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Cooperation in river basins

the Scheldt case

Delft, May 1995

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PREFACE

Delft University of Technology and the Dutch Ministry of Transport, Public Works and Water Management cooperate in the research project TWINS (ToWards and Integrated water management of the Scheldt). Three PhD students from different disciplines are working on this project for four years. One subproject is being carried out at the Centre for Comparative Studies on River Basin Administration (RBA Centre). It focuses on the cooperation between the relevant actors in river basins. This report is a product of this subproject and presents the results of the first phase of research, which had a mainly descriptive and explorative character.

I am grateful to prof.mr. J. Wessel, the members of the steering group of the TWINS-project and the members of the supervising team for their guidance during the first phase of research. Their names are listed in the Appendices C and D. Furthermore, thanks should be expressed to all those interviewed. Space is lacking here to mention them all, but they are mentioned in the list of references. Erik Mostert made useful comments on drafts of the chapters five and six, dealing with theories on cooperation and cooperation in the Scheldt basin. Jeroen Maartense commented on chapter three, describing the functions of the Scheldt basin. Last but not least I would like to thank Paul Verlaan for comments on chapter three and an important contribution to this report, a description of the natural system of the Scheldt river basin.

Delft, May 1995

Drs. Sander V. Meijerink

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0.1 Abstract

Research on cooperation in river basins

Introduction
In 1993, the research project TWINS (ToWards an INtegrated water management of the Scheldt) has been started at the Delft University of Technology (TU Delft) in cooperation with the Dutch Ministry of Transport, Public Works and Water Management (Rijkswaterstaat). The main objective of this project is to find better ways for integrating the knowledge of different disciplines, which is important for integrated water management.
The project primarily focuses on the problems related to sediment (mud) in the Scheldt basin. Three PhD students from different disciplines are working on this project for four years.
The TWINS-project is divided into three subprojects. One subproject aims at a better quantification of mud-related processes, which is necessary to come to an improved mud balance of the entire Scheldt catchment. The second subproject aims at contributing to the development of an innovative policy analysis approach. This approach should consider the participation of multiple actors in decision making, diverging interests and the demand for quick and less detailed information. The third subproject focuses on the cooperation between the relevant actors in river basins and is being carried out at the Centre for Comparative Studies on River Basin Administration (RBA Centre). The central question of this research is: *What factors influence the extent of cooperation between the relevant actors in a river basin?*

This report is a product of this third research project and presents the results of the first phase of research, which had a mainly descriptive and explorative character.

The report contains a description of the natural system, the main functions of the Scheldt basin and a description of the water management organization in the riparian states. Furthermore, it addresses the concept of integrated river basin management, presents some theory on cooperation in river basins and gives a description of the cooperation in the Scheldt basin.

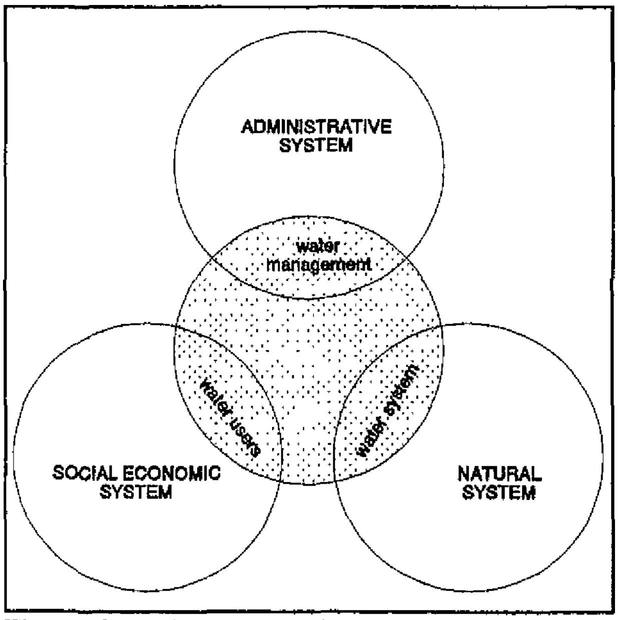


Figure 0.1: ***Contents of Integrated Water Policy*, modified after [Grijns & Wisserhof, 1992]**

Integrated river basin management
Integrated water management should consider three interrelated systems [Grijns & Wisserhof, 1992]:
I. The Natural System (the water system)
II. The Social Economic System (the water users)
III. The Administrative System (water management)
Figure 0.1 shows these three systems. An integrated approach to the mostly very complex water management problems in river basins should address the relations within the three systems as well as the relations between these systems. Characteristic for river basins are the diverse upstream-downstream relationships. Such an integrated approach can only be realized if all parties who influence or are affected by these relationships (the relevant 'actors') cooperate extensively. Therefore, it would be interesting to know more about the factors influencing the extent of cooperation between the relevant actors in river basins.

Cooperation in river basins
Although few theories on cooperation in river basins have been developed, there are many theories on cooperation in general. Two important theoretical approaches to cooperation are the network approach and the game theoretical approach.

The network theory points out the mutual dependencies that exist between actors. Policy networks are defined as patterns of interactions between mutual dependent actors, which are formed around policy problems or policy programmes. For the preparation and implementation of policy, interactions between (representatives of) governmental and non-governmental organizations (NGOs) are necessary. Since these interactions are continuous, institutionalization can emerge. In this way networks are shaped.

Game theory investigates how individuals pursuing their own interests will act, and analyses what effects these actions will have for the system as a whole. It provides information on the conditions that allow cooperation to emerge. By understanding these conditions, appropriate actions can be taken to foster the development of cooperation in a specific setting. Both the network theory and the game theory provide information on the patterns of interaction and cooperation and the strategies actors are using to achieve their goals.

Knowledge on the factors influencing the extent of cooperation is essential to understand the existing patterns of cooperation in river basins and the development of cooperation over time (the dynamics of cooperation). Table 0.1 gives five interrelated and partly overlapping groups of factors influencing cooperation and agreement in international river basins. All these factors can be useful to explain the development of cooperation. Some of them, such as the existence of networks, can be manipulated. Others, such as the hydrological sequence of the basin countries, can explain the development of cooperation to a high degree, but cannot be manipulated. For prescriptive research, the factors that can be manipulated are most interesting.

Hydrologic-Economic patterns of incentives and disincentives	Foreign policy considerations	Domestic policy-making and consensus formation	Factors facilitating communication between basin countries	Existence of common threats or the occurence of calamities
Hydrologic sequence of basin countries: Upstream-downstream relationships/ Externalities Social-economic demands of basin countries Economies of scale	Image of basin country International law Linkage of issues Reciprocity Sovereignty of basin country	Policy stemming from political level Policy stemming from national bureaucracy Policy stemming from regional and local governments Political demands stemming from interest groups	Existence of extensive network of transnational contacts between countries The same social-economical and cultural values The same administrative culture The same perceptions of facts The use of a common language	Existence of common threats Occurence of calamities

Table 0.1: ***Factors influencing cooperation and agreement in international river basins.*** **Modified after [LeMarquant, 1977]**

Two types of success criteria for cooperation can be defined: content criteria and process criteria. Content criteria refer to the goal of cooperation. Cooperation is successful if it contributes to the achievement of goals. Process criteria are related to the process of cooperation. An important process criterion is consensus. According to this criterion cooperation is successful if it results in a high degree of consensus among the cooperating actors. This can be consensus on procedures, on the actual and the desired situation (= consensus on the problem definition) and/or consensus on policy.

Cooperation in the Scheldt basin

Recently, two important treaties for the water management of the river Scheldt were signed. In 1994 a treaty between the Scheldt riparian states concerning the rehabilitation of the river Scheldt was convened, while in 1995 a treaty between Flanders and the Netherlands concerning the deepening of the navigation channel of the Western Scheldt was signed. Many other positive developments can be identified. For example, the foundation of basin committees in the riparian states, which are aiming at an integrated water management for a hydrologically defined area.

Cooperation on water management issues between Flanders and the Netherlands has developed best, whereas cooperation between France and Belgium and within Belgium between Wallonia and Flanders is poorly developed. Cooperation on user functions, such as the nautical function, started early and is well organized. Regarding the nature function cooperation is starting now. Civil servants of water agencies affirmed that the hydrologic sequence of basin countries and their social-economic demands are factors that can explain the willingness to cooperate to a high degree. The linkage of issues regarding water management and other policy sectors, both inside and outside the basin, characterized cooperation for decades. The existence of a common culture and common goals and perceptions appeared to be relevant factors as well.

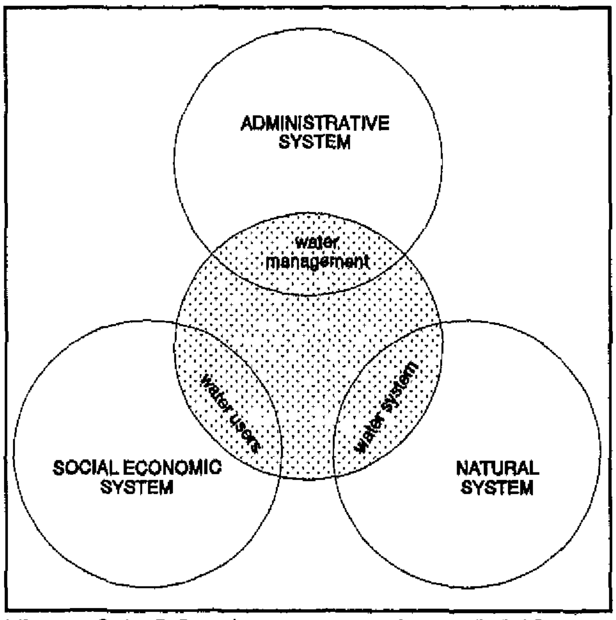
0.2 Samenvatting

Onderzoek naar samenwerking in stroomgebieden

Inleiding
In 1993 is het onderzoeksproject TWINS (*ToWards an INtegrated water management of the Scheldt*) van start gegaan. In dit project werken de Technische Universiteit Delft en Rijkswaterstaat samen. De belangrijkste doelstelling van het project is de integratie van kennis uit verschillende disciplines, wat belangrijk is voor integraal waterbeheer. Het project richt zich primair op de sediment-gerelateerde problemen in het stroomgebied van de Schelde. Drie AIO's, opgeleid in verschillende disciplines, werken vier jaar lang aan dit project. Het TWINS-project bestaat uit drie deelprojecten. Eén deelproject heeft tot doel te komen tot een betere kwantificering van sediment-gerelateerde processen. Een tweede deelproject heeft tot doel bij te dragen aan de ontwikkeling van een vernieuwde beleidsanalytische methode. Deze methode zal rekening moeten houden met de participatie van vele (verschillende) actoren in besluitvormingsprocessen, uiteenlopende belangen en de vraag vanuit de beleidspraktijk naar snel beschikbare en minder gedetailleerde informatie.
Het derde deelproject richt zich op de samenwerking tussen de relevante actoren in stroomgebieden en wordt uitgevoerd op het Centrum voor vergelijkend rivier- en stroomgebiedbeheer (RBA Centre). De centrale vraagstelling van dit laatste onderzoek is:
Welke factoren beïnvloeden de mate van samenwerking tussen de relevant actoren in een stroomgebied?

Dit rapport is een produkt van het derde onderzoeksproject en presenteert de resultaten van de eerste fase van het onderzoek. Het onderzoek in deze fase was beschrijvend en explorerend van aard.

Het rapport bevat een beschrijving van het natuurlijk systeem, de belangrijkste functies van de Schelde en een beschrijving van de bestuurlijke organisatie van het waterbeheer in de oeverstaten. Verder besteedt het rapport aandacht aan integraal stroomgebiedbeheer, behandelt het enige theorie over samenwerking in stroomgebieden en geeft het een beschrijving van de stand van zaken m.b.t. de samenwerking in het stroomgebied van de Schelde.



Figuur 0.1: ***Inhoud van Integraal waterbeleid,*** **naar [Grijns & Wisserhof, 1992]**

Integraal stroomgebiedbeheer
In integraal waterbeheer moeten drie systemen in hun onderlinge samenhang worden beschouwd [Grijns & Wisserhof, 1992]:
I. Het Natuurlijk Systeem (het watersysteem)
II. Het Sociaal Economisch Systeem (de watergebruikers)
III. Het Bestuurlijk Systeem (de waterbeheerders)
Figuur 0.1 laat deze drie systemen zien. Een integrale benadering van de meestal zeer complexe waterbeheersproblemen in stroomgebieden dient rekening te houden met zowel de relaties binnen de drie systemen als met de relaties tussen deze systemen. Karakteristiek voor stroomgebieden zijn de diverse *upstream-downstream* relaties. Zo'n integrale benadering kan alleen worden gerealiseerd door uitgebreide samenwerking tussen alle partijen die deze relaties beïnvloeden of door deze relaties beïnvloed worden (de relevante 'actoren'). Daarom is het interessant om meer te weten te komen over de factoren die de mate van samenwerking tussen de relevante actoren in een stroomgebied beïnvloeden.

Samenwerking in stroomgebieden
Hoewel er weinig theorieën over samenwerking in stroomgebieden zijn ontwikkeld, zijn er vele theorieën over samenwerking in het algemeen. Twee belangrijke theoretische benaderingen van het fenomeen samenwerking zijn de netwerktheoretische benadering en de speltheoretische benadering.

De netwerktheorie wijst op het bestaan van wederzijdse afhankelijkheden tussen actoren. Beleidsnetwerken worden gedefinieerd als patronen van interactie tussen wederzijds afhankelijke actoren, die zich hebben gevormd rond beleidsproblemen of beleidsprogramma's. Voor de voorbereiding en uitvoering van overheidsbeleid zijn interacties tussen (vertegenwoordigers van) overheden en niet gouvernementele organisaties noodzakelijk. Omdat deze interacties een continu karakter hebben, treedt een zekere mate van institutionalisering op. Op deze manier worden netwerken gevormd.

De speltheorie onderzoekt hoe individuën of organisaties die hun eigen belang nastreven handelen, en analyseert welke gevolgen dit handelen heeft voor een (sociaal) systeem als geheel. De theorie verschaft informatie over de voorwaarden waaronder samenwerking tot stand kan komen. Kennis over deze voorwaarden maakt het mogelijk om maatregelen te nemen waarmee samenwerking kan worden bevorderd. Zowel de netwerktheorie als de speltheorie verschaffen informatie over de interacties en vormen van samenwerking tussen actoren, en de strategieën die actoren gebruiken om hun doelen te verwezenlijken.

Kennis van de factoren die de mate van samenwerking beïnvloeden is voorts een vereiste voor begrip van de huidige samenwerking in stroomgebieden en de ontwikkeling van de samenwerking in de tijd (de dynamiek van samenwerking). Tabel 0.1 geeft vijf onderling samenhangende en deels overlappende groepen van factoren die van invloed zijn op de tot standkoming van samenwerking in internationale stroomgebieden. Sommige factoren, zoals het bestaan van netwerken, kunnen gemakkelijk worden beïnvloed, andere, zoals de hydrologische volgorde van de oeverstaten in een stroomgebied, verklaren de ontwikkeling van samenwerking in hoge mate, maar kunnen niet worden beïnvloed. Voor prescriptief onderzoek zijn de manipuleerbare factoren het interessants.

Hydrologisch-*economische prikkels*	Factoren die *samenhangen met de* buitenlandse politiek	Binnenlandse beleids- *en consensus vorming*	Factoren die de *communicatie tussen* de oeverstaten vergemakkelijkt	Het bestaan van *gemeenschappelijke* bedreigingen of het voorkomen van calamiteiten
Hydrologische volgorde van de oeverstaten: Upstream-downstream relaties/ externaliteiten	Image van een oeverstaat	Beleid gemaakt op het politieke niveau	Het bestaan van een uitgebreid netwerk van grensoverschrijdende contacten	Het bestaan van gemeenschappelijke bedreigingen
	Internationaal recht	Beleid van de nationale overheidsbureaucratie		Calamiteiten
Sociaal-economische functies in de oeverstaten	Koppelingen van issues	Beleid van de regionale en lokale overheden	Dezelfde sociaal-economische en culturele waarden	
	Wederkerigheid			
Schaalvoordelen	Soevereiniteit van een oeverstaat	Politieke eisen van belangengroepen	Dezelfde bestuurscultuur	
			Dezelfde perceptie van feiten	
			Het gebruik van een gemeenschappelijke taal	

Tabel 0.1: ***Beïnvloedingsfactoren van samenwerking in internationale stroomgebieden.*** **Naar [LeMarquant, 1977]**

Twee typen succescriteria voor samenwerking kunnen worden gedefinieerd: inhoudelijke criteria en procescriteria. Inhoudelijke criteria hebben betrekking op het doel van de samenwerking. Samenwerking is dan succesvol wanneer deze bijdraagt aan de realisatie van bepaalde doelstellingen. Procescriteria zijn afgeleid van het proces van samenwerking. Een belangrijk procescriterium is consensus. Volgens dit criterium is samenwerking succesvol wanneer deze leidt tot een hoge mate van consensus tussen de samenwerkende actoren. Er kan consensus zijn over procedures, over de bestaande en de gewenste situatie (= consensus over de probleemdefinitie) en/of consensus over het beleid.

