Development of institutional frameworks for the management of transboundary water resources

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Abstract: This paper presents a comparative analysis of institutions (treaties, agreements) for the management of transboundary water resources. The nine river basins investigated are divided according to their level of cooperation and commitment to three categories: the highly committed (Colorado, Niger, Rio Grande and Senegal): the least cooperative (Ganges-Brahmaputra and Indus); and the middle level of cooperation (Danube, Elbe and Mekong). Very few of the investigated rivers corresponded to the ideal model of institutions for the management of transborder water resources, namely a basin-wide multipurpose institution and almost all showed that competition among various users and water uses was growing rapidly.

Keywords: Colorado River; Danube River; Elbe River; Ganges River; Indus River; international cooperation; Mekong river; Niger River; Rio Grande River; Senegal River; transboundary resources; water institutions.

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1 Introduction

There are many methods and variations in the study of transboundary water resources: as a scarce resource, as a focus for political conflict, as a hydrological phenomenon with environmental impact or, as we chose to explore it – as an institution. Broadly defined, 'institutions' are bodies or organisations often shaped in the form of international commissions and committees, founded by formal and legal agreements such as treaties for the management of transboundary water resources. This form of management requires the cooperation of all the co-basin (or co-riparian) states as their actions, and sometimes reluctance to take action, affect other partners to the same water body. There are more than 2000 instruments or agreements relating to international watercourses. Worldwide, some 286 international treaties concerning fresh water have been concluded, about two-thirds in Europe and North America [1]. Most agreements concerning shared water resources are bilateral and relate to specific rivers that form or cross boundaries, or lakes that straddle them. There is a lesser number of multilateral agreements. The treaties were established for the regulation of the various uses of transboundary water resources: navigation, water allocation, water use, water quality and other uses. Most treaties also establish management mechanisms for these shared water resources. Over centuries of development, experience was gained in management and mismanagement of transboundary water resources. Some principles of international law were evolved as guiding principles for managing common water resources and were accepted by most states. The main principles of international law which are more or less accepted as rules concerning shared water resources are:

- Allocation of the uses and benefits of a watercourse in an equitable manner.
- A state may not significantly harm other states through its actions affecting an international watercourse [2].
- In the Doctrine of Correlative Rights the emphasis is on the most efficient utilisation of joint water resources, rather than on ownership rights [3,1,4, p.115].

These principles, which are accepted today as valuable legal norms which are binding on states, also mean that states have the duty to cooperate and negotiate in good faith with other states with the genuine intention of reaching an agreement on their shared water resources; they have the duty of prior consultation with other co-basin states and there is a prohibition of management practices likely to cause substantial injury to other states.

Treaties and agreements on international river basins vary according to:

1 Parties to the agreement (bilateral/multilateral)

2 Subject matter (data collection, allocation, planning, construction)

3 Territorial extent (the whole basin or parts of it)

4 Intensity of cooperation (from duty to inform to implementation of joint programs).

The depth of cooperation also affects the regime of ownership of the waterworks resulting from a treaty [5, p.119]. Joint development of transboundary water resources is ideal for shared water resources, but is difficult to achieve because of questions of sovereignty, ownership of waterworks, jurisdiction, financing, scope of cooperation and other related matters.

There are three requisites for an international institution to be established in a transboundary water resource:

- active support and long-term commitment on the part of top level political leaders (and representatives involved in the establishment of such an institution)
- mobilisation of the available expertise
- a domestic governmental structure capable of effective international cooperation and collaboration [6, p.2].

The various institutional arrangements and mechanisms as reflected in treaties, conventions and agreements are divided into three broad categories (according to their level of commitment).

1 Agreements by riparian states stopping short of formal allocation;

2 Agreements allocating water between states;

3 Agreements for joint communal management of internationally shared waters [3].

After a decision is reached in relation to the establishment of an institution or a legal regime for the management of transboundary water resources, key aspects of the institutional structure have also to be decided. These are:

1 *Level of centralisation-decentralisation* of the management institutions. Small countries can effectively manage all aspects of water resources by a single centralised agency, but large countries need a more decentralised structure.

2 *Basin-wide planning*, namely that planning and management will cover the whole river basin and thus the institution should cover the whole basin.

3 *Multipurpose projects* vs. single purpose projects. Multipurpose projects are constructed and developed for various functions and uses such as flood control, irrigation, navigation and hydropower generation. Single purpose projects are narrow in their function.

4 *Financing* of institutions, particularly those which manage multipurpose projects, is expensive but financial difficulties burden many of the institutions of transboundary

water resources. Often, institutions' success or failure will solely depend on their ability to obtain international funding.

The purpose of this paper is to make a comparative analysis of the institutional features of nine international river basins located in various parts of the world The main aims of the study are to explore areas of problems in the evolution and functioning of these institutions, and also their relative success and failure in managing transboundary water resources.

2 Structure, functions and features of institutions for the management of transboundary water resources

Table 1 presents data on some of the geographical and hydrological features of nine international river basins: the Mekong, Indus, Ganges-Brahmaputra, Senegal, Niger, the Danube, Elbe and the Colorado and Rio Grande. The Table also adds some background data on the studied basins such as major uses, water quality as well as evaluation of the level of competition or even conflict over the water resources of that basin.

The nine river basins include some of the largest international river basins in the world, both in their territorial extension and volume of water: the Ganges-Brahmaputra, Mekong, Niger, and the Danube. They are located in four continents and in all types of climate regions: from the wet equatorial (Senegal, Niger, Mekong, Ganges) to the arid and semi-arid areas: Colorado, Rio-Grande, Indus). Climatic variability affects most of the river basins and concerns over water quality trouble the Mekong, Ganges, Elbe, the Danube, Colorado and Rio Grande. The investigated basins vary also in their major uses: consumptive uses, especially irrigation, are important in most of them; navigation is extremely important in the Mekong, Danube and Elbe, whereas hydropower production is of secondary importance in most of them. Competition and conflict, over quantity and quality of water resources in the common transboundary rivers, is growing in the Mekong and is a source of a conflict between India and Bangladesh in the Ganges. Therefore, it is not surprising to note that the nine basins are also very heterogeneous in their treaty regimes (Table 2).

For our analysis the nine basins will be grouped in three categories according to their level of organisation, cooperation and commitment: from the most cooperative and more committed basins (Senegal, Niger, Colorado and Rio Grande) to the least cooperative and least committed (Indus, Ganges-Brahmaputra). In an intermediate category are located the Mekong Danube and Elbe. It should be stressed that a high level of cooperation and commitment is defined not only by the formal structure and functions of the common institutions but also by the spirit and levels of de facto cooperation. As will be seen, those two do not always coincide.

3 The model of cooperative committed institution

The four basins in that category are characterised by the following features: (see also Table 2).

Table 1 Economic and social features of international river basins and their effects on the formation of institutional frameworks

1 – River Basin 2a – Population Growth 1995-2000* (M – medium; H – high (more than 2.0); L – low (less than 1.0)) 2b – Total 1998 population (in millions); 3 – GNP per capita (1998); 4 – Life Expectancy (a – female, b – male; 1997); 5 – Adult illiteracy rate (% of people 15 and above – 1997; a – male; b - female); 6 – Per capita domestic water use (below 100 litre per person per day);
7 – Water shortage – availability of less than 1000 m^3 of water per capita per year; 8 – Water stress – Less than 1700 m^3 of water per capita per year; 9 – % of Total population with access to safe drinking water; 10 – Annual internal renewable water resources (000 m^2, 1990); 11 – Dependence on imported surface water (in %); 12 – Legal regime; 13 – Social indicators effect on institutions; 14 – Economic indicators effect on institutions; N.D. = No data

