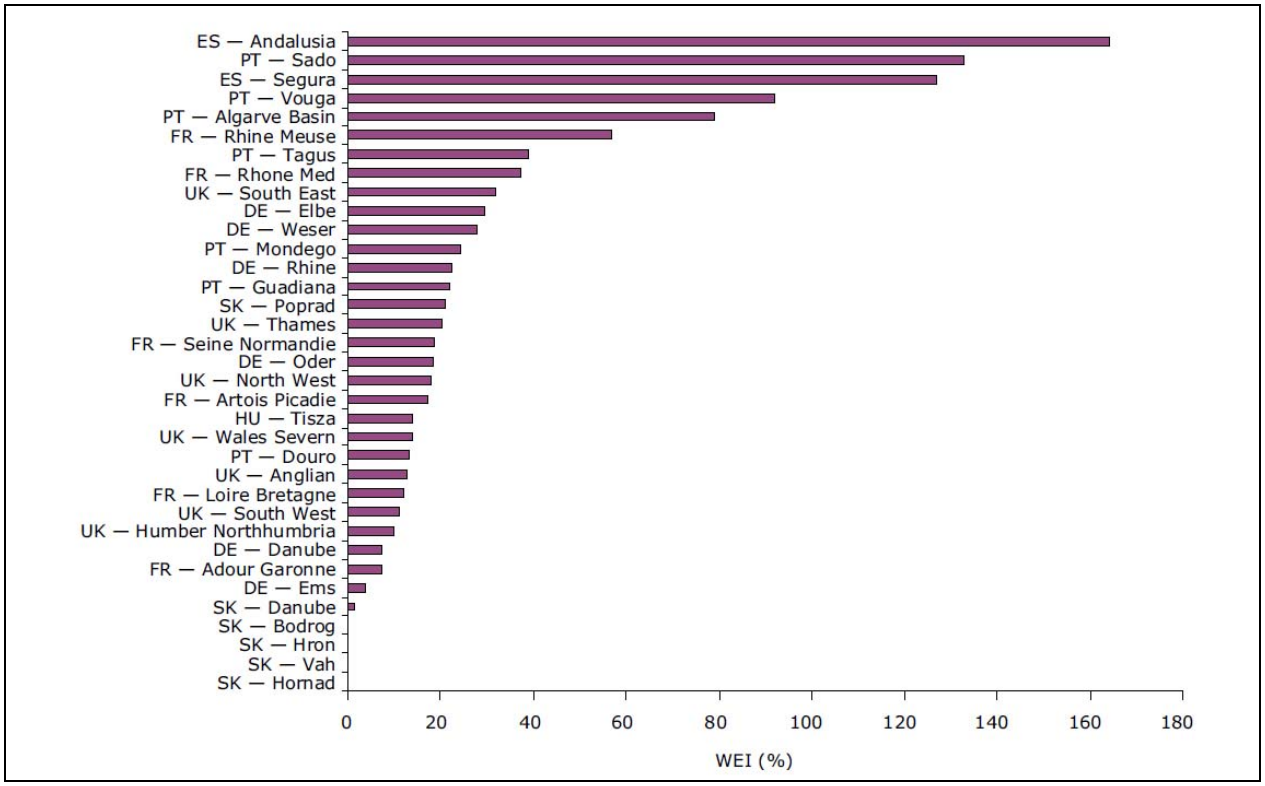


Fig. 8: WEI for selected river basins across Europe (Source: EEA Report No 2/2009)

Although calculating the WEI at a river basin scale provides additional detail, such analysis still struggles to reflect fully the level of stress upon local water resources. This is primarily because the WEI is based on annual data and cannot, therefore, account for seasonal variations in water availability and abstraction. During the summer months in southern Europe, for example, agricultural and tourist water demands peak at a time when the natural water resource reaches a minimum. The annual average approach of the WEI is unable to capture this and cannot, therefore, fully reflect the potential threat to, for example, the freshwater ecosystem. On the other hand, the WEI can overestimate water stress, because it does not account for the consumptive use of water. Where abstraction is dominated by power generation, for instance, nearly all the abstracted water is returned to the source.

Despite its limitations, the WEI still provides a useful indication of water scarcity, and there is a broad geographical correlation between those river basins with the highest WEI and reports, from a range of sources, of diminished water resources and associated detrimental impacts.

The scoring scheme used for the Twin2Go purpose is given in Table 17. The Water Exploitation index has been added in the addendum as a new performance indicator (number 91). The data for all basins has been collected by DHI, the values and sources are listed in Table 18. Since various sources were consulted, the source data reflects different years ranging between 2002 and 2010. Data sources have been included as a comment in Table 11.

Table 17: Scoring scheme WEI

No.	Indicator	Hypothesis/ statement on relationship	Scoring scheme	How to assign scores (i.e. on which basis are scores allocated)	Comment on data source
	Water Exploitation Index (WEI)	High performance is reflected in low water exploitation.	- A - B - C - D Percentage number and category	(A) < 10%: No or limited water scarcity (B) 10-20%: Moderate water scarcity (C) > 20-50%: Water resources under stress (D) > 50%: Extreme water stress.	Calculated by Twin2Go partner DHI for the national part of the basin. If data is not available for this scale, the score refers to the country or entire basin. The scale needs to be documented as comment. Indicator code CSI 018: http://www.eea.europa.eu/data-and-maps/indicators/use-of-freshwater-resources/use-of-freshwater-resources-assessment-1 WEI = totABS / LTAA x 100 Where: totABS = total annual freshwater abstraction for all uses; LTAA = long term annual average of freshwater resources, where data are averaged over a period of at least 20 consecutive years. Unit = %

Table 18: Water Exploitation Index (WEI) for Twin2Go cases; indicator 91

Country/Basin	Score	Comments
Biobio/Chile	A (1,3%)	Score at basin level calculated on the basis of information on annual renewable resources and water uses from TWINBAS and TWINLATIN Work Packages.
Catamayo/Peru	A (1,1%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2002), taken from the FAO country fact sheet - http://www.fao.org/nr/water/aquastat/main/index.stm
Catamayo/Ecuador	A (4,0%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2002), taken from the FAO country fact sheet, rounded up figure - http://www.fao.org/nr/water/aquastat/main/index.stm
Cauca/Colombia	A (0,5%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2002), taken from the FAO country fact sheet, rounded down figure - http://www.fao.org/nr/water/aquastat/main/index.stm
Quarai/Brazil	A (0,7%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2002), taken from the FAO country fact sheet - http://www.fao.org/nr/water/aquastat/main/index.stm
Cocibolca/Nicaragua	A (0,7%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2002), taken from the FAO country fact sheet - http://www.fao.org/nr/water/aquastat/main/index.stm
Baker/Chile	A (1,3%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2002), taken from the FAO country fact sheet, rounded up figure - http://www.fao.org/nr/water/aquastat/main/index.stm
Cuareim/Uruguay	A (2,3%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2002), taken from the FAO country fact sheet, rounded down figure - http://www.fao.org/nr/water/aquastat/main/index.stm
Cuayas/Ecuador	A (4,0%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2002), taken from the FAO country fact sheet, rounded up figure - http://www.fao.org/nr/water/aquastat/main/index.stm
Paute/Ecuador	A (4,0%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2002), taken from the FAO country fact sheet, rounded up figure - http://www.fao.org/nr/water/aquastat/main/index.stm
Norrström/Sweden	A/B (10%)	Score at basin level reported by case study expert.
Nura/Kazakhstan	C (25%)	Score at basin level calculated on the basis of information on annual renewable resources and water uses from TWINBAS and TWINLATIN Work Packages (2007)
Okavango/Namibia	B (15%)	Score at basin level (national part) calculated on the basis of information on annual renewable resources and water uses from TWINBAS and TWINLATIN Work Packages (2007)
Thames/UK	C (20%)	Score at basin level. Data reported by UK to the EU Commission for the "Scarcity and Drought, 2. Interim report", 2010. WEI is 20% at the border of score B and C.
Kyoga/Uganda	A (0,5%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2002), taken from the FAO country fact sheet, rounded up figure - http://www.fao.org/nr/water/aquastat/main/index.stm
Niger/Mali	A	Score at national level: 'Total freshwater withdrawal as percentage

Country/Basin	Score	Comments
	(6,5%)	of annual renewable water resources (ARWR)' value (2002), taken from the FAO country fact sheet, rounded down figure - http://www.fao.org/nr/water/aquastat/main/index.stm
BangPakong/Thailand	C (26%)	Score at basin level. Calculated on the basis of information from a study on water resources in Bang Pakong. www.adb.org/water/BangPakong
Volga/Russia	A (1,5%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2002), taken from the FAO country fact sheet, rounded up figure - http://www.fao.org/nr/water/aquastat/main/index.stm
Brahmaputra/Bhutan	A (1,0%)	Data calculated on the basis of data from UNEP study on " Development of a Water resources Inventory in Bhutan". 2010.
Brahmaputra/India	C (34%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2010), taken from the FAO country fact sheet, rounded down figure - http://www.fao.org/nr/water/aquastat/main/index.stm
Brahmaputra/Nepal	A (4,0%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2002), taken from the FAO country fact sheet, rounded down figure - http://www.fao.org/nr/water/aquastat/main/index.stm
Tisza/Hungary	B (14%)	Score at basin level (national part). Data reported by Hungary to the EU Commission for the "Scarcity and Drought, 2. Interim report", 2010.
Guadiana/Spain	C/D (48%)	Score at basin level (national part). Data reported by Spain to the EU Commission for the "Scarcity and Drought, 2. Interim report", 2010.
Elbe/Germany	C (28%)	Score at basin level (national part). Data reported by Germany to the EU Commission for the "Scarcity and Drought, 2. Interim report", 2010.
Rhine/The Netherlands/Germany	B (22%)	Score at basin level (national part). Data reported by Netherlands to the EU Commission for the "Scarcity and Drought, 2. Interim report", 2010.
Amudarya/Uzbekistan	D (115%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2002), taken from the FAO country fact sheet, rounded down figure - http://www.fao.org/nr/water/aquastat/main/index.stm
Orange/South Africa	C (30%)	Score at basin level (national part). Calculated on the basis of data from Orange River Water Resources Plan. http://www.orasecom.org/publications/iwrm+plan.aspx (2009)
Red River/Vietnam	A (8%)	Score at national level: 'Total freshwater withdrawal as percentage of annual renewable water resources (ARWR)' value (2007), taken from the FAO country fact sheet, rounded down figure - http://www.fao.org/nr/water/aquastat/main/index.stm
Olifants/South Africa	C (33%)	Score at basin level (national part) calculated on the basis of data from http://www.dwa.gov.za/ORWRDP/documents/Strategic%20Perspective%20FINAL.pdf (2005)

3 Hypotheses

Hypotheses were formulated to structure data analysis in the qualitative examination (section 4), statistical investigation (section 5) and cross tab approach (section 6). The hypotheses reflect the most important propositions that are currently debated in water policy on characteristics of water governance regimes and their influence on regime performance.

3.1 Hypotheses for structuring the synthesis

One possibility for a synthesis is to define a set of hypotheses to be tested for plausibility. Each indicator already includes one hypothesis, on which the scoring was developed (see deliverable 1.3). One can derive a large number of expected relationships between individual regime characteristics and regime performance measures, because each of the indicators is based on a hypothesis. However, given the fact that the indicator scores have been derived in a quite pragmatic way, it is more robust to analyze in a first hypotheses related to general regime characteristics that are described by several related indicators. Here it is useful to develop aggregations summarizing indicators for analysis. This implies that the combined scores of several indicators relating to the same characteristics/aggregation will be used. This allows grouping the different basins in groups and searching for patterns. These can be more refined by comparing in a second step the scores for individual relationships.

The hypotheses to be checked are linked to the analytical framework:

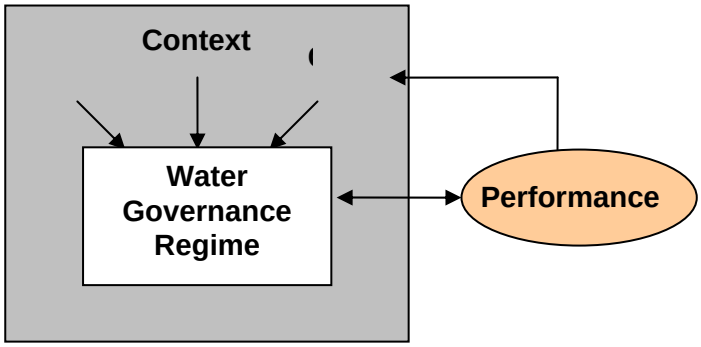


Fig. 9: Analytical framework

Hypotheses have the structure of:
IF RC_i (regime characteristic based on S_i score to indicator i) is high/low then P_j (performance measure based on S_j score to indicator j) is high/low. RC may also refer to an aggregated score over several indicators that refer to one regime characteristic.

Furthermore, the expected influence of specific context variables may be specified.

3.2 Hypotheses to guide the analysis:

3.2.1 Institutional Setting

<u>Hypothesis 1:</u> The presence of legal frameworks regulating water management is increasing performance regarding good governance principles and the achievement of sustainability goals (indicators 1-4, 7).

<u>Hypothesis 2:</u> Legal frameworks prescribing the basin principle increase performance regarding the achievement of sustainability goals and increase adaptive capacity (indicators 8, 10, 11 – possibly also 9).

<u>Hypothesis 3:</u> Dominance of either formal or informal institutions is reducing effectiveness and adaptive capacity of water management. – In case of ineffective formal institutions substitution is desirable instead of competition (sensu Helmke and Levitsky, 2003) (indicators 22, 23, 36, 37, 47).

Some explanations on formal and informal institutions

Formal institutions are linked to any kind of legislation and written contracts. They can be enforced by a regulatory procedure and the corresponding formal bodies. *Informal institutions* are agreed upon by actors. They may even be written down (e.g. in protocols of meetings), but there is no formal obligation to comply with the rules. Compliance depends either on trust or threat of sanctions by the collective.
The importance of informal institutions has two parts: Role of informal institutions in the established regime and the importance of informal learning cycles.
Depending on the effectiveness and the goal conflict one can derive four possible relationships between formal and informal institutions (Helmke and Levitsky, 2003):

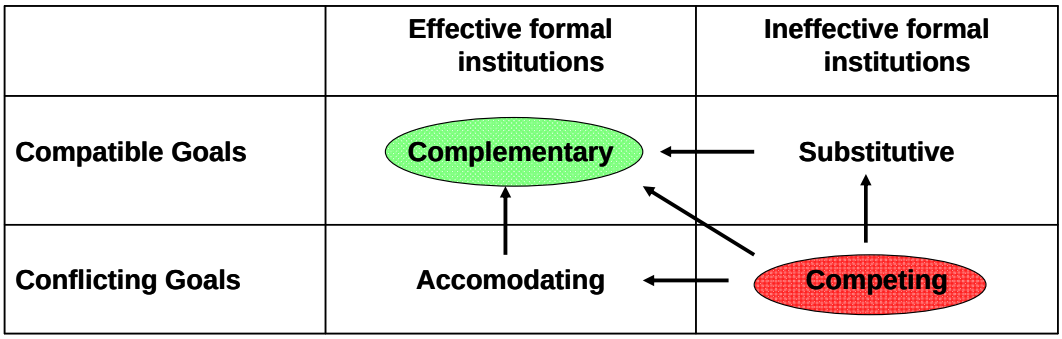


Fig. 10: Possible relationships between formal and informal institutions (Helmke and Levitsky, 2003)

Regarding our normative model "complementary" is desirable. However, one can often find competing institutions in countries with high corruption (e.g. Uzbekistan). In such cases, change is desirable – the arrows from the red to the green state denote potential trajectories for change. It is most plausible though to move from competing to substitutive, since changing the effectiveness of formal institutions is a long-term process that has to take place in the societal context.