Samenwerking in het stroomgebied van de Schelde

In het afgelopen jaar zijn er twee voor het waterbeheer van de Schelde belangrijke verdragen ondertekend. In 1994 ondertekenden alle oeverstaten een verdrag over de bescherming van de Schelde tegen verontreiniging. Begin 1995 ondertekenden Vlaanderen en Nederland het verdrag voor de verruiming van de vaarweg van de Westerschelde. Vele andere positieve ontwikkelingen kunnen worden gesignaleerd. Als voorbeeld kan de oprichting van bekkencomités in alle oeverstaten worden genoemd. Deze hebben tot doel om te komen tot integraal waterbeer in een hydrologisch gedefinieerd gebied.

De samenwerking op het gebied van het waterbeheer is het best ontwikkeld tussen Vlaanderen en Nederland, terwijl de samenwerking tussen Frankrijk en België en binnen België tussen Wallonië en Vlaanderen nog grotendeels ontbreekt. Samenwerking m.b.t. gebruiksfuncties, zoals de scheepvaartfunctie is al vroeg ontstaan en goed georganiseerd. Samenwerking m.b.t. het natuurlijk herstel van het riviersyteem komt nu op gang. Ambtenaren van waterbeheersinstanties in de verschillende oeverstaten bevestigden dat de hydrologische volgorde van de landen in het stroomgebied en de sociaal-economische functies in de oeverstaten belangrijke verklarende factoren zijn voor de bereidheid tot samenwerken.

De koppeling van diverse kwesties op het gebied van het waterbeheer, maar ook met andere beleidsterreinen karakteriseerde de samenwerking gedurende tientallen jaren. Het al dan niet bestaan van een gemeenschappelijke cultuur en gezamenlijke doelen en percepties bleken eveneens belangrijke factoren te zijn.

1 Introduction

1.1 The TWINS-project

In 1993, the research project TWINS (ToWards and INtegrated water management of the Scheldt) has been started at the Delft University of Technology (TU Delft) in cooperation with the Dutch Ministry of Transport, Public Works and Water Management (Rijkswaterstaat). The main objective of this project is to find better ways for integrating the knowledge of different disciplines, which is important for integrated water management. The project primarily focuses on the problems related to sediment (mud) in the Scheldt basin. Three Ph.D. students are working on this project for four years. The TWINS-project is divided into the following three subprojects.

A. Physical system

*Ph.D. student: Drs. P.A.J. Verlaan**
*Supervising professor: Prof.dr. M. Donze***

Pollution is an aspect of many policy decisions. This part of the project aims to supply accurately defined data to decision makers. Mud is chosen since it is associated with most pollutants. A better quantification of mud-related processes is necessary to come to an improved mud balance of the entire Scheldt catchment. Physical, Chemical and biological processes are considered.

B. Policy analysis

*Ph.D. Student: Ir. V.J. Maartense**
*Supervising professor: Prof.dr.ir. W.A.H. Thissen***

The current approach to policy analysis does not sufficiently meet the information demands of transboundary decision making. This project aims at contributing to the development of an innovative policy analysis approach. This approach takes into account the participation of multiple actors in decision making, diverging interests and the demand for quick and less detailed information.

C. Institutional system

*Ph.D. Student: Drs. S.V. Meijerink**
*Supervising professor: Prof.mr. J. Wessel***

Cooperation between the relevant actors of the states in a transboundary river basin is of extreme importance to policy making. Governmental actors as well as non-governmental actors have their own interests, which can be conflicting or complementary. The objective of this research is to develop a theory for promoting successful cooperation in river basins.

* For full addresses see Appendix E.
**For full addresses see Appendix C.

1.2 Integrated water management

In the Netherlands, the concept of integrated water management was introduced in the policy document 'Living with water' (*Omgaan met water*) [Ministry of Transport, Public Works and Water Management, 1985]. The integrated water policy for the Netherlands is elaborated in the Third Policy Document on Water Management (*Derde Nota Waterhuishouding*) [Ministry of Transport, Public Works and Water Management, 1989].

Integrated water management may be contemplated in at least three ways [Mitchell, 1990]. First, the interrelations between surface and groundwater, quantity and quality can be addressed. In this approach, water is seen is an ecological system formed by a number of interdependent components. This kind of integration is called internal integration. Second, the interactions between water, land and the environment can be added. Both aquatic and terrestrial issues are being addressed. This may be referred to as external integration. Apart from these interrelations, in integrated river basin management so-called upstream-downstream relations[1] are of the utmost importance [Wessel, 1991, Wessel, 1992]. A third interpretation is to approach integrated water management with reference to the interrelationships between water and social and economic development. For sustainable river basin management the third and broadest interpretation seems to be the most appropriate one[2]. The contents of integrated water policy are schematized in Figure 1.1. These contents comprise:

I- The Natural System
The components water, beds, and banks or shores with their pysical, chemical and biological aspects constitute the aquatic ecosystem.

II- The Social Economic System
The aquatic ecosystem can have diverse social economic functions, often corresponding with target groups of policy. Major target groups (the water usesrs) are navigation, agriculture, fisheries and industry.

III- The Administrative System
The administrative organization comprises the legislation and institutions.

[1]Upstream-downstream relations can be diverse: Upstream land-use influences the quality of the downstream water system, whilst the quality of the upstream water system influences the possibilities for downstream land-use. Another important upstream-downstream relation is the relation between upstream water quality and the quality of the downstream water bed.

[2]In the report "Our common future" (Brundtland-report) [World Commission on Environment and Development, WCED, 1987] the term "sustainable development" is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

1.3 Research on cooperation in river basins

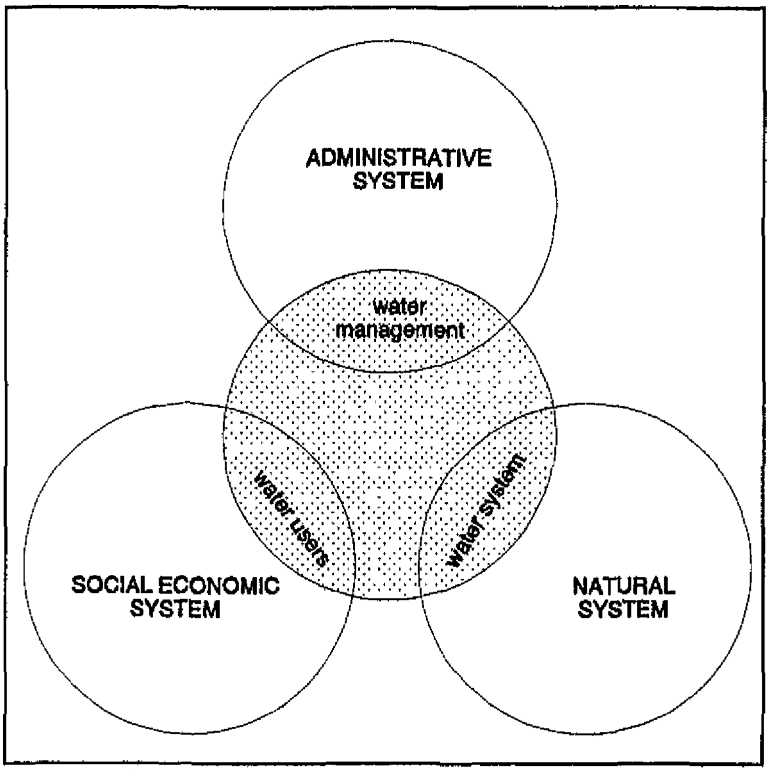


Figure 1.1: *Contents of Integrated Water Policy*, modified after [Grijns & Wisserhof, 1992]

The need for cooperation in (international) river basins is frequently expressed in the literature on the management of international rivers [LeMarquant, 1977], [Wessel, 1992], [Frey, 1993].[3] The main reason for this is that sustainable development of river basins requires an integrated approach to the mostly very complex water management problems in river basins.[4] This can only be realized by extensive cooperation between all relevant actors. Cooperation can be defined in several ways. In ordinary language it usually means "*working together for common benefits*". Sometimes it implies "*coordination of behaviour among actors to realize at least some common goals*" [Frey, 1993]. In this research project, the focus will be on inter-organizational cooperation. Cooperation between individuals, for example within organizations, is not discussed.

There is not one administration with adequate competencies, instruments, power etc. to control all the relationships within the natural system and between the natural and social economic system. Therefore, an integrated approach to water management problems calls for cooperation between all relevant actors. Relevant actors are actors who can either directly or indirectly influence one or more of these relationships, or can directly or indirectly be affected by one or more of these relationships. All these influencing and affected actors are relevant for developing and implementing policy on water management problems in river basins.

Three main types of cooperation can be distinguished: cooperation between governmental organizations, cooperation between governmental organizations and non-governmental organizations (NGOs), and cooperation between NGOs. Governmental

[3]In this report the terms "river basin" and "drainage basin" will be treated as perfectly synonymous. Art.II of the Helsinki rules declares that: "An international drainage basin is a geographical area extending over two or more States, determined by the watershed limits of the system of waters, including surface and underground waters, flowing into a common terminus."

[4]A problem is defined as a discrepancy between a perception of the actual situation and a desired situation.

organizations, having tasks in the field of integrated water management, have to cooperate to overcome institutional bottlenecks. These bottlenecks are caused by the sectoral organization of water management, i.e. separate bodies are reponsible for surface water and groundwater, water quality and water quantity [Jong, de, van Rooy, Hosper, 1994]. Furthermore, cooperation is needed between water agencies and governmental organizations dealing with land-use planning and environmental management. Cooperation between the relevant governmental actors promotes the administrative support of new policies. This is important since most governmental actors are mutual dependent, i.e. the policy of actor A can easily be obstructed by the policy of actor B and vice versa. Apart from cooperation between government agencies also cooperation between government agencies and target groups of policy on water resources is needed. Most target groups are represented by NGOs, such as chambers of commerce, environmental protection groups, fishery associations, drinking water companies etc. Cooperation with NGOs can contribute to an increased public support of (the implementation of) policy measures. Both administrative and public support of policy measures enhance the effectiveness of policy. Cooperation between NGOs can play a major role in policy making processes in water management too. Mostly, NGOs are cooperating to enlarge their impact on policy making.

The study of cooperation in river basins will address the following question [Stuurgroep Scheldeproject, 1994]:

What factors influence the extent of cooperation between the relevant actors in a river basin?

The subquestions are:
- What relevant actors in river basins can be distinguished?
- What types of cooperation between these actors can be distinguished?
- What strategies are actors using to achieve their goals?
- What factors influence the extent of cooperation between the relevant actors?
- How and by whom can these factors be influenced?

Answers to these questions enhance insight into the present interactions between the relevant actors and make possible to formulate recommendations for improving cooperation.

1.4 Structure of the report

Chapter one introduced the concept of integrated water management. Furthermore, the need for cooperation in (international) river basins was explained. The chapters two, three and four describe the three subsystems of the Scheldt basin that have been distinguished in section 1.2: the Natural System, the Social Economic System and the Administrative System. In chapter five, some theory on cooperation in river basins is presented. It deals with the types of cooperation that can be distinguished in river basins, the success criteria for cooperation and the factors influencing the extent of cooperation between the relevant actors in river basins. Apart from that, two main theoretical approaches to the interactions between actors are introduced: the network approach and the game theoretical approach. Chapter six describes the present cooperation in the Scheldt basin, the success of this cooperation and the factors influencing cooperation. In chapter seven some concluding remarks regarding the cooperation in the Scheldt basin are made. Figure 1.2 visualizes the structure of the report.

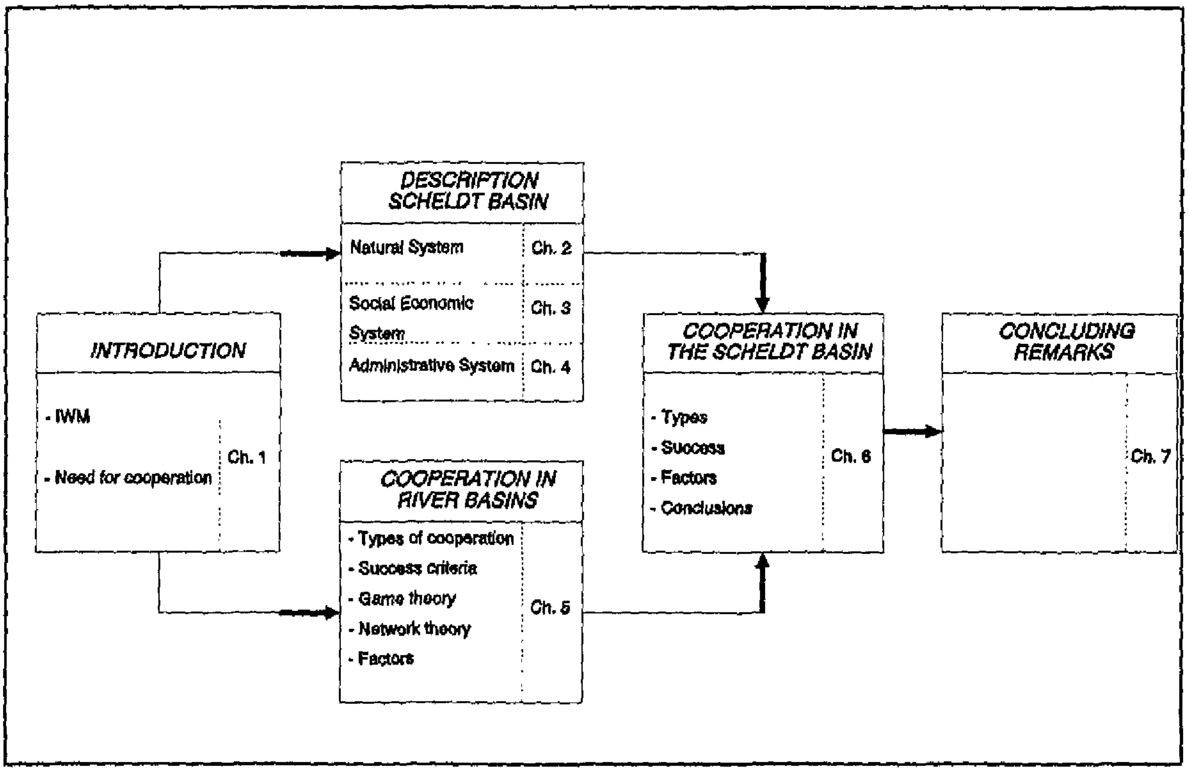


Figure 1.2: ***Structure of the report***

2 The Scheldt basin: Natural System

(P.A.J. Verlaan)

2.1 Introduction

The Scheldt catchment covers about 21,000 km^2 in northwest France, west Belgium and the southwestern part of the Netherlands. The river Scheldt has five small sources that flow together at the Mont Saint-martin nearby Gouy-le-Catelet, just north of saint-Quentin. The Mont Saint-Martin is part of the so-called "ridge of Artesia" situated about 120 metres above sea level. The river that is about 350 km long flows through France, Belgium (Flanders, Wallonia and Brussels) and the Netherlands and debouches in the North sea between Flushing and Breskens. The fall between the source and the mouth is only 100 metres. Therefore, the Scheldt and her tributaries are lowland river systems. Such systems are characterized by relatively low current velocities and meandering.

The Scheldt estuary is that part of the river basin where the tidal influence is present. It extends from Flushing to the weirs in the tributaries.

The estuary can be divided into three zones with different hydrographical characteristics.

1. The fluvial estuary upstream of Rupelmonde that contains only fresh water.
2. The upper estuary or Lower Sea Scheldt from Rupelmonde to the Dutch/Belgian border is 40 km long.
3. The lower estuary or Western Scheldt from the Dutch/Belgian border to Flushing is 55 km long.

The brackish water zone or mixing zone, where the fresh river water and sea water are mixed extends over approximately 100 km and consists of the upper and lower estuary.

The river discharge is controlled by rainfall; it ranges from 20 to more than 600 m^3/s (see Figure 2.1) with an annual average of 120 m^3/s at the mouth corresponding to 5 million m^3 in a tidal cycle. The tidal volume at Flushing is about 1000 million m^3. The mean tidal difference is 3.8 m at Flushing, 5 m at Antwerp and 2 m in Gent.
Postma (1980) proposed a classification of estuaria based on the ratio of the tidal volume and river volume. Since the Scheldt discharge is small compared to the tidal volume, the estuary is considered well mixed or partially mixed. Only small vertical salinity gradients occur. Nevertheless, these gradients markedly influence current velocities resulting in an upstream directed residual current near the bottom and a downstream directed water flow at the surface. [Wollast and Peters, 1978].

In section 2.2 we describe the main characteristics of the water economy of the Scheldt catchment. An extensive description of all water courses can be found in several reports [ISG, 1993; Ovaa, 1994].