1	*2a*		*2b*	*3*	*4a*	*4b*	*5a*	*5b*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Tigris-Euphrates	Turkey	M	63	3160	67	72	8	26			2246	76	3.52	5	No treaty	Water scarcity and shortage may affect lack of cooperation	None
	Syria	H	15	1020	67	71	13	43	98	859		85	0.61	75			
	Iran	H	62	1770	69	70	19	34			1339	83	2.08	9			
	Iraq	H	17	1770	N.D.	N.D.	N.D.	N.D.			N.D.	44	1.80	2/3			
Senegal	Mali	H	11	250	49	52	57	72	8			37	6.62	N.D.	The Senegal River Basin Authority 1972; Navigation, Irrigation	Social indicators have very little effect	Important effects of donor countries
	Mauritania	H	3	410	52	55	51	72		None	None	76	0.20	95			
	Senegal	H	9	600	51	54	55	75	25.4			56	3.15	33			
	Guinea	H	7	540	51	56	52	57	35.2			62	32.87	0			
Niger	Guinea	H	7	540	51	56	52	57	35.2			62	32.87	0	Niger River Authority 1980 Navigation coordinating plans Pollution Hydropower	Social indicators have a little effect on functioning of the institution	Modest support from donor countries and international institutions
	Mali	H	11	250	49	52	57	72	6.0			37	6.62	70			
	Niger	H	10	190	45	50	78	93	28.4			53	1.97	75			
	Nigeria	H	121	300	52	55	31	49	28.4		(2375)	39	2.31	15			
	Algeria	M	30	1550	69	72	27	52	98.0	463		68	0.75	0			
	Cameroon	H	14	610	55	58	21	35	42.6			44	18.50	0			
	Burkina-Faso	H	11	240	44	45	70	89	22.2		1671	78	3.11	N.D.			
	Benin	H	6	380	52	55	52	79	19.5			50	5.48	65			
	Cote d'Ivoire	H	14	700	46	47	49	66	35.6		None	72	5.87	Less than 2			
	Chad	H	7	230	47	50	N.D.	N.D.	13.9			24	6.76	70			
Lake Chad	Chad	H	7	230	47	50	N.D.	N.D.	13.9			24	6.76	70	The Lake Chad Basin Convention (1964, 1972) is no longer active	Water scarcity but lack in infrastructure	Donors (FAO, UNDP, USAID, UNESCO) had effect on the establishment of institution
	Niger	H	10	190	45	50	78	93	28.4			53	1.97	75			
	Nigeria	H	121	300	52	55	31	49	28.4		(2375)	39	2.31	15			
	Cameroon	H	14	610	55	58	21	35	42.6			44	18.50	0.0			
Danube	Romania	L	22	1390								62	1.59	85	Treaty on navigation and institution on environmental program for the Danube. Pollution, water equality ecology	Conflict between rich and industrial north and less developed mid- and lower riparian	Important impact of the European Union, European banks, World Bank, World conservation Union, WWF, Women's Health Organization
	Croatia	L	5	4520	68	77	1	4				63	61.40	N.D.			
	Serbia-Montenegro	L	N.D.	N.D.									N.D.	N.D.			
	Hungary	L	10	4570	66	75	1	1		604		--	6.04	95			
	Austria	L	8	26860	74	81	-	-				--	7.51	40			
	Slovakia	L	5	2700								--	4.31	80			
	Germany	L	82	25850							1165	--	96.00	53**			
	Bulgaria	L	8	1230	67	74	1	2			2146	--	18.00	90			
	Ukraine	L	50	850								55	53.0	60			
	Moldova	L	4	410						225		56	1.0	95			

Table 1 Economic and social features of international river basins and their effects on the formation of institutional frameworks (continued)

1	*2a*		*2b*	*3*	*4a*	*4b*	*5a*	*5b*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Elbe	Germany	L	82	25850	74	80	N.D.	–					1.30**	45**	The treaty refers only to the pollution of the Elbe	Major development gap between the Czech Republic and Germany	Support and pressure of the EU, Germany is putting most of the investment
	Czech Republic	L	10	5040	71	78	–	–					1.79	80 *			
	Austria	L	81	26860	74	81	–	–					7.51	40			
	Poland	L	39	3900									1.29	15			
Indus	India	M	980	430	62	64	33	61	31	None	(2167)	81	2.17	12	Indus Treaty 1960 (Agreement on Partition)	None	Strong effect to World Bank and donor countries
	Pakistan	H	147	480	61	63	45	75	55		(3256)	60	2.43	40			
	Afghanistan	H	23.3	N.D.	N.D.	N.D.	N.D.	N.D.	39.3		N.D.	12	3.02	20			
	China	M	1,239.	750	68	71	9	25	28		(2282)	90	2.47	0			
Ganges-Brahmaputra	Nepal	H	23	210	58	57	44	79	17	None		44	8.88	N.D.	Treaty between India and Bangladesh on sharing of the Ganges at Farakka	Demography and population growth important, particularly in Bangladesh	None
	Bangladesh	H	126	350	58	58	50	73	173			97	11.74	80			
	India	M	980	430	62	64	33	61	31		(2167)	81	2.17	12			
	Bhutan	H	1.9	N.D.	N.D.	N.D.	N.D.	N.D.	14.8			64	62.66	N.D.			
	China	M	1.239	750	68	71	9	25	28		(2282)	90	2.47	0			
Mekong	Laos	H	5	330	52	55	N.D.	N.D.	N.D.	None		39	25.96	N.D.	The Mekong Committee 1957 Mekong Commission 1995 (navigation, hydropower, fishing)	Large populations and growing demand for water – an important factor	UN, UNDP, ECAPE, ASIAN Development Bank, World Bank
	Myanmar	M	44	N.D.	59	62	11	21	19.8			38	10.68	N.D.			
	Cambodia	M	11	280	53	55	N.D.	N.D.	9.5			N.D.	66.32	90			
	China	M	1.239	750	68	71	9	25	59		(2282)	90	1.97	65			
	Thailand	M	59.6	2200	66	72	3	7	58		(2954)	64	5.60	N.D.			
	Vietnam	M	77.8	330	66	71	5	11	28.8			36					
Colorado	USA	L	270	29340	73	79	N.D.	N.D.	–	None	None	73	9.94	-1%	The 1944 Treaty, multi-purpose	Mexican social welfare	Yes – USA contribution
	Mexico	M	96	3970	69	75	8	12	–			95	4.03	N.D.			
Rio Grande/ Rio Bravo	USA	L	270	29340	73	79	–	–		None	None	73	9.94		"	"	"
	Mexico	M	96	3970	69	75	8	12				95	4.03				
La Plata	Brazil	M	166	4570	63	71	16	16	N.D.	None	None	72	35.52	~30	La Plata Treaty (1993) (Boundary navigation, islands pollution)	None	None
	Argentina	M	36	8970	70	77	3	4	32			56	21.47	~40			
	Paraguay	H	5	1760	N.D.	N.D.	N.D.	N.D.	41			34	21.98	~60			
	Bolivia	H	8	1000	60	63	9	23	33			55	41.02	N.D.			
	Uruguay	L	3	6180	N.D.	N.D.	N.D.	N.D.	N.D.			890	18.86	~55			

Note: **Germany – Federal Republic
* Czech Republic / Slovakia – data for Czechoslovakia

Table 2 Water demand and water control in the economy

1 – River Basin; 2 – Co-Riparians; 3 – Fresh water withdrawals by sector (3a,b – Domestic Uses m^3/yr and %; 3c,d – Industrial Uses, m^3/yr and %; 3e,f – Agricultural Uses, m^3/yr and %; 4 – Index of food production 1995-7 (1989-91 = 100); 5 – Irrigated land as percentage of cropland 1994-6; 6 – Virtual water grains (I=import or E=export); 7 – Water as limiting factor in economy[2]; 8 – Uneven distribution of water; 9 – Urban and rural water competition; 10 – Dependence on hydropower (%); 11 – Subsidies for water resources; 12 – Pace of implementation of projects; 13 – External impact on institution; 14 – Effect on institutional framework