The analysis does not include hypothesis 3, because several case study experts, who were involved in data collection, misinterpreted the indicators 22 and 23.

Hypothesis 11: The use of economic and financial instruments increases effectiveness (indicators 13-21).

Hypothesis 12: Legal provisions prescribing good governance principles increase the probability that they are realized (indicators 50-53).

Legal provisions for good governance principles have been moved to regime characteristics, since they refer predominantly to the water sector.

3.2.2 Regime architecture - Type

Hypothesis 4/5: Polycentricity and multi-level arrangements and a balance between bottom-up <-> top-down processes and between decentralization and coordination increase effectiveness and adaptive capacity of a regime. Centralized top-down regimes lead to compliance problems, impede advanced learning processes and reduce adaptive capacity. Decentralization without coordination leads to fragmented regimes (indicators 6, 34, 35, 36, 39, 40, 41, 42).

Some explanations on regime typologies

Regime properties are not independent. First results suggest that it may be useful to identify regime typologies that integrate some elements of the individual hypotheses. These typologies go beyond the first characterizations of centralized and polycentric already addressed in hypothesis 4/ 5.

Relationship between centralized, fragmented and polycentric governance regimes

Polycentric systems can be characterized as neither centralized in power, nor fragmented, nor are they fully connected. Hence polycentric systems reside somewhere in between these three poles as sketched in the following diagram:

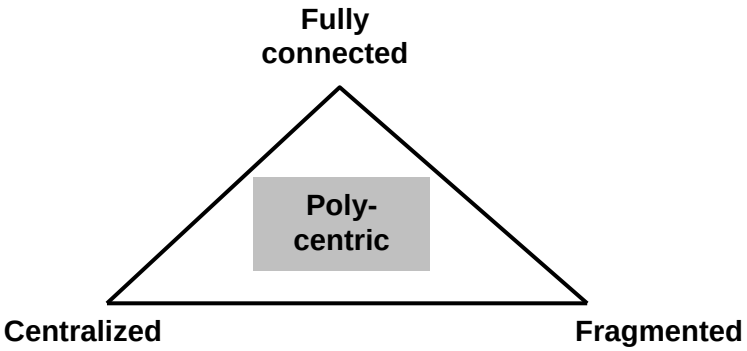


Fig. 11: Relationship between centralized, fragmented and polycentric governance regimes

Fully connected is largely a hypothetical case. However, it could be representative for a regime with too many and thus inefficient and ineffective connections. Our analyses are not sufficiently detailed to analyze this kind of property though.

Centralized: Power located at one, usually the top-level. One actor has most of the decision making power. Other actors / levels are not involved in planning or decision making.
Fragmented: decentralized system with little connection between the various centers of power / decision making, e.g. individual decision making without collective choice arrangements, power and authority for provinces in a river basin without efficient and effective coordination mechanisms.
Polycentric: this category comprises a large class of potential regime configurations, characterized by the distribution of power with effective structures for coordination.

3.2.3 Integration and coordination

Hypothesis 6: Lack of vertical integration leads to policy failures due to disconnection of levels and gap between policy process and operational implementation. High vertical integration and cooperation increases adaptive capacity and performance (indicators 6, 34, 36).

Hypothesis 7: Lack of horizontal integration leads to policy failures due to disconnection of sectors or regions and gap between demand/need for integration in water policies and operational implementation. High horizontal integration and effective cooperation increase adaptive capacity and performance (indicators 35, 5).

Hypothesis 10: The adoption of the IWRM principles increases adaptive capacity and stakeholder involvement (indicators 24-26).

3.2.4 Knowledge and information management

Hypothesis 8: Open access to information and integration of different kinds of knowledge support higher levels of learning and increase adaptive capacity (indicators 37, 38)

Hypothesis 9: Adaptive capacity increases if different kinds of uncertainties are taken into account and addressed in an appropriate way (indicators 29-33)

4 Qualitative analysis

This analysis is based on processed data sets:

For each hypothesis, the relevant indicators for the regime characteristic under consideration were listed. In most cases, the overall score of a basin regarding the regime characteristic was determined by the number of A scores in the different indicators, which were treated as equal without giving any a special weight. This can be justified, since the emphasis is more on the low and high score groups. Nevertheless, this scoring was sometimes refined by noticing that one indicator was decisive and could not be compensated by A values in other indicators. Furthermore, sometimes the next lower score was also taken into consideration – in particular, if the distinction between an A and a B score was rather subtle.

For each performance category, aggregated indicators were calculated with a score of 0-4 for each question and overall scores ranging from 8 to 24 for the different performance categories depending on the number of indicator scores that contributed to a category.

The following analyses were made:

Assessment of the validity of the different hypotheses stated.

The overall score for the regime characteristic was compared to the scores in all performance categories that are supposed to be influenced by this regime characteristic. Context was sometimes taken into account but not in a systematic fashion.

Assessment of the explanatory power of the different hypotheses regarding the different performance categories.

The overall score of a performance category was compared to the scores for all regime characteristics that are supposed to influence this performance category. Context was sometimes taken into account but not in a systematic fashion.

4.1 Hypothesis Testing

4.1.1 Assess the validity of the individual hypotheses

4.1.1.1 Institutional Setting

Table 19: Domestic legislation

Hypo 1 Domestic legislation							
National Basin	Scores	P1	P2&P3	P5a	P5b		CPI
Thames/ UK	A/AAAA	24	24	11	16		7,70
Tisza/Hungary	A/AAAA	24	22	8	16		5,10
Elbe/Germany	A/AAA	24	19	12	20		8,00
Rhine/TheNetherlands	A/AAA	24	21	11	16		8,90
Norrström/Sweden	A/AA	20	22	12	18		9,20
Cuareim/Uruguay	A/AA	23	20	13	10		6,70
Guadiana/Spain	A/AAAA	24	21	4	14		6,10
Olifants/SouthAfrica	A/AAAA	16	10	8	12		4,70
Volga/Russia	A/AAA	13	14	9	20		2,20
Okavango/Namibia	A/AAA	10	16	15	11		4,50
Kyoga/Uganda	A/AAA	6	12	8	5		2,50
Quaraí/Brasil	A/AA	15	22	11	12		3,70
Cauca/Colombia	A/AA	11	15	11	16		3,70
Niger/Mali	B/AAAA	5	16	11	9		2,80
Catamayo/Peru	B/AAA	12	17	8	9		3,70
Orange/SouthAfrica	B/AAAA	16	12	7	9		4,70
Brahmaputra/Bhutan	D/AAAA	11	24	11	9		5,00
Biobio/Chile	A/0	17	4	12	9		6,70
Catamayo/Ecuador	A/0	19	6	11	11		2,20
Baker/Chile	A/0	18	8	12	11		6,70
Guayas/Ecuador	A/0	19	6	12	5		2,20
Nura/Kazahstan	B/AA	20	12	11	14		2,70
BangPakong/Thailand	D/A	20	16	7	15		3,40
Paute/Ecuador	A/0	19	9				2,20
Cocibolca/Nicaragua	C/AA	7	13	9	11		2,50
RedRiver/Vietnam	A/A	17	9	5	5		2,70
Brahmaputra/Nepal	A/0	10	14	9	7		2,30
Amudarya/Uzbekistan	A/0	16	2	5	7		1,70
Brahmaputra/India	B/0	10	9	11	11		3,40

1. The presence of legal frameworks regulating water management is increasing performance regarding good governance principles and the achievement of sustainability goals (1-4, 7).

Regarding regime characteristics the score of the first question (X/….) was regarded as crucial for an assessment. It denotes if legislation is already implemented for some time (A) or just in the formation or preparation phase. If excellent legislation is yet under formation, one cannot expect that it had already any influence on the performance of the water regime. The same applies, if it has been

implemented only recently (score B). Regarding the other scores, not having an A but a B must not denote a major difference.

The hypothesis is weakly supported.

Group 1 (Thames – Cauca) represents basins with excellent to rather well developed legislation and good to excellent performance in all criteria.

Group 2 (Guadiana – Volga) is quite a mixed set. All basins have a (rather) high score in legislation but fail at least in one criterion in performance or even perform poorly in general. One simple overall explanation is not straightforward or visible. Overall, these basins have a capacity problem regarding the implementation. For some it can be explained by a lack of the effectiveness of formal institutions as measured by the CPI (Corruption Perception Index).

Group 3 (Niger – Orange). This group has quite a promising legislation, which has been implemented only recently. The implementation gap is also clearly visible in the low score for management practice.

Brahmaputra/Bhutan. This basin has only legislation under formation. However, regarding the overall process characteristics the basins performs quite well, and planned legislation is of high quality. However, Bhutan is quite a special case and cannot easily be compared to other countries.

Group 4 (Biobio – Brahmaputra/India). The basins in this group have either no legislation in place or existing legislation has quite poor coverage of important aspects. Basins do not perform well, which would support the hypothesis. This applies to all regarding performance in process characteristics. Performance regarding the state of the environment seems not to be dependent on the presence of an effective and well developed legal framework. This is quite an unexpected result. One explanation can be that the effect of the pressure on the water resource is the key factor – related to per capita water availability and modification of the watershed.

Conclusion:

Having domestic legislation in place is a necessary but not sufficient condition for increasing the performance of the water governance and management regime. Effectiveness is affected by:

- Capacity for implementation (knowledge, resources)
- Effectiveness of formal institutions in general (measured by the Corruption Perception Index – CPI), which is a characteristic of the political and economic system, in which the water governance regime is embedded.

Table 20: Economic instruments

Hypo 11 Economic Instruments						
National Basin	Scores		P1	P3	P4	P5a
Thames/UK	AAAAAAAA		24	8	21	11
Tisza/Hungary	AAAAAA		24	8	18	8
Elbe/Germany	AAAAAA		24	6	17	13
Rhine/TheNetherlands	AAAAA		24	6	24	11
Brahmaputra/Bhutan	AAA		11	8	16	11
Quaraí/Brasil	AA		15	8	10	11
Cuareim/Uruguay	AA		23	6	18	13
Orange/SouthAfrica	AA		16	4	15	7
RedRiver/Vietnam	AA		17	4	14	5
Olifants/SouthAfrica	AA		16	4	16	8
Baker/Chile	A		18	2	8	12
Norrström/Sweden	A		20	8	16	12
Guadiana/Spain	A		24	8	20	4
Biobio/Chile	0		17	0	7	12
Catamayo/Peru	0		12	6	11	8
Catamayo/Ecuador	0		19	6	14	11
Cauca/Colombia	0		11	6	10	11
Cocibolca/Nicaragua	0		7	6	14	9
Guayas/Ecuador	0		19	6	14	12
Paute/Ecuador	0		19	6	14	
Nura/Kazahstan	0		20	4	13	11
Okavango/Namibia	0		10	6	11	15
Kyoga/Uganda	0		6	4	14	8
Niger/Mali	0		5	6	22	11
BangPakong/Thailand	0		20	8	7	7
Volga/Russia	0		13	4	11	9
Brahmaputra/India	0		10	2	8	11
Brahmaputra/Nepal	0		10	4	9	9
Amudarya/Uzbekistan	0		16	2	11	5

11. The use of economic and financial instruments increases effectiveness (13-21).

The use of economic instruments – in particular a diverse set – is not wide spread. Where used this is associated with high performance scores as well.

Table 21: Good governance principles

Hypo 12 Good Governance			
National Basin	Scores	P2&P3	CPI
Thames/UK	16	24	7,70
Norrström/Sweden	16	22	9,20
Rhine/TheNetherlands	16	21	8,90
Elbe/Germany	16	19	8,00
Tisza/Hungary	16	22	5,10
Quaraí/Brasil	14	22	3,70
Cuareim/Uruguay	14	20	6,70
Orange/SouthAfrica	14	12	4,70
Brahmaputra/Bhutan	12	24	5,00
Guadiana/Spain	12	21	6,10
Catamayo/Peru	12	17	3,70
Cauca/Colombia	12	15	3,70
Brahmaputra/Nepal	12	14	2,30
Cocibolca/Nicaragua	12	13	2,50
Niger/Mali	12	16	2,80
Olifants/SouthAfrica	12	10	4,70
Brahmaputra/India	12	9	3,40
Volga/Russia	10	14	2,20
Kyoga/Uganda	10	12	2,50
Baker/Chile	10	8	6,70
Okavango/Namibia	8	16	4,50
Nura/Kazahstan	8	12	2,70
RedRiver/Vietnam	8	9	2,70
Guayas/Ecuador	6	6	2,20
Biobio/Chile	6	4	6,70
Amudarya/Uzbekistan	2	2	1,70
BangPakong/Thailand	2	16	3,40
Catamayo/Ecuador	2	6	2,20
Paute/Ecuador	2	9	2,20

12. Legal provisions prescribing good governance principles increase the probability that they are realized (50-53).

The pattern is even more pronounced than that for domestic legislation. Having good governance principles in legislation in place is a necessary but not sufficient condition for increasing the performance of the water governance and management regime regarding a good governance process.

A key factor of influence is the effectiveness of formal institutions in general (measured by the Corruption Perception Index – CPI), which is a characteristic of the political and economic system, in which the water governance regime is embedded.

However, one potential problem in this comparison might be that experts did not make a clear distinction between what is implemented in the law and what is implemented in practice.

Table 22: Basin principle

Hypo 2 Basin Principle						
National Basin	Scores		P1	P4	P5a	P5b
Thames/UK	AAA		24	21	11	16
Tisza/Hungary	AAA		24	18	8	16
Guadiana/Spain	AAA		24	20	4	14
Elbe/Germany	AAA		24	17	13	20
Rhine/TheNetherlands	AAA		24	24	11	16
Quaraí/Brasil	AAA		15	10	11	12
Okavango/Namibia	AA		10	11	15	11
Niger/Mali	AA		5	22	11	9
Amudarya/Uzbekistan	AA		16	11	5	7
Cocibolca/Nicaragua	A		7	14	9	11
Baker/Chile	A		18	8	12	11
Cuareim/Uruguay	A		23	18	13	10
Norrström/Sweden	A		20	16	12	18
Nura/Kazahstan	A		20	13	11	14
BangPakong/Thailand	A		20	7	7	15
Volga/Russia	A		13	11	9	20
Brahmaputra/Bhutan	A		11	16	11	9
Brahmaputra/Nepal	A		10	9	9	7
Orange/SouthAfrica	A		16	15	7	9
RedRiver/Vietnam	A		17	14	5	5
Olifants/SouthAfrica	A		16	16	8	12
Biobio/Chile	0		17	7	12	9
Catamayo/Peru	0		12	11	8	9
Catamayo/Ecuador	0		19	14	11	11
Cauca/Colombia	0		11	10	11	16
Guayas/Ecuador	0		19	14	12	5
Paute/Ecuador	0		19	14		
Kyoga/Uganda	0		6	14	8	5
Brahmaputra/India	0		10	8	11	11

2. Legal frameworks prescribing the basin principle increase performance regarding the achievement of sustainability goals and increase adaptive capacity (8,10,11 / 9)

The basin principle on its own seems to have no influence on the overall performance characteristics – similar arguments apply as for domestic legislation. Implementing the basin principles without securing the conditions for an effective implementation is of no big value.