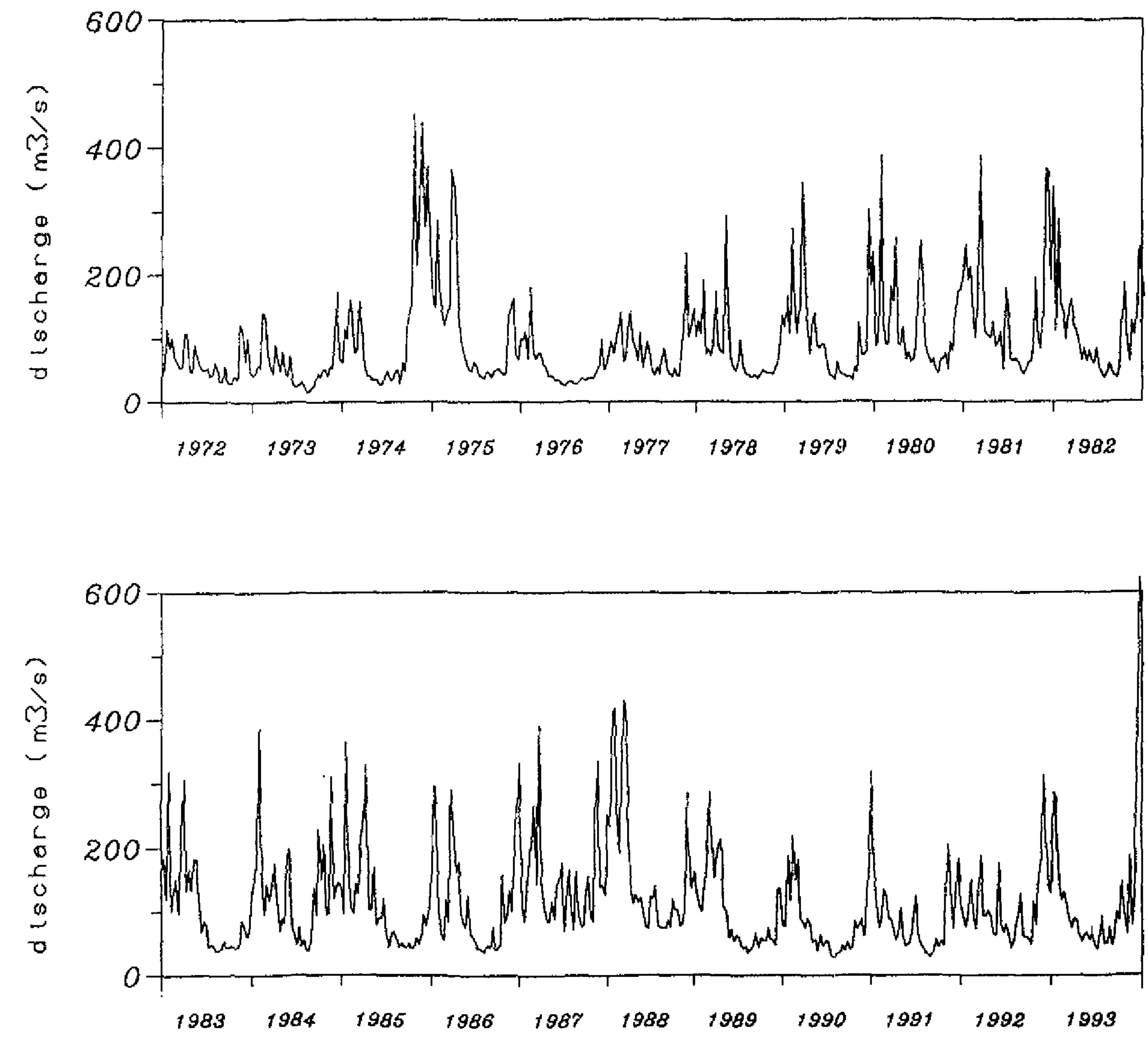


Figure 2.1: ***River discharge at Schelle between 1972 and 1993***
The discharge ranges from 20 to more than 600 m^3/s. The lowest discharge is usually observed during summer and autumn. The highest discharges occur in winter and spring. Since the river discharge during one tidal cycle is much smaller than the tidal volume, the Scheldt estuary is considered well mixed.

2.2 Hydrographic classification

Figure 2.2 is a topographic map the entire Scheldt basin. The river Scheldt, the tributaries and also the main in- and outcoming canals are shown.

The Scheldt basin is bounded by the North Sea and the Yser basin in the west, a number of small coastal river basins (Canche, Authie and Somme) in the southwest and in the north, east and south-east by the Rhine and Meuse catchments. The North Sea can be considered part of the Scheldt basin: it receives water from a number of canals as quoted above and the Western Scheldt and it gives water to the Scheldt by the Western Scheldt. Here, we exclude the North Sea from the Scheldt basin since it complicates a description unnecessarily. Therefore, it is decided that the North Sea is only treated as a receiving basin.

Table 2.1 lists the hydrographic subbasins and gives for each subbasin the surface, population density (1993), the main tributaries and most important cities. A schematic presentation of the various subbasins of the Scheldt river basin can be found in Figure 2.3.

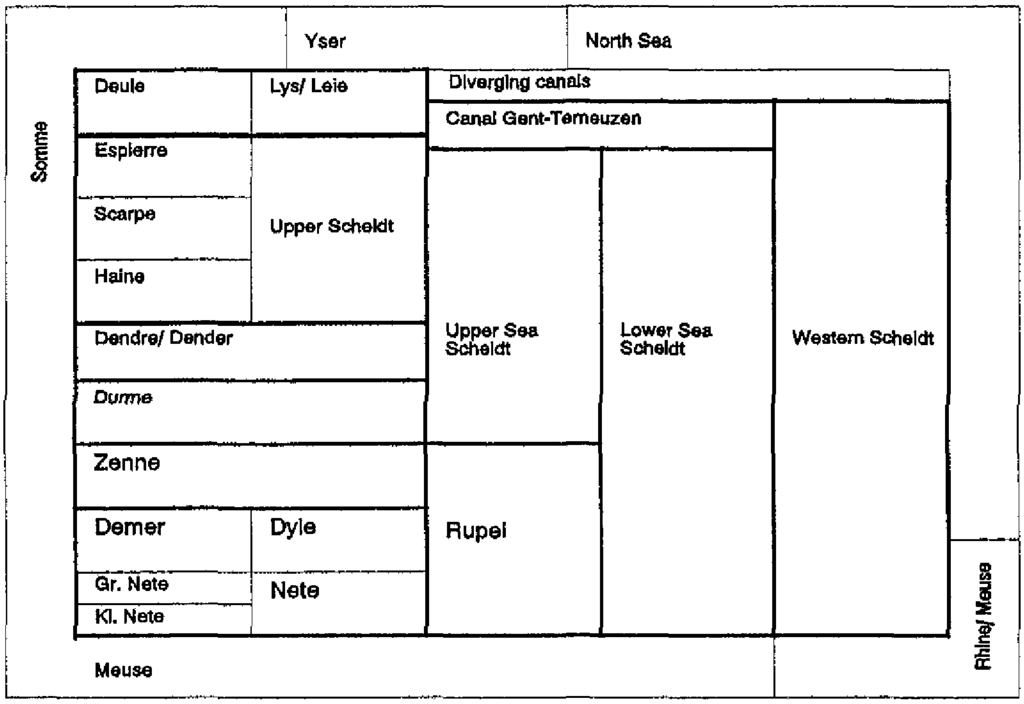


Figure 2.3: ***Schematic presentation subbasins Scheldt basin***

Topographic map of the Scheldt basin ISG 1993

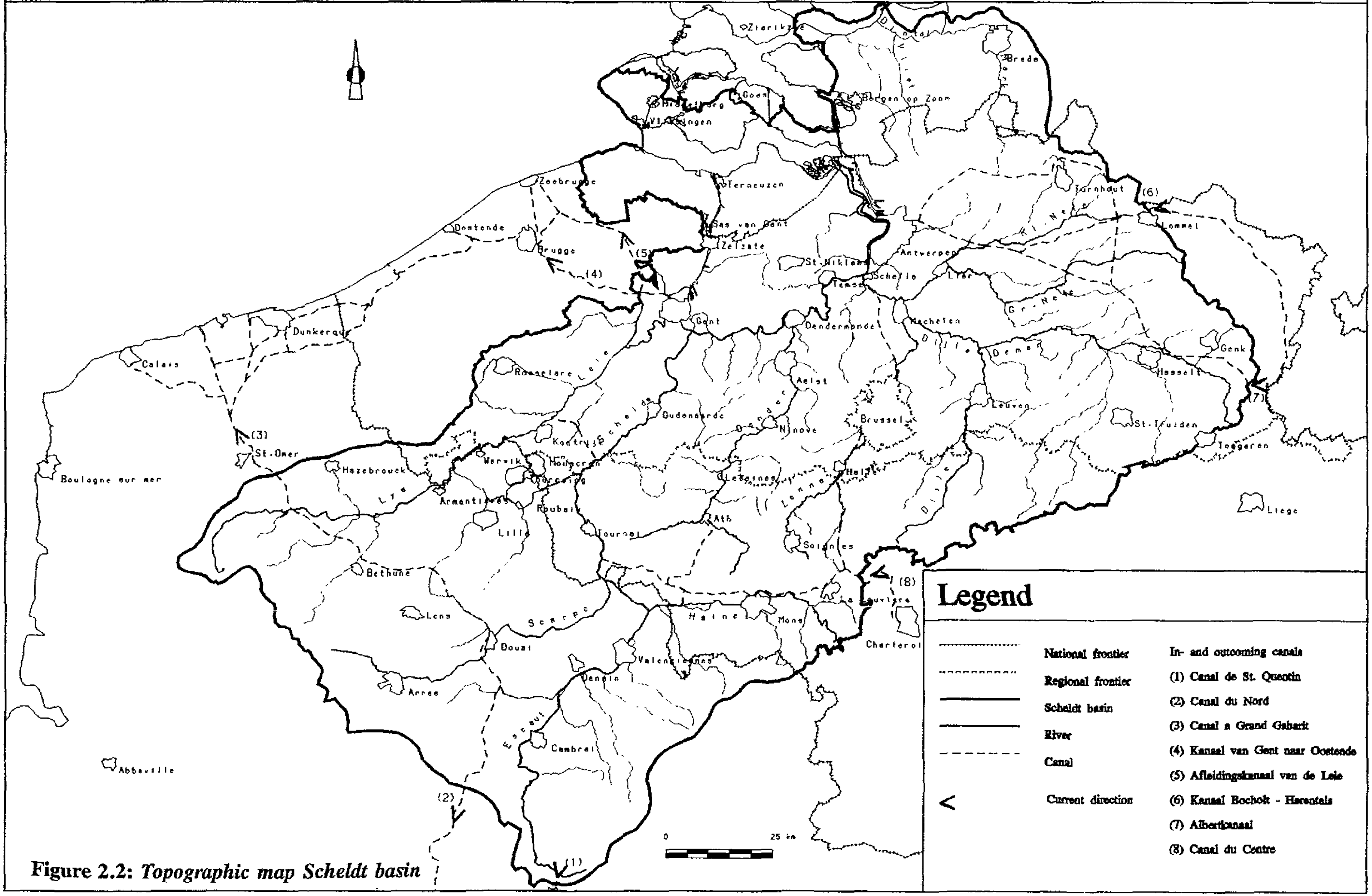


Figure 2.2: *Topographic map Scheldt basin*

Subbasin	Surface (km^2)	Population density (km^{-2})	Tributaries	Important cities
Upper-Scheldt *Haut-Escaut*	6,088	313	Scarpe Haine Espierre	Cambrai Denain Valenciennes Arras Douai Mons Roubaix Tourcoing La Louvriere Tournai Mouscron Oundenaarde
Leie *Lys*	4,305	746	Deule	Lille Lens Béthune Hazebrouck Kortrijk
Dender *Dendre*	1,386	281		Ath Lessines Nivove Aalst Dendermonde
Zenne *Senne*	1,171	1291		Soignies Brussel Mechelen
Demer	2,188	326		Hasselt Aarschot Tongeren
Nete	1,560	342	Grote Nete Kleine Nete	Lier Turnhout Lommel
Dijle *Dyle*	1.265	397	Demer	Leuven
Upper Sea Scheldt	1,007	472	Upper Scheldt Dender Leie	Gent

Subbasin	Surface (km²)	Population density (km⁻²)	Tributaries	Important cities
Lower Sea Scheldt	1,854	520	Rupel - Dijle - Zenne - Nete Up.Sea Scheldt	Antwerpen
Canal Gent-Terneuzen	668	526	xx	Zelzate
Western Scheldt	2,841	204	Lower Sea Scheldt Canal Gent-Terneuzen	Vlissingen Middelburg Terneuzen Breskens

Table 2.1: *The hydrographic subbasins*

The Scheldt catchment is connected to other catchments by several canals. Water can flow in or out of the Scheldt Catchment. Table 2.2 lists the inflow and outflow canals.

Outflow canals	Inflow canals
Canal de St.Quentin[2]	Canal du Centre[1]
Canal du Nord[2]	Albertkanaal[1]
Canal de Neufossé[3]	Schelde-Rijnverbinding[1]
Kanaal Gent-Oostende[3]	Bathse spuikanaal[1] (Zoommeer)
Afleidingskanaal van de Leie[3]	Kanaal door Zuid Beveland[1]
Rigole D'oise et du Norrieu[1]	Kanaal door Walcheren[1]
	Zuid-Willemsvaart[1]

[1] Connection between Meuse/Rhine catchment and Scheldt
[2] Connection between Somme/Seine catchment and Scheldt
[3] Connected to the North Sea

Table 2.2: ***Inflow and outflow canals***

1. *Upper Scheldt (Haut-Escaut)*
This subbasin has the largest surface. It contains the main course of the river Scheldt. Most important tributaries are the Scarpe, the Haine and the Espierre. The Scarpe flows through big towns like Arras and Douai and joins the Upper Scheldt at the Belgian-French border. A few kilometers upstream the Haine flows out on the Upper Scheldt. Most water from Lille, Roubaix and Tourcoing (situated in the Leie basin) flows out in the Upper Scheldt via the Espierre. The Upper Scheldt is connected to the Meuse catchment by the *Canal de St.Quentin* and the *Rigole d'Oise et du Norrieu* and connected to the Somme catchment by the *Canal du Nord*. All other canals that connect this basin to other subbasins are described hereafter.

2. *Leie (Lys)*
The Leie rises in the north of France. Its main tributary is the Deule. Both rivers emanate from an area with a high population density. Most important cities are Lille, Roubaix and Tourcoing. The Leie follows its natural course until Aire-sur-La Lys where it crosses the *Canal a Grand Gabarit*. This canal consists of a number of sub canals that connect the Upper Scheldt to the Scarpe (*Canal de la Sensee*), the Scarpe to the Deule (*Canal de la Deule*), the Deule to the Leie (*Canal d'Aire*) and the Leie to the Aa basin and the North Sea (*Canal de la Neufossé*).
Further downstream, the Leie forms the border between France and Wallonia. There, the Leie is connected to the Upper Scheldt by the *Canal de Roubaix*.
In Belgium, the Leie flows out on the Upper Sea Scheldt at Gent. However, most water is already discharged to the North Sea by *het Afleidingskanaal van de Leie*, *het kanaal Gent-Bruge* and the *Gentse ringvaart*. Due to this lateral discharge, most of the Leie water does not reach the Upper Sea Scheldt. Some water of the Upper Scheldt is discharges on the the Leie via the *kanaal Bossuit-kortrijk*.

3. *Dender (Dendre)*
This tributary has its source in Wallonia and joins the Upper Sea Scheldt at Dendermonde. The Dender is connected with the Upper Scheldt by the *Canal Nimy-Blaton-Péronnes* and to the Haine by the *Canal Pommeroel-Condé*.

4. *Zenne (Senne)*
The Zenne rises in Soignies, flows to Brussels and debouches in the Dijle. Two canals in this basin have to be mentioned:
- The Canal from Brussels to the Rupel (*Willebroekkanaal*) connects Brussels directly with the Rupel.
- The Canal from Brussels to Charleroi results in a connection with the Meuse Catchment. The *Canal du Centre* and the *Canal Nimy-Blaton-Peronnes* make that the Zenne, Upper Scheldt and the Dender are navigable.

5. *Demer*
The Demer has its source at Tongeren. It acumulates the water of many small tributaries (e.g. *Grote en Kleine Gete*) and creeks and flows out in the Dijle. North of Hasselt an important canal, *het Albertkanaal*, that connects the basin of the Lower Sea Scheldt with the

Meuse catchment, cuts through the Demer basin.

6. ***Nete***

The Nete subbasin has two tributaries, the *Grote Nete* and the *Kleine Nete*. North of Mechelen, the Nete flows out on the Dijle. The Nete subbasin is, similar to the Demer basin, cut through by *het Albertkanaal* and its cross canals. Furthermore, *het Netekanaal* directly connects the Nete with *het Albertkanaal*.

7. ***Dijle (Dyle)***

The Dijle has its source about 15 km north of Charleroi. The Demer flows out on the Dijle. The Dijle flows out on the Rupel, along with the Zenne and the Nete.

8. ***Upper Sea Scheldt (Boven Zeescheldе)***

This subbasin is influenced by a vertical tide. Since the water is usually completely fresh, it is also called the fresh water estuary.
The Upper Sea Scheldt gets its water from the Upper Scheldt and the Dender and flows out on the Lower Sea Scheldt. Some water of the Leie also reaches the Upper Sea Scheldt, especially during high discharge periods in winter. The Durme discharges only small amounts of water on the Upper Sea Scheldt. Most important towns along the Upper Sea Scheldt are Gent and Dendermonde.

9. ***Lower Sea Scheldt (Beneden Zeescheldе)***

This basin is situated between the town of Rupelmonde and the Dutch-Belgian border. It is also called the upper estuary. The Lower Sea Scheldt receives its water from the Rupel (and her tributaries: Zenne, Dijle, Demer and Nete) and the Upper Sea Scheldt (and her tributaries: Dender and Leie). Both rivers discharge about the same amount of water on the Lower Sea Scheldt. The agglomeration Antwerp is situated in this basin.
Het Albertkanaal connects the Lower Sea Scheldt via the Nete and Demer basin with the Meuse catchment. The *Schelde-Rijnverbinding* also discharges some water to the Lower Sea Scheldt by the *Zandkreeksluizen*.