1	*2*	*3a*	*3b*	*3c*	*3d*	*3e*	*3f*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Tigris-Euphrates	Turkey	51	16	35	11	228	72	106.3	15.4	I 3,332,800								
										E 949,000								
	Syria	18	4	9	2	422	94	136.7	20.4	I 531,300								
										E 601,100								
	Iran	82	6	27	2	1253	92	136.8	38.0	I 5,746,300								
	Iraq	137	3	229	5	4209	92	N.D.	N.D	I1,111,600								
												Affects Syria and Iraq more than Turkey	Severe competition in Syria. Moderate in Iraq.	Syria 45% Turkey and Iraq 40%; highly dependent on hydro-power	Water is subsidized in all four riparians	Turkey fast; Syria and Iraq slow	None	No institution
Senegal	Mali	3	2	2	1	143	97	118.7	2.3	I 79,900	No			Mali 79.4				
	Mauritania	50	6	15	2	742	92	103.2	10.3	I 298,900		Affects all but Guinea	No competition yet		Water is subsidized in Senegal	Projects in the Senegal were imple-mented very fast	Donor countries Ban KS, EEC, USAID, OPEC, UNDE, World Bank	L (Uneven distribution)
	Senegal	9	5	6	3	171	92	90.8	3.1	I 734,800								
	Guinea	13	10	4	3	112	87	129.2	10.9	I 296,100								
Niger	Guinea	13	10	4	3	112	87	129.2	10.9	I 296,100	No	Affects Mali and Niger	Low	Burkina Faso 397 Cote d'Ivoire 68	Partial in Mali and Niger for irrigation	Slow	World Bank UNDP, CIDA, USAID, FAO – Technical and financial support	L (Uneven distribution)
	Mali	3	2	2	1	143	97	118.7	2.3	I 298,900								
	Niger	10	16	1	2	53	82	118.4	1.4	I 109,400								
	Nigeria	10	31	25	15	18	54	134.2	0.7	I 1,189,300								
	Algeria	45	25	27	15	198	60	118.9	6.9	I 3,890,300								
	Cameroon	16	46	6	19	12	35	118.71	0.3	I 79,200								
	Burkina	8	19	--	0	34	81	22.4	0.7	I 104,200								
	Faso	7	23	3	10	21	67	129.5	0.5	I 93,400								
	Benin	13	22	6	11	49	67	119.2	1.0	I 512,400								
	Cote d'Ivoire	5	16	1	2	26	82	117.5	0.2	I 47,800								
	Chad																	
Lake Chad	Chad	5	16	1	2	26	82	117.5	0.2	I 47,800	Yes – arid areas and droughts	Between north and south (Chad+ Niger, Nigeria + Cameroon	Growing competition between domestic and agriculture sectors	Cameroon 97.2	No data	Slow-failure in imple-mentation	Chad – very little	L (Water as limiting factor in economy)
	Niger	10	16	1	2	53	82	118.4	1.4	I 109,400								
	Nigeria	10	31	5	15	18	54	134.2	0.7	I 1,189,300								
	Cameroon	16	46	6	19	12	35	118.7	0.3	I 79,200								

Table 2 Water demand and water control in the economy (continued)

1	*2*	*3a*	*3b*	*3c*	*3d*	*3e*	*3f*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Danube	Romania	92	8	378	33	675	59	100.5	31.4	I 132,500 E 1,745,500	Not an issue	Not an issue	Competition between urban and domestic uses; strong in downstream riparians; Romania, Ukraine, Moldova	Austria 70.9 Low in other countries (Croatia 42%)	No data	Fast	Danube none (Inter-national Court of Justice decision on Gabcikov Dam)	Water quality is the major factor with a partial impact to hydropower
	Croatia	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	57.7	0.2	I 39,100 E 52,800								
	Yugoslavia-Serbia	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	I 87,800 E 780,300								
	Hungary	45	9	276	55	181	36	76.8	4.2	I 140,100 E 642,000								
	Austria	79	19	304	73	33	8	100.0	0.3	I 348,500 E 702,800								
	Slovakia**	87	23	258	68	34	9	74.7	13.4	I 164,400 E 52,100								
	Germany*	69	10	482	70	138	20	90.9	3.9	I3,588,200 10,185,500								
	Bulgaria	112	7	608	38	880	55	68.3	18.7	I 522,900 E 52,800								
	Ukraine	N.D.	16	N.D.	54	N.D.	30	69.9	7.5	I 866,300 E 1,905,400								
	Moldova	N.D.	7		70		23	58.3	14.1	I 42,400 E 116,800								
Elbe	Germany*	69	10	482	70	138	20	90.9	3.9	I 3,588,200 E10,185,500	No	Not an issue	Yes – water for domestic and irrigation is needed	Germany 27 Czech Republic 6 Austria 70.9	Not an issue	Slow – lack of finances	EU is a full member in the ICPE and supports it	No features had an effect on institution
	Czech	87	23	258	68	34	9	81.9	0.7	I 501,500 E 214,800								
	Republic/ Austria	79	19	304	73	33	8	100.0	0.3	I 348,500 E 702,800								
	Poland	76	16	283	60	113	24	84.8	0.7	I 3,682,300 E 85,100								
Indus	India	18	3	24	4	569	93	117.1	32.0	I 626,900 E 4,290,100	not yet	The Indus flows in very dry and very wet areas	Competition within the rural sector in India and Pakistan	Afghanistan 60.8% Pakistan 45% India – 26%	No data	India – fast Pakistan – slow	Important and crucial role by the World Bank as arbitrator and financier of the Partition Project	L (Uneven distribution and development level)
	Pakistan	41	2	41	N.D.	1991	97	130.5	80.2	1,980,000 F 1,603,500								
	Afghanistan	14	1	0	0	1422	99	N.D.	N.D.	N.D.								
	China	28	6	32	7	402	87	155.8	37.0	I 18,083,600 E 1,456,200								
Ganges-Brahmaputra	Nepal	6	4	2	1	147	95	113.5	30.6	I 73,800 E 2,500	Extremely crucial in Bangladesh Brahmaputra water limits economy	Affects both India and Bangladesh	Competition is growing in Bangladesh	Nepal 95.2 85.7	No data but water is not priced or priced partially	India – fast unilateral projects	None	L (Water limiting factor in Bangladesh; uneven distribution)
	Bangladesh	6	3	2	1	203	96	106.0	39.1	I 1,741,500 E 0								
	India	18	3	24	4	569	93	117.1	32.0	I 626,900 E 4,290,100								
	Bhutan	5	36	2	10	8	54	N.D.	N.D.									
	China	28	6	32	7	402	87	155.8	37.0									

Table 2 Water demand and water control in the economy (continued)

1	*2*	*3a*	*3b*	*3c*	*3d*	*3e*	*3f*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Mekong§	Laos	18	8	23	10	187	82	112.4	20.3	I 35,300 E 0	not yet	Not an issue	Competition between various uses is rising and will increase	Laos 95.5 Thailand depends on important of hydro-electricity Vietnam 72 Myanmar 48	Not an issue	Not an issue though implementation is currently slow	UN, UNDP, IECAFE, World Bank, Asian Development Bank, donor countries: technical and financial support	L (Only hydropower and development level have effect)
	Myanmar	7	7	3	3	93	90	133.5	15.9	I 35,700 E 196,000								
	Cambodia	3	5	1	1	65	94	124.8	4.5	I 95,900 E 28,000								
	China	28	6	32	7	402	87	155.8	37.0	I 18,083,600 E 1,456,200								
	Thailand	24	4	36	6	539	90	107.2	23.2	I 1,042,800 E 5,540,000								
	Vietnam	11	13	7	9	63	78	132.7	29.6	I 436,000 E 1,082,000								
Colorado	USA	259	12	995	46	908	42	128.8	12.0	I 4,420,000 E 92,946,500	In south-west USA-Mexico water is limiting factor	Yes, within USA and Mexico, maldistribution between states	South-west competition between domestic and agricultural sectors	USA 8 Mexico 17	Yes, Mexico; Partial, USA	Fast	None	Water is limiting factor; uneven distribution, urban and rural competition, implementation
	Mexico	54	6	72	8	775	86	120.6	23.1	I 10,594,400 E 190,200				USA 9.9 Mexico 28				
Rio-Grande/ Rio-Bravo	U.S.A.	259	12	945	46	908	42	128.8	12.0	I 4,420,000 E 92,946,500	Ground water is limiting factor in the border area	Yes, within USA and Mexico, maldistribution between states	South-west competition between different sectors (Domestic Agricultural)	USA 98	Yes, Mexico; Partial, USA	Fast	None	Same as for Colorado
	Mexico	54	6	72	8	775	86	120.6	23.1	I 10,1594,400 E 190,200				Mexico 28				
La Plata	Brazil	91	43	36	17	85	40	122.2	3.3	I 9,283,500	No	Not an issue	None	Brazil 7	For Brazil subsidies for water	Slow	None	L (Economic development of resources, hydro, irrigation)
	Argentina	95	9	191	8	773	73	121.9	6.3	E 380,600				Argentina 4				
	Paraguay	17	15	8	7	87	78	116.7	3.0	I 359,000				Paraguay 99				
	Bolivia	18	10	9	5	156	85	126.7	3.7	E 11,264,700				Bolivia 59				
	Uruguay	14	6	7	3	219	91	128.8	10.7	I 85,200 E 191,800 I 224,600 E 10,100 I 121,200 E 7,821,00				Uruguay 88				
Legend:																		
		Percent of total flow originating outside High – above 60%the border Low – below 60%									a) high dependence b) low dependence of economy	Refers to either internal or uneven distribution between states	a) competition high b) competition low	Hydro- electric production as a percent- age of total electricity generation	a) high b) low	a) slow b) fast		L=low H=high N=none N.D.= no data