Integration and coordination

Table 23: Vertical coordination

Hypo 6 Vertical Coord							
National Basin	Scores		P1	P2&P3	P4	P5a	P5b
Rhine/TheNetherlands	AAA		24	21	24	11	16
Thames/UK	AAA		24	24	21	11	16
Tisza/Hungary	AAA		24	22	18	8	16
Quaraí/Brasil	AAA		15	22	10	11	12
Brahmaputra/Bhutan	AAA		11	24	16	11	9
Guadiana/Spain	AAB		24	21	20	4	14
Okavango/Namibia	AAB		10	16	11	15	11
Catamayo/Peru	ACA		12	17	11	8	9
Brahmaputra/Nepal	AAC		10	14	9	9	7
Olifants/SouthAfrica	ADA		16	10	16	8	12
Elbe/Germany	ABB		24	19	17	13	20
Norrström/Sweden	ABB		20	22	16	12	18
Niger/Mali	ABB		5	16	22	11	9
Cauca/Colombia	ACB		11	15	10	11	16
Nura/Kazahstan	ADB		20	12	13	11	14
Kyoga/Uganda	ACC		6	12	14	8	5
Orange/SouthAfrica	ADB		16	12	15	7	9
BangPakong/Thailand	CAC		20	16	7	7	15
Volga/Russia	ACB		13	14	11	9	20
Brahmaputra/India	ADC		10	9	8	11	11
Biobio/Chile	BAC		17	4	7	12	9
Catamayo/Ecuador	BEC		19	6	14	11	11
Cocibolca/Nicaragua	BBB		7	13	14	9	11
Baker/Chile	BCC		18	8	8	12	11
Cuareim/Uruguay	BBC		23	22	18	13	10
Guayas/Ecuador	BEC		19	6	14	12	5
Amudarya/Uzbekistan	BDC		16	2	11	5	7
RedRiver/Vietnam	BBB		17	9	14	5	5

6. Lack of vertical integration leads to policy failures due to disconnection of levels and gap between policy process and operational implementation. High vertical integration and cooperation increases adaptive capacity and performance (6, 34, 36).

Scores A and B of question 34 (2nd score) make quite a subtle distinction between cooperation (A) and coordination (B) in combination with a clear allocation of tasks. Hence the difference is not that substantial between the two scores.

One can see support for this hypothesis. Basins that score high in vertical coordination have a high performance. Good governance shows a clear pattern and seems to be influenced significantly by vertical coordination.

Table 24: Horizontal cooperation

Hypo7 Horizontal Coop						
National Basin	Scores	P1	P2&P3	P4	P5a	P5b
Norrström/Sweden	AA	20	22	16	12	18
Thames/UK	AA	24	24	21	11	16
Tisza/Hungary	AB	24	22	18	8	16
Rhine/TheNetherlands	AB	24	21	24	11	16
Guadiana/Spain	AB	24	21	20	4	14
Niger/Mali	AB	5	16	22	11	9
Cocibolca/Nicaragua	AB	7	13	14	9	11
Orange/SouthAfrica	AC	16	12	15	7	9
Olifants/SouthAfrica	AC	16	10	16	8	12
Elbe/Germany	AC	24	19	17	13	20
Catamayo/Peru	AC	12	17	11	8	9
Volga/Russia	AC	13	14	11	9	20
Okavango/Namibia	AC	10	16	11	15	11
Kyoga/Uganda	AC	6	12	14	8	5
Brahmaputra/Bhutan	AC	11	24	16	11	9
Brahmaputra/Nepal	AC	10	14	9	9	7
Amudarya/Uzbekistan	AD	16	2	11	5	7
Cuareim/Uruguay	BB	23	20	18	13	10
RedRiver/Vietnam	BB	17	9	14	5	5
Cauca/Colombia	BC	11	15	10	11	16
Nura/Kazahstan	BD	20	12	13	11	14
Biobio/Chile	CB	17	4	7	12	9
Baker/Chile	CC	18	8	8	12	11
BangPakong/Thailand	CC	20	16	7	7	15
Quaraí/Brasil	CD	15	22	10	11	12
Catamayo/Ecuador	CE	19	6	14	11	11
Guayas/Ecuador	CE	19	6	14	12	5
Brahmaputra/India	CE	10	9	8	11	11

7. Lack of horizontal integration leads to policy failures due to disconnection of sectors or regions and gap between demand/need for integration in water policies and operational implementation. High horizontal integration and effective cooperation increase adaptive capacity and performance (35, 5).

Scores A and B of question 35 (2nd score) make quite a subtle distinction between cooperation (A) and coordination (B) in combination with a clear allocation of tasks. Hence the difference is not that substantial between the two scores.

The basins with the highest scores in performance have also high scores in horizontal cooperation. We find no basin with exceptional good performance without high horizontal cooperation/coordination. Regarding the Brahmaputra in Nepal, one should note that the score for

domestic legislation indicated water legislation under formation. Hence the single piece of legislation may not yet be operative.

Basins with very low score in horizontal cooperation also score low in performance measures.

Table 25: IWRM principles

Hypo 10 IWRM Principles				
National Basin	Scores		P2&P3	P4
Thames/UK	AAA		24	21
Rhine/TheNetherlands	AAA		21	24
Brahmaputra/Bhutan	AA		24	16
Tisza/Hungary	AA		22	18
Norrström/Sweden	AA		22	16
Guadiana/Spain	A		21	20
Elbe/Germany	A		19	17
Niger/Mali	A		16	22
Catamayo/Peru	A		17	11
Cocibolca/Nicaragua	A		13	14
Orange/SouthAfrica	A		12	15
Olifants/SouthAfrica	A		10	16
Nura/Kazahstan	A		12	13
Okavango/Namibia	A		16	11
Volga/Russia	A		14	11
Brahmaputra/India	A		9	8
Quaraí/Brasil	B>C		22	10
Cauca/Colombia	B>C		15	10
Kyoga/Uganda	B>C		12	14
BangPakong/Thailand	B>C		16	7
RedRiver/Vietnam	B>C		9	14
Cuareim/Uruguay	C>B		20	18
Brahmaputra/Nepal	C>B		14	9
Paute/Ecuador	C>B		9	14
Guayas/Ecuador	C>B		6	14
Catamayo/Ecuador	C>B		6	14
Baker/Chile	C>B		8	8
Biobio/Chile	C>B		4	7
Amudarya/Uzbekistan	C>B		2	11

10. The adoption of the IWRM principles increases adaptive capacity and stakeholder involvement (24-26).

This hypothesis seems to be supported to some extent. However, one has to acknowledge that the interpretation of what are the IWRM principles may vary.

Basins with a single A have all formalized IWRM principles in legislation but are not yet advanced in implementation and lack capacity for the implementation.

Performance of basins with low scores in IWRM principles varies considerably though. Hence this seems not to be a decisive criterion.

4.1.1.2 Knowledge and information management

Table 26: Information management

Hypo 8 Information National Basin	Scores	P2&P3	P4
Thames/UK	AA	24	21
Norrström/Sweden	AA	22	16
Quaraí/Brasil	AA	22	10
Tisza/Hungary	AB	22	18
Cuareim/Uruguay	AB	20	18
Niger/Mali	AB	16	22
Elbe/Germany	AB	19	17
Brahmaputra/Bhutan	AB	24	16
Kyoga/Uganda	AC	12	14
Guadiana/Spain	AC	21	20
Olifants/SouthAfrica	BA	10	16
Cocibolca/Nicaragua	AB	13	14
Cauca/Colombia	AB	15	10
Brahmaputra/Nepal	AC	14	9
Brahmaputra/India	AC	9	8
BangPakong/Thailand	AB	16	7
Rhine/TheNetherlands	BB	21	24
Orange/SouthAfrica	BB	12	15
Nura/Kazahstan	BB	12	13
Catamayo/Peru	BB	17	11
Okavango/Namibia	BB	16	11
Volga/Russia	BB	14	11
Catamayo/Ecuador	DD	6	14
Baker/Chile	BC	8	8
Guayas/Ecuador	DD	6	14
Paute/Ecuador	DD	9	14
RedRiver/Vietnam	BC	9	14
Biobio/Chile	DB	4	7
Amudarya/Uzbekistan	BE	2	11

8. Open access to information and integration of different kinds of knowledge support higher levels of learning and increase adaptive capacity (37, 38.)

This hypothesis seems to be supported for the adoption of good governance principles. Regarding climate change adaptation, no clear pattern is discernible.

Table 27: Handling Uncertainties

Hypo 9 Uncertainties National Basin	Scores	P4
Niger/Mali	AAAA	22
Guadiana/Spain	AAAA	20
Norrström/Sweden	AAAA	16
Rhine/TheNetherlands	AAA	24
Thames/UK	AAA	21
Quaraí/Brasil	AAA	10
Tisza/Hungary	AA	18
Elbe/Germany	AA	17
Catamayo/Peru	AA	11
Okavango/Namibia	AA	11
Cuareim/Uruguay	A	18
Brahmaputra/Bhutan	A	16
Olifants/SouthAfrica	A	16
Orange/SouthAfrica	A	15
Catamayo/Ecuador	A	14
Guayas/Ecuador	A	14
Paute/Ecuador	A	14
Kyoga/Uganda	A	14
RedRiver/Vietnam	A	14
Nura/Kazahstan	A	13
Brahmaputra/Nepal	A	9
Baker/Chile	A	8
Cocibolca/Nicaragua	0	14
Volga/Russia	0	11
Amudarya/Uzbekistan	0	11
Cauca/Colombia	0	10
Brahmaputra/India	0	8
Biobio/Chile	0	7
BangPakong/Thailand	0	7

9. Adaptive capacity increases if different kinds of uncertainties are taken into account and addressed in an appropriate way (29-33).

This hypothesis is weakly supported. Basins scoring high in how to deal with uncertainties score also high in performance regarding climate change adaptation, and basins with very low scores regarding uncertainties have also poor performance in climate change adaptation. In the middle range one finds considerable variability though.

Regime Architecture – Type:

Table 28: Polycentricity

Hypo 4/5 Polycentricity

National Basin	Q6	Q34	Q35	Q36	Q39	Q40	Q41	Q42	P2&P3	P4
Rhine/TheNetherlands	A	A	B	A	A	B	A	A	21	24
Tisza/Hungary	A	A	B	A	B	A	A	A	22	18
Norrström/Sweden	A	B	A	B	A	B	A	A	24	16
Thames/UK	A	A	A	A	B	B	A	A	24	21
Niger/Mali	A	B	B	B	A	B	A	A	16	22
Elbe/Germany	A	B	C	B	A	B	B	A	19	17
Okavango/Namibia	A	A	C	B	A	B	B	A	16	11
Quaraí/Brasil	A	A	D	A	A	A	B	A	22	10
Cauca/Colombia	A	C	C	B	B	B	A	A	15	10
Guadiana/Spain	A	A	B	B	B	C	A	A	21	20
Olifants/SouthAfrica	A	D	C	A	A	B	A	A	10	16
Orange/SouthAfrica	A	D	C	B	A	B	A	A	12	15
Brahmaputra/Bhutan	A	A	C	A	A	B	B	B	24	16
Brahmaputra/Nepal	A	A	C	C	A	C	B	A	9	9
Catamayo/Peru	A	C	C	A	A	B	B	B	17	11
Cocibolca/Nicaragua	B	B	B	B	A	B	B	A	13	14
RedRiver/Vietnam	B	B	B	B	B	B	B	A	9	14
Cuareim/Uruguay	B	B	B	C	A	B	B	B	20	18
Nura/Kazahstan	A	D	D	B	B	C	B	A	12	13
Kyoga/Uganda	A	C	C	C	A	B	A	B	12	14
Brahmaputra/India	A	D	E	C	C	A	B	B	9	8
BangPakong/Thailand	C	A	C	C	B	B	B	A	16	7
Volga/Russia	A	C	C	B	B	C	B	B	14	11
Biobio/Chile	B	A	B	C	C	C	B	B	4	7
Baker/Chile	B	C	C	C	B	B	B	B	8	8
Catamayo/Ecuador	B	E	E	C	B	C	A	B	6	14
Guayas/Ecuador	B	E	E	C	B	C	A	B	6	14
Paute/Ecuador	B	E	E	C	B	C	A	B		
Amudarya/Uzbekistan	B	D	D	C	B	C	B	B	2	11

4./5. Polycentricity and multi-level arrangements and a balance between bottom-up <-> top-down processes and between decentralization and coordination increase effectiveness and adaptive capacity of a regime. Centralized top-down regimes lead to compliance problems, impede advanced learning processes and reduce adaptive capacity. Decentralization without coordination leads to fragmented regimes (6, 34, 35, 36, 39, 40, 41, 42).

Shadings: dark and light denote essential and relevant characteristics for polycentric (green), centralized (red) and fragmented (blue) regimes. Polycentric regimes show better performance than centralized or fragmented regimes. A simple calculation of As does not convey a good assessment, since the questions have quite different meaning and importance. Guadiana for example has more characteristics of a centralized regime.

Table 29: Characteristics of regimes to different types:

	Polycentric	Fragmented	Centralized
Distribution of formal power	High	High	Low
Multi-level distribution of functions and resources	High	High	Low
Cooperation vertical	High	Low	Low
Cooperation horizontal	High	Low	Low
Typical case	Netherlands	India	Uzbekistan

4.2 Assess the explanatory power of hypotheses for the different performance categories

4.2.1 Climate Change Adaptation

Table 30: Climate change adaptation

P4 Response CC

National Basin	P4	Score H 2	Score H6	Score H 7	Score H 10	Score H 8	Score H 9
Rhine/TheNetherlands	24	AAA	AAA	AB	AAA	BB	AAA
Niger/Mali	22	AA	A	AB	A	AB	AAAA
Thames/UK	21	AAA	AAA	AA	AAA	AA	AAA
Guadiana/Spain	20	AAA	AA	AB	A	AC	AAAA
Tisza/Hungary	18	AAA	AAA	BB	AA	AB	AA
Cuareim/Uruguay	18	A	0	AB	C>B	AB	A
Elbe/Germany	17	AAA	A	AC	A	AB	AA
Norrström/Sweden	16	A	A	AC	AA	AA	AAAA
Brahmaputra/Bhutan	16	A	AAA	AA	AA	AB	A
Olifants/SouthAfrica	16	A	AA	AC	A	BA	A
Orange/SouthAfrica	15	A	A	AC	A	BB	A
Catamayo/Ecuador	14	0	0	CE	C>B	DD	A
Cocibolca/Nicaragua	14	A	0	AB	A	AB	0
Guayas/Ecuador	14	0	0	CE	C>B	DD	A
Kyoga/Uganda	14	0	A	AC	B>C	AC	A
Paute/Ecuador	14	0	0	CE	C>B	DD	A
RedRiver/Vietnam	14	A	0	BB	B>C	BC	A
Nura/Kazahstan	13	A	A	BD	A	BB	A
Amudarya/Uzbekistan	11	AA	0	AD	C>B	BE	0
Catamayo/Peru	11	0	AA	AC	A	BB	AA
Okavango/Namibia	11	AA	AA	AC	A	BB	AA
Volga/Russia	11	A	A	AC	A	BB	0
Cauca/Colombia	10	0	A	BC	B>C	AB	0
Quaraí/Brasil	10	AAA	AAA	CD	B>C	AA	AAA
Brahmaputra/Nepal	9	A	AA	AC	C>B	AC	A
Baker/Chile	8	A	0	CC	C>B	BC	A
Brahmaputra/India	8	0	A	CE	A	AC	0
BangPakong/Thailand	7	A	A	CC	B>C	AB	0
Biobio/Chile	7	0	A	CB	C>B	DB	0

The hypotheses related to adaptive capacity and the response to climate change seem to be reasonably well chosen. Horizontal integration, information management and innovative ways for dealing with uncertainty seem to be key requirements for an innovative response. But they seem not to be sufficient in isolation.