10. ***Canal Gent-Terneuzen***

The Canal Gent-Terneuzen receives its water mainly from the Leie and to a minor extent from the Durme and the Upper Scheldt. Water from the Leie basin and the Upper Scheldt reaches the Canal Gent-Terneuzen via the *Gentse ringvaart*. The river Durme is disclosed by a transverse dam at Lokeren. Water upstream of Lokeren is discharged to the *kanaal Gent-Terneuzen* by the *Moervaart*.

11. ***Western Scheldt (Westerschelde)***

The Western Scheldt is the only subbasin that is entirely situated in the Netherlands. It receives river water from the Lower Sea Scheldt and sea water from the North Sea. Besides, a number of man-made canals flow out on the Western Scheldt:
1. Since 1988 superfluous water in *het Zoommeer* is discharged to the Western Scheldt by the *Bathse spuisluis*. *Het Zoommeer* receives its water from the rivers Rhine and Meuse.

2. The Western Scheldt is connected to the Eastern Scheldt by *het kanaal door Zuid-Beveland.*
3. A significant amount of water flows into the Western Scheldt by *het kanaal van Gent naar Terneuzen.*
4. Only small amounts of water are discharged on the Western Scheldt by *het kanaal door Walcheren.*

Table 2.3 contains the average flow rates in the Scheldt basin for the period 1961-1990.

Location	Flow rate (m^3/s)
Conde	14
Bleharles	18
Kain	19
Melle	22
Boven Zeeschelde	45
Rupel	55
Dender	5
Beneden Zeeschelde	100
Kanaal Gent Terneuzen	18
Vlissingen	140

Table 2.3: ***Average flow rates in the Scheldt basin, period 1961-1990***

2.3 Water quality

A measure of the water quality can be based on the quality of life. A probably more reliable measure of the water quality are a number of chemical and physical parameters. The most commonly used parameters are : temperature, oxygen content, pH, turbidity, bio(chemical) oxygen demand and the concentrations of several chemical substances.

If the river discharge is small, the concentration of a certain substance can become very high while the load carried by the river is small. Therefore, complete information on the water quality not only requires concentrations but also loads of chemical substances.

Pollution loads are discharged by point sources and by diffuse sources. Point sources are for instance companies, urban sewerage and purification plants. Agricultural waste loads and precipitation are examples of diffuse sources.
Loads of certain substances cannot simply be added up because they can be subject to degradation, evaporation or they are adhered to bottom sediment.

Three groups of parameters are distinguished:
1. organic degradable material and nutrients
2. heavy metals
3. organic micropolutants

2.3.1 Organic degradable material and nutrients

Organic waste loads mainly originate from domestics and industrial companies. They are degradable if the oxygen content is high enough. A measure for the amount of oxygen needed to degrade organic waste loads is the BOD (Biological Oxygen Demand). Due to these degradation processes, the oxygen content reduces, thus leading to retarding degradation activity and more unfavourable conditions for living organisms.
Organic waste loads hold a lot of nitrogen compounds. When the degradation proces is retarded, nitrogen is conversed to ammonium (NH_4^+) having toxic properties.
Organic waste loads discharged by the chemical industry cannot so easily be degraded. The oxygen demand of these substances, the COD (Chemical oxygen Demand), is much larger than the BOD. Under normal background conditions :
COD = 5 x BOD. If COD exceeds 5 x BOD, industrial discharges play a role.
The residual products of degraded organic waste loads are nitrates and phosphates. They can have damaging effects on the water quality. Phosphates and nitrates are also directly discharged by fertilizer plants, agriculture and domestics (detergents). Moreover, high phosphate and nitrate concentrations give rise to excessive algae grow that in turn causes oxygen depletion.

Table 2.4 gives the relative contribution of all pollution sources for BOD, COD, Phosphate and Nitrate. Table 2.5 gives the mean concentration (1987-1990) of BOD,COD, Nitrate and Phosphate.

Components	BOD	COD	Nitrate	Phosphate
Natural (%)	0	0	6	8
Agriculture (%)	0	0	60	16
Atm. deposition (%)	0	0	6	3
Domestic (%)	90	50	27	72
Industrial sew. (%)	?	?	0	0
Diffuse sources (%)	90	50	100	100
Point sources (%)	10	50	0	0
Load France (%)	10	29	<15	15
Load Belgium (%)	85	65	>80	74
Load Netherlands (%)	5	5	<4	12

Table 2.4: *Relative contribution of various sources for BOD,COD and nutrients* **[Ludikhuize, 1989]**

	COD mg/l	BOD mg/l	Nitrate mg/l	Phosphate mg/l
Bleharles	57.5	3.82	52.5	0.98
Kain	61.3	3.78	52.5	0.97
Pottes	91.8	7.47	51.3	1.30
Oudenaarde	107.5	7.60	35.3	1.40
Zwijnaarde	71.3	5.05	33.7	1.34
Melle	76.3	5.57	34.0	1.52
Dendermonde	75.6	5.90	34.5	1.50
Kl.Nete	>30	<6	-	>0.4
Gr.Nete	>30	<6	-	>0.4
Dijle	>30	>6	-	>0.4
Zenne	>30	>6	-	>0.4
Rupel	60.0	5.72	20.5	1.23
Kruibeke	65.0	4.03	20.7	0.88
Doel	62.5	2.75	50.7	0.67
Hansweert	-	1.02	33.5	0.47
Terneuzen	-	1.05	21.3	0.32
Vlissingen	-	1.00	10.3	0.20
Bas.level (Bel)*	30	6	10	0.3

* Basic quality for Flanders (Belgisch Staatsblad 06-01-1988)

Table 2.5: ***Mean concentration (1987-1990) of BOD, COD, Nitrate and Phosphate*** **[Klap, Heip, 1991]**

2.3.2 Heavy metals

Heavy metals are mainly discharged by industries and households. Nevertheless, the natural background levels of some elements like chromium and lead cannot be neglected. Heavy metals are characterized by a high toxicity. Even low concentrations can be extremely damaging, especially for animals. Heavy metals are nondegradable.

Heavy metals are mainly transported in the particulate form, making that deposition of fine sediment can result in heavily polluted waterbeds. If only a minor part of the metal load discharged upstream is found downstream in a river, it probably indicates that deposition has occurred. These deposition processes are particularly important in the area between Rupelmonde and the Dutch-Belgian border. Moreover, metals can be released from the bottom sediment owing to the anoxic conditions in this area (Lower Sea Scheldt). In the Western Scheldt, the salinity and pH are significantly higher than in the Lower Sea Scheldt, causing metal desorption from suspended matter to a certain extent.

Some heavy metals have been studied extensivily because they are very toxic (e.g. cadmium and mercury) or because their concentration, especially that of the dissolved fraction, are not too low (chromium, copper, lead and zinc). Other metals, for instance, silver, beryllium, tin and vanadium have hardly been studied. Table 2.6 and 2.7 show the relative contribution of various sources of heavy metals and mean concentrations repectively.

Components	Cd	Cr	Cu	Pb	Zn	Hg
Natural (%)	2	30	14	22	12	8
Agriculture (%)	0	0	0	0	0	0
Atm. deposition (%)	9	0	5	11	16	13
Domestic (%)	3	0	23	5	6	5
Industrial (%)	9	14	45	44	37	4
Diffuse sources (%)	23	44	87	82	71	30
Point sources (%)	77	56	13	18	29	70
Load France (%)	6	40	13-24	4-7	9-12	7-13
Load Belgium (%)	91	59	73-85	91-94	84-88	87-92
Load Netherlands (%)	3	1	2-3	2	3-4	0-1

Table 2.6: ***Relative contribution of various sources of heavy metals*** **[Ludikhuize, 1989]**

	Cd ug/l	Hg ug/l	Pb ug/l
Bleharles	0.95	0.057	11.3
Kain	0.87	0.027	14.3
Pottes	0.93	0.015	14.3
Oudenaarde	0.95	0.035	8.7
Zwijnaarde	0.67	0.027	11.3
Melle	0.70	0.032	10.5
Dendermonde	1.07	0.032	17.3
Kl.Nete	>2.5	<0.5	<50
Gr.Nete	>2.5	<0.5	<50
Dijle	>2.5	<0.5	<50
Zenne	>2.5	<0.5	<50
Rupel	1.16	0.060	17.6
Kruibeke	0.80	0.040	11.6
Doel	0.86	0.195	9.2
Hansweert	0.27	0.040	3.8
Zelzate	0.21	0.032	3.1
Vlissingen	0.13	0.022	2.6
Bas.Level (Bel)*	2.5	0.5	50

** Basic quality for Flanders (Belgisch Staatsblad 06-01-1988)*

Table 2.7: ***Mean concentration (1987-1990) of Cd, Hg, Pb and Cr*** **[Klap, Heip, 1991]**

2.3.3 Organic micropollutants

These group of pollutants are hardly measurable, owing to their low concentration (a few nanogram per litre). Nevertheless, they can have considerable damaging effects on fish and insects. Organic micropollutants have strongly varying properties concerning toxicity, solubility, their affinity to particulate matter and degradability. Organic micropollutants are discharged by point sources (industries and urban sewerage) and diffuse sources.

We distinguish four families of organic micropollutants:
- P.A.H.'s (polycylic aromatic hydrocarbons)
- P.C.B.'s (polychlorinated biphenyls)
- P.C.D.D.'s (dioxines)
- P.C.D.F.'s (structures similar to dioxines)

PAH's are released during combustion processes and as residual products of production processes. PCB's are unnatural substances that are produced with a special objective owing to their specific profitable properties. They are suitable for applications in capacitors and transformers. PCCD's have a structure similar to that of PCB's but they are even more dangerous. PCCD's are produced during combustion processes of chlorine compounds.
Organic micropollutants are mostly adhered to particulate matter and are easily adsorbed by the fat of living organisms. PAH's are degradable. PCB's, however, cannot be degraded. Some kinds of PCB's have carcinogenic properties. Due to a lack of information it is not possible to give an overview of the relative contribution of all sources to PAH's and PCB's.

2.3.4 Water quality of the Scheldt basin

The water quality of most subbasins in the Scheldt catchment is still inadequate. Concentrations of most substances are higher than the required basic quality standards (see Table 2.5 and Table 2.7). Some subbasins are so heavily polluted that the developement of aquatic life is impossible. The concentrations of COD, phosphates and nitrates nearly everywhere exceed the basic quality norm, except for the Western Scheldt. The concentrations of heavy metals and BOD are usually not exceeding the basic quality norms.
Table 2.4 and 2.6 show that some pollutants like BOD and nutrients are most diffusively discharged while other pollutants like cadmium and mercury are mainly discharged by point sources. Moreover, nutrients and BOD are mainly discharged by domestic sources while for heavy metals industrial sources are the most important. The highest pollution discharges originate from Belgium (as can be expected, for the largest part of the basin is situated in Belgium). The French contribution is mainly of importance for chromium and COD. The contribution of the Netherlands is only significant for phosphate.

2.4 Fine sediment

Suspended sediment mainly consists of mud, which we define here as all particles smaller than 63 μm. In this section we only consider the mud fraction; we ignore the sand fraction. Mud can have a marine or a fluviatile origin. Marine mud enters the Scheldt catchment from the North Sea and is transported from the Western Scheldt up to the Lower Sea Scheldt. It can reach as far as Rupelmonde. Fluviatile or terrestial mud is produced in the entire Scheldt catchment and transported downstream. Only a minor part of this mud reaches the North Sea.

Sources of fluviatile or terrestial mud are:
- domestic waste loads
- industrial waste loads
- (illegal) manufacture waste loads
- erosion of muddy beds
- atmospheric deposition

A first detailed estimation of the total fluviatile mud production in the Scheldt basin was given by Wollast and Marijns (1981) and summarized by D'Hondt and Jacques (1982). According to these authors, the estimated mud production is 753,000 ton/year and consists for 25% of domestic origin, 39% of industrial origin and for 36% of natural origin. The natural contribution concerns manufacture waste loads and erosion of muddy beds as well.
In a more recent study of the IMDC (1993) the total mud production in the entire Scheldt basin was estimated. All sources of fluviatile mud were estimated for four subbasins, the Leie basin, the Scheldt basin (Upper Scheldt, Upper Sea Scheldt and Dender subbasin), the Rupel basin (Dijle, Nete, Zenne and Demer subbasin) and the upper estuary (Lower Sea Scheldt). It is assumed that mud from the Leie basin does not reach the mixing zone. (see also in section 2.2)

Table 2.8 shows that the total terrestial mud production lies between 1.09 and 1.15 million tons per annual. This is significantly higher than the 753,000 ton found by Wollast and Marijns (1981). This higher value is only a result of the higher estimated mud production by erosion of muddy beds which is responsible for about 80% of the terrestial mud production. The 80% found by the IMDC (1993) is much higher than the 36% found by Wollast and Marijns (1981). In contrast, the estimated mud production by domestic and industrial waste loads in the IMDC study (1993) is rather low compared to the results of Wollast and Marijns (1981). The contribution of precipitation and agriculture is very small.
Only the uncertainties of the industrial and agricultural contributions are known. There is no information on the uncertainty of the other sources.

Sources of terrestial mud	Leie basin	Scheldt[1] basin	Rupel[2] basin	Upper[3] estuary	Total mud product.
Domestic	31.4	35.9	66.8	12.5	146.6
Industrial	13.8 -23.6	13.8-19.6	28-35.1	11.7-24.4	67.5-102.7
Agriculture	1.7 - 17.5	0.0	1.6-15.8	0.0	3.3-33.3
Atmospheric deposition	0.2	0.3	0.3	0.4	1.2
Erosion	130.9	417.1	321.9	2.9	872.8
Total	178-203.6	467.1 - 472.9	418.6 - 439.9	27.5-40.2	1091.4 - 1156.6

[1] Upper Scheldt, Dender and Upper Sea Scheldt subbasin
[2] Dijle, Zenne, Nete and Demer subbasin
[3] Lower Sea Scheldt subbasin

Table 2.8: ***Terrestial mud production in the Scheldt catchment (x 1000 tons/annual)*, IMDC (1993)**

A substantial part of the terrestial mud produced in the river basin will not reach the mixing zone for a number of reasons:
1. deposition of mud
2. removal of mud by dredging works
3. decomposition processes

It is assumed that the amount of terrestial mud deposited upstream of the mixing zone is equal to the amount of mud dredged or decomposed in that area. The amount of dredging works is estimated in the IMDC study. Since the dredging amounts are specified in m^3, the adopted bulk density (density of the dredged material which is a mixture of water, sand and mud) and mud percentage determine how many tons of mud are being dredged (see Table 2.9). A mud percentage of 70% is adopted (30% of the dredged material is sand).

Bulk density (ton/m^3)	Leie basin	Scheldt[1] basin	Rupel basin[2]
1.2	79.0	169.2	104.0
1.4	158.0	338.2	207.9

[1] Upper Scheldt, Dender and Upper Sea Scheldt subbasin
[2] Dijle, Zenne, Nete and Demer subbasin

Table 2.9: ***Dredging amounts (x 1000 tons/annual)***

If we subtract the dredging amounts from the mud production, we obtain the amount of mud that remains in suspension and is transported to the mixing zone (Table 2.10).

Bulk density (ton/m^3)	Leie basin	Scheldt[1] basin	Rupel[2] basin	Total	Mud at Rupelmonde
1.2	99-124	298-304	315-336	712-764	613-640
1.4	20-46	129-134	211-232	360-412	340-366

Table 2.10: ***Terrestial Mud available for transport (X 1000 ton/annual)***

Table 2.10 shows that 340,000 to 640,000 ton of mud enters the mixing zone or Lower Sea Scheldt at Rupelmonde. We have to emphasize that this estimation is based on an indirect approximation.

Since 1973, the mud discharge to the Lower Sea Scheldt can also be calculated from direct measurements of the sediment concentration and the river discharge. Figure 2.4 depicts the mud discharge from 1973 until 1986. The computed mud discharge is calculated from the quarterly average sediment concentration multiplied by river discharge. Correction for peak discharges and lateral mud discharges within the Lower sea Scheldt has been carried out. It is shown that, except for 1974 and 1975, the mud discharge varies from 300,000 to 400,000 tons/annual. This values correspond in rough approximation to the indirect approximation mentioned in Table 2.10.

Many studies have been carried out to investigate the fluviatile (=terrestial) and marine mud percentage of bottom sediment and suspended sediment in the Lower Sea Scheldt (Salomons et al, 1981; Mariotti, 1985; van Maldegem, 1991; Wartel, 1993). These studies indicate that 20% to 50% of the bottom sediment is of marine origin, depending on location. It is assumed that a significant part of mud (fluviatile as well as marine) imported to the Lower Sea Scheldt is deposited there. This assumption is based on the extensive dredging works that have to be carried out to keep the main shipping lane navigable. It is still uncertain how much marine mud enters the Lower Sea Scheldt at the Dutch-Belgian border. Recent estimations indicate a value between 80,000 ton (van Maldegem et al, 1993) and 130,000 ton (Vereeke, 1994). The export of fluviatile mud to the Western Scheldt at the border is larger and ranges from 120,000 ton (Verreeke, 1994) to almost 300,000 ton (van Maldegem, 1993).