Legend: a) Fresh water withdrawals: in m^3/per person, per year, in the domestic, industrial and agricultural sectors; b) Index of production: base year 1989-91, data for 1995; c) Virtual water – water embedded in grains production; d) Water as limiting factor in the economy – refers to limited water resources for agricultural use – in developing countries; e) Dependence on hydropower refers to countries with more than 50% of their electricity originating from hydropower generation; f) Uneven distribution refers to uneven distribution of water resources within states; g) External impact refers to the role of donors, NGO's, UN bodies, etc. on the formation of cooperative frameworks; h) The most effective factors in the formation of institutions

Sources: *World Resources 1998-9*; *World Development Report 1999-2000*; Gleick, 1992, 1998; *World Bank, 2000*; Kliot, Shmueli & Shamir, 1997.

3.1 Intensity of cooperation

The institution of all four basins was established by a treaty or a compact and it covers the whole basin. As stated before, the territorial extent of an institution should cover the whole basin for purposes of joint development and planning as coordination of uses and functions is needed in the basin as a whole. The extension of the institution on the whole basin is extremely impressive in the Niger (nine members) and the Senegal (four members). In the Colorado and Rio-Grande there are only two co-basin states – the USA and Mexico – but cooperation is very significant between two states which differ so much in their level of economic development, economic and socio-economic priorities and in their specific interests in the common river basins.

The organisation and management of the *Senegal River Basin* evolved when the region was still a French colony. The MAS, as it was called then, was in existence between 1934 and 1952; its major functions were collection of data, organisation of studies and formulation of proposals to harness the river for navigation, irrigation and power production [7]. Since 1963, the Senegal Interstate Committee and its successor The Senegal River Basin Development Authority (OMVS) has been the institution which manages the river, having four members: Guinea, Mali, Mauritania and Senegal. Thus, the territorial extent of the OMVS covers the whole basin. The OMVS is a multipurpose organisation with broad authority in the following areas: navigation, construction and maintenance of river ports-of-call, construction and maintenance of hydropower plants (which, according to the 1978 Convention, the OMVS jointly owns), water allocation and approval of utilisation of river water resources, irrigation, development policy, planning, data exchange and scientific research [8, p.283–7,9, p.252,10]. Intensity of cooperation is very high.

In the Niger seven of the nine co-basin states convened and adopted the Act of Niamey in 1963 in which they stressed freedom of navigation and economic cooperation among co-basin states. Accordingly, the Niger River Commission was founded in 1964, came into force in 1966 and was replaced in 1980 by the Niger Basin Authority [11 pp.247–9]. The territorial extension of the Commission covers the whole basin including its tributaries. The nine member states were former French and British colonies: Nigeria, Mali, Niger, Dahomey, Cameroon, Upper Volta, Chad, Ivory Coast and Guinea.

The Niger River Commission is, similarly to the OMVS, also a multi-purpose institution with functions in areas such as data collection and processing, navigation planning, water control and utilisation, irrigation development, infrastructure development, hydropower and environmental monitoring, but many of the development plans have not been implemented. The institution was empowered with a broad authority over many areas, but practically it failed in taking advantage of its structure. In the case of the Niger, its territorial extension to the whole basin with nine member states is its source of weakness. Only a few of the nine states shared a common interest in any one mode of water resource development in the basin [12, p.47]. Not surprisingly, efforts to improve the work of the Niger's Commission encourage limitation of the number of member states. As a result, the level of cooperation in the Niger is low, though its structure allows it a very high level of cooperation.

The International Boundary and Water Commission (IBWC/CILA) is a unique institution which manages the two basins of the Colorado and Rio-Grande-Rio Bravo which are shared by the USA and Mexico. The same body also maintains the border

between the states. There are one treaty and two inter-state compacts to regulate the Colorado and two treaties and one compact for the Rio Grande (Rio-Bravo). The first treaty is dated 1889 and the latest is 1944; thus, the IBWC is one of the most veteran and experienced institutions for the management of transboundary water resources [13–18].

The territorial extent of the IBWC/CILA is over the whole basin of both the Colorado and Rio Grande/Rio Bravo. The various treaties and conventions which established this institution are mainly allocation agreements which apportion water in accurate measures to the USA and Mexico. The IBWC/CILA is fundamentally a technical agency whose primary functions are technical and scientific. The IBWC/CILA has two national sections each responsible to its respective government for policy authority. However, the Commission has developed a unique and equitable approach to the problem of generating binational support for joint projects such as sewage facilities to serve both sides. The Commission is now dealing with all matters concerning border sanitation and water quality, construction and maintenance of flood control in the river basins, regular water allocations to users, and ground water issues of allocation and quality. The IBWC/CILA is responsible for coordination, investigation and planning of actions and works deemed necessary to the implementation of the goals specified in the various treaties and conventions [19,15]. It should be noted that the IBWC/CILA is functioning today as a 'multipurpose' agency, though according to the original treaties and conventions it does not have authority over these matters. The IBWC/CILA added these functions by the adoption of Minutes which expanded its jurisdiction into new areas – as required. The level and intensity of cooperation in this institution is very high.

It is possible to conclude, from the four river basins which were analysed above, that a high level of cooperation is not necessarily gained by a formal structure which turns the institution into a multi-purpose joint development agency, nor will territorial extension over the basins in total accomplish this.

3.2 Legal and political facets of the cooperative model of institution

Four other characteristics of the three institutions also deserve particular attention. First, do legal principles of international law emerge from the treaty or convention which established the institutions? Second, is there an involvement of external organisations (UN, NGOs) in the foundation of the institution? Third, what is the involvement and control of national leaders in the establishment and functioning of these institutions, and finally, what is the availability and use of conflict management mechanisms within the institutional framework?

In the Senegal the following principles of international law appear overtly or covertly in the 1972 and 1978 conventions:

- freedom of navigation
- equity-allocation of benefits and costs not in three equal parts, but on the basis of the needs of co-basin states [7]
- equal treatment of users
- no projects that cause harm can be carried out without prior approval by the contracting states [8].

The OMVS also manifested very large external influences on its creation and functioning. The donor community which comprised 14 different sources – including Arab Funds, Germany, France, Italy, Canada, USAID, OPEC, UNDP and World Bank – was a force in shaping the institutional framework of that river [20]. The investments made by these bodies were very high and reached $700 million. The leaders of the three founding basin-states which initiated the evolution of OMVS were very skillful in convincing the donors, separately, to take single projects and finance them [7, p.230, 20].