4.2.2 State Environment

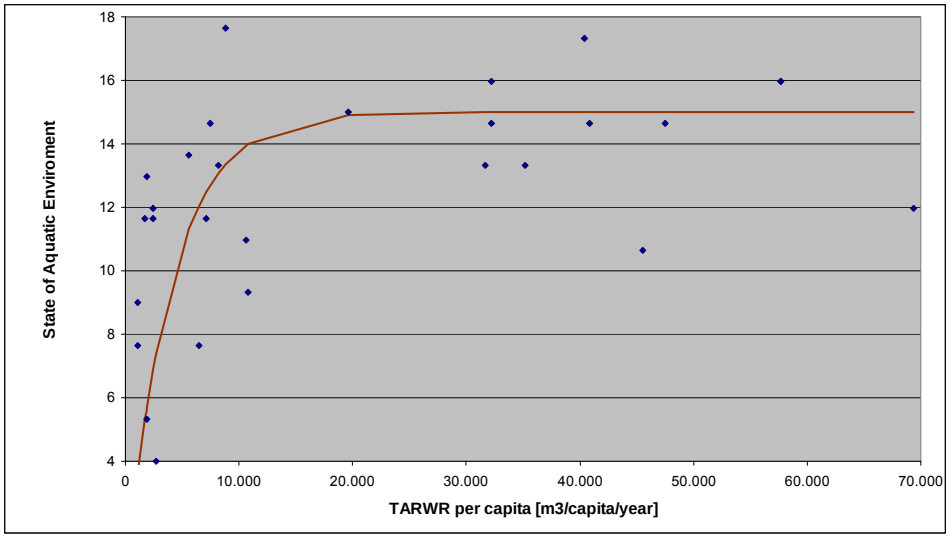
Table 31: State of the environment

P5a State Environment						
National Basin	P5a		Score H 1	Score H 2	Score H 6	Score H 7
Okavango/Namibia	15		A/AAA	AA	AA	AC
Cuareim/Uruguay	13		A/AA	A	0	BB
Norrström/Sweden	12		A/AA	A	A	AA
Baker/Chile	12		A/0	A	0	CC
Biobio/Chile	12		A/0	0	A	CB
Elbe/Germany	12		A/AAA	AAA	A	AC
Guayas/Ecuador	12		A/0	0	0	CE
Niger/Mali	11		B/AAAA	AA	A	AB
Brahmaputra/India	11		B/0	0	A	CE
Nura/Kazahstan	11		B/AA	A	A	BD
Quaraí/Brasil	11		A/AA	AAA	AAA	CD
Rhine/TheNetherlands	11		A/AAA	AAA	AAA	AB
Brahmaputra/Bhutan	11		D/AAAA	A	AAA	AC
Catamayo/Ecuador	11		A/0	0	0	CE
Cauca/Colombia	11		A/AA	0	A	BC
Thames/UK	11		A/AAAA	AAA	AAA	AA
Cocibolca/Nicaragua	9		C/AA	A	0	AB
Brahmaputra/Nepal	9		A/0	A	AA	AC
Volga/Russia	9		A/AAA	A	A	AC
Olifants/SouthAfrica	8		A/AAAA	A	AA	AC
Catamayo/Peru	8		B/AAA	0	AA	AC
Kyoga/Uganda	8		A/AAA	0	A	AC
Tisza/Hungary	8		A/AAAA	AAA	AAA	AB
Orange/SouthAfrica	7		B/AAAA	A	A	AC
BangPakong/Thailand	7		D/A	A	A	CC
Amudarya/Uzbekistan	5		A/0	AA	0	AD
RedRiver/Vietnam	5		A/A	A	0	BB
Guadiana/Spain	4		A/AAAA	AAA	AA	AB

The state of the environment as quantified in our analyses seems not to be linked to any kind of regime characteristics. In particular, some basins score very high regarding the state of the environment despite very low performance in the regime. This is not a very satisfactory finding and needs further reflection – possibly taking into account context. A first preliminary assessment showed that neither the state of economic development nor basin size do offer an explanation.

However, there seems to be clear correlation between the state of the environment and the availability of water resources TARWR (see Table 32). Even when TARWR is only available for the national level, it gives an indication of the pressure on water resources. Hence, the state of the environment needs to be related to the pressure on water resources. The higher the pressure, the more likely it is that good governance will make a difference. This can serve as a guide for a more refined indicator.

Table 32: TARWR – State of the environment



The figure indicates a kind of threshold for per capita water availability. But the data base on per capita water availability in the different basins and changes over time are too poor to draw more robust conclusions from these preliminary analyses.

4.2.3 Environmental Management Practice

Table 33: Environmental management practice

P5b EnvManag Practice National Basin	P5b	Score H 1	Score H 2	Score H 6	Score H 7	GDP
Elbe/Germany	20	A/AAA	AAA	A	AC	34.401
Volga/Russia	20	A/AAA	A	A	AC	14.690
Norrström/Sweden	18	A/AA	A	A	AA	36.712
Cauca/Colombia	16	A/AA	0	A	BC	8.587
Rhine/TheNetherlands	16	A/AAA	AAA	AAA	AB	38.694
Thames/UK	16	A/AAAA	AAA	AAA	AA	35.130
Tisza/Hungary	16	A/AAAA	AAA	AAA	AB	18.755
BangPakong/Thailand	14,66	D/A	A	A	CC	8.135
Guadiana/Spain	14	A/AAAA	AAA	AA	AB	31.560
Nura/Kazahstan	14	B/AA	A	A	BD	10.863
Olifants/SouthAfrica	12	A/AAAA	A	AA	AC	9.757
Quaraí/Brasil	12	A/AA	AAA	AAA	CD	9.567
Baker/Chile	11,33	A/0	A	0	CC	13.880
Cocibolca/Nicaragua	11,33	C/AA	A	0	AB	2.570
Brahmaputra/India	10,66	B/0	0	A	CE	2.753
Catamayo/Ecuador	10,66	A/0	0	0	CE	7.449
Okavango/Namibia	10,66	A/AAA	AA	AA	AC	5.155
Cuareim/Uruguay	10	A/AA	A	0	BB	11.216
Orange/SouthAfrica	8,66	B/AAAA	A	A	AC	9.757
Brahmaputra/Bhutan	8,66	D/AAAA	A	AAA	AC	4.837
Catamayo/Peru	8,66	B/AAA	0	AA	AC	7.836
Niger/Mali	8,66	B/AAAA	AA	A	AB	1.083
Biobio/Chile	8,66	A/0	0	A	CB	13.880
Amudarya/Uzbekistan	7,33	A/0	AA	0	AD	2.425
Brahmaputra/Nepal	7,33	A/0	A	AA	AC	1.049
Guayas/Ecuador	5,33	A/0	0	0	CE	7.449
Kyoga/Uganda	5,33	A/AAA	0	A	AC	1.059
RedRiver/Vietnam	4,66	A/A	A	0	BB	2.600
Paute/Ecuador		A/0	0	0	CE	7.449

Environmental management practice seems to be more strongly related to domestic legislation and the basin principle. High and low performance corresponds to high and low scores in these two regime characteristics, respectively.

However, a decisive criterion is the state of economic development. Management practices including data collection and monitoring depend on resources, which is clearly shown in the correlation between management practice and GDP per capita (see Fig. 12). However, one can note as well that there is considerable variation within a given state of economic development.

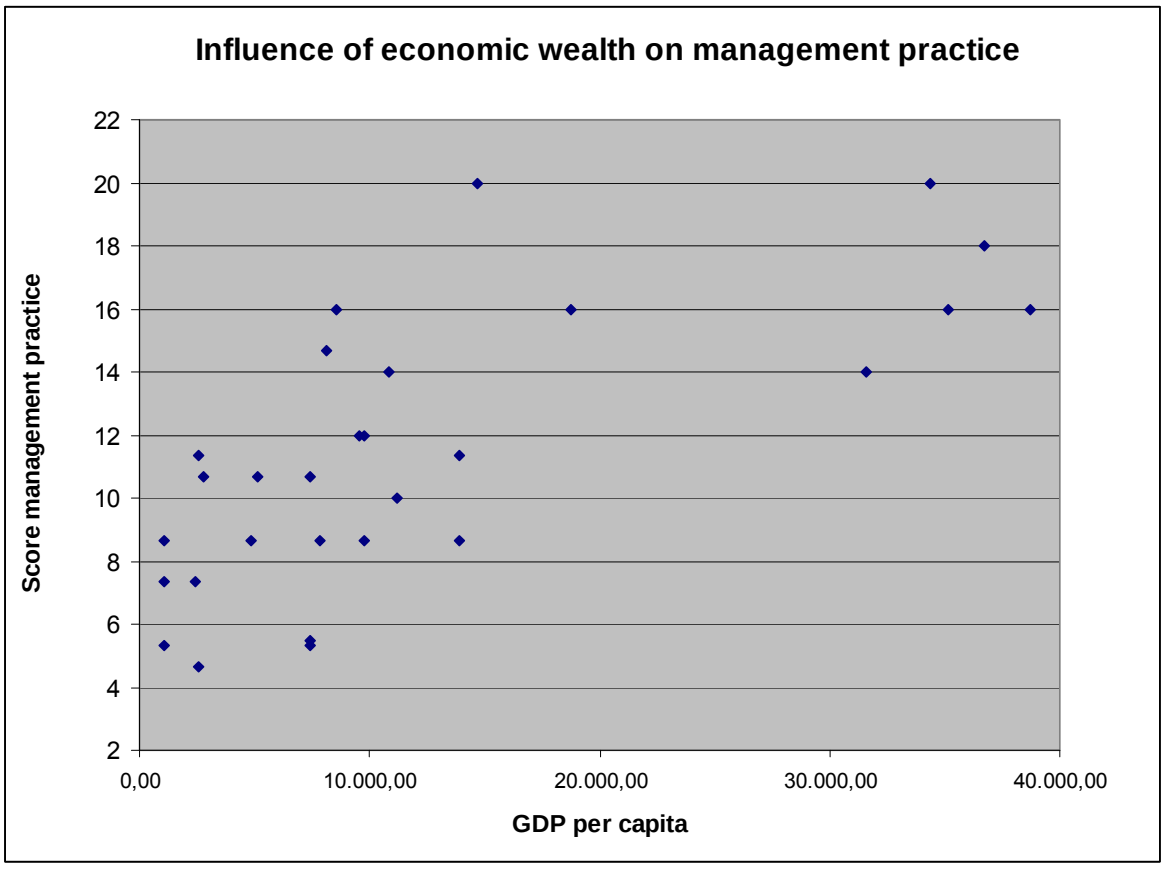


Fig. 12: Association between GDP per capita and management practice

4.2.4 Good Governance (including stakeholder participation)

Table 34: Good governance (including stakeholder participation)

P2 & P3 Good Governance

National Basin	P2 & P3	Score H 1	Score H 12	Score H 6	Score H 7	Score H 8
Thames/UK	24	A/AAAA	16	AAA	AA	AA
Brahmaputra/Bhutan	24	D/AAAA	12	AAA	AC	AB
Tisza/Hungary	22	A/AAAA	16	AAA	AB	AB
Norrström/Sweden	22	A/AA	16	A	AA	AA
Quaraí/Brasil	22	A/AA	14	AAA	CD	AA
Rhine/TheNetherlands	21	A/AAA	16	AAA	AB	BB
Guadiana/Spain	21	A/AAAA	12	AA	AB	AC
Cuareim/Uruguay	20	A/AA	14	0	BB	AB
Elbe/Germany	19	A/AAA	16	A	AC	AB
Catamayo/Peru	17	B/AAA	12	AA	AC	BB
Niger/Mali	16	B/AAAA	12	A	AB	AB
Okavango/Namibia	16	A/AAA	8	AA	AC	BB
BangPakong/Thailand	16	D/A	2	A	CC	AB
Cauca/Colombia	15	A/AA	12	A	BC	AB
Brahmaputra/Nepal	14	A/0	12	AA	AC	AC
Volga/Russia	14	A/AAA	10	A	AC	BB
Cocibolca/Nicaragua	13	C/AA	12	0	AB	AB
Kyoga/Uganda	12	A/AAA	10	A	AC	AC
Nura/Kazahstan	12	B/AA	8	A	BD	BB
Orange/SouthAfrica	12	B/AAAA	14	A	AC	BB
Olifants/SouthAfrica	10	A/AAAA	12	AA	AC	BA
Brahmaputra/India	9	B/0	12	A	CE	AC
RedRiver/Vietnam	9	A/A	8	0	BB	BC
Paute/Ecuador	9	A/0	2	0	CE	DD
Baker/Chile	8	A/0	10	0	CC	BC
Catamayo/Ecuador	6	A/0	2	0	CE	DD
Guayas/Ecuador	6	A/0	6	0	CE	DD
Biobio/Chile	4	A/0	6	A	CB	DB
Amudarya/Uzbekistan	2	A/0	2	0	AD	BE

Also good governance shows a recognizable pattern. Brahmaputra/Bhutan scores very low in H1, since domestic legislation is yet in the formation stage. However, the other attributes of domestic legislation are very advanced.

5 Statistical investigation

5.1 Introduction

There are strong but diverse views on what needs to be done to make water governance regimes more effective. Some believe that legal regulatory frameworks and basin-orientation are essential. Others argue the need for multi-level and polycentric architectures. Some focus on ways of expanding multi-stakeholder participation and deliberation. Many argue the importance of knowledge management. Each group can point to instances of partial success and failure.

Perspectives also differ with respect to the emphasis placed on goals and outcomes such as economic efficiency or opportunities for wealth creation and growth, fairness and equity in allocation and mitigation of adverse environmental impacts or ecological sustainability. Others argue that water governance would benefit from greater emphasis on social-ecological or other more integrative system perspectives.

At the same time there is a growing recognition that there may be no universal solutions, that social, institutional and biophysical context matters. Transferring institutional designs or other best practices from one basin, region or country to another may not be as straightforward as hoped.

Moreover, what works today may not tomorrow. Rapid changes in land and water use as well as prospects of climate change imply that key contextual variables are dynamic and uncertain (Palmer et al. 2008, Hallegatte 2009). Management and governance of water will often have to be adaptive to anticipate and adjust effectively to changing circumstances (Pahl-Wostl 2007, Pahl-Wostl et al. 2008, Huntjens et al. 2010).

Unfortunately, in contrast to the many excellent case studies and small-N comparative studies of particular governance elements, there have been few comprehensive empirical analyses of water governance regimes that can be drawn onto critically scrutinize accepted wisdom and speculate on future needs.

This section reports on a quantitative analysis of the water governance regimes of 29 river basins in Europe, Asia, Latin America and Africa. The main objective of the study was to test a set of relationships about the features of water governance regimes widely believed to be important for performance. A secondary objective was to explore and identify other key relationships between key

regime variables and performance and context that may have not yet been given sufficient attention in past studies.

5.2 Methods

5.2.1 Performance, regime and context measures

Five performance measures were considered (Table 35). Scores on performance measures were calculated by summing for each variable the difference between the observed score and maximum possible score divided by the maximum possible score and then taking the total and dividing by the total number of variables (n) or:

$$\text{Performance}_p = \left(\Sigma \left(\max(s_{p,i}) - s_{p,i}\right)/(\max(s_{p,i})-1)\right) / n \quad \text{for } i=1 \text{ to } n$$

In this approach individual variables were thus given equal weight, and all composite performance measures varied between 0 – 1. If responses on all variables fell into the lowest performance category, then the performance measure would be 0 and if all in highest category the measure would be 1. Alternative indices using unequal weights based on logical arguments about the relative importance of variables were explored and rejected, as they yielded results highly correlated with simpler un-weighted indices. As the performance measures could take on many values, they were treated as continuous variables for further analysis using regression methods. An overall performance measure was also defined as the unweighted average of the individual performance measures.

Table 35: Performance, regime and context measures

Performance measures			**Regime measures**	
P1	Progress towards stated goals		*Institutional setting*	
P23	Good governance principles		R1	Legal frameworks
P4	Response to climate change		R2	Basin principles formalized
P5A	Environmental conditions		R11	Economic and financial instruments
P5B	Environmental management practices		R12	Good governance principles in legislation
			Regime architecture	
			R4	Polycentric
			R6	Vertical integration
Context measures			R7	Horizontal integration
C1	Economic & institutional development		R10	Integrated water resources management
C2	Water availability		*Knowledge and information management*	
C3	Watershed modification		R8	Knowledge
C4	Basin Size		R9	Handling uncertainty

Composite regime measures (Table 35) were calculated from a set of contributing variables in the same way as performance measures. One regime variable had more complex definitions: The idea of polycentricity (R4) is that power is distributed without loss of coordination. To capture this idea in a single index is difficult but was done here by considering two elements. First, if there is distribution of power to multiple centers with horizontal coordination. Second, if there is decentralization, then it is with authority and capacity to act at lower levels. Details of calculations for all measures are given in the annex *Derivation of aggregate measures for statistical analysis*.