Suspended sediment as well as bottom sediment in the Western Scheldt are mainly of marine origin. Probably, a minor part of the fluviatile mud that enters the Western Scheldt reaches the North Sea. The sedimentation is concentrated in the marshes (e.g. Saeftinghe salt marsh). Thus, in the estuary the marshes form a natural storage for fluviatile mud.

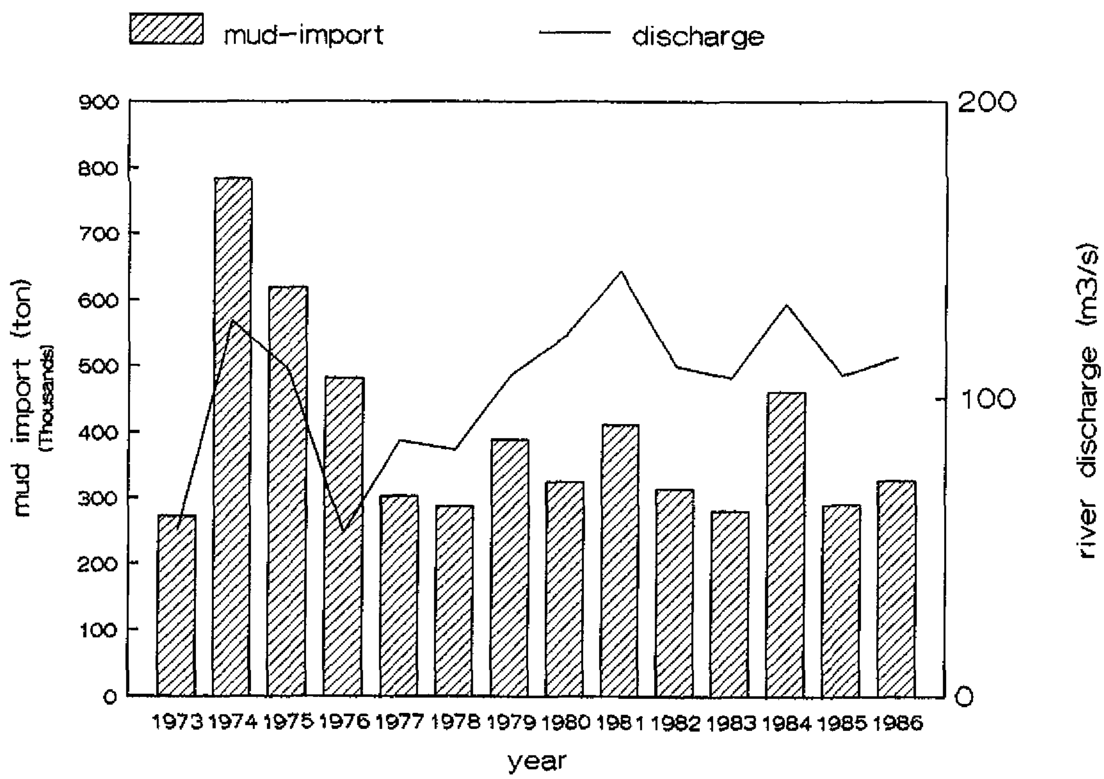


Figure 2.4: ***River discharge at Schelle and mud import to Lower Sea Scheldt***

3 The Scheldt basin: Social Economic System

3.1 Introduction

A water system is more than just water. It concerns groundwater and surface water including the direct surroudings, where they are relevant to the functioning of the water and the flora and fauna which belong to the water. In practise a water system includes the water, the bed and the banks or shore. The depth and current of the water and the form of the banks are the physical components. The substances which occur naturally or otherwise in the water and the sediments form the chemical components. The plants and animals in the water system form the biological components.

In the Third National Policy Document on Water Management [Ministry of Transport, Public Works and Water Management, 1989] functions of water systems are defined as: "[...] the destination, in a water management sense, of surface water and groundwater, bearing in mind the interests involved." The following main functions of water systems are distinguished:

1. Discharge of water, ice and sediments
2. Nature
3. Safety
4. Agriculture
5. Fishing
6. Hydropower
7. Discharge of domestic- and industrial effluents
8. Provision of drinking water and water for industry
9. Navigation
10. Recreation
11. Mineral extraction

Each function makes demands on the properties of the water systems. As a result of these demands, the functions of a water system can correspond, conflict or compete with one another. Functions of water systems are often related to specific target groups of policy [Wisserhof, 1994]. This Chapter shortly describes the main functions and interests (3.2) and the interest conflicts (3.3).

3.2 Functions and interests

Except for the function "hydropower" in the Scheldt basin all functions listed in the previous section are present.

In the following, we shortly describe these functions.

Discharge of water, ice and sediments
One of the functions of river systems is the discharge of rain water, ice and sediments. This function is related to other functions, such as agriculture, for this function often requires a stable groundwater level. A stable groundwater level is also required in urban areas. Water administrations canalized large parts of the river basin, not only for navigation purposes, but also to guarentee an adequate drainage of water [Klap, Heip, 1991]. The importance of the discharge function is particularly evident in Gent. Here, the Leie flows out on the Upper Scheldt. Floodings of the downstream areas can result if all this water is discharged to the Upper Sea Scheldt. Therefore, a part of this water is discharged by some man-made canals (see section 2.2). Transport of fertile sediments to the Scheldt estuary is another important function of the Scheldt river. Due to changes in land-use (an increase of paved surfaces) the drainage of water improved. The average flow rate has therefore increased [Klap, Heip, 1991]. The higher flow rates result in an increased erosion of sediment and thus to an increased sediment transport to the mouth of the river.

Nature
The Scheldt estuary is often described as a unique ecosystem. Together with the Ems estuary, the Scheldt estuary is the only remaining real estuary in the Netherlands. [Hoogweg, P.H.A., F. Colijn, 1992]. Extensive areas, especially the Western Scheldt, get flooded during each tide. These areas are of great natural value. Examples are the saltmarsh ("Het Verdronken Land van Saeftinghe" covering 2800 hectares), brackish- and fresh water marshes situated between Flushing and the mouth of the Durme. The tidal waters are also the habitat for many water birds like the stilt bird.
Areas of high natural value are also found in the upstream parts of the basin. With respect to this, the "Kempen" (Kleine Nete) can be mentioned. Since the flow rates of the upstream water courses are rather low, relatively small waste loads lead to high concentrations of pollution that have disastrous effects on the ecosystems.

Safety
the safety function of river systems is closely related to the discharge function. When a high river discharge period coincides with spring-tide, the safety of the area around Rupelmonde can become critical. Due to an expected sea-level rise of about 60 cm. per century [Peerbolte, 1993] this critical situation will probably occur more often in the future. In the Sigmaplan [Ministerie van Openbare Werken, 1977], the Belgian government presents plans:
1. to heighten and reinforce the dikes along the Lower Sea Scheldt
2. to create controlled flooding areas
3. to build a storm surge barrier in the Lower Sea Scheldt (at Oosterweel).

In 1995, most dikes along the Lower Sea Scheldt are heightened and/or reinforced. No storm surge barrier has been built yet. The second option, the creation of controlled flooding areas, appeared to be hardly possible to realize, for the resistance of local citizens is extremely high.

Agriculture
In dry periods, water use for agricultural purposes can become an important function.

Fishing
Commercial fishing only takes place in the Western Scheldt. In the last decades, the importance of the commercial fishing function diminished (In 1975, the production was only one third of the production in 1915) [Ravensberger, Scheele, 1990]. Some reasons for this are the increased pollution of the river Scheldt and dredging activities in the Lower Sea Scheldt and the Western Scheldt.

Discharge of domestic and industrial effluents
1. Waste water discharge by industries.
The whole basin is highly industrialized. The main industrialized zones are found around Lille and Roubaix (Northern France), the harbour of Antwerp and along the canal Gent-Terneuzen.
2. Waste water discharge by households.
There are still problems with the waste water treatment in large part of the basins. The lack of waste water treatment plants in Brussels is probably the worst example. Fortunately, water treatment plants are being built now in Brussels.

Provision of drinking water and water for industry
1. Drinking water.
With the exception of one drinking water company, near to Terneuzen, no water is extracted for drinking water purposes [Ovaa, 1991] in the brackish and salt water zone of the Scheldt estuary. Flanders mainly produces its drinking water out of dune- and ground water. Moreover, the water of the Yser and Meuse (via the "Albertkanaal") is used for drinking water production. In Wallonia and France drinking water is mostly prepared out of ground water.
2. Industrial water use.
Use of water for production and cooling purposes occurs in the entire river basin. Self-evidently, the water consumption concentrates in the urban areas around the harbours.

Navigation
Klap and Heip (1991) describe the main functions of the Scheldt river basin. The function "navigation" is described first, since it is the economical most important function of the Scheldt river. The main ports in the basin are Antwerp, Gent, Terneuzen and Flushing, among which the harbour of Antwerp is by far the greatest. The harbour of Antwerp is crucial to Flanders' economy. The Western Scheldt connects the harbour of Antwerp to the North Sea. To guarantee free access to the harbour of Antwerp extensive dredging works, causing physical-morphological disturbances, have to be carried out. Most of the dredged material is heavily polluted. The storage of the dredged material is therefore another environmental problem. Needless to say, the navigation function of the Scheldt river, is often to a high degree conflicting with the nature function of the river system. Apart from the Western Scheldt, the canal Gent-Terneuzen is an other important fairway. The harbours of Antwerp, Gent, Terneuzen and Flushing are part of the so-called Rhine-Scheldt Delta (RSD), an economic core area in Europe. The importance of the harbours is illustrated by the data shown in table 3.1. Other shipping activities are mainly concentrated on the canals such as the "Alberkanaal" that connects Luik to Antwerp and the "Willebroekkanaal" that connects

Brussels to the Rupel.

The safety of transport is an aspect that is strongly related to the navigation function of rivers. Government agencies are discussing the safety of transport routes in the Western Scheldt now.

Harbour	Trans-shipment 1990 (x 1.000 ton)	Trans-shipment 1990 1982 = 100	Employment in industrial activities related to the harbour.	Gross Regional Product per inhabitant (2) Average EU = 100
Antwerp (1)	102.000	121	66.000	142
Gent (1)	24.400	107	18.000	121
Zeebrugge	30.300	322	1.700	108
Oostende	4.600	107	1.800	100
Rotterdam	300.000	116	53.338	115
Terneuzen/ Vlissingen (1)	17.800	129	12.605	110

(1) = Situated in the Scheldt basin
(2) = Data for the region in which the harbour is situated

Table 3.1: ***Economic data harbours Rhine Scheldt Delta*****, Source: [Onderzoekers RSD, 1994]**

Recreation

The recreation along the Scheldt upstream of Antwerp concerns mainly river side recreation. Downstream of Antwerp pleasure trips are more important. Most important marinas in this area are Antwerp, Terneuzen, Breskens and Flushing (connected to Middelburg). Sea yachting is mostly concentrated in the western part of the Western Scheldt. In the Dutch province of Zeeland, beach recreation along the mouth of the Western Scheldt is important. Due to the bad water quality, the recreation diminishes rapidly going eastward. Recreational fishing takes place in the whole catchment area so long as the total number of fishes has not reduced too much. Finally, we certainly have to mention the recreative visits to towns like Gent and Mechelen, known for their canals and boulevards.

Mineral extraction

In the Western Scheldt sand and shells are extracted from the river system. The 'Structuurschema Oppervlaktedelfstoffen' [Ministerie van Verkeer en Waterstaat, 1994] describes the policy regarding the yield of minerals. In the Western Scheldt 2.6 million m^3 sand a year will be extracted till 1997. As much as possible sand extractions will be combined with the maintenance dredging works that have to be carried out in the Western

Scheldt. In the mouth of the Western Scheldt extracted sand is being used for coastal defence (beach nurishments). The extraction of shells will be continued.

3.3 Conflicting interests

Most of the functions and interests described in the last section are to a high degree conflicting. The most evident conflict is that between the nature function and several economic functions, such as professional shipping and the discharge of domestic and industrial waste water. The high population density combined with insufficient waste water treatment infrastructure has given rise to a heavily polluted river system. Similarly, the industrialized zones in the catchment have severe impacts on the ecosystem.

The list of problems can easily be extended. According to the ISG (1994), most water management problems are comparable in the different parts of the basin.
The most important problems are:
- pollution of ground- and surface water
- insufficient waste water treatment
- sediment contamination
- low flow rates
- low ground- and surface water levels

From source to mouth the emphasis of the problems tends to shift from the surface water to the bottom sediments. Additional problems specifically for the Scheldt estuary are:
- physical-morphological disturbance due to dredging works
- deposition of contaminated particulate matter
- flow of heavily polluted river water (and particulate matter) into the estuary.

In the policy document for the Western Scheldt [Core Working Party for the Western Scheldt, 1991] an analysis of the diverse functions and interests and the function conflicts has been made for the Western Scheldt. Most problems in this region are related to the high waste loads and maintenance- and infrastructure dredging works for the navigation function. The ecosystems in the Western Scheldt suffer from water- and sediment pollution as well as morphological disturbances. For a more elaborate description of the conflict between the navigation and nature function can be referred to [Pieters et al., 1991]. The negative impacts of dredging works on the ecosystem of the Western Scheldt and mitigating measures are discussed in [Ministerie van Verkeer en Waterstaat, 1994b].

4 The Scheldt basin: Administrative System

4.1 Introduction

Integrated management of international river basins cannot be realized without extensive knowledge on the administrative organization of water management in the riparian states. Although administrations in the fields of physical planning and nature and environmental management often are relevant as well, this chapter primarily focuses on water management organization. For each riparian state, the administrations having water management tasks and the most important water management acts and plans are described. Thereafter, the international organizations and agreements relevant to the Scheldt water management are discussed.

4.2 Water management organization in the French part of the basin

France is a centralized democracy. There are six administrative levels: State (*Etat*), Regions (*Régions)*, Departments (*Départements*), Districts (*Arrondissements*), Cantons (*Cantons*) and Municipalities (*Communes*). Each Region comprises a number of Departments, each Department a number of Districts and so on. The Districts and Cantons have no competencies in the field of water management. In the Water Act 1964 (*Loi sur l'Eau 1964*) six basin agencies (*Agences de l'Eau*) were created, five of them corresponding with the river basins Rhône, Loire, Garonne, Seine and Rhine. The sixth agency, the *Agence de l'Eau Artois-Picardie,* was set up in the industrial and mining Northern France. French water management distinguishes navigable watercourses (*domaniaux*) and non-navigable watercourses (*non-domaniaux*).

State

At the state level, nine ministries have water management tasks. The Ministry of the Environment (*Ministère de l'Environnement*) is in charge of coordinating water policy. The *Direction de l'Eau* of this ministry is the secretary of the *Commission Interministérielle de l'Eau* and of the *Comité National de l'Eau*, the two institutions where national water policy is discussed. The former consists of representatives of the sectoral ministries. In the latter, water users, local governments and ministries are represented. Several other ministries have responsibilities on parts of water policy. The Ministry for Public Health (*Santé*) is responsible for the control of drinking water, the Ministry of Public Works (*Travaux Publics*) for navigation and the Ministry of Industry (*Industrie*) for underground waters and pollution control. Most of the ministries have deconcentrated services in the regions and departments. In both the regions and the departments, state representatives, the *prefects de la Région/ du Département* are coordinating the regional policy. The Water Act 1964 and the Environmental Permitting Act of 1976 (*Loi Rélative eaux installations classées pour la protection de l'environnement*) contain the waste water discharges permits regulation.

The national environmental and water policy is formulated in the *Plan national pour l'Environnement/Plan Vert* [Ministère de l'Environnement, 1990].

Basins
Nowadays, the basin level is most important in French water management. In each basin there is a Basin Agency (*Agence de l'Eau de Bassin*) and a Basin Committee (*Comité de Bassin*). The aim of the Basin Agencies is to stimulate solidarities through economic incentives. Water management problems are dealt with in hydrographic basins, with the involvement of all water users. The costs are divided according to the interests of the parties. The Basin Agencies levy charges on the extraction and the pollution of water and subsidize purification by industries and municipalities. The Basin Committee is a de facto "regional water parliament", consisting of representatives of users, associations and local authorities, who form the majority, and state representatives. It pronounces on the fixing of charges and on the investment programme (*VI^{ème} Programme d'Interventions*) [Agence de l'Eau Artois-Picardie, 1991]. According to the Water Act 1992 (*Loi sur l'Eau 1992*) each of the six basin committees has to make an integrated water management plan, the SDAGE (*Schéma Directeur de l'Aménagement et de Gestion des Eaux*) [Agence de l'Eau Artois-Picardie, 1994]. In the *Livre Blanc* [Agence de l'Eau Artois-Picardie, 1990] the long term policy is described. The French part of the Scheldt basin is situated in the Artois-Picardie basin. The Artois-Picardie basin is divided into a number of subbasins, for which local plans are being developed. Figure 4.1 depicts the subbasins that are situated in the Scheldt basin: *l'Escaut* (E1), *la Scarpe* (E2) and *la Lyse* (E3).