The political leaders of Senegal, Mali and Mauritania were very active and effective in the process of establishment of the OMVS, and the formal structure of the OMVS reflected this: the higher level of government, namely the Conference of Heads of States, is the body which determines the policies of development and cooperation [8]. Conflict resolution mechanisms are a part of the institutional framework. In the process of its establishment the founding states had disputes which centred on the location of the various projects, and also political tensions which arose from the political rivalry among the co-basin states, but they were able to overcome their differences.

The various conventions relating to the *Niger* (Act of Niamey 1963, Niger River Commission 1966, and Niger Basin Authority 1980) emphasised the following principles of international law (see also Table 2):

- freedom of navigation
- all members are equal in their rights and obligations in this legal regime
- to abstain from taking, without prior agreement, any measures likely to have an appreciable effect on water losses or the annual flow of the river or on its sanitary and biological conditions [11]

Similarly to the Senegal, external organisations were involved in the establishment of the institution. The UN undertook to finance the comprehensive survey of all the existing and future national projects on the Niger. The World Bank, UNDP, CIDA, USAID and FAO were also involved in both technical and financial matters. Altogether these supporting agencies provided more than $30 million plus substantial technical assistance to the Niger Commission and Authority [12, pp.45–47].

In its political structure the Niger River Authority is similar to OMVS in that its higher decision making mechanism is the Summit of the heads of state and its executive body comprising the council of Ministers [7]. But this system, which was effective in the Senegal river basin, failed in the Niger.

A conflict resolution mechanism is built into the institution and if this mechanism fails, a dispute must be referred to arbitration to the Organisation of African Unity. As the institution is hardly active, no disputes have had to be solved in that manner. The various treaties and compacts which established the IBWC/CILA also stress principles of international law. The 1906 convention is named ‘The 1906 Convention for the Equitable Division of the Waters of the Rio Grande/Rio Bravo for Irrigation Purposes’, and the 1944 Treaty specified the equitable distribution of the waters from the lower Rio Grande and the Colorado. An equitable approach was adopted also to binational financing of water improvement projects.

In political/legal aspects the IBWC/CILA is very different from the institutions in the Senegal and Niger. First, it did not receive any external funding and no UN, UN-

affiliated organisations or NGOs were involved in its establishment or maintenance. IBWC/CILA also differs from the institutions on the Senegal and Niger in that national leaders play no formal part in the structure of that agency, and only rarely are contested issues dealt with by the highest echelon of government.

Generally, in a dispute between the two sections of the Commission, the two sides refer it to the Ministries of Foreign Affairs in both countries for resolution through diplomatic negotiations. Basically, this institution is successful because of the political interests of the USA and Mexico to adhere to a good neighbourly relationship between the two states, as reflected in many areas of cooperation. The recent NAFTA agreement is a positive manifestation of these relations. Also important is the good 'chemistry' or cooperation and trust between the two Commissioners – the American and Mexican heads of the IBWC/CILA. Interviews with both revealed that this factor played a big part in the smooth functioning of IBWC/CILA [21,22].

A general pattern is reflected in the politics and legal aspects of the institutions in the Senegal, Niger and Colorado-Rio Grande – in perhaps only one respect – the adoption and use of principles of international law as the foundation of their institutions. However, external involvement was important in the Senegal and Niger, but not in the Colorado and Rio-Grande and the political elite was involved in water institutions only in the Niger and Senegal. We cannot look for a 'definite' answer to the relative success of these institutions in their political and legal facets.

4 The middle of the way: river basins with medium levels of cooperation

This category of river basin institutions contains certain areas in which they cooperate, even well, but levels of cooperation and formal institutionalisation of that cooperation are fewer than in the first group of basins.

4.1 Intensity of cooperation

The Mekong Committee (1957) and its successor, the Mekong Commission (1995) is one of the oldest institutions in this study. It was founded in 1957 by the Lower Mekong co-riparians: Thailand, Cambodia, Laos, and Vietnam. Burma (Myanmar) and China, the upstream riparians, were never members, though the 1995 Commission was founded with the intention of luring the upper riparians into that institution. China and Myanmar are members of MDRN, a network of scientific and research institutions, which serves as a bridge among the riparians in climate data collection in areas of water related issues. Thus, the Mekong's institutions do not extend to the whole river basin; hence, management of that basin is less than optimal. Activities in the upper basin such as deforestation in Myanmar and extensive dam construction in China have their ramifications in the lower parts of the Mekong and the lower riparians are anxious to integrate China into the Mekong Commission.

On the other hand, levels of cooperation as expressed in its functioning are very high (Table 2). The Mekong Committee was given authority to coordinate, supervise and control planning of and investigation into water resources development of the Lower Mekong. Major proposals to abstract water in riparian states must be approved by the Committee. As a multipurpose joint development agency, the Committee's activities included collection of basic data, flood control, hydropower development, fishing,

navigation and environmental issues [23,24, pp.10–11]. The Mekong Commission was founded in 1995 as a successor to the Mekong Committee, in order to convince China and Myanmar to join. It added activities and projects with a basin-wide character, such as a plan to integrate the national power grids of the co-basin states into a regional network.

The Commission continued functioning in all other sectors in which the former body had been active. Thus the high levels of cooperation in the Mekong are offset by the fact that that institution does not cover the whole basin, and separate development in the uppermost part of the basin harms development in the lower basin.

The Elbe and Danube institutions are also classified in this category of institutions with lower levels of cooperation. The first institution for the Elbe was the International Commission of the Elbe established by the Treaty of Versailles in 1919 and was focused on free navigation in the river [25]. Germany renounced the international regime for the Elbe and after 1945 no international attempt was made to return to the status quo ante and establish the river's international regime. The new institution was established in 1990 by Germany, the then Czechoslovakia and the EU. The International Commission for the Protection of the River Elbe (ICPE) has a narrow scope of activity: water quality. Its role was defined so as to enable the Elbe to be used for drinking water supply and irrigation, restoring the natural ecosystem and reducing the waste load carried by the Elbe into the North Sea [26, p.3]. The ICPE covers the whole basin of the Elbe in Germany and the Czech Republic, which constitutes 98% of the drainage area of that basin. It is possible to conclude that the Elbe reflects high levels of cooperation in respect to its territorial extension but has a single purpose only, so that its scope of activities is narrow.

In the Danube, there are two institutions with different roles, and territorial extension. According to the Treaty of Versailles of 28.6.1919 the European Commission of the Danube established free navigation on the Danube for all European countries. This freedom of navigation was abolished in favour of exclusive control by individual co-basin states after the second World War, among the Socialist Eastern European States which had come under the Soviet sphere of influence. This is the Danube Commission, which has power over river navigation and shipping and its members are all the co-basin countries: Austria, Hungary, Bulgaria, Romania, Slovakia, Serbia-Montenegro, Russia and Ukraine. Croatia, Moldova and Germany have observer status in the Commission [27, p.539]. However, Ukraine objects to Russian and Moldovan membership in the Commission and Croatia is not recognised as a member by Serbia. There are also arguments as to whether all the riparians of the Black Sea should join the new institution. We may conclude that even the extension of this body is not agreed upon.

Another institution is in the process of being formed in the Danube River basin. The first component in this emerging institution is the Convention on cooperation for the Protection and Sustainable Use of the River Danube which was signed in Sofia in 1994. The major concerns which led to the signature of that convention were separate and uncoordinated development of hydropower plants on the river, differing standards for water quality among the co-basin countries and pollution, mainly industrial [28, p.634]. In 1991 the Danube co-basin states established an integrated program for a basin-wide control of water quality which laid the foundation for the 1994 Convention. The co-basin states started working on water quality through a task force in which all the riparians have representatives [29]. The main goals of the new convention environmental program are:

- improving the aquatic ecosystems and biodiversity in the Danube river basin and reducing the pollution load
- maintaining and improving the quantity and quality of water in the Danube River basin
- development of regional cooperation in water management [29, pp.69–70].

The Danube Convention provides a legal framework for integrated watershed management and environmental protection in the whole basin.