Associations between regime and performance measures were adjusted where appropriate by context measures. Context measures (Table 35) were calculated from a set of contributing variables in the same way as performance measures. Variable sets for context measures were identified using exploratory factory analysis and then simplified further with logic.

5.2.2 Data analysis

The general logical structure of the analysis in this section attempted to relate sets of variables or measures describing regimes to performance adjusting for context (Fig. 13). As performance, regime and context variables could take on several to many values between 0 and 1, and all had reasonable distributions, they were treated as continuous variables and relationships between them analyzed

using linear regression methods. Analyses were made using multiple linear regression routines in SPSS Version 16.0 software.

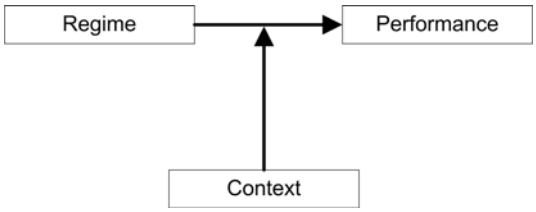


Fig. 13: General model for explaining performance based on regime characteristics in different contexts.

5.3 Results

5.3.1 Variation among basins

River basins that scored highly on one performance measure did not necessarily do so on another (Fig. 14). For example, river basins scoring highly on progress on MDGs are, not surprisingly, mostly from developed countries in Europe, but environmental conditions in these basins varied widely.
Fig. 15 summarizes the distribution of scores on the regime measures. Average scores are high for some measures and relatively low for others.

Fig. 14: Variation among basins in performance measures. Basins are organized according to broad geographical regions (source: Pahl-Wostl et al., in press).

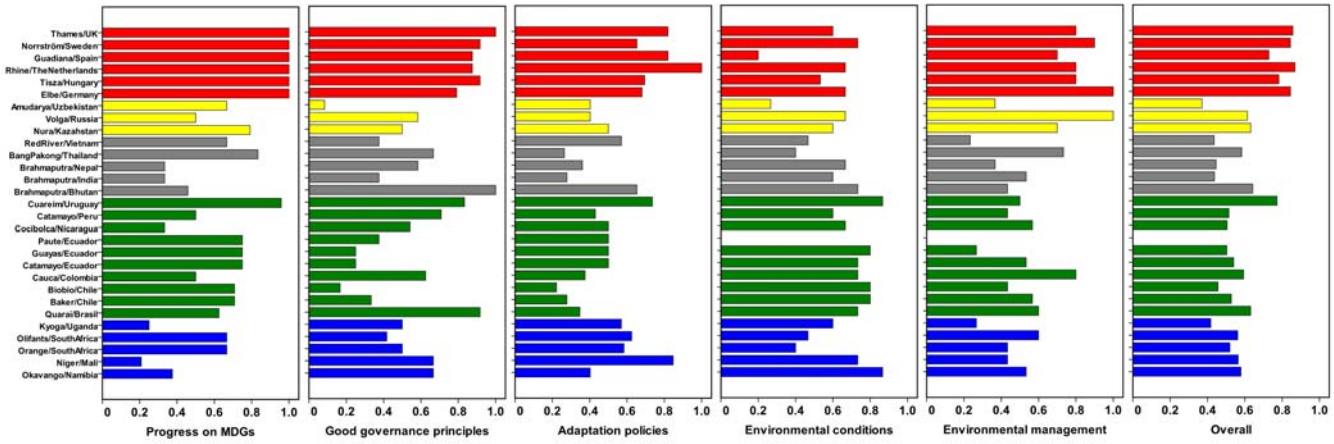
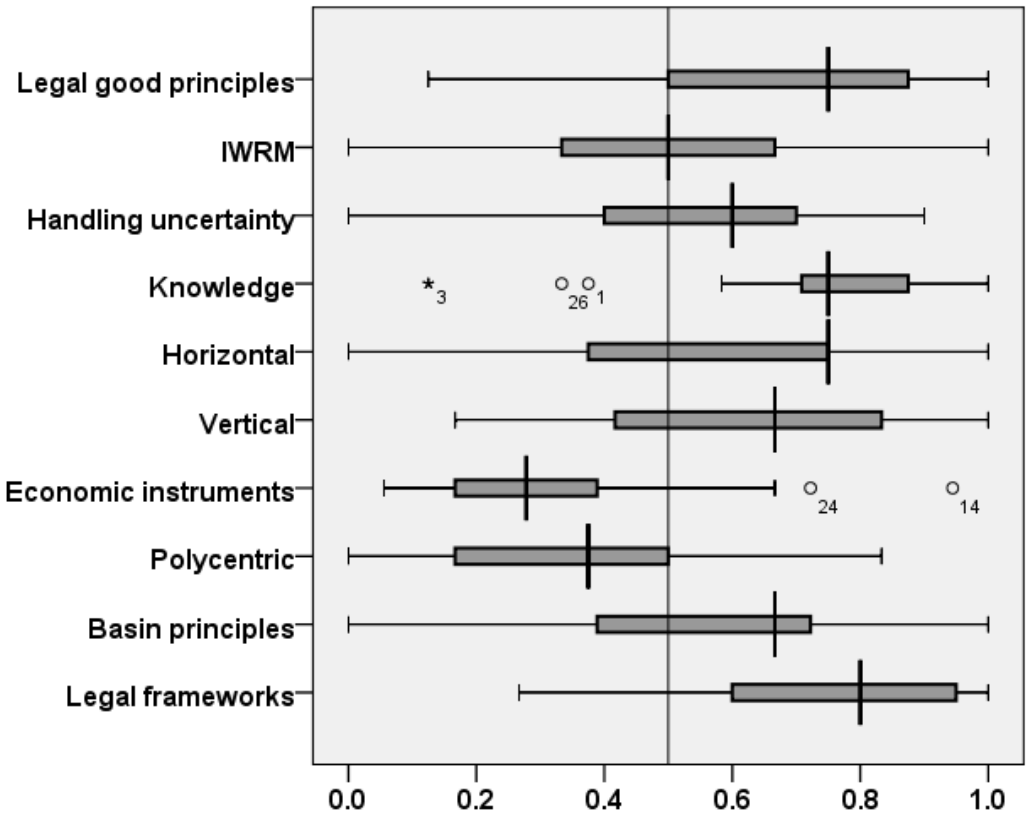


Fig. 15: Box-plot summary of variation in regime variables. Boxes span inter-quartile range and vertical dashes are medians.



5.4 Simple tests of association

The importance of different regime measures was tested by examining the correlation between performance and regime measures. In this first analysis no adjustment was made for context variables.

Good governance and stakeholder engagement (P2P3) and adaptive capacity (P4) performance measures were associated with most regime measures hypothesized to be important (Table 36). In contrast, few or no regime measures were associated with progress towards MDG goals (P1), environmental conditions (P5A) or environmental management (P5B) performance indicators (Table 36).

Some key associations will now be highlighted.

The presence of water related legal frameworks (R1) and the formalization of basin principles (R2) was closely related to the adoption of good governance principles and stakeholder engagement (P2P3) but not to measures of environmental performance (P5A, P5B). Legal frameworks were also associated with having climate change adaptation policies (P4).

A polycentric architecture (R4) was strongly associated with adoption of good governance principles and stakeholder engagement (P2P3), presence of climate change adaptation policies (P4), and environmental management measures (P5B) of performance (Table 36). Patterns of association with other measures of regime architecture – vertical and horizontal integration (R6, R7) – were similar to those for more complex and comprehensive measure of polycentricity (Table 36).

Open access to information and integration of different kinds of knowledge (R8) are associated with high performance in adopting good governance principles (P2P3) and environmental management practices (P5B). Taking into account different kinds of uncertainties (R9, handling uncertainty) was positively associated with good governance principles (P2P3) and presence of climate change adaptation policies (P4) as might be expected (Table 36).

Table 36: Associations between performance and regime measures. Values are regression coefficients with SE in parentheses. (* P<.05 ** P<.01 *** P<.001).

Regime measure *Performance Measure*	*P1* *MDG goals*	*P2P3* *Good gov-ernance*	*P4* *Adaptation policies*	*P5A* *Environmen-tal condi-tions*	*P5B* *Environmen-tal man-agement*	*P All* *Overall*
R1 Legal frameworks	.06 (.21)	.67 (.18)***	.47 (.14) **	-.02 (.14)	.33 (.13)	.31 (.11) **
R2 Basin principles	.15 (.16)	.56 (.12)***	.23 (.12)	-.14 (.10)	.24 (.14)	.23 (.09) *
R4 Polycentricity	.18 (.19)	.81 (.13)***	.54 (.11)***	.04 (.13)	.34 (.16)*	.40 (.09) ***
R11 Econ. instruments	.53 (.20)*	.68 (.20)**	.61 (.13)***	-.04 (.15)	.44 (.18)*	.45 (.10) ***
R6 Vertical integration	.07 (.18)	.78 (.11)***	.35 (.12)**	.01 (.12)	.33 (.15)*	.33 (.09)***
R7 Horizontal integration	.04 (.15)	.44 (.12)**	.36 (.09)***	-.10(.10)	.18 (.13)	.20 (.08) *
R8 Knowledge	-.01 (.19)	.79 (.12)***	.22 (.14)	.02 (.13)	.43 (.16)*	.32 (.10) **
R9 Handling uncertainty	.35 (.22)	.84 (.18)***	.69 (.12) ***	-.04 (.15)	.22 (.19)	.41 (.10) ***
R10 IWRM	.16 (.15)	.62 (.11) ***	.35 (.10) **	-.04 (.11)	.37 (.12) **	.31 (.07) ***
R12 Good governance principles in legislation	.12 (.16)	.65 (.12) ***	.34 (.11) **	.08 (.11)	.34 (.14) *	.33 (.08) ***

5.4.1 Taking into account context

A second analysis of the importance of various regime features was carried out using multiple regression to adjust associations between regime and performance by four context measures. The procedure followed was to force the regime measure under test into the equation and then enter the four context regime variables using automatic stepwise procedure. The results of this second set of analyses are shown in Table 37.

Context variables helped explain additional variation in all performance measures (Table 37). Overall level of economic and institutional development (C1) in particular was strongly associated with three performance measures (P1, P2P3 and P5B) for almost all regime associations tested. The level of watershed modification (C3) – as might be expected – was strongly inversely associated with environmental conditions (P5A). Basin size (C4) was positively associated with good governance (P2P3) for several regime associations (Table 37).

Adjusting for context had little impact on most associations between regime features and performance, but there were a few exceptions as follows.

Associations between economic instruments (R11) and two performance measures (P1, P5B) were no longer significant after adjusting for level of economic and institutional development context (C1). Similarly, the association between legal good governance principles (R12) with environmental management performance (P5B) was no longer significant after adjustment with development context (C1).

Associations for five regime measures (R1, R4, R6, R8, R12), which were not originally detected (Table 36), became significantly negatively associated with achievement of water related MDGs after adjustment for confounding by context (Table 37). For these regime measures achievement of water related MDGs are dominated by the overall state of economic and institutional development (C1 high regression coefficients). Why association should become negative after this adjustment, however, is not easy to explain without additional information, but may in part be a result of many cases from Europe having basically achieved full scores and thus no further improvement is possible (see Fig. 14).

Another clear pattern was the strong association of degree of water and watershed modification (C3) on status of biodiversity and environmental conditions in rivers (P5A) across all regime measures tested (Table 37). Environmental management practices (P5B), however, were more closely related to economic and institutional development (C1) as might be expected. Water availability (C2) was not strongly associated with any of the performance measures (Table 37).

Table 37: Associations between performance and regime measures after adjustment for confounding by context. Values are regression coefficients with SE in parentheses. Entries on second or third line in each row prefixed with a C refer to the regression coefficients and significance of the corresponding context variable (* P<.05 ** P<.01 *** P<.001).

Regime measure ***Performance Measure***	***P1*** ***MDG goals***	***P2P3*** ***Good governance***	***P4*** ***Adaptation policies***	***P5A*** ***Environmental conditions***	***P5B*** ***Environmental management***	***Pall*** ***Overall***
R1 Legal frameworks	-.32 (.12) * C1 .88 (.10) ***	.66 (.17) *** C1 .36 (.14) * C4 .34 (.14) *	.47 (.14) ** -	-.02 (.13) C3 .24 (.10) *	.12 (.15) C1 .50 (.13) ***	.14 (07) C1 .41 (.06) ***
R2 Basin principles	-.02 (.10) C1 .79 (.11) ***	.48 (.11) *** C1 .36 (.13) *	.17 (.11) C1 .28 (.13) *	-.18 (.09) C3 .27 (.09) ** C1 .21 (.10) *	.13 (.11) C1 .50 (.12) ***	.14 (.05) ** C1 .42 (.06) ***
R4 Polycentricity	-.28 (.15)* C1 .91 (.11) ***	.88 (.12)*** C4 .26 (.11) *	.54 (.11)*** -	-.04 (.13) C3 .23 (.10) *	.07 (.15) C1 .51 (.14) ***	.21 (.06) ** C1 .36 (.06) ***
R11 Economic instruments	-.08 (.17) C1 .82 (.13) ***	.68 (.20)** -	.61 (.13)*** -	-.01 (.14) C3 .24 (.10) *	.06 (.18) C1 .51 (.15) **	.17 (.09) C1 .38 (.07) ***
R6 Vertical integration	-.31 (.10)* C1 .91 (.10) ***	.75 (.11)*** C1 .24 (.11) * C4 .28 (.10) **	.35 (.12)** -	-.01 (.11) C3 .24 (.10) *	.12 (.13) C1 .49 (.13) ***	.16 (.06) * C1 .39 (.06) ***
R7 Horizontal integration	-.16 (.09) C1 .84 (.11) ***	.42 (0.12)** C1 .41 (.14) ** C4 .31 (.14) *	.36 (.09)*** -	-.09 (.09) C3 .23 (.10) *	.05 (.11) C1 .52 (.12) ***	.10 (.05) * C1 .42 (.06) ***
R8 Knowledge	-.27 (.10)* C1 .85 (.10) ***	.70 (.12)*** C1 .31 (.11) *	.13 (.14) C1 .30 (.13) *	-.04 (.13) C3 .24 (.10) *	.29 (.13)* C1 .47 (.11) ***	.20 (.06) ** C1 .41 (.05) ***
R9 Handling uncertainty	-.08 (.15) C1 .81 (.12) ***	.84 (.18)*** -	.69 (.12)*** -	-.21 (.14) C3 .29 (.10) ** C1 .24 (.11) *	-.08 (.16) C1 .56 (.13) ***	.21 (.07) ** C1 .38 (.05) ***
R10 IWRM	-.14 (.10) C1 .85 (.11) ***	.62 (.11) *** -	.35 (.10) ** -	-.01 (.09) C3 .23 (.10) *	.21 (.11) C1 .43 (.12) ***	.17 (.05) *** C1 .37 (.05) ***
R12 Good governance principles in legislation	-.33 (.09)*** C1 .97 (.10) ***	.65 (.12) *** -	.34 (.11) ** -	.02 (.11) C3 .23 (.10) *	.10 (.13) C1 .48 (.14) **	.14 (.06) * C1 .38 (.06) ***

5.5 Discussion

Water governance regimes helped explain variation in some but not all proposed measures of performance. Regime measures describing institutional settings were closely related to adoption of good governance principles in water management but not environmental measures of performance. Regime architecture was particular important to responsiveness to climate change. Knowledge and information management were relevant to all performance measures apart from environmental conditions.