Regions
The Regional Parliament (*Conseil Régional*) subsidizes water management projects. For water planning the regions compete with the basin agencies. The regional services of the Ministry of the Environment, the DIRENs (*Directions Régionales de l'Environnement*), are in charge of water planning coordination. In each of the six basins, one of the regional prefects has the title *Préfet coordinateur de bassin*, being in a superseding position when water planning overlaps the limit between two regions. The Scheldt basin is situated in the regions *Nord-Pas de Calais* and *Picardie*.

Departments
The Departmental Parliament (*Conseil Général*) gives advise and/or money for water quality management projects. Except from the Ministry of the Environment most ministries have territorial services at the level of the 95 departments, in particular as far as environmental permitting and enforcement is concerned. The French part of the Scheldt basin is situated in the departments *Nord*, *Pas de Calais* and *Aisne*.

Municipalities
The 36.000 municipalities are responsible for the building and exploitation of sewage systems and waste water purification plants. Furthermore, they are traditionally in charge of delivering water services, alone or through joint boards. This localism is compensated by the concentration of the privatized water industry. 81% of the water volumes are served by three

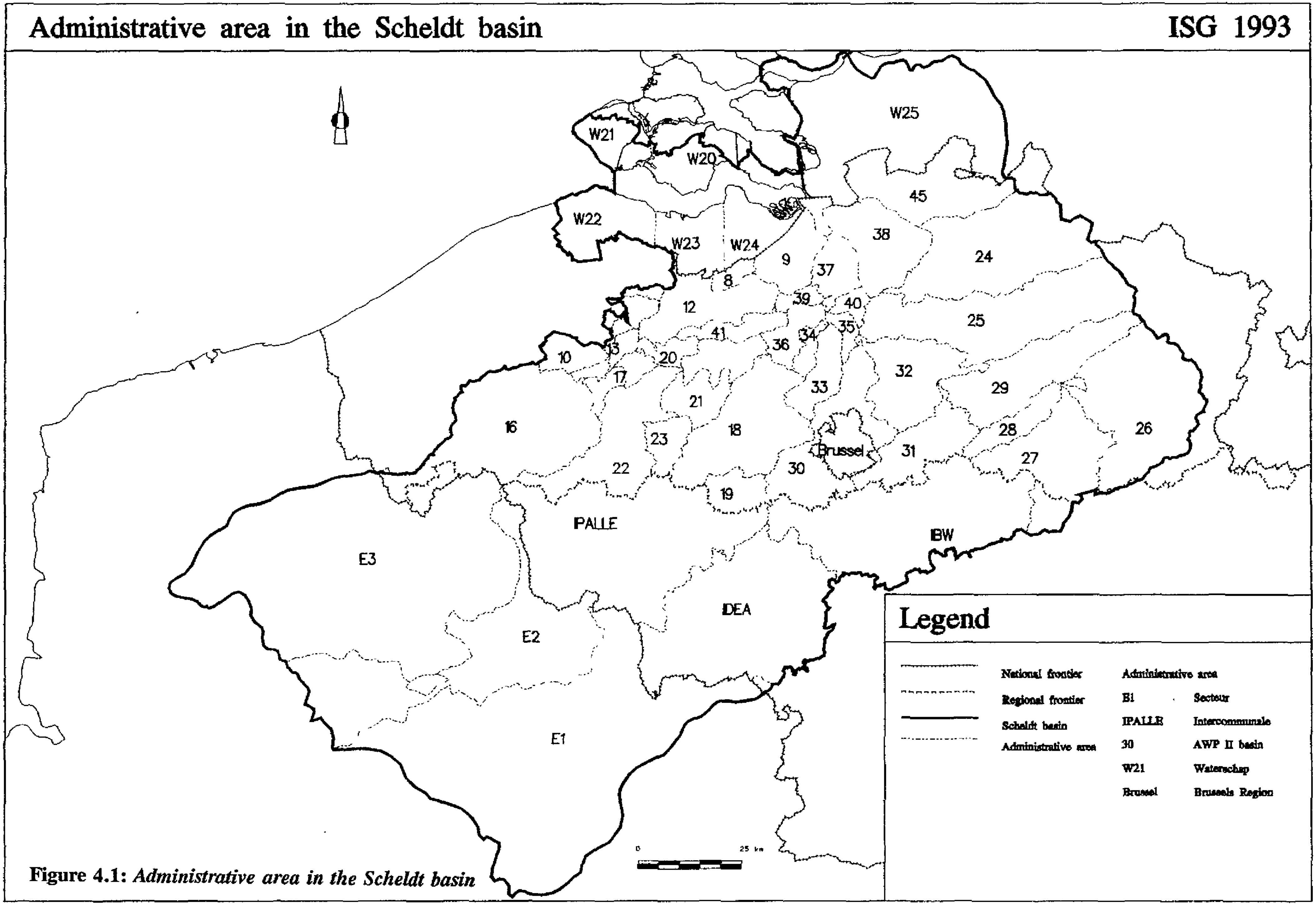


Figure 4.1: *Administrative area in the Scheldt basin*

giant companies. Table 4.1 gives an overview of the water management competencies in France.

France	Navigable watercourses				Non-navigable watercourses			
	Quantity		Quality		Quantity		Quality	
	Str.	*Op.*	*Str.*	*Op.*	*Str.*	*Op.*	*Str.*	*Op.*
Ministère de l'Environnement	*		*		*		*	
Commission Interministérielle de l'Eau	*		*		*		*	
Comité National de l'Eau	*		*		*		*	
Agence de l'Eau de Bassin		*		*		*		*
Comité de Bassin	*		*		*		*	
Région (+ deconcentrated services)	*	*	*	*	*	*	*	*
Département (+ deconcentrated services)	*	*	*	*	*	*	*	*
Commune				*		*		*

Str. = Strategic Op. = Operational

Table 4.1: ***Water management competencies in France***

4.3 Water management organization in the Belgian part of the basin

Since 1980 Belgium is a federal state. There are four administrative levels: Federal State, Regions (3) and Communities (3), Provinces and Local governments: municipalities and polderboards. The regions are Flanders, Wallonia and Brussels, the communities are the Flemish, French and German community. The communities deal with social and cultural affairs and have no water management competencies. Except from some minor coordinating tasks, all water management tasks are transferred to the regions. The water management administrations in Wallonia and Flanders use a division in navigable and non-navigable water courses. Navigable water courses are economical important transport routes that also have a drainage function. The non-navigable watercourses are divided in three categories, from the source (category 3), via the middle parts (category 2) to the mouth (category 1) of the watercourse. In the following, the water management organization of the regions is shortly described.

4.3.1 Wallonia

Region

The Direction of Natural Resources and the Environment (*Direction Générale des Ressources Naturelles et de l'Environnement*) of the Walloon ministry is in charge with the water quality aspects of all surface waters and the quantitative aspects of non-navigable watercourses of the first category. The Ministry of Equipment and Transport (*Ministère Wallon de l'Equipement et des Transports*) is responsible for the quantitative aspects of the navigable water courses. The water management advise committee (*Commission wallone pour la protection des eaux de surface contre la pollution*), consisting of representatives of several water users, advises the Walloon Executive on water management issues. The Decree concerning the protection of surface water against pollution (*Décret du 07.10.1985 sur la protection des eaux de surface contre la pollution*) [Ministère de la Région Wallone, 1985] deals with water quality objectives and contains the regulation on environmental permitting.

Provinces

The provinces have the responsibility for the quantitative management of the non-navigable water courses of the second category, unless these watercourses are under the jurisdiction of the polderboards. The Scheldt basin is situated in the provinces *Hainaut, Brabant, Namur* and *Liège*.

Wallonia	Navigable watercourses				Non-navigable watercourses			
	Quantity		Quality		Quantity		Quality	
	Str.	*Op.*	*Str.*	*Op.*	*Str.*	*Op.*	*Str.*	*Op.*
						Cat.		
Direction Générale des Ressources Naturelles et de l'Environnement			*	*	*	1	*	*
Ministère wallone de l'Equipment et du Transport	*	*						
Province						2		
Intercommunale				*				*
Wateringue						2/3		
Commune						3		

Str. = Strategic Op. = Operational Cat. = Category

Table 4.2: ***Water management competencies in Wallonia***

Local governments
The polderboards (*wateringues*) are responsible for the quantitative management of non-navigable water courses of the second and third category. The municipalities manage the sewage systems and are in charge with quantitative aspects of non-navigable watercourses of the third category. The Ministry of the Walloon Region has ordered so-called *intercommunales* to build and exploit the waste water treatment infrastructure. The eight *intercommunales* are financially fully dependent on the Ministry of the Walloon Region. The *intercommunales* IDEA (Haine, Canal du Centre, upstream Senne), IPALLE (Lys, Espierre, Escaut, Dendre) and IBW (Senne, Dyle, Gete) are situated in the Scheldt basin. Figure 4.1 depicts the administrative areas of these *intercommunales*. Table 4.2 gives an overview of the water management competencies in Wallonia.

4.3.2 Brussels

The Administration of Natural Sources and the Environment (*Administration des Ressources Naturelles et de l'Environnement*) is responsible for the technical and administrative aspects of water management, including discharge permits and monitoring of surface and groundwater quality. The Brussels Institute for Environmental Management develops the water policy for the Brussels Region. Table 4.3 gives an overview of the water management competencies in Brussels.

Brussels	Navigable watercourses				Non-navigable watercourses			
	Quantity		Quality		Quantity		Quality	
	Str.	*Op.*	*Str.*	*Op.*	*Str.*	*Op.*	*Str.*	*Op.*
Administration des Ressources Naturelles et de l'Environnement		*		*		*		*
Brussels Institute for Environmental Management	*		*		*		*	

Str. = Strategic Op. = Operational

Table 4.3: ***Water management competencies in Brussels***

4.3.3 Flanders

Region
The Department of Environmental Affairs and Infrastructure (*Leefmilieu en Infrastructuur*), one of the six departments of the Flemish Region, has the administrative and technical responsibility for the water management in Flanders. The Administration Environment, Nature, Land- and Water Management (*Administratie Milieu, Natuur-, Land- en Waterbeheer*), under the jurisdiction of this department, is in charge with the water

management strategy, the qualitative aspects of the operational water management of the navigable watercourses and the qualitative and quantitative aspects of the operational water management of the non-navigable water courses of the first category. The Administration Water infrastructure and Marine Affairs (*Administratie Waterwegen en Zeewezen*) of the Department of Environmental Affairs and Infrastructure is responsible for the quantitative aspects of the operational water management of the navigable watercourses. The most important national plan is the National Environmental Policy and Nature Development plan (MINA-plan 2000) [Ministerie van de Vlaamse Gemeenschap, 1989]. For the period 1990-1995 this plan is elaborated in two plans: the Environmental Policy Plan and the Nature Development plan. In the former plan policy is formulated on surface water pollution and the pollution of sediments. The environmental permitting policy is mainly based on the Law on the protection of surface water against pollution (1971). In 1976 the SIGMA-plan [Ministerie van Openbare Werken, 1977] was drawn up. This plan aims at defending the basin of the Lower Sea Scheldt from storm surges.

Provinces
The Provinces are in charge with the management of the non-navigable water-courses of the second category. The Scheldt basin is situated in the Flemish provinces *Antwerpen, Limburg, Oost-Vlaanderen, Vlaams-Brabant*, and *West-Vlaanderen*.

Local governments
The polderboards (*polders/wateringen*) carry out the quantitative management of the watercourses of the second and third category. The *polders* are responsible for the maintenance of the dikes and the regulation of the inland water levels. The *Wateringen* are in charge with the regulation and protection of suitable conditions for agriculture and hygiene. The municipalities build and exploit the sewage systems and carry out the operational management for non-navigable water courses of the third category.

Paragovernmental institutions
In addition to these administrations, several so-called "paragovernmental institutes" (*parastatalen*) exist with their own tasks and objectives. One of these is the Flemish Environment Agency (VMM), making the General Water Purification Programmes (*Algemene Waterzuiverings Programma's*: AWP's). Figure 4.1 depicts the areas for which these programmes are being developed. The privatized organization AQÙAFIN carries out these programmes by building, improving and exploiting waste water treatment plants. Another important paragovernmental institute is the Public waste matter company for the Flemish Region (OVAM), dealing with water bed pollution.

Basin committees
A relatively new phenomena in Flemish water management are the basin committees (bekkencomités). These basin committees, in which governmental and non-governmental organizations are cooperating, aim at an integrated water management for a specific basin and give advise on water management policy. Table 4.4 gives an overview of the water management competencies in Flanders.

Flanders	**Navigable watercourses**				**Non-navigable watercourses**			
	Quantity		**Quality**		**Quantity**		**Quality**	
	Str.	*Op.*	*Str.*	*Op.*	*Str.*	*Op.*	*Str.*	*Op.*
						Cat.		Cat.
Administratie Milieu, Natuur-, Land- and Waterbeheer	*		*	*	*	1	*	1
Administratie Waterwegen en Zeewezen		*						
Vlaamse Milieu Maatschappij (VMM)			*	*			*	1/2/3
Openbare Afvalstoffen maatschappij voor het Vlaamse Gewest (OVAM) *(water bed)*			*	*			*	1/2/3
AQUAFIN				(*)				(1/2/3)
Provincie						2		2
Polder/watering						2/3		
Gemeente						3		3

Str. = Strategic Op. = Operational Cat. = Category
(*) = only concerning waste water treatment

Table 4.4: ***Water management competencies in Flanders***

4.4 Water management organization in the Dutch part of the basin

The Netherlands are a decentralized unitarian state. There are three administrative levels: State (*Centrale overheid*), Provinces (*Provincies*), Municipalities (*Gemeenten*) and Waterboards (*Waterschappen*). Municipalities and waterboards are on the same administrative level. In Dutch water management, national and regional waters are distinguished.

State
At the state level, the water management tasks are the responsibility of the Ministry of Transport, Public Works and Water Management. These tasks are carried out by its operational department: *Rijkswaterstaat* (RWS). Other ministries, such as the Ministry of Housing, Physical Planning and the Environment and the Ministry of Agriculture, Nature Management and Fisheries are relevant to water management as well. The National Law on Water Management 1989 (*Wet op de Waterhuishouding*) introduced an integrated water planning system in the Netherlands. The national policy on water management is formulated in de Third Policy Document on Water Management (*Derde Nota Waterhuishouding*)

[Ministerie van verkeer en Waterstaat, 1989], an integrated policy plan, addressing groundwater and surface water, water quantity and water quality. The Pollution of Surface Waters Act (1970) regulates the qualitative water management and the environmental permitting. Besides the general policy making, the central government is involved in the following two aspects of water resources management: (1) direct management of the waters that belong to the national system (national waters), see Management plan for the National Waters 1992-1996 (*Beheersplan voor de Rijkswateren*) [Ministrie van Verkeer en Waterstaat, Rijkswaterstaat, 1993]; and (2) supervision of the management of the regional and local waters and the management of groundwater resources that is carried out by the provinces. The regional directorate Sealand of Rijkswaterstaat is responsible for the water management of the Western Scheldt, the canal Gent-Terneuzen and a part of the Scheldt-Rhine connection (see the management plan for the national waters in Sealand 1993-1996 *(Regionota Zeeuwse Rijkswateren)* [Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, directie Zeeland, 1993]).

Provinces

The Provinces are responsible for the water management of the regional waters. Most provinces have delegated the water quantity and water quality tasks to the waterboards (*waterschappen*). The provinces have supervision over them. Concern for groundwater, quantitative and qualitative, is a task of the provinces as well. Each province has to make an integrated water management plan. The Dutch part of the Scheldt basin falls for the greater part within the province of Sealand. The eastern part is situated in the province Northern Brabant.

Local governments

The Dutch waterboards are (as distinct from the Walloon and Flemish waterboards) very powerful organizations. The waterboards build and exploit the waste water treatment plants, maintain the dikes and regulate the water quantity in the provinces. The Waterboard-Act (1991) deals with the organization, tasks, competencies and instruments of the water boards. In the province of Sealand there are so-called all-in waterboards, i.e. the waterboards are responsible for both the water quantity and the water quality. The waterboards in the Scheldt basin are: Waterschap *Noord-en Zuid-Beveland* (W20), *Walcheren* (W21), *Het Vrije van Sluis* (W22), *De Drie Ambachten* (W23) and *Hulster Ambacht* (W24). In the Province of Northern-Brabant the waterboard *Hoogheemraadschap West-Brabant* (W25) is responsible for the water quality management, whilst there are several small waterboards having water quantity tasks. Figure 1 depicts the administrative areas of the waterboards. The policy of the waterboards is described in operational water management plan. The municipalities manage the harbours, channels and the sewage systems. For the management of the Western Scheldt their competencies in the field of land-use planning are most important. For the dredging works in the Western Scheldt the Dutch Rijkswaterstaat needs a permit based on the local land-use plans.

Working party for the Western Scheldt
In 1992 a not legally-binding agreement between all governmental organizations relevant to an integrated development of the Dutch part of the basin was convened. The parties prepared an integrated water policy plan for the Western Scheldt (*Beleidsplan Westerschelde*) [Core working party for the Western Scheldt, 1991], including a concrete plan of action. Table 4.5 gives an overview of the water management competencies in the Netherlands

The Netherlands	**National waters**				**Regional waters**			
	Quantity		**Quality**		**Quantity**		**Quality**	
	Str.	*Op.*	*Str.*	*Op.*	*Str.*	*Op.*	*Str.*	*Op.*
Rijkswaterstaat	*	*	*	*				
Provincie					*		*	
Waterschap						*		*
Gemeente								*

Str. = Strategic Op. = Operational

Table 4.5: ***Water management competencies in the Netherlands***

4.5 International framework

This section gives an overview of the main international organizations, laws, treaties and agreements that are relevant for the Scheldt water management. Successively European agreements, the role of the European Union, multi-lateral agreements, the role of the Benelux Economic Union and bi-lateral agreements are discussed.