To summarise, at present the Danube is regulated by one Commission which deals solely with navigation and by another, emerging body which will have a broader spectrum of functions. In both cases the institution covers the whole basin. In sum, lower levels of cooperation in river basins can result from two sources: coverage of only parts of a certain basin or by institutions with single purpose only.

The levels and intensity of cooperation in the Mekong, Danube and Elbe provide us with a mixed picture: the Mekong is very cooperative – but not in the whole basin; in the Elbe cooperation is extended to the whole basin but to only one (crucial) issue of pollution. As for the Danube it looks as if the current single function of pollution will be supplemented by multi-purpose management. The institution for the management of that river is basin-wide and, considering the number of riparians – this is more than a minor achievement.

4.2 Legal and political facets of the 'middle of the way' institutions

The Mekong Committee served as a framework for the equitable sharing of the resources of the Mekong [30, p.5]. The treaties which concern the Mekong were signed in 1957 and in 1995; when this body became The Mekong Commission. The Articles of the 1995 Agreement on Cooperation for Sustainable Development of the Mekong Basin guarantee fairness (equity) in the use of the water and related resources [23, p.3, 31].

In the Danube the principle of free navigation was secured by the Treaty of Versailles of 1919. The other emerging regime has yet not specified any principle of international law. Freedom of navigation was secured in the Elbe also by the Treaty of Versailles. The new I.C.P.E. Treaty which deals with water quality did not mention a specific principle of international law as guiding its work.

The second characteristic in all three basins is the broad involvement of external organisations in the process of their establishment and even their everyday activities. In the Mekong, the UN, ECAFE and the US Bureau of Reclamation were involved in the early studies on the economic potential of the Mekong. The cost of planning investigation and feasibility studies was financed by the UN, the Asian Development Bank and also by the USA, UK, Canada, France, the Netherlands, Australia, New Zealand, Germany, Japan and others.

The UN played an important role in provision of technical support, which was needed for the Mekong Committee in the first years of its evolution. The development fund accumulated for the Mekong reached $800 million [32].

In the Danube and Elbe, external involvement was of a different type. In the new institution which is being implemented in the Danube, the 'Environmental Programme for the Danube River Basin', the UN, and EU organisations are also members as well as

the co-basin states. UNDP, UNEP, the World Bank, WWF and other NGOs and investment banks take part in the programs and in the preparation of the strategic action plan for the river [29, pp.69–70]. In the '1994 Convention on Cooperation for the Protection and Sustainable Use of the River Danube' the EU is a full member. The EU is also a full member in the ICPE, in the Elbe River. The EU interest and involvement in these two institutions is motivated by its wish for uniform standards of water quality in all parts of Europe, and its realisation that many of the Eastern European countries cannot afford expensive programs of monitoring, construction of sewage projects and implementation of cleaning programs. As some of the riparians to the Danube and Elbe are in the process of joining the EU as full members and others aspire to do so, they share the same interest – that the EU will be an active member in these institutions.

Political leaders' involvement in the three institutions is not equal. In the Mekong, the structure of the Mekong Committee was perceived by its members as too weak and its replacement, the Mekong Commission was created as a three-tier body consisting of a ministerial council aimed at laying down policies. The superimposition of this political layer on the two-tier Mekong Committee was apparently meant to reinforce it along similar lines to those in Senegal [24, p.2]. In the Danube and Elbe the ministers for water and environment are involved in the institutions as the highest political stratum. Conflicts and disputes are also solved at this level (in the Danube and Elbe), whereas the new ministerial level added to the Mekong Commission is also the forum for conflict resolution.

The above survey of the three basins showed a few common features: external involvement and impact is very high in all three. UN, EU, World Bank and United Nations affiliated bodies are deeply involved in the creation and regular day-to-day functioning of the three institutions. Also common to all three institutions is the overt emphasis on legal principles such as free navigation, equitable management, and prevention of harm. There is no important role for national leaders, but ministerial level is now part of the structure of all three institutions.

5 The least cooperative institutions for the management of transboundary water resources

The regimes in the Indus and Ganges-Brahmaputra are intentionally non-committed with cooperation restricted to very narrowly defined areas. The 1960 Indus Treaty established the Indus Commission, which is authorised to implement the agreement to divide the water resources of the Indus between India and Pakistan. A period of transition followed the formal agreement, in which the two countries developed their separate infrastructure and irrigation systems. The Commission simply monitors and inspects each of the member states to check that they will adhere to their water quotas and that no projects which may harm water quantity or quality will be constructed without approval [33, p.107]. Data exchange is the single and most important function of the Commission which is empowered as a 'watch dog' to ensure strict adherence of the co-basin states to the 1960 water allocation agreement. Although the original treaty called for cooperation in the planning and development of the river, no matter requiring joint planning has been jointly referred by the two governments to the Commission. Though the jurisdiction of the Indus Commission is over the whole basin, only inspection and monitoring is carried

out in the basin as a whole; each of the states utilises its water resources individually and there is no basin-wide joint management of the Indus. It should be noted that the Indus Commission is considered a successful institution because India and Pakistan, with their history of conflict, could not cooperate in any other way and needed to maintain a very low level of commitment and cooperation in that institution. The Indus Commission has been functioning successfully for more than 30 years and was able to solve controversies and disputes which surfaced during this period. The recent 1996 Treaty on sharing of the Ganges waters at Farrakka, signed by India and Bangladesh, also reflects a political environment of hostility and mutual suspicion. The Treaty refers to a single issue: how much Ganges water will be used by India and Bangladesh in various seasons in order for India to have enough water to flush the port of Calcutta., whereas Bangladesh needs the water of the Ganges for domestic use and for irrigation. Thus, this institution inspires very narrow cooperation and has a single purpose. Its purpose is limited to a small portion of the river, not to its total territory. India and Bangladesh also share the Indo-Bangladesh Joint Rivers Commission which was established in 1972. This body failed in its task to arrive at a permanent solution to the water dispute between the two countries [34]. India, the upperstream riparian, utilises the Ganges according to its own priorities with no consideration of the needs of the lower riparian – Bangladesh. The Ganges-Brahmaputra is burdened by a great water variability, floods and silting and very serious competition among its users. It urgently needs a basin-wide institution which will include all the co-basin states, including Nepal.

The narrow cooperation which characterises both the Indus and Ganges points clearly to the flaws in such cooperation. In the Indus, the partition of the water and duplication of infrastructure produced water management which is sub-optimal and an institution with only one monitoring function. Extending that institution to the whole basin of the Indus does not provide further benefits to the riparians. The Ganges exemplifies the shortcomings of any unwillingness to cooperate in the whole basin: the upper riparians continue with their separate development schemes, whereas Bangladesh is exposed to devastating floods. India is the force behind the minimal level of cooperation, as it refuses to allow any institutions with broad authority and wide jurisdiction.

5.1 Legal and political facets of the least cooperative model institutions

The treaties on the Indus and Farakka dam do not specify any principle of international law, but the negotiating parties raised various principles such as ‘prior use’, ‘historical rights’, and ‘equitable apportionment’ during negotiations and in their attempts to justify this position in the conflict.

The two weak institutions also differ in the level of external involvement in their creation. The Indus Treaty is, no doubt, the outcome of successful mediation by the World Bank, which also supplies the financial support which was needed for such an immense project [35]. The investment involved in the implementation of the Indus agreement was very large because it was based on partition of the water and the duplication of all the water delivery systems and storage in both riparians.

Pakistan (predecessor of Bangladesh) tried to internationalise its Ganges dispute with India as early as 1957 but India was strongly against the interference of a third party in an ‘essentially bilateral problem’ [34, p. 927]. Bangladesh which ‘inherited’ the dispute with India tried also to recruit foreign involvement, but it did not succeed. None of the attempts was successful [36, p.19].

Conflict resolution, according to the Indus Treaty, is carried out first by the Indian and Pakistani Water Commissioners and only when these two fail does a dispute have to be referred by the two commissioners to a neutral expert or to an arbitral court [37]. During the 18 years of the treaty's functioning, no occasion has arisen to necessitate referring any dispute to a third party for arbitration, and differences were settled through bilateral negotiations.