A key and somewhat surprising finding of our study is that the association between regime features and performance were only rarely confounded by context. At the same time context is very important helping explain a lot of residual variation in most performance-regime measure associations. Institutional and economic development for example was often significant for associations between regime variables and progress towards goals, adoption of good governance principles, and environmental management practices. For environmental conditions the extent of land and water modification was a key context variable.

Overall, very few associations between governance regimes and measures of environmental performance were detected in this study. One possible explanation is that basins in countries with high level of economic and institutional development also tend to be the most heavily modified. Water governance regimes addressing environmental problems may tend to be introduced only after they have started to occur.

The analyses in this study have several limitations. First are measurement problems with the questionnaire process itself. Many basin-specific indicators were based on judgments of experts, and these necessarily varied across basins and regions of the world. Substantial effort was put in the design of the instrument to reduce comparability problems by explaining scoring levels as explicitly as possible. Even so language differences and effects of who happened to participate in scoring exercises cannot be completely eliminated. The use of composite measures rather than individual variables should help reduce the influence of scores on individual questions, which might have been more difficult to understand or scored less consistently across basins.

Second, a substantial fraction of variables used to derive performance measures were national level rather than basin-specific. Exceptions were the environmental performance measures, which were often available at the basin levels. This likely weakened our ability to detect associations between regimes and performance.

Third, the sample of basins for which data was available was not ideal. As it is based on prior twinning projects with EU, there were no basins in North America, Australia or the Pacific in the study. A broader geographic spread and larger sample size would greatly improve the ability of this approach to explore hypotheses more rigorously, in particular effects of context, and interactions between regime features. Although we tried to reduce the number of statistical tests made by having explicit hypotheses drive the work from the start, and created composite measures for regime and context, there were still a lot of hypotheses and variables measured relative to number of observations.

Fourth, the analysis required making assumptions about the distribution and statistical behavior of composite measures that did not strictly hold. For exploratory purposes and to keep methods simple this is justifiable but not necessarily the most optimal way to assess all these associations. Other approaches should also be tried and compared to ensure findings are robust. This has already been done as part of the Twin2Go project. Two of the co-authors of this paper have analyzed the same datasets using different qualitative procedures (see sections 4 and 6) and have come to similar conclusions suggesting that the main patterns are robust.

The immediate significance of this study is that it demonstrates the plausibility of systematic and comprehensive comparison of water governance regimes. The set of indicators are a good foundation for more rigorous testing of propositions and developing recommendations.

From a policy perspective the findings of this study also give some confidence as well as cautions about common generalizations on what works and what does not in water governance and thus should inform on-going debates to identify best practices for particular basins.

5.6 Literature Cited

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6 Cross tab approach

6.1 Summary

This analysis approach has two objectives: (1) to detect relationships between governance regime and performance and (2) to examine the impact of context. First, aggregations for regime, context and performance were defined and built based on the indicators from the Twin2Go questionnaire (see Twin2Go deliverable 1.3), for which case study data had been collected. Values for these aggregations from various case studies were subsequently inserted in contingency tables (cross tabs). The interpretation of how case study values were distributed in the cross tabs allowed identifying associations between regime and performance aggregations as well as between context and performance aggregations.

6.2 Methodology

The methodological approach comprises the following steps:

1. **Define aggregations:** To achieve more robust results and reduce complexity, aggregations were defined to combine indicators from the Twin2Go questionnaire. Indicators describing regime were aggregated according to hypotheses in section 3, whereas context and performance indicators were aggregated according to insights from statistical factor analysis (covarying indicators). To facilitate interpretability of the context and performance aggregations, those indicators were dropped from a factor that address a different topic than the other indicators. The aggregations and the indicators on which they build are shown in the annex *Cross tab approach: Regime, context and performance aggregations*.
2. **Recode indicators & build aggregations:** As the indicators from the Twin2Go questionnaire have varying data ranges (e.g. A-C, A-E), these data ranges had to be recoded to a standardized A-C range for each indicator. Afterwards, an overall score of the aggregation was chosen for each aggregation (e.g. if three recoded scores were “A” and two “B”, the score of the aggregation became “A”). This was done for all 29 case studies. The rules for recoding indicators and building aggregations are shown in the annex *Cross-tab approach: Recoding rules for the creation of aggregations*. The annex *Cross tab approach: Values of the aggregations, measure to assess overall governance, recoded TARWR values* presents the values of the aggregations built as well as a coarse measure to assess the overall governance of each case study.

3. **Create cross tabs:** For each pairwise combination of regime and performance aggregations, a cross tab was created. The 29 case studies (resp. 28 for combinations with P5A and P5B) were inserted in the cross tab fields that corresponded to the value of their accordant regime and performance aggregation values (see Table 38). The same was done for pairwise combinations of context and performance aggregations.

Table 38: Cross tab

	P_Y: A	**P_Y: B**	**P_Y: C**
R_X: A	case study 1		case study 4 case study 6
R_X: B	case study 3 case study 5	case study 7	
R_X: C		case study 2	

4. **Interpret cross tabs:** The distribution pattern of the case studies in the cross tabs allows identifying associations between a regime or context aggregation and a performance aggregation: If case studies accumulate along the diagonal line from AA to CC in the cross tab, this suggests a positive association between these two aggregations. If however case studies accumulate along the diagonal line from CA to AC, this suggests a negative association. Table 39 shows the rules that were applied to detect positive or negative associations between two aggregations.

Table 39: Rules for the detection of associations between two aggregations

		Condition 2: Number of cases located on diagonal line*	
		10 - 14	15 or more
Condition 1: Number of cases in AC and CA cells divided by number of cases in AA and CC cells	1/3 or lower	Medium positive association	Strong positive association
	3 or higher	Medium negative association	Strong negative association

* diagonal line AA-BB-CC for positive associations, CA-BB-AC for negative associations

6.3 Results

Table 40 and Table 41 show detected associations between regime and performance aggregations as well as between context and performance aggregations. See annex *Cross-tab approach: Details of analysis results* for the details analysis results.

Table 40: Detected associations, Regime - Performance

Detected Associations: Regime - Performance	P1: Progress towards water-related Millennium development Goals	P2/3: Realization of Good Governance Principles (including participation)	P4: Climate change adaptation	P5A: Good state of the environment	P5B: Good management practice (monitoring)
R1: Advanced water legislation		1			
R2: Adoption of basin principle		1	2		1
R4/5a: Avoidance of fragmentation in governmental governance regime		1			
R4/5b: Polycentric instead of centralized governance		1			
R6: Strong Vertical Integration		1			
R7: Strong Horizontal integration			2		
R8: Participative Knowledge management		1			2
R9: Handling uncertainties comprehensively	2	1	2		2
R10: Adoption of IWRM		1			2
R11: Application of economic & financial instruments			1		1
R12: Incorporation of Good Governance Principles in legislation		1			2

-2: medium neg. association; -1: strong neg. association; 1: strong pos. association; 2: medium pos. association

Table 41: Detected Associations: Context - Performance

Detected Associations: Context - Performance	P1: Progress towards water-related Millennium development Goals	P2/3: Realization of Good Governance Principles (including participation)	P4: Climate change adaptation	P5A: Good state of the environment	P5B: Good management practice (monitoring)
C1: Advanced societal development	1	1			1
C2: High water availability			-1		
C3: Low watershed modification	-2				
C4: Low basin size					

-2: medium neg. association; -1: strong neg. association; 1: strong pos. association; 2: medium pos. association

Table 42: Overall Governance[2] and Total Actual Renewable Water Resources (TARWR[3]) values.

No.	Case Study	Overall Governance	TARWR (2005)
1	Catamayo/Peru	14	69.390,00
2	Biobio/Chile	7	57.640,00
3	Baker/Chile	9	57.640,00
4	Cauca/Colombia	12	47.470,00
5	Quaraí/Brazil	16	45.570,00
6	Brahmaputra/Bhutan	18	40.860,00
7	Cuareim/Uruguay	14	40.420,00
8	Cocibolca/Nicaragua	11	35.140,00
9	Catamayo/Ecuador	1	32.170,00
10	Guayas/Ecuador	1	32.170,00
11	Paute/Ecuador	1	32.170,00
12	Volga/Russia	11	31.650,00
13	Norrström/Sweden	21	19.580,00
14	Red River/Vietnam	12	10.810,00
15	Tisza/Hungary	22	10.580,00
16	Okavango/Namibia	14	8.810,00
17	Brahmaputra/Nepal	11	8.170,00
18	Niger/Mali	19	7.460,00
19	Nura/Kazakhstan	8	7.120,00
20	BangPakong/Thailand	8	6.460,00
21	Rhine/The Netherlands	23	5.610,00
22	Guadiana/Spain	18	2.710,00
23	Kyoga/Uganda	11	2.470,00
24	Thames/UK	24	2.460,00
25	Amudarya/Uzbekistan	4	1.900,00
26	Elbe/Germany	20	1.870,00
27	Brahmaputra/India	4	1.750,00
28	Orange/South Africa	14	1.110,00
29	Olifants/South Africa	15	1.110,00

[2] See annex *Cross tab approach: Values of the aggregations, measure to assess overall governance, recoded TARWR values* for the calculation of the Total Governance values.
[3] Indicator 58 from the Twin2Go questionnaire (see deliverable 1.3), measured per capita at the national level.

6.4 Interpretation of Results

The results show that good water governance alone is not sufficient to achieve significant progress towards the water-related Millennium Development Goals (access to drinking water and sanitation). Instead, progress in this regard requires advanced societal development (e.g. measured by per capita income and effectiveness of institutions).
Although advanced societal development supports the satisfaction of human basic needs, it is not associated with a better state of the environment. This finding may appear surprising given the fact that advanced societal development leads to better management practice, which has been examined here with regard to monitoring. Societal development apparently occurs at the expense of environmental needs; ensuring widespread access to drinking water and sanitation has commonly been associated with a certain degree of watershed modification. Improved management practice can mitigate negative effects on ecosystems, but obviously does not achieve a better state of the environment than in low developed countries.

Favorable water governance is highly relevant to the realization of the Good Governance Principles in practice, bringing about water management processes that are participatory, transparent, effective and efficient, as well as equitable and inclusive. Nearly all analyzed governance characteristics are strongly associated with performance in this respect. An advanced level of societal development is conducive as well.

Several governance regime features support climate change adaptation. The application of economic and financial instruments (e.g. appropriate water prices, polluter-pays principle) apparently strongly increases the awareness of threats to water resources posed by climate change, and it supports the generation of knowledge for climate change adaptation. However, this finding has to be regarded with caution, because a wide range of economic and financial instruments has been applied only in a few case studies. The basin principle, horizontal integration as well as a comprehensive way of dealing with uncertainties seem to be moderately linked to climate change adaptation. Furthermore, the context analysis reveals that low water availability is conducive to climate change adaptation, whereas awareness and knowledge tend to be smaller in case of high water availability.

Good management practice in terms of sound water monitoring is linked to several water governance characteristics. The associations with the basin principle and the application of economic instruments are the strongest ones (the latter link needs to be regarded with caution again due to the limited prevalence). Furthermore, IWRM, participative knowledge management, comprehensive handling of

uncertainties and the incorporation of the Good Governance Principles in legislation tend to improve management practice.

The analysis does not reveal clear associations between characteristics of water governance regimes and the ecological state. Moreover, environmental management practice (examined here for water monitoring) is apparently not linked to the ecological state either. In other words, case studies with good water governance or management practice do not tend to have a better ecological state than case studies with worse water governance or management. This surprising finding may be explained by the pressure on water resources as an important context factor. The analysis reveals that high Total Actual Renewable Water Resources (TARWR) values, which indicate low pressure on water resources, are associated with a good ecological state. In this survey, case studies with advanced governance regimes are mainly located in spatial contexts with low TARWR values implying high pressure on the water resources[4]. Good water governance obviously helps to mitigate negative impacts by the pressure on the water resources but, it cannot fully compensate them.
Many river basins with low pressure on the water resources are still in a relatively good ecological state. It is therefore crucial to establish measures that prevent degradation caused by rising water demand in the future. Such measures should include improved governance structures.

[4] Seven out of eight case studies with the highest overall governance values have below-average TARWR values (see Table 42). These case studies have an average TARWR value of 11,391 m3/year/person, whereas the total average of all case studies is 21,458 m3/year/person.

7 Summary of results

7.1 Impacts of the water governance regime

The analyses show that water governance matters. Numerous characteristics of water governance regimes have a significant impact on performance, even though the extent of their influence varies.

The most outstanding impact can be attributed to regime architecture: Polycentric regimes, which are characterized by distributed centers of power with effective coordination, are highly conducive to the adoption of the good governance principles in practice, meaning that they help to make water management processes more participatory, transparent, effective and efficient, as well as equitable and inclusive. Polycentric regimes are clearly superior to centralized or fragmented regimes in this regard. Polycentricity also increases performance with regard to (expected) climate change. Polycentric regimes are associated with higher levels of climate change awareness and knowledge as well as with the existence of more advanced policies for climate change adaptation.
The other two regime architecture measures – vertical and horizontal integration – show a similar pattern, even though less distinctive than the more encompassing measure of polycentricity. Vertical integration is strongly associated with the adoption of the good governance principles in practice, but its significance for climate change adaptation is less strong. Horizontal integration shows an intermediate association with water management processes complying with the good governance principles. Its significance with regard to climate change adaptation is higher than in the case of vertical integration.

Another influential characteristic of water governance regimes is the way how uncertainties are addressed. If different kinds of uncertainties are addressed in a comprehensive way – including uncertainties that cannot be quantified (e.g. responses by human actors, different perspectives) – this is strongly conducive to participatory, transparent, effective and efficient, as well as equitable and inclusive management processes. Moreover, dealing with uncertainties in a comprehensive way is more strongly associated with high performance related to climate change adaptation than any other regime characteristic.

The use of financial and economic instruments in water management was found to be highly significant to climate change adaptation, and it has an intermediate association with the realization of the good governance principles in water management practice. However, a comprehensive application of financial and economic instruments could be found only in a few case studies. Therefore, this finding should be regarded with care.

The other regime characteristics that refer to the institutional setting – the presence of legal frameworks for water, the incorporation of the good governance principles in legislation and the adoption of the basin principle – as well as the adoption of IWRM principles are conducive to the realization of the good governance principles in practice, albeit not as strong as in the case of polycentric regime architecture, vertical integration and uncertainty handling. Whereas the presence of legal frameworks for water and the adoption of good governance and IWRM principles have an intermediate association with climate change adaptation, the basin principle is apparently not relevant in this regard.

The integration of different kinds of knowledge (both expert and local knowledge) and open access to information are particularly supportive to implementing water management processes that are participatory, transparent, effective and efficient, as well as equitable and inclusive. But surprisingly, this regime characteristic is not relevant to performance with regard to climate change adaptation.

Water governance is apparently not significantly linked to the realization of the water-related Millennium Development Goals, i.e. access to drinking water and basic sanitation. Surprisingly, only few clear associations with environmental management practice and none with the state of the environment could be found. These aspects will be addressed in the next section.

7.2 Taking the natural and socio-economic context into account

In general, adjusting for context has little impact on most association patterns, but it helps to explain additional variation.

Context analysis reveals that progress towards the water-related Millennium Development Goals heavily depends on the institutional and economic development within a society (e.g. general effectiveness of formal institutions, gross domestic product), and the influence of water governance is rather low. Advanced institutional and economic development also favors the realization of the good governance principles in water management. Nevertheless, the influence of the water governance regime remains clearly dominant in this regard.

Environmental management practice seems to be influenced only by a few water governance properties. After taking context into account, only the association with knowledge management persists. The general institutional and economic development within a society is apparently an important factor favoring environmental management practice. But although it is a significant context

factor, its impact is much less strong than in the case of progress towards the water-related Millennium Development Goals. This shows that institutional and economic development does not automatically improve environmental management practice to the same extent.