European agreements
There are several European agreements dealing with water management. For the Scheldt water management the Convention on the protection of the marine environment in the Northeast-Atlantic Ocean (Paris-Oslo Convention, 1992) and the North Sea Action Programme are most interesting. The Paris-Oslo Convention aims at reducing pollution of the North-Atlantic Ocean and the North Sea, stemming from land. Three conferences aiming at the protection of the North Sea have been organized. At the Second North Sea Conference held in London in 1987 the North Sea Action Programme was adopted by agreement that input of dangerous substances, which are entering the North Sea via main European rivers, will be reduced by 1995 approximately for 50% in comparison to 1985. The prime concern was directed towards the Northwest European rivers, under which the Scheldt river. On the Third North Sea Conference in The Hague (1990) the North Sea co-states agreed upon further pollution reduction, i.e. a minimum reduction of 50% for 36 selected prior substances and at least 70% for mercury, cadmium, lead and dioxin. In 1995, during the fourth North

Sea Conference, the situation in the riparian states will be evaluated.

European Union
The European Union is an important framework for international environmental policy. The European Union has produced a series of not-legally binding Environmental Action Programmes, containing general guidelines for environmental policy in Europe. [Commission of the European Communities, 1992]. In European law, we can distinguish directives, regulations, decisions and resolutions. For European water policy, the directives are most important. We can distinguish between emission directives and water quality directives. The most important emission directives are the directives for the discharge of hazardous substances in the aquatic environment (76/464/EEC);the protection of groundwater against pollution caused by hazardous substances (80/068/EEC); waste water discharge form urban areas (91/271/EEC) and for the protection of water against nitrogen pollution from agriculture (91/676/EEC). The most important water quality directives are the directives for the quality of surface water for the production of drinking water (75/440/EEC); the quality of bathing water (76/160/EEC); the procedure for the exchange of information on the quality of fresh surface water (77/795/EEC); the quality of fresh water for supporting fish life (78/659/EEC); the quality of fresh water for supporting shellfish growth (79/923/EEC) and the quality of drinking water for human consumption (80/778/EEC).

Multi-lateral agreements
In 1995, a multi-lateral treaty on the protection of the Scheldt was signed by the Scheldt riparian states. It forms the basis for the International Scheldt Commission that will prepare an Action programme for the restoration and protection of the river Scheldt. This treaty is in the spirit of the Convention on the Protection and Use of Transboundary Watercourses and international lakes [United nations Economic Commission for Europe, 1992]. This Framework Convention was signed by 22 countries, among which the Scheldt riparian states. It offers a framework for bilateral and multi-lateral agreements on the protection and use of international waters. In this convention the precautionary principle, the polluter pays principle and the concept of sustainable development are formulated.

Benelux Economic Union
The Benelux Economic Union (BEU) plays no major role in water management. However, the BEU has a working group coordinating the groundwater management of Belgium, the Netherlands and Luxembourg.

Bi-lateral agreements
Bi-lateral agreements between the Netherlands and Belgium are the treaty concerning the improvement of the canal Gent-Terneuzen (1960), the treaty concerning the Scheldt-Rhine connection (1963) and the treaty concerning the deepening of the Western Scheldt (1995). Furthermore, there are two permanent commissions, in which Belgium and the Netherlands are cooperating: The "Permanente Commissie van Toezicht op de Scheldevaart" (PC) and the Technical Scheldt Commission (TSC). The PC is responsible for pilotage and marking and dates from 1839, when Belgium was separated from the Netherlands. The TSC carries out research and advises on nautical affairs in the Sea Scheldt and the Western Scheldt.

5 Cooperation in river basins

5.1 Introduction

Although few theories on cooperation in river basins have been developed, there are many theories on cooperation in general. In this chapter, two main theoretical approaches to cooperation will be described shortly. First, the game theoretical approach to cooperation will be explained (5.2.1). This is a classic approach stemming from political economy. An enormous amount of research on game theory has been carried out over the last decades. The second theory that will be addressed is the network theory from public administration (5.2.2). This is a rather new theory. A lot of research on policy networks is being carried out. Both theories provide possibilities to analyze existing patterns of cooperation. The other sections deal with the types of cooperation that can be distinguished in river basins (5.3), success criteria for cooperation (5.4) and the factors influencing the extent of cooperation (5.5).

5.2 Theoretical approaches to cooperation

5.2.1 Game theory

This section is mainly based on the book *The Evolution of Co-operation*[5]. The approach of this book is to investigate how individuals pursuing their own interests will act, followed by an analysis of what effects this will have for the system as a whole. The objective of this is to develop a theory of cooperation that can be used to discover what is necessary for cooperation to emerge. By understanding the conditions that allow cooperation to emerge, appropriate actions can be taken to foster the development of cooperation in a specific setting.

The game theoretical approach offers good possibilities to enhance understanding of cooperation. One famous game is the *Prisoner's Dilemma game*. In the Prisoner's Dilemma game, there are two players. Each has two choices, namely cooperate or defect. Each must make the choice without knowing what the other will do. No matter what the other does, defection yields a higher payoff than cooperation. The dilemma is that if both defect, both do worse than if both had cooperated.

The way the game works is shown in figure 5.1. One player chooses a row, either cooperating or defecting. The other player simultaneously chooses a column, either cooperating or defecting. Together, these choices result in one of the four possible outcomes shown in the matrix. If both players cooperate, both do fairly well. Both get *R*, the *reward for mutual cooperation*. In the concrete situation of figure 5.1 the reward is 3 points. If one player cooperates but the other defects, the defecting player gets the *temptation to defect*, while the cooperating player gets the *sucker's payoff*. In the example, these are 5 points and 0 points respectively. If both defect, both get 1 point, the *punishment for mutual defection*.

[5]Axelrod, R., *The Evolution of Co-operation*, 2 nd impression, (first impression 1984), London, 1990.

	Cooperate	Defect
Cooperate	R=3, R=3 Reward for mutual cooperation	S=0, T=5 Sucker's payoff, and temptation to defect
Defect	T=5, S=0 Temptation to defect and suckers's payoff	P=1, P=1 Punishment for mutual defection

Note: The payoffs to the row chooser are listed first.

Figure 5.1: ***The Prisoner's Dilemma***

The prisoner's dilemma is simply an abstract formulation of some very common and very interesting situations in which what is best for each person individually leads to mutual defection, whereas everyone would be better off with mutual cooperation.

The best a player can do is get *T*, the temptation to defect when the other player cooperates. The worst a player can do is get *S*, the sucker's payoff for cooperating while the other player defects. In ordering the other two outcomes, *R*, the reward for mutual cooperation, is assumed to be better than *P*, the punishment for mutual defection. This leads to a preference ranking of the four payoffs from best to worst as *T,R,P* and *S*.

Two egoists playing the game *once* will both choose their dominant choice, defection, and each will get less than they both could have got if they had cooperated. If the game is played a known finite number of times, the players still have no incentive to cooperate. This is certainly true in the last move since there is no future to influence. On the next-to-last move neither player will have an incentive to cooperate since they can both anticipate a defection by the other player on the very last move. Such a line of reasoning implies that the game will unravel all the way back to mutual defection on the first move of any sequence of plays that is of known finite length. This reasoning will not apply if the players will interact an indefinite number of times. And in most realistic settings, the players cannot be sure when the last interaction between them will take place. With an indefinite number of interactions, cooperation can emerge. The issue then becomes the discovery of the precise conditions that are necessary and sufficient for cooperation to emerge. Usually one thinks of cooperation as a good thing. This is the natural approach when one takes the perspective of the players themselves. After all, mutual cooperation is good for both players in a Prisoner's Dilemma. As long as the interactions are not iterated, cooperation is very difficult. That's why an important way to promote cooperation is to arrange that the same two individuals will meet each other again, be able to recognize each other from the past, and to recall how the other has behaved until now. This continuing interaction is what makes it possible for cooperation based on reciprocity to be stable. The advice dealing with how this mutual cooperation can be promoted comes in three categories:
1. Making the future more important relative to the present
2. Changing the pay-offs of the players of the four possible outcomes of a move
3. Teaching the players values, facts and skills that will promote cooperation.

1. ***Enlarge the shadow of the future***

Mutual cooperation can be stable if the future is sufficiently important relative to the present. This is because the players can each use an implicit threat of retaliation against the other's defection - if the interaction will last long enough to make the threat effective. There are two basic ways to enlarge the shadow of the future:

- by making the interactions more durable
- by making them more frequent

Prolonged interactions allows patterns of cooperation which are based on reciprocity to be worth trying and allows them to become established. A good way to increase the frequency of interactions between two individuals is to keep others away. In a small group, interactions can be more frequent. This is one reason why cooperation emerges more readily in small towns than in small cities. Another possibility to increase interactions is to concentrate the interactions. Hierarchy and organization are especially effective at concentrating interactions between specific individuals. Finally, by breaking down issues in small pieces (decomposition) interactions can become more frequent. Many small steps will promote cooperation as compared to just a few big steps. Making sure that defection on the present move is not too tempting relative to the whole future course of the interaction is a good way to promote cooperation.

2. ***Change the payoffs***

Getting out of Prisoner's Dilemmas is one of the primary functions of government. Laws are past to cause people to pay taxes, not to steal, and to honour contracts with strangers. Each of these activities could be regarded as a giant Prisoner's Dilemma game with many players. What governments do is to change the effective pay-offs. If you avoid paying your taxes, you must face the possibility of being caught and sent to jail. This prospect makes the choice of defection less attractive. Large changes in the payoff structure can transform the interaction so that it's no longer even a Prisoner's Dilemma. If the punishment for defection is so great that cooperation is the best choice in the short run, no matter what the other player does, then there is no longer a dilemma. Even a relatively small transformation of the payoffs might help cooperation based on reciprocity stable. So, to promote cooperation through modification of the payoffs, it is not necessary to go so far as to eliminate the tension between the short-run incentive to defect and the long-run incentive to achieve mutual cooperation. It is only necessary to make the long-term incentive for mutual cooperation greater than the short-term incentive for defection.

3. ***Teaching the players values, facts and skills that will promote cooperation***

- Teach people to care about each other.

An excellent way to promote cooperation in society is to teach people to care about the welfare of others. In game theory terms, this means that people's values have to be shaped in such a way, that preferences incorporate not only the own individual welfare, but to some degree at least, the welfare of others as well.

- Teach reciprocity.
Unconditioned cooperation provides an incentive for the other player to exploit you. Unconditional cooperation can not only hurt you, but it can hurt other innocent bystanders with whom the successful exploiters will interact later. The TIT FOR TAT strategy seems to be the best one. TIT FOR TAT starts with a cooperative choice, and thereafter does what the other player did on the previous move. this strategy if well-known and can elicit a good degree of cooperation.

- Improve recognition abilities.
The ability to recognize the other players from past interactions, and to remember the relevant features of those interactions, is necessary to sustain cooperation. Without these abilities, a player could not use any form of reciprocity and hence could not encourage the other to cooperate. The problem can be verification: knowing with an adequate degree of confidence what move the other player has actually made. The ability to recognize defection when it occurs is not the only requirement for cooperation to emerge, but it is certainly an important one. Therefore, the scope of sustainable cooperation can be expanded by any improvements in the players' ability to recognize each other from the past, and to be confident about the prior actions that have actually been taken.

Caveats
Argyle (1991) questions the usefulness of the Prisoner's Dilemma Game (PDG) According to him, there are several aspects in which it is very different from real-life cooperative issues.

1. *Simultaneous play, ignorance of other's move, risk if other fails to cooperate.*
These are all key features of the PDG, but very rarely apply to real life. It is particularly odd that the players have to move simultaneously rather than taking turns.

2. *The game itself is too abstract.*
How the game is being played depends on the subject: economy, international or interpersonal relations? In experiments it was found that in the economic condition there was less cooperation than usual, since it seemed to be an excuse for exploitation and self-interest, but in the other conditions there was more cooperation.

In experiments it was found that:
1. The more communication is allowed, the more cooperation emerges.
2. The stronger the relationships between the players, the more cooperation emerges.

5.2.2 Network theory
In the last decade, the steering possibilities of government agencies were more and more doubted. According to scientists in the field of public administration the limited steering possibilities of government are caused by networks: stable relations between government agencies, semi-private and private organizations that are formed around a specific problem or task field. Therefore, in the beginning networks were seen as a negative phenomena.

However, there are two main reasons why networks are worth studying. The first reason is that whether you like it or not networks exist. The second reason is that networks offer a lot of possibilities for steering. By activating networks in the right way governments can use resources, they don't possess themselves. Bruijn, de, Kickert and Koppenjan (1993) give the following definition of a policy network: *Policy networks are patterns of interactions between mutual dependent actors, which are formed around policy problems or policy programmes.*

The core of this definition is the existence of "mutual dependent actors". Most actors are dependent on other actors when they want to achieve their goals by a certain policy (strive towards certain goals with specific means). For the preparation and implementation of policy, interactions between (representatives) of governmental and non-governmental organizations (NGOs) are necessary. These interactions comprise exchange of information, policy objectives and means. Since these interactions are going on continuously, processes of institutionalization emerge. In this way networks are shaped.

The network approach is often seen as an alternative for the classic steering paradigm. In this paradigm the relation between the governor and the governed is central. The governed are seen as one steering object and therefore this approach is also called the one-actor-approach.

Network management can be defined as: *The ways in which actors try to influence the structure, the functioning and the policy outcomes of networks.* There are several possibilities for network management [Termeer, 1993]. One can influence the relations between actors, the rules of interaction and the perceptions of actors:

1. *To influence relations between actors*
By influencing relations between actors, the outcome of policy processes can be influenced. Potential relations can be activated. Existing relations can be stopped. The extent to which certain resources, such as information and financial resources, are needed for realizing a specific policy outcome and the extent to which actors possess these resources, determines the selection of actors.

2. *To influence the rules of interaction*
By influencing the rules of interactions, the outcome of policy processes can be influenced. One can change the formal rules of interaction, such as consultation procedures.

3. *To influence perceptions*
By influencing perceptions of actors, the outcome of policy processes can be influenced. One possibility is to work towards some kind of common perception of situations. This should result in a common definition of an existing situation. Another way to influence perceptions is by internalizing certain values. For example, internalization of environmental values.

One main difference between the classic approach to policy and the network approach is that there are different ways to measure the effectiveness of policy. In the classic steering paradigm, the government has one policy objective, so the effectiveness of policy can be determined by carrying out research on the extent to which a certain policy contributes to the realization of this policy objective. In networks all actors have their own policy objectives as a consequence of diverging interests. So there is not one measuring rot for determining the effectiveness. In the network approach alternative norms, so called process norms have been developed. For example [Bruijn, de, Ringeling, 1993]:

1. Continuing interactions: Continuing (intensive) interactions are an indicator of successful policy
2. Satisficing: If solutions are satisficing to all actors, this is an indicator of successful policy.
3. Continuing consensus on procedures: If actors continuously agree with certain procedures, they will accept the policy outcomes of the procedures as well.
4. Consensus: Consensus on policy is an indicator of success of policy

One can distinguish three perspectives on network management [Bruijn, de, Kickert and Koppenjan, 1993]:

1. *An instrumental perspective*
In this perspective the central question is: To what extent can network management contribute to the realization of specific policy objectives or to the solution of specific problems?

2. *An interactive perspective*
In this perspective the problems of collective action are addressed. What are the consequences of horizontal relations between actors for the coordination of actions? The task of the network manager is to **promote cooperation**.
The network manager is an intermediary and facilitator. The norms of policy are not effectiveness and efficiency, but satisfaction, consensus, legitimacy and openness. The interactive perspective offers possibilities to solve problems that actors cannot solve on their own and where diverging interests hinder collective action. Weak aspects of this perspective are the little attention that is given to the institutional aspects of policy networks, such as the asymmetric division of resources and relations.

3. *An institutional perspective*
In this perspective the structural and the cultural aspects of networks are addressed. Structural aspects are the actors, the relations and the division of resources. Cultural aspects are the rules, norms and perceptions. The question is: How do structural and cultural characteristics of networks influence interaction processes and how do the interactions influence the development of networks?

Because in the interactive perspective on network management, the research focuses on processes of cooperation and network management aims at promoting cooperation, the interactive perspective seems to be the most promising perspective for research on cooperation in river basins. The other perspectives, however, are interesting too. The instrumental perspective provides information on the strategies actors are using, and the institutional perspective points out the relevance of the structural and cultural characteristics of policy networks, which influence cooperation patterns.

5.3 Types of cooperation

In order to describe cooperation in river basins, a typology of cooperation is very useful. In this section seven possibilities to classify cooperation in river basins are given.

1. Types of actors cooperating
Cooperation can be classified according to the types of actors that are cooperating. In section 1.3, the need for cooperation in river basins was illustrated by indicating the importance of cooperation between government agencies having tasks in the field of integrated water management and between government agencies and the target groups of policy, often organized in NGOs. A third category of cooperation that was distinguished is the cooperation between NGOs. Cooperation between government agencies can be classified according to the administrative level (supra-national, national, regional, local). Cooperation can be international or intra-national, and bi-lateral or multi-lateral. Chapter four described for each administrative level the relevant water management agencies in the riparian states.