Bangladesh tried once to bring its water dispute over the Ganges for discussion in the international court, but failed to do so.

Nehru, the Indian Prime Minister, was directly involved in the negotiations, and in moments of crisis was able to reach a compromise with his Pakistani counterpart, President Ayub. The recent Treaty on the sharing of the Ganges waters at Farakka is also related to a 'moment of grace', in which the Indian and Bangladeshi Prime Ministers were able to come to an understanding. Sheikh Hasina of Bangladesh and Gujral from India were anxious to solve the dispute and reach an agreement. The willingness and new approach to the dispute of Gujral, who served as foreign minister before he became prime minister, was emphasised as one of the major forces behind the settlement (International Herald Tribune, 25 May, 1997).

The Indus Treaty and Ganges Treaty reflect adoption of international law only in its narrower sense, namely, that the two agreements which are basically those of allocation, were preferable to constant conflict over the shared water resources. National leaders' goodwill, particularly Indian leaders, did play an important role in the conclusion of these agreements. External intervention and mediation helped in the case of the Indus, where India allowed it. In the case of the Ganges, India refused any outside intervention and the conflict continued for many years.

6 Concluding remarks

This paper examined the institutional framework for the management of nine transboundary river basins, which were classified into three categories according to the level and intensity of their cooperation and the degree of success of their management.

The nine river basins differed in their physical-hydrological features, in their major uses, in their institutions, territorial extent, experience and success. Very few of the examined institutions corresponded to the ideal model of institutions for management of transborder water resources, namely a basin-wide multi-purpose institution which treats the whole basin as one unit and integrates all riparians in an equitable manner. Almost all the discussed basins showed that competition among various users and water use was growing rapidly and that the institutions which functioned well were able to contend with overt conflict. Pollution of the water resources is a growing problem in many basins, and in the case of European river basins is the main incentive for the establishment of the institution. Pollution also takes up more and more time and money in the functions of the institutions in the Mekong, and Colorado-Rio Grande.

Analysis comparing the formal structure and the practice of the nine basins shows the following:

1 Institutions which are established with broad authority over many areas (multi-purpose institutions) with jurisdiction over the territory of a whole basin of a river,

do not always succeed in managing transboundary water resources as the Niger case exemplifies so well. On the other hand, institutions which do not have jurisdiction over the whole territorial extent of a basin such as the Mekong were able to become very active in many areas related to the transboundary water resources. In the case of both the Mekong and the IBW/CILA, the success of these two institutions was explained as resulting from a 'spirit of cooperation'. In the Elbe and Danube, intensity and levels of cooperation remained low either because of the single purpose of the institution (Elbe) or because the number of riparians is too large (Niger) and the economic and political gaps among them is too wide to bridge in one institution (Danube). The Ganges-Brahmaputra also manifested the evil of establishing institutions with very narrow functions such as the recent 1996 Ganges Treaty, which deals only with the division of water between India and Bangladesh at the Farakka Dam. The Indus, on the other hand, with its regime of partition, works well within its narrow authority and provides the member states India and Pakistan with exactly the level of cooperation suitable for them.

2 Though the number of river basins investigated is low, it seems that treaty or convention regimes which formally state the principles for cooperation, including principles of customary international law, are generally preferred and adhered to more than other arrangements, such as temporary agreements. It was also found that external intervention or external power in the form of mediation, technical assistance and financial support is a very influential component in the establishment and success of institutions. This was found to be extremely important in both the developed and developing realms.

Water management institutions had more chance to succeed if they were perceived as an important part of the foreign policy of their respective countries. If this is the case, the national leaders and the relevant ministries would be interested in the welfare and success of these institutions and would be politically active in negotiations and even in conflict resolution in cases of dispute.

Finally, mechanisms for conflict resolution were either built in or adopted by most of the institutions examined, but their existence or non-existence did not guarantee cooperation among riparians. More influential was something intangible which could be called a 'spirit of cooperation' and when this was absent (Indus, Ganges, Niger) the intensity and level of cooperation tend to be very restricted.

3 This paper pointed to a need to differentiate between the *formal* structure of institutional frameworks and their *de facto functioning*. The Niger could exemplify this point. Its formal structure favoured broad cooperation; hence, its classification within the category of the most cooperative institutions. However, in reality, the de facto realisation of that framework is weak. The Mekong, in contrast, shows harbingers of future conflict: it practises intensive cooperation, both in its institutional framework and in reality, but only for the benefit of the lower-basin states, whereas China, the upper riparian, is involved in massive development in the upper basin. This development eventually will harm the lower basin and inevitably lead to conflict. So, what really entails basin-wide cooperation and management? Should the Niger and Mekong switch places in their classification as 'most cooperative' and 'medium level cooperative'?

It was also found that sometimes, as in the cases of the Mekong or Niger, the partners believed that a change in the formal structure of the institution would strengthen it. In some cases, the institution remained weak intentionally (Ganges) because it served the purpose of one of the riparians – India. In other cases (Colorado-Rio Grande) the partners saw no need to change the formal structure of the institution as they developed a way to expand cooperation in water related issues beyond the narrow mandate of their formal institution.

More detailed research is needed in the structure and functioning of institutions for the management of transboundary water resources. Such research may add more insight to our ability to improve the work of such institutions.

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References

1 Caponera, D. (1995) 'Shared waters and international law', in G. Blake, W. Hildesley, M. Pratt et al. (Eds.) *The Peaceful Management of Transboundary Resources*, London/Dordrecht: Graham & Trotman, pp.121–126.

2 McCaffrey, S.C. (1993) 'Water politics and international rivers', in P. Gleick (Ed.) *Water in Crisis*, New York: Oxford University Press, pp.92–112.

3 Dellapenna, J. (1995) 'Designing the legal structures of water management needed to implement the Israeli Palestinian declaration of principles', in Haddad, Marwan and E. Feitelson (Eds.) *Joint Management of shared Aquifers: The Second Workshop*, Jerusalem: The Palestine Consultancy Group and Truman Research Institute, pp.261–311.

4 Naff, T. (1993) 'International riparian law in the West and Islam', *Proceedings of the International Symposium on Water Resources in the Middle East: Policy and Institutional Aspects*, Urbana, IL: University of Illinois at Urbana-Champaign, pp.114–123.

5 Solanes, M. (1992) 'Legal and institutional aspects of river basin development', *Water International*, Vol. 17, No. 3, September, pp.116–122.

6 Housen-Couriel, D. (1994) *Some Examples of Cooperation in the Management and Use of International Water Resources*, Tel Aviv: The Armand Hammer Fund for Economic Cooperation.

7 Godana B.A. (1985) *Africa's Shared Water Resources*. Boulder, Colorado: Lynne Rienner.

8 OMVS (1988) 'The Senegal river basin development authority', in *UN Conference on River and Lake Basin Development*. Addis Ababa, 10–15 October, New York: UN Natural Resources Water Series No. 2, pp.276–294.

9 Ibrahim, M. (1988) 'The Senegal River Basin development project', in United Nations *Conference on River and Lake Basin Development*, Addis Ababa, 10–15 October, Natural Resources Water Series, No. 20, New York.

10 Sylla, M. (1992) 'Examining Senegal's development objectives and strategies for the Senegal River Basin', in G. Le Moigne, S. Bargouti, *et al.* (Eds.) *Country Experiences with Water Resources*, The World Bank, Washington DC, pp.203–206.

11 Ofosu-Amaah, G. (1990) 'Niger River regime', in R. Bernhardt (Ed.) *Encyclopedia of Public International Law*. Vol. 12, North Holland, Amsterdam, pp.246–248.

12 Rangeley, R. Thiam, B. Andersen, R. and Lyle, C. (1994) *International River Basins in Sub-Saharan Africa*, Washington D.C.: World Bank Technical Paper, No. 250, pp.43–48.

13 Mumme, S. (1992) 'New directions in United States-Mexican transboundary environmental management: a critique of current proposals', *Natural Resources Journal*, Vol. 32, summer, pp.539–562.