A strong degree of watershed modification seems to have a negative impact on the ecological state, as one might expect. But the strength of this association is not very large. Apparently there is a link between the per capita amount of water available at the national level (as measured by TARWR) and the ecological state within a basin. This finding implies that the pressure on the water resource is a decisive factor for its actual state. It also provides a potential reason why the analysis did not detect any clear association between water governance and the ecological state: Numerous river basins with a good ecological state lie in countries with low pressure on water resources. As long as the pressure remains low, an advanced governance regime is apparently not needed to protect the river basin from degradation. One should note however, that economic development and population growth will probably increase the pressure on water resources in many parts of the world. It is therefore advisable to establish mechanisms for the protection of water resources as early as possible, including advanced water governance structures.

A remarkable finding from the cross-tab approach is the finding that high water availability seems to be associated with less climate change awareness and accordant knowledge.

A central conclusion from the qualitative analysis is that it is necessary, but not sufficient to provide an elaborate legal framework for water management. It is also crucial to ensure the conditions for an effective implementation, for example, through providing enough financial resources and reducing corruption.

In the synthesis of the three analysis approaches above more emphasis was given to statistical investigation and qualitative examination than to the cross tab analysis. The reason is that the latter approach was explorative. Its quantitative methodology is less elaborate than statistical investigation. In contrast to qualitative examination, it is not case-sensitive. However, the qualitative analysis is complementary to the other two approaches and adds nuances to the joint analysis. The use of three methods improved the robustness of the findings.

Nevertheless, the analyses in this study have several limitations. First are measurement problems with the questionnaire process itself. Many basin-specific indicators were based on judgments of experts, and these necessarily varied across basins and regions of the world. Second, a substantial fraction of variables used to derive performance measures were national level rather than basin-

specific. Third, the sample of basins for which data was available was not ideal. As it is based on prior twinning projects with EU there were no basins in North America, Australia or the Pacific in the study.

8 Conclusions

The comparative analyses conducted by the Twin2Go project constitute a milestone in the field of water governance. They provide for the first time clear empirical evidence for the importance of polycentric architectures to increase the adaptive capacity of a water governance regime and its performance in general. It is also a step forward towards a diagnostic approach.

The analyses show that simplistic panaceas that reduce policy advice to one-dimensional generic recipes do not hold. The insights derived in the Twin2Go project provide generic principles for a governance regime's organization that can be tailored to specific conditions and allow countries to find their own path compatible with history, societal and environmental context.

The approach chosen by the Twin2Go project provides clear evidence for the importance of comparative analyses to deepen the scientific understanding of complex resource governance regimes and to develop evidence-based policy advice. Despite the promising results a lot of work remains to be done. We advocate a two-track approach to foster progress: extend and improve the Twin2Go data base using the methodology developed[5], and employ the insights gained to set priorities for in-depth analyses collecting new data on aspects that have proven to be critical in prior analyses.

More studies of river basins in the United States, Australia and other developed economies, for example, would be valuable to strengthen geographical coverage. Likewise, additional and better indicators to describe social and political dimensions of context would enable more fine-grained analyses of how and where context matters. Further, more sensitive basin-level indicators of environmental quality and ecological conditions would allow more robust analysis of environmental performance. These extensions would help overcome some of the main limitations of the current work.

Regarding the collection of new primary data for more in-depth analyses it will be important to use a shared conceptual and methodological framework as base to establish a shared data and knowledge base. Without such an integrative framework the risk is large that no general insights can be derived. Such a framework should also include a shared language / ontology for key terms. The language should be specific enough that data protocols can be derived as base for large comparative analyses. It should however be flexible and not impose one theoretical framework. It is important to

experiment with different theoretical approaches and different analytical emphasis, however in a way that results can be compared. Some efforts are on their way in the scientific community, on which such a development could build (e.g. SES Framework[6,7], Management and Transition Framework[8]).

[5] Further case studies can, for example, be added through the Twin2Go database (deliverable 4.2.2), which is available online on (http://www.watergovernance.uni-osnabrueck.de/)
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9 Annex

9.1 Cross tab approach: Regime, context and performance aggregations

Table 43: Aggregation of indicators from the Twin2Go questionnaire

No.	Regime Aggregation	Combined Indicators
R1	Advanced water legislation	01 Domestic water legislation (laws, by-laws, etc.) in place? 02 Domestic Water Law: Public character of water and legal status of water use rights 03 Domestic Water Law: Explicit recognition of traditional and indigenous water uses 04 Domestic Water Law: On flow availability, third party rights and ecological requirements 07 Existence of formal domestic administrative structure for water governance
R2	Adoption of basin principle	08 National basin organisation or comparable arrangement 10 Formal institution (legislation) that prescribes the basin management principle 11 Water (basin) strategies, programmes and plans
R4/5a	Avoidance of fragmentation in governmental governance regime	34 Vertical coordination. (governmental) 35 Horizontal coordination. (governmental) 41 Technical capacity and economies of scale 42 Legal obligations and responsibility
R4/5b	Polycentric instead of centralized governance	6 Multilevel structure of domestic water legislation and subsidiarity 36 Role of local governments 39 One level one actor? 40 Degree of centralisation
R6	Strong Vertical Integration	6 Multilevel structure of domestic water legislation and subsidiarity 34 Vertical coordination. (governmental) 36 Role of local governments
R7	Strong Horizontal integration	5 Integration of domestic water legislation 35 Horizontal coordination. (governmental)
R8	Participative Knowledge management	37 Kinds of knowledge included => Role of experts/ science, local/traditional knowledge 38 Access to information => about expert knowledge and management plans
R9	Handling uncertainties comprehensively	29 General practices for dealing with uncertainties 30 Dealing with uncertainties: Reversible and flexible options 31 Dealing with uncertainties: Safety margins 32 Are scenarios used for decision making? 33 Climate risks: Climate variability and change
R10	Adoption of IWRM	24 Formalized IWRM principles 25 State of implementation of IWRM principles 26 Capacity to implement IWRM
R11	Application of economic & financial instruments	13 Economic instruments. Is water for irrigation priced? 14 Economic instruments. Is water for households priced in urban areas? 15 Economic instruments. Is water for industry priced? 16 Tradable permits related to water abstraction/use 17 Polluter pays principle (related to water) 18 Environmental subsidies (related to water) 19 Payment for ecosystem services (related to water) 20 Tradable permits (related to water quality, maximum, allowable loads etc.) 21 Environmental tax (related to water)

R12:	Incorporation of Good Governance Principles in legislation	50 Participatory regarding decision making in the water sector 51 Transparency regarding water allocation 52 Effectiveness and efficiency regarding decision making in the water sector 53 Equitable and inclusive
No.	**Context Aggregation**	**Combined Indicators**
C1	Advanced societal development	43 Proportion of the population living in rural areas 44 State of societal development 46 Economic sustainability (GDP) 47 Effectiveness of formal institutions 48 Trustworthiness of economic institutional setting - degree of risk for foreign direct investment
C2	High water availability	59 Average water availability at the river basin level (1995) 60 Annual renewable water supply per person by river basin (1995) 61 Projected annual renewable water supply per person by river basin (2025) 62 Relative Water Stress Index
C3	Low watershed modification	65 Extent of flow and channel modification 66 Impact of land-use changes on hydrological processes
C4	Low basin size	67a SubBasin Size (km²)
No.	**Performance Aggregation**	**Combined Indicators**
P1	Progress towards water-related Millennium Development Goals	69 Proportion of population with access to improved drinking water 70 Proportion of rural population with access to improved drinking water 71 Progress towards sustainable access to basic sanitation (MDG sanitation target) 72 Proportion of population with access to improved sanitation facilities 73 Proportion of rural population with access to improved sanitation facilities
P2/3	Realization of Good Governance Principles (including participation)	74 Participatory regarding decision making in the water sector 75 Transparency regarding water allocation 76 Effectiveness and efficiency regarding decision making in the water sector 77 Equitable and inclusive 80 Inclusiveness of stakeholder participation
P4	Climate change adaptation	82 Availability of specific knowledge enabling adaptation 83 Awareness of water managers regarding adaptation to climate change
P5A	Good state of the environment	88 Invasive exotic species 89 Surface and groundwater quality
P5B	Good management practice (monitoring)	94 Water quality monitoring 95 Hydrometeorological monitoring - levels 96 Level of understanding of groundwater resources

9.2 Cross-tab approach: Recoding rules for the creation of aggregations

See annex *Cross tab approach: Regime, context and performance aggregations* or deliverable 1.3 get to know to which indicators the indicator numbers refer.

GOVERNANCE REGIME

Table 44: R1 – Advanced water legislation

Indicator no.	Indicator score recoding	Total score of aggregation
1	A => A B = B C, D, E => C	- A/B/C dominant (>50%) => chose A/B/C - Rest: chose B
2	A => A B => B C, D => C	
3	A => A B => B C => C D => excluded	
4	A => A B => B C, D => C E => excluded	
7	Keep score	

Table 45: R2 – Adoption of basin principle

Indicator no.	Indicator score recoding	Total score of aggregation
8	A => A B = B C, D => C	- A/B/C dominant (> 50%) => chose A/B/C - Rest: chose B
10	A => A B => B C, D => C	
11	Keep score	

Table 46: R4/5a – Avoidance of fragmentation in governmental governance regime

Indicator no.	Indicator score recoding	Total score of aggregation
34	A, B => A C => B D, E => C	- A/B/C dominant (> 50%) => chose A/B/C - 2 x A and 2 x B => chose A - 2 x B and 2 x C => chose C - Rest: chose B
35	A, B => A C => B D, E => C	
41	A => A B => C	
42	A => A B => C	

Table 47: R4/5b – Polycentric instead of centralized governance

Indicator no.	Indicator score recoding	Total score of aggregation
6	Keep score	- A/B/C dominant (> 50%) => chose A/B/C - 2A and 2B => A - 2B and 2 C => C - 2A and 2C => B - three scores present => B
36	Keep score	
39	Keep score	
40	Keep score	

Table 48: R6 – Strong vertical integration

Indicator no.	Indicator score recoding	core of aggregation
6	Keep score	- A/B/C dominant (>50%) => chose A/B/C - Rest: B
34	A, B => A C => B D, E => C	
36	Keep score	

Table 49: R7 – Strong horizontal integration

Indicator no.	Indicator score recoding	Total score of aggregation
5	A => A B, C => C	- Only A/B/C => chose A/B/C - Rest: B
35	A, B => A C => B D, E => C	

Table 50: R8 – Participative knowledge management

Indicator no.	Indicator score recoding	Total score of aggregation
37	A => A B, C => B D => C	- Only A/B/C => chose A/B/C - A and C => B - A and B => A - B and C => C
38	A => A B => B C, D, E => C	

Table 51: R9 – Handling uncertainties comprehensively

Indicator no.	Indicator score recoding	core of aggregation
29	Keep score	- A/B/C (> 50%) dominant => chose A/B/C - Rest: chose B
30	Keep score	
31	Keep score	
32	Keep score	
33	Keep score	

Table 52: R10 – Adoption of IWRM

Indicator no.	Indicator score recoding	Total score of aggregation
24	Keep score	- A/B/C dominant (> 50%) => chose A/B/C - Rest: chose B
25	Keep score	
26	Keep score	

Table 53: R11 – Application of economic & financial instruments

Indicator no.	Indicator score recoding	Total score of aggregation
13	Keep score	- A/B/C dominant (> 50%) => chose A/B/C - Rest: chose B
14	Keep score	
15	Keep score	
16	Keep score	
17	Keep score	
18	Keep score	
19	Keep score	
20	Keep score	
21	Keep score	

Table 54: R12 – Incorporation of Good Governance Principles in legislation

Indicator no.	Indicator score recoding	Total score of aggregation
50	Keep score	- A/B/C dominant (> 50%) => chose A/B/C - Rest: chose B
51	Keep score	
52	Keep score	
53	Keep score	

CONTEXT

Table 55: C1 – Advanced societal development

Indicator no.	Indicator score recoding	Total score of aggregation
43	D, E=> A C => B A, B => C	- A/B/C dominant (> 50%) => chose A/B/C - Rest: chose B
44	A => A B => B C, D => C	
46	A, B => A C => B D, E => C	
47	A, B => A C => B D, E => C	
48	A, B => A C => B D => C	

Table 56: C2 – High water availability

Indicator no.	Indicator score recoding	Total score of aggregation
59	A => A B, C => B D, E => C	- A/B/C dominant (>50%)=> chose A/B/C - 2 x A and 2 x B => chose A - 2 x B and 2 x C => chose C - Rest: chose B
60	A => A B, C => B D, E => C	
61	A => A B, C => B D, E => C	
62	A, B => A C => B D, E => C	

Table 57: C3 – Low watershed modification

Indicator no.	Indicator score recoding	Total score of aggregation
65	Keep score	- 2 x A/B/C => chose A/B/C - A and C => chose B - A and B => chose AB and C => chose C
66	Keep score	

Table 58: C4 – Low basin size

Indicator no.	Indicator score recoding	Total score of aggregation
67a	>= 60,000 km2 => C 20,000 – < 60,000 km2 => B < 20,000 km2 => A	- A => A - B => B - C => C

PERFORMANCE

Table 59: P1 – Progress towards water-related Millennium Development Goals

Indicator no.	Indicator score recoding	Total score of aggregation
69	A, B => A C => B D, E => C	- Only A/B/C => chose A/B/C - Only A (>50%) and B => chose A - Only A and B (>50%)=> chose B - Only B (>50%)and C => chose B - Only B and C (>50%)=> chose C - Rest: chose B
70	A, B => A C => B D, E => C	
71	Kept scores	
72	A, B => A C => B D, E => C	
73	A, B => A C => B D, E => C	

Table 60: P2/P3 – Realization of Good Governance Principles (including participation)

Indicator no.	Indicator score recoding	Total score of aggregation
74	A, B => A C => B D, E => C	- A/B/C (> 50%) dominant => chose A/B/C - Rest: chose B
75	Keep score	
76	Keep score	
77	Keep score	
80	Keep score	

Table 61: P4 – Climate change adaptation

Indicator no.	Indicator score recoding	Total score of aggregation
82	A, B => A C => B D, E => C	- Only A/B/C => chose A/B/C - A and B => chose A - B and C => chose C - A and C => chose B
83	Keep score	

Table 62: P5A – Good state of the environment

Indicator no.	Indicator score recoding	Total score of aggregation
88	A, B => A C => B D => C	- Only A/B/C => chose A/B/C - 1 x C => C
89	A, B => A C => B D => C	

Table 63: P5B – Good management practice (monitoring)

Indicator no.	Indicator score recoding	Total score of aggregation
94	Keep score	- Only A/B/C => chose A/B/C - 1 x A and 2 x B => chose B - 2 x A and 1 x B => chose A - 2 x B and 1 x C => chose C - 1 x B and 2 x C => chose C - Rest: chose B
95	A => A B => B C, D => C	
96	Keep score	

INDICATOR 58: TOTAL ACTUAL RENEWABLE WATER RESOURCES (TARWR)

Table 64: Indicator 58 (TARWR)

Indicator no.	Indicator score recoding = Total score of aggregation
58	- A => A - B, C => B - D, E => C

9.3 Cross tab approach: Values of the aggregations, measure to assess overall governance, recoded TARWR values

The following tables show the scores of the aggregations, which were built by recoding and merging indicators from the questionnaire. See annex *Cross-tab approach: Recoding rules for the creation of aggregations* for the aggregation names and aggregation building rules.

Table 65: Scores of the built governance aggregations and overall governance value

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
	Biobio / Chile	Catamayo / Peru	Catamayo / Ecuador	Cauca / Colombia	Quaraí / Brazil	Cocibolca / Nicaragua	Baker / Chile	Cuareim / Uruguay	Guayas / Ecuador	Paute / Ecuador	Norrström / Sweden	Nura / Kazakhstan	Okavango / Namibia	Thames / UK	Kyoga / Uganda	Niger / Mali	Bang Pakong / Thailand	Volga / Russia	Brahmaputra / Bhutan	Brahmaputra / India	Brahmaputra / Nepal	Tisza / Hungary	Guadiana / Spain	Elbe / Germany	Rhine / The Netherlands	Amudarya / Uzbekistan	Orange / South Africa	Red River /Vietnam	Olifants / South Africa
R1	B	A	C	A	A	B	B	A	C	C	A	B	A	A	A	A	C	A	A	B	B	A	A	A	A	C	A	B	A
R2	C	B	C	C	A	C	B	B	C	C	B	B	B	A	C	B	B	B	B	C	B	A	A	A	A	B	B	B	B
R4/5a	B	C	C	A	B	A	C	B	C	C	A	C	B	A	B	A	B	C	B	C	B	A	A	B	A	C	B	A	B
R4/5b	C	A	C	B	A	B	B	B	C	C	A	B	A	A	B	A	C	B	A	B	B	A	B	A	A	C	A	B	A
R6	B	A	C	B	A	B	B	B	C	C	A	B	A	A	B	A	C	B	A	C	A	A	A	A	A	C	B	B	A
R7	B	B	C	C	C	A	B	B	C	C	A	C	B	A	B	A	B	B	B	C	B	A	A	B	A	B	B	B	B
R8	C	B	C	A	A	A	C	A	C	C	A	B	B	A	B	A	A	B	A	B	B	A	B	A	B	C	B	C	A
R9	C	B	B	B	A	B	B	B	B	B	A	B	B	A	B	A	B	B	B	C	B	B	A	B	A	B	B	B	B
R10	C	B	C	B	B	C	C	C	C	C	A	B	B	A	B	B	B	B	A	C	C	A	B	B	A	B	C	B	C
R11	C	B	C	B	C	C	C	C	C	C	C	C	C	A	C	B	C	B	C	C	C	A	B	A	A	C	B	B	B
R12	B	B	C	B	A	B	B	A	C	C	A	B	B	A	B	B	C	B	A	B	B	A	B	A	A	C	A	B	B
Overall Governance*	***7***	***14***	***1***	***12***	***16***	***11***	***9***	***14***	***1***	***1***	***21***	***8***	***14***	***24***	***11***	***19***	***8***	***11***	***18***	***4***	***11***	***22***	***18***	***20***	***23***	***4***	***14***	***12***	***15***

* To calculate the overall governance value, 2 points were given for each A score and 1 point for each B score. The sum of all points given to a case study represents the case study's overall governance value.

Table 66: Scores of the built context aggregations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
	Biobio / Chile	Catamayo / Peru	Catamayo / Ecuador	Cauca / Colombia	Quaraí / Brazil	Cocibolca / Nicaragua	Baker / Chile	Cuareim / Uruguay	Guayas / Ecuador	Paute / Ecuador	Norrström / Sweden	Nura / Kazakhstan	Okavango / Namibia	Thames / UK	Kyoga / Uganda	Niger / Mali	Bang Pakong / Thailand	Volga / Russia	Brahmaputra / Bhutan	Brahmaputra / India	Brahmaputra / Nepal	Tisza / Hungary	Guadiana / Spain	Elbe / Germany	Rhine / The Netherlands	Amudarya / Uzbekistan	Orange / South Africa	Red River /Vietnam	Olifants / South Africa
C1	A	B	B	B	B	C	B	B	B	B	A	B	C	A	C	C	B	B	C	C	C	A	A	A	A	C	B	B	B
C2	A	C	C	A	A	A	A	A	C	B	A	B	C	C	B	B	C	A	A	A	A	B	B	B	A	B	C	A	C
C3	C	C	B	C	B	B	A	B	C	C	B	B	B	C	B	B	C	C	A	B	A	C	C	B	C	C	B	C	C
C4	B	A	A	A	A	A	B	A	B	A	B	B	C	A	B	C	A	C	B	C	C	B	A	C	B	C	C	C	B

Table 67: Scores of the built performance aggregations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
	Biobio / Chile	Catamayo / Peru	Catamayo / Ecuador	Cauca / Colombia	Quaraí / Brazil	Cocibolca / Nicaragua	Baker / Chile	Cuareim / Uruguay	Guayas / Ecuador	Paute / Ecuador	Norrström / Sweden	Nura / Kazakhstan	Okavango / Namibia	Thames / UK	Kyoga / Uganda	Niger / Mali	Bang Pakong / Thailand	Volga / Russia	Brahmaputra / Bhutan	Brahmaputra / India	Brahmaputra / Nepal	Tisza / Hungary	Guadiana / Spain	Elbe / Germany	Rhine / The Netherlands	Amudarya / Uzbekistan	Orange / South Africa	Red River /Vietnam	Olifants / South Africa
P1	B	B	A	B	B	C	B	A	A	A	A	A	B	A	C	C	A	B	B	C	C	A	A	A	A	A	B	B	B
P2/3	C	A	C	B	A	B	B	A	C	C	A	B	B	A	B	B	B	B	A	C	B	A	A	A	A	C	B	B	B
P4	C	C	B	C	C	B	C	A	B	B	C	A	A	A	B	A	C	B	C	C	C	A	A	A	A	B	B	C	A
P5A	A	B	A	A	B	B	A	A	A	-	B	B	A	A	B	C	B	A	A	B	A	B	B	A	B	C	C	B	C
P5B	C	B	B	A	B	C	C	B	C	-	A	B	C	A	C	C	B	A	C	B	C	A	A	A	A	C	B	C	B

The following table shows the recoded value of indicator 58 from the questionnaire: Total Actual Renewable Water Resources (TARWR). See Annex *Cross-tab approach: Recoding rules for the creation of aggregations* for the recoding rules.

Table 68: Scores of the recoded TARWR values

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
	Biobio / Chile	Catamayo / Peru	Catamayo / Ecuador	Cauca / Colombia	Quaraí / Brazil	Cocibolca / Nicaragua	Baker / Chile	Cuareim / Uruguay	Guayas / Ecuador	Paute / Ecuador	Norrström / Sweden	Nura / Kazakhstan	Okavango / Namibia	Thames / UK	Kyoga / Uganda	Niger / Mali	Bang Pakong / Thailand	Volga / Russia	Brahmaputra / Bhutan	Brahmaputra / India	Brahmaputra / Nepal	Tisza / Hungary	Guadiana / Spain	Elbe / Germany	Rhine / The Netherlands	Amudarya / Uzbekistan	Orange / South Africa	Red River /Vietnam	Olifants / South Africa
Q58	A	A	A	A	A	A	A	A	B	B	B	B	B	C	C	B	B	A	A	C	B	B	C	C	B	C	C	B	C

9.4 Cross-tab approach: Details of analysis results

The following tables show the calculated values, which are the basis for the detection of associations. See Table 39 for the detection rules. See annex *Cross tab approach: Regime, context and performance aggregations* to get to know to which aggregations the aggregation numbers refer.

Table 69: Associations between water governance and performance aggregations

	R1					R2					R4/5a				
	P1	P2/3	P4	P5A	P5B	P1	P2/3	P4	P5A	P5B	P1	P2/3	P4	P5A	P5B
Number of cases located on diagonal line AA-BB-CC	10	19	11	12	12	16	21	11	7	15	12	16	10	6	14
Number of cases located in cells AA and CC	7	14	10	8	10	8	11	8	2	9	6	10	8	3	9
Number of cases located in cells AC and CA	7	0	5	5	4	3	0	1	4	1	7	1	4	5	4
100 x (Number of cases in AC and CA cells) / (number of cases in AA and CC cells)	*100.0*	*0.0*	*50.0*	*62.5*	*40.0*	*37.5*	*0.0*	*12.5*	*200.0*	*11.1*	*116.7*	*10.0*	*50.0*	*166.7*	*44.4*
Type of association detected*	-	1	-	-	-	-	1	2	-	1	-	1	-	-	-

* -2: medium negative association; -1: strong negative association; 1: strong positive association; 2: medium positive association

	R4/5b					R6					R7				
	P1	P2/3	P4	P5A	P5B	P1	P2/3	P4	P5A	P5B	P1	P2/3	P4	P5A	P5B
Number of cases located on diagonal line AA-BB-CC	9	21	12	11	11	13	22	14	10	11	15	16	12	5	11
Number of cases located in cells AA and CC	5	13	9	5	8	7	14	10	6	8	6	7	8	1	6
Number of cases located in cells AC and CA	6	0	4	6	3	7	0	5	4	4	6	3	2	4	3
100 x (Number of cases in AC and CA cells) / (number of cases in AA and CC cells)	*120.0*	*0.0*	*44.4*	*120.0*	*37.5*	*100.0*	*0,0*	*50.0*	*66.7*	*50.0*	*100.0*	*42.9*	*25.0*	*400.0*	*50.0*
Type of association detected*	-	1	-	-	-	-	1	-	-	-	-	-	2	-	-

	R8					R9					R10				
	P1	P2/3	P4	P5A	P5B	P1	P2/3	P4	P5A	P5B	P1	P2/3	P4	P5A	P5B
Number of cases located on diagonal line AA-BB-CC	10	18	12	12	14	14	19	14	8	12	13	18	10	11	13
Number of cases located in cells AA and CC	6	12	9	6	10	5	7	6	1	5	7	10	7	4	9
Number of cases located in cells AC and CA	6	0	5	6	3	1	0	2	2	1	4	1	4	6	1
100 x (Number of cases in AC and CA cells) / (number of cases in AA and CC cells)	*100.0*	*0.0*	*55.6*	*100.0*	*30.0*	*20.0*	*0.0*	*33.3*	*200.0*	*20.0*	*57.1*	*10.0*	*57.1*	*150.0*	*11.1*
Type of association detected*	-	1	-	-	2	2	1	2	-	1	-	1	-	-	2

	R11					R12				
	P1	P2/3	P4	P5A	P5B	P1	P2/3	P4	P5A	P5B
Number of cases located on diagonal line AA-BB-CC	14	16	15	6	16	14	17	9	12	11
Number of cases located in cells AA and CC	8	10	12	3	13	6	10	6	5	7
Number of cases located in cells AC and CA	9	4	2	8	1	5	2	3	3	1
100 x (Number of cases in AC and CA cells) / (number of cases in AA and CC cells)	*112.5*	*40.0*	*16.7*	*266.7*	*7.7*	*83.3*	*20.0*	*50.0*	*60.0*	*14.3*
Type of association detected*	-	-	1	-	1	-	1	-	-	2

Table 70: Associations between context and performance aggregations

	C1					C2					C3				
	P1	P2/3	P4	P5A	P5B	P1	P2/3	P4	P5A	P5B	P1	P2/3	P4	P5A	P5B
Number of cases located on diagonal line AA-BB-CC	19	16	13	10	21	3	10	7	13	7	3	12	9	11	10
Number of cases located in cells AA and CC	11	8	8	5	13	3	7	4	9	6	0	6	5	5	4
Number of cases located in cells AC and CA	1	2	4	3	1	7	4	12	4	7	9	5	8	5	9
100 x (Number of cases in AC and CA cells) / (number of cases in AA and CC cells)	*9.1*	*25.0*	*50.0*	*60.0*	*7.7*	*233.3*	*57.1*	*300.0*	*44.4*	*116.7*	-	*83.3*	*160.0*	*100.0*	*225.0*
Type of association detected*	1	1	-	-	1	-	-	-1	-	-	-2	-	-	-	-

	C4				
	P1	P2/3	P4	P5A	P5B
Number of cases located on diagonal line AA-BB-CC	12	11	8	12	10
Number of cases located in cells AA and CC	8	7	6	7	8
Number of cases located in cells AC and CA	3	3	7	4	3
100 x (Number of cases in AC and CA cells) / (number of cases in AA and CC cells)	*37.5*	*42.9*	*116.7*	*57.1*	*37.5*
Type of association detected*	-	-	-	-	-

Table 71: Further Associations

	P5B	Indicator 58 (TARWR)
	P5A	P5A
Number of cases located on diagonal line AA-BB-CC	11	16
Number of cases located in cells AA and CC	6	10
Number of cases located in cells AC and CA	6	2
100 x (Number of cases in AC and CA cells) / (number of cases in AA and CC cells)	*100.0*	*20.0*
Type of association detected*	-	1

9.5 Derivation of aggregate measures for statistical analysis

The full expressions in the table explicitly define how each measure was calculated and reflect the general formula shown above. Variables in the expression are of the form 'qnn' referring to the number of variable in the questionnaire

1. Performance measures.

Table 72: Performance measures

Performance Measure		Contributing variables *Full expression*
P1	Progress towards stated goals	68-73 *((3-q68)/2+(3-q71)/2 +(5-q69)/4+(5-q70)/4+(5-q72)/4+(5-q73)/4)/6*
P23	Good governance and principles including stakeholder engagement	74-77, 79-80 *((5-q74)/4+(3-q75)/2 +(3-q76)/2+(3-q77)/2+(3-q79)/2+(3-q80)/2)/6*
P4	Response to climate change	81-86 *((4-q81)/3+(5-q82)/4 +(3-q83)/2+(4-q84)/3+(5-q85)/4+(3-q86)/2)/6*
P5A	Environmental conditions	87-90 *((4-q87)/3+(4-q88)/3 +(4-q89)/3+(4-q90)/3)/4*
P5B	Environmental management practices	92-96 *((3-q92)/2+(3-q93)/2+(3-q94)/2 +(4-q95)/3+(3-q96)/2)/5*

2. Regime measures

Table 73: Regime measures

Regime Measure		Contributing variables *Full expression*
R1	Legal frameworks	1-4,7 *((5-q1)/4+(4-q2)/3 +(4-q3)/3+(5-q4)/4+(3-q7)/2)/5*
R2	Basin principles formalized	8,10,11 *((4-q8)/3+(4-q10)/3+(3-q11)/2)/3*
R4	Polycentric	6,34,35,36,39-42 *(((((3-q40)/2+(3-q36)/2)/2)*(2-q41)/1*(2-q42)/1)+((5-q35)/4*(3-q39)/2)+((5-q34)/4*(3-q6)/2))/3*
R11	Economic instruments	13-21 *((3-q13)/2+(3-q14)/2+(3-q15)/2+(3-q16)/2+(3-q17)/2+(3-q18)/2+(3-q19)/2+(3-q20)/2+(3-q21)/2)/9*
R6	Vertical integration	6,34,36 *((3-q6)/2+(5-q34)/4+(3-q36)/2)/3*
R7	Horizontal integration	35,5 *((3-q5)/2+(5-q35)/4)/2*
R8	Knowledge	37,38 *((4-q37)/3+(5-q38)/4)/2*
R9	Handling uncertainty	29-33 *((3-q29)/2+(3-q30)/2+(3-q31)/2+(3-q32)/2+(3-q33)/2)/5*
R10	IWRM principles	24-26 *((3-q24)/2+(3-q25)/2+(3-q26)/2)/3*
R12	Good governance principles in legislation	50-53 *((3-q50)/2+(3-q51)/2+(3-q52)/2+(3-q53)/2)/4*

3. Context measures

Table 74: Context measures

Context Measure		Contributing variables *Full expression*
C1	Economic & institutional development	43-48 *((5-q46)/4+(4-q44)/3+(q43-1)/4 +(5-q47)/4+(4-q48)/3)/5*
C2	Water availability	58-62 *((5-q59)/4+(5-q60)/4+(5-q61)/4 +(5-q62)/4+(5-q58)/4)/5*
C3	Watershed modification	65-66 *((3-q65)/2+(3-q66)/2)/2*
C4	Basin Size	67a *(5-q67)/4*