14 Mumme, S. (1993) 'Innovation and reform in transboundary resource management: a critical look at the international boundary and water commission, United States and Mexico', *Natural Resources Journal*, Vol. 33, winter, pp.93–120.

15 Mumme, S. (1995) 'NAFTA and North American transboundary environmental management', *Draft Paper*, in the *Conference on International Boundaries and Environmental Security: Frameworks for Regional Cooperation. 14–17 June, Singapore.*

16 Utton, A. (1988) 'Problems and successes of international water agreements: the example of the United States and Mexico', in J. Carroll (Ed.) *International Environmental Diplomacy*, pp,117–122.

17 Utton, A. (1991) 'An assessment of the management of the US-Mexican water resources: anticipating the year 2000', *Transboundary Needs and Issues*, pp.365–381.

18 Utton, A. (1991) 'Mexican international waters', in G. Beck (Ed.) *Water and Water Rights*, Ch. 51, pp.95–128.

19 Utton, A. (1982) 'Water and the arid southwest: an international region under stress', *National Resources Journal*, Vol. 34, Spring, pp.1–5.

20 Le Marquand, D. (1986) 'International development of the Senegal' in E. Vlachos *et al*. (Eds.) *Management of International River Basin Conflicts*, Washington D.C.: George Washington University.

21 Arturo Herrera, Commissioner, IBWC/CILA 13.9.94.

22 Joseph Friedkin, former Commissioner IBWC, 12.9.94.

23 Matics, K. (1995) 'Development of the Mekong River and law: some environmental problems', in *The Conference on International Boundaries and Environmental Security: Framework for Regional Cooperation*. 14–17 June, Singapore.

24 Chomchai P. (1995) 'Transboundary protection of the environment: a Mekong perspective' in *The Conference on International Boundaries and Environmental Security*: *Framework for Regional Cooperation*. 14–17 June, Singapore.

25 Rauschning, D. (1992) 'Elbe River', in R. Dolzer, R. Hollway *et al*. (Eds.) *Encyclopedia of Public International Law*, North Holland, Amsterdam: NE, Vol. 9, pp.96–98,

26 Schumann, A. and Simon, S. (1994) 'The International Commission for the Protection of the River Elbe – a transboundary water management organisation', in *NATO-ASI, Transboundary Water Resources Management – Theory and Practice*, Skopelos, forthcoming.

27 Linnerooth-Bayer, J. (1994) 'The Danube River Basin: international cooperation for sustainable development'. *Transboundary Resource Report*, Spring.

28 Linnerooth, J. (1990) 'The Danube River Basin: negotiating settlements to transboundary environmental issues', *Natural Resources Journal*, Vol. 30, No. 3, summer, pp.629–659.

29 Bingham, G., Wolf, A. and Wohlgenant, T. (1994) *Resolving Water Disputes: Conflict and Cooperation in the United States, the Near East, and Asia*, Irrigation Support Project for Asia and the Near East (ISPAN) November.

30 Chomchai, P. (1986) 'The Mekong committee: an exercise in regional cooperation to develop the lower Mekong basin', in E. Vlachos, A.C. Webb and I. Murphy, (Eds.) *The Management of International River Basin Conflicts, Proceedings of a Workshop* held at Laxenburg, Austria, 22–25 September.

31 Bingham G., Wolf, A. and Wohlgenant, T. (1994) 'The Mekong Committee', in *Resolving Water Disputes*', Washington D.C.: Irrigation Support Project for Asia and the Near East, pp.124–134.

32 Savasdibutre, P. (1988) 'The development of the lower Mekong River Basin' in *River and Lake Development. United Nations Natural Resources Water Series*, No. 20, pp.170–179.

33 Rahim, A. (1990) 'Indus Basin development in United Nations Department of Technical Cooperation', *Natural Resources Water Series No. 20, River and Lake Basin Development. Proceedings of the UN Meeting*, Addis Ababa, Ethiopia, 10–15 October 1988, pp.203–210.

34 Islam, R.M. (1987) 'The Ganges water dispute', *Asian Survey*, Vol. XXVII, No. 8, August, pp,918–934.

35 Baxter, R.R. (1967) 'The Indus basin', in A. Garretson, *et al.* (Eds.) *The Law of International Drainage Basins*, New York: Oceania Books, Ch. 9, pp.443–485.

36 Abbas, B.M. (1992) 'Development of water resources in the Ganges and Brahmaputra River Basin', in D. Eaton (Editor) *The Ganges-Brahmaputra Basin*, The University of Texas at Austin: Lyndon B. Johnson School of Public Affairs, pp.14–22.

37 Sharma, K.S. (1990) 'India's experience in developing the Indus River Basin programme' in *United Nations Department of Technical Cooperation, Natural Resources Water Series No. 20, River and Lake Basin Development. Proceedings of the United Nations Meeting*, Addis Ababa, Ethiopia 10–15 October 1988, pp.194–202.

Bibliography

Chomchai, P. (1994) 'Management of transboundary water resources: a case study of the Mekong', in G. Blake, W. Hildesley and M. Pratt (Eds.) *The Peaceful Management of Transboundary Resources*, London and Dordrecht: Graham Trotman and Martinus Nijhoff, pp.245–260.

Dellapenna, J. (1993) 'Institutional building', *Paper presented at the Israeli-Palestinian First Conference on Water Resources*, Zurich, Switzerland, January.

Eaton, D. and Chaturvedi, M. (Eds.) (1993) 'Water resource cooperation in the Ganges Brahmaputra River Basin', The University of Texas at Austin. Lyndon B. Johnson School of Public Affairs, *Policy Research Project Report No. 101*.

Gleick P. (Ed.) (1993) *Water in Crisis*. New York: Oxford University Press.

Guggenheim, S. (1992) 'Institutional arrangements for water resources development' in G. Le Moigne, S. Barghouti, G. Feder *et al.* (Eds.) *Country Experiences with Water Resources*, Washington D.C,, World Bank Technical Paper, Number 175, pp.21–24.

Khan, T.A. (1996) 'Management and sharing of the Ganges', *Natural Resources Journal*, Vol. 36, Summer, No. 34, pp.455–480.

Le Marquand, D. (1990) 'International development of the Senegal River', *Water International*, Vol. 15, No. 4, pp.223–230.

Linnerooth-Bayer, J. and Murcott, S. (1996) 'The Danube River Basin: international cooperation or sustainable development', *Natural Resources Journal*, Vol. 36, Summer, No. 3, pp.521–548.

Mehta, J.S. (1986) 'The Indus water treaty' in E. Vlachos, A. Webb and I. Murphy (Eds.), *The Management of International River Basin Conflicts, Proceedings of a Workshop held at the Institute for Applied Systems Analysis*, Laxenberg, Austria, September 22–25, pp.1–24.

Meyers, C. (1967) 'The Colorado Basin', in Garretson *et al. The Law of International Drainage Basins*, Oceana Publications, NY:NY.

Mumme, S. and Moore, S. (1990) 'Agency autonomy in transboundary resource management: the United States section of the international boundary and water commission, United States and Mexico', *Natural Resources Journal*, Vol. 30, No. 3, summer, pp.661–684.

Rene Valenzuela, Secretary IBWC/CILA, 12.9.94.

Szekely, A. (1992) 'Establishing a region for ecological cooperation in North America', *Natural Resources Journal*, Vol. 32, summer, pp.563–622.

Szekely, A. (1993) 'Emerging issues: Mexico and the United States', *Natural Resources Journal*, Vol. 33, winter, pp.1–46.

United Nations (1978) *Register of International Rivers*, New York: United Nations.

Vlachos, E., Webb, A.C. and Murphy, I. (Eds.) (1986) 'The management of international river basin conflicts', *Proceedings of a Workshop*, held at Laxenburg, Austria, 22–25 September.

World Bank (1992) *World Development Report*, Oxford: Oxford University Press.

World Resources Institute (1994) *World Resources 1992–3*, New York: Basic Books.