2. Form of the cooperation
A second criterion is the form of the cooperation, which can be formal or informal. Examples of formal cooperation are a legally binding, a not-legally binding agreement or the foundation of a new organization. Apart from formal cooperation informal types of cooperation exist. Even when there is no agreement at all, exchange of information can take place or open-ended negotiations might be going on. These informal types of cooperation make it possible to make known ones preferences, to gather information on a policy topic and on the preferences of the other parties, or to come to some kind of consensus of opinion between the involved parties.

3. Goal of cooperation
Cooperation can be classified according to the goal of cooperation. Goals of cooperation can be general, such as the general development and conservation of a river basin or can refer to specific developments, uses or protection issues. Cooperation can aim at the exchange of information, for example warning systems for cases of emergency. Other goals of cooperation can be joint regulation, control and enforcement of regulation, joint planning, building, operation, maintenance, research, data collection, consultancy or monitoring. Another important goal of cooperation can be joint financing of certain projects, which would be too expensive for one organization to exploit. Finally, agenda setting can be an important objective.

4. Duration of cooperation
Cooperation can be permanent or temporary, such as cooperation in research projects.

5. Territorial extent of cooperation
A fifth criterion that can be used to classify cooperation is the territorial extent of cooperation. This can be local, such as in cases of cooperation on the building of infrastructure. The territorial extent can coincide with jurisdictions or with hydrologically defined areas, such as a sea, lake, estuary, river valley, canal or a (part of a) river basin.

Cooperation in basin committees is an example of cooperation with a hydrologically defined territorial extent.

6. Part of the natural system cooperation refers to

Cooperation can refer to different parts of the natural system. These can be specific components (surface water, groundwater, banks, water bed) or specific aspects (biological, chemical or physical water quality, water quantity) of the aquatic ecosystem, infrastructure or (parts of) the terrestrial ecosystem.

7. Functions of the natural system cooperation refers to

A final classification can be made according to the functions of the natural system cooperation refers to. Functions can be nature, safety and user functions. Examples of user functions are agriculture, hydropower, the use of cooling water, the water use of industry and households, for example the use of drinking water, waste water discharge by households and industry, navigation, fishing, recreation and the yield of minerals. In chapter 3, the main functions in the Scheldt basin were described. Table 5.1 gives an overview of the possibilities to classify cooperation between the relevant actors in river basins.

Types of actors cooperating	**Form of cooperation**	**Goal of cooperation**	**Duration of cooperation**	**Territorial extent of cooperation**	**Part of Natural System cooperation refers to**	**Function of Natural System cooperation refers to**
Governments - Local - Regional - National - Supra-national NGOs - Chambers of Commerce - Environmental protection groups - Fishery associations	Informal Formal - Non-legally binding agreement - Legally binding agreement - Creation new organization	General goal Specific goal - Exchange of information - Agenda setting - Joint regulation - Control/ Enforcement - Planning - Building - Operation - Maintenance - Monitoring - Financing - Research - Data collection - Consultancy	Temporary Permanent	Local Administrative area(s) Hydrologically defined area - Lake - Sea - Estuary - River/canal - (Part of) a river basin	Aquatic ecosystem 1) Components - Surface water - Groundwater - Banks - Water bed 2) Aspects - Quality Biological Chemical Physical - Quantity Terrestrial ecosystem Infrastructure	Nature Safety Agriculture Fishing Electricity: - Hydropower - Cooling-water Households: - Water use - Waste water Industry: - Water use - Waste water - Cooling water Navigation Recreation Yield of minerals

Table 5.1: ***Possibilities to classify cooperation in river basins***

5.4 Success criteria for cooperation

In this section the possible success criteria for cooperation will be discussed. Both content criteria and process criteria can be defined. Table 5.2 contains these success criteria for cooperation.

Norm type **Perspective**	Content criteria	Process criteria
One-actor perspective	Contribution of cooperation to the achievement of actor-specific goal	------
Multiple-actor perspective	Contribution of cooperation to the achievement of - formal goal - common goal	Continuity of cooperation Satisficing Consensus on procedures Contribution of cooperation to consensus on: - actual situation - desired situation - policy Number of cooperating actors

Table 5.2: *Success criteria for cooperation*

Content criteria refer to the goal of cooperation. In the previous section, a classification of cooperation was made according to the goals of cooperation. These were the *formal* goals of cooperation. The formal goals of cooperation can differ from the *actual* goals actors have regarding cooperation. The actual goals of actors are often diverging and therefore actor-specific. When the actual goals of actors are overlapping there are *common goals*. Because of the difference between formal and actual goals, the success of cooperation depends highly on the perspective one chooses. Cooperation can be beneficial for one actor, whereas it is less beneficial or even harmful for another. In the one-actor perspective one may look at the achievement of actor-specific goals, whilst in the multiple-actor perspective the achievement of the formal or common goals is relevant.

Common goals are often lacking or relatively unimportant compared to the actor-specific goals. Therefore, alternative norms have been developed. These norms are related to the process of cooperation (see also section 5.2.2). Process norms can be [Bruijn, J.A. de, A.B. Ringeling, 1993]: a) Continuing interactions: as long as the interactions between the cooperating actors are continuous, the cooperation is successful. b) Satisficing: if cooperation is satisficing to all cooperating actors, cooperation is successful. c) Consensus: cooperation is successful if there is a high degree of consensus among the cooperating actors. There can be consensus on procedures, on the actual and the desired situation (= consensus on the problem definition) and consensus on policy (measures, division of costs etc.). For the consensus criteria also the number of relevant actors among which consensus has been achieved is an indicator of successful cooperation.

Goals-achievement or consensus is not enough for cooperation to be successful. What we are really interested in is to what extent cooperation contributed to the achievement of goals or a certain degree of consensus, i.e. the effectiveness of cooperation.

5.5 Factors influencing the extent of cooperation

Knowledge on the factors influencing the extent of cooperation is essential to understand the existing patterns of cooperation in river basins and the development of cooperation over time (the dynamics of cooperation). In this section the factors influencing international cooperation are discussed first. Some of these factors are crucial to the development of intra-national cooperation as well. In [LeMarquand, 1977] four groups of factors, which can promote or hinder cooperation and agreement in international river basins are presented.

1. Hydrologic-economic patterns of incentives and disincentives
2. Foreign policy considerations
3. Domestic policy-making and consensus formation
4. Factors facilitating communication between basin countries

5. A fifth group of factors that will be added is the existence of common threats or the occurence of calamities.

ad 1: ***Hydrologic-economic patterns of incentives and disincentives***
Both the hydrologic sequence of countries within a basin and the present or potential social-economical demands on the river by the basin countries create different patterns of incentives for cooperation. Regarding the hydrological sequence a distinction can be made between successive rivers and contiguous or boundary rivers. Within successive river basins upstream, midstream and downstream countries can be distinguished. An international river is a so-called 'common property resource'. This brings along so-called 'externalities'. An externality occurs whenever an action taken by some economic unit has a direct impact on the welfare or productivity of some other economic unit, while this change in welfare is not compensated. When the medium through which the external effect or externality is transmitted is physical, that medium is a common property resource. [LeMarquand, 1977]. A clear example of externalities are the waste discharges in an upstream basin country, affecting the water quality in a downstream basin country. In this case, the downstream country has an incentive to cooperate, whereas the upstream country has a disincentive to cooperate. In the same river system the upstream country may have an incentive to cooperate on nautical affairs, for they want the downstream country to guarantee free passage of ships.

A theory providing insight in the need for cooperation on the use of common property resources is the theory of the 'tragedy of the commons'. In the international rivers case, each riparian has an incentive to use the waste assimilative capacity of a water course in order to increase its own benefits. If the costs are not borne by a country in proportion to the use it makes of the resource, the river may be depleted or seriously damaged.

Another economic factor, which can promote cooperation is the existence or potential of *economies of scale*, which means that the net benefits either country can achieve through independent action will be less than through cooperative effort. An example is the joint building of a dam.

ad 2: ***Foreign policy considerations***
[LeMarquand, 1977] discusses five, partly overlapping and interrelated, international relations factors that influence country's willingness to cooperate. A first factor is the image of a country. The desire to be a good neighbour, to be a model of cooperative international behaviour are examples of national attitudes that may positively influence the willingness to cooperate. A second important factor is international law. International accepted principles, such as the territorial sovereignty and the 'polluter pays principle' affect a countries attitude towards cooperation. A third factor Lemarquant mentions is the linkage of a river basin issue with other bilateral issues. A fourth factor influencing cooperation is reciprocity. If there is no reciprocity most countries are not willing to cooperate. There is a general desire for mutual commitment and obligation. Therefore, the reputation of countries/actors as regards their cooperation in the past is an important factor as well. Finally, sovereignty considerations can be relevant. Any agreement to some extent limits a nation's flexibility and, thus, reduces sovereignty.

ad 3: ***Domestic policy-making and consensus formation***
Apart from hydrologic-economic and foreign policy considerations also policy-making within one basin country influences a nation's attitude towards cooperation on international river basins. A distinction can be made between policy stemming from the political level, the national bureaucracy and the regional and local governments. The interest in cooperation can be different for each level. Furthermore, there are diverse interdependencies. The regional and local governments are dependent on the policy stemming from the national bureaucracy and vice versa. The national bureaucracy is dependent on the political leadership and vice versa. Within the national bureaucracy, ministries, such as the ministry of foreign affairs and the ministry dealing with water management, often have different preferences regarding cooperation. Also interest groups can influence a nations policy on cooperation. An analysis of the processes leading to some kind of consensus on a nations's policy towards cooperation on international river basins, gives information on the factors influencing the extent of cooperation.

ad 4: ***Factors facilitating communication between basin countries***
Communication between basin countries is a prerequisite for cooperation to be started. Therefore, conditions influencing the extent of communication are interesting. Favourable conditions that can exist between basin countries are:
- the existence of an extensive network of transnational and transgovernmental contacts between countries.
- the same social-economical and cultural values.
- the same administrative culture.
- the same perceptions of facts.
- the use of a common language.

ad 5: ***Existence of common threats or the occurence of calamities***

The existence of common threats can be an important reason for cooperation to emerge. As an example the development of the Water Boards in the Netherlands aiming at flood control can be mentioned. The Sandoz calamity in the Rhine basin and the recent floods of the north-west European rivers show that calamities often facilitate processes of cooperation to a high degree.

Table 5.3 gives an overview of the factors influencing cooperation and agreement in international river basins. Although this classification of factors is made to explain international cooperation, some of them can be used to explain cooperation in general. Upstream-downstream relationships, externalities and the potential of economies of scale can influence intra-national cooperation on river basins as well. Furthermore, reciprocity is crucial to all cooperation as can be learned from game-theoretical experiments (see section 5.2.1). Finally, the existence of extensive networks and the same perceptions of facts may positively influence intra-national cooperation.

Hydrologic-Economic patterns of incentives and disincentives	**Foreign policy considerations**	**Domestic policy-making and consensus formation**	**Factors facilitating communication between basin countries**	**Existence of common threats or the occurence of calamities**
Hydrologic sequence of basin countries: Upstream-downstream relationships/ Externalities Social-economic demands of basin countries Economies of scale	Image of basin country International law Linkage of issues Reciprocity Sovereignty of basin country	Policy stemming from political level Policy stemming from national bureaucracy Policy stemming from regional and local governments Political demands stemming from interest groups	Existence of extensive network of transnational contacts between countries The same social-economical and cultural values The same administrative culture The same perceptions of facts The use of a common language	Existence of common threats Occurence of calamities

Table 5.3: ***Factors influencing cooperation and agreement in international river basins.*** **Modified after [LeMarquant, 1977]**

All these factors can be useful to explain the development of cooperation. Some of them, such as the existence of networks, can be manipulated. Others, such as the hydrologic sequence of the basin countries, can explain the development of cooperation to a high degree, but cannot be manipulated [Ellemers, 1987]. For prescriptive rather than descriptive research, the factors that can be manipulated are most interesting. In the next section, cooperation in the Scheldt basin will be used as a case study. For this river basin, the types of cooperation and the factors influencing the extent of cooperation are described.

6 Cooperation in the Scheldt basin

6.1 Introduction

Recently, two important treaties for the water management of the river Scheldt were signed.[6] In 1994 a treaty between the Scheldt riparian states concerning the rehabilitation of the river Scheldt was convened, while in 1995 a treaty between Flanders and the Netherlands concerning the deepening of the navigation channel of the Western Scheldt was signed. Both treaties mark the end of long and intensive negotiations between the involved parties.
Therefore, it is a good moment to present a state of the art of the cooperation in the Scheldt basin (6.2). Special attention is paid to cooperation in the basin committees that have developed in the diverse subbasins of the Scheldt basin (6.3). Furthermore, the factors influencing the extent of cooperation in the Scheldt basin are discussed (6.4). The content of this section are mainly based on a series of interviews with civil servants of water agencies in the riperian states of the Scheldt river basin. To respect confidentiality, respondents are not identified. Finally, some preliminary conclusions regarding the cooperation in the Scheldt basin are drawn (6.5).

6.2 International cooperation in the Scheldt basin

In this section the main cooperations in the Scheldt basin will be described, using the classification presented in chapter 5. Based on the treaty on the protection of the Scheldt, which was signed in 1994, an International Scheldt Commission (ISC) will be installed. In the ISC all basin countries will cooperate on the preparation of an Action Programme for the rehabilitation of the river Scheldt, analogous to programmes such as the North sea Action Programme and the Rhine Action Programme.

Bi-lateral negotiations took place between Flanders and the Netherlands on the deepening of the shipping lane of the Western Scheldt, which makes possible for large container ships to reach the harbour of Antwerp. These negotiations resulted in a treaty, which was signed by Flanders and the Netherlands on 17 January 1995. In the Technical Scheldt Commission (TSC) the Flemish and Dutch are cooperating on the *technical infrastructure* for the nautical function of the Scheldt. Cooperation between Flanders and the Netherlands on nautical affairs of the Western Scheldt, such as pilotage and marking, takes place in a commission called "Permanente Commissarissen van Toezicht op de Scheldevaart" (PC).[7]

Exchange of information and coordination of policies and plans regarding the water management of transboundary watercourses takes place in the Belgian-Dutch commission for

[6] Both treaties are signed, but not ratified yet.

[7] The formal basis of this commission can be found in the 1839-treaty dealing with the separation of Belgium from the Netherlands.

the transboundary non-navigable water courses. In the workinggroup groundwater of the Benelux Economic Union (BEU) Belgium, the Netherlands and Luxemburg are coordinating groundwater management. The Belgian-Dutch commission for the transboundary non-navigable water courses and the working group groundwater of the BEU are the formal basis for new regional transboundary basin committees, dealing with the management of surface water, groundwater, water quality and water quantity. Cooperation in basin committees will be the subject of the next section.

All basin countries are participating in the LIFE-projects, a research-project based on the LIFE-regulation of the European Union. This project aims at developing a decision support system for policy on water quality and emissions in the Scheldt basin.

Apart from these formal cooperations, a lot of informal contacts have been established. Prior to the ISC, there were informal contacts between the water agencies of the basin countries in the International Scheldt Group (ISG). The main objective of this group was to exchange data on water quality, emissions and the water policy of the basin countries. The working group ISG-DES (Description of the Ecology of the Scheldt) is carrying out research on the possibilities of a basin-wide bio-monitoring network. Furthermore, there are regularly informal meetings between water agencies of the riparian states. Another type of informal contacts that have been established were two large symposia dealing with the management of the river Scheldt.

At the regional and local administrative levels international cooperation has developed on diverse projects. Most of these projects are set up within the framework of EUREGIONS and are being subsidized by the EU (INTERREG[8]-projects). This type of cooperation mostly refers to research and can be found between France and Belgium as well as between Belgium and the Netherlands. A lot of projects are initiated by the "Euregion Scheldemond", a cooperation between one Dutch and two Flemish Provinces.

Additional cooperation between Flemish and Dutch regional authorities has developed on the further elaboration of the Rhine-Scheldt-Delta (RSD), which is based on a decision made in the Dutch national policy document on physical planning. In this project, the balance between spatial-economic and ecological development of the RSD is searched for.

In the project "Scheldt without frontiers" [Rooy, de, 1993] French, Belgian and Dutch environmental protection groups are cooperating. Their aim is to prevent and reduce the pollution of the river. Table 6.1 gives an overview of transboundary cooperation in the Scheldt basin.

Of course, numerous intra-national cooperations relevant to water resources management have developed. Among those, the cooperation in basin committees seems to be the most promising for realizing an integrated approach to water management problems. Basin committees have developed in all basin countries. Their characteristics will be discussed in the next section.

Bi-lateral cooperation between Flanders and the Netherlands has developed best, whereas basin-wide cooperation is of more recent date, and bi-lateral cooperation between France and Belgium and within Belgium between the regions still has to be developed. A lot

[8]The INTERREG-programm of the European Union subsidizes projects on transboundary cooperation between European regions.

of formalized cooperation exists, such as the cooperation in the ISC, TSC and the PC. A network of informal contacts created by the ISG, ISG-DES, the Scheldt symposia and diverse informal contacts between government agencies has developed as well. Cooperation on user functions such as navigation and the technical infrastructure started many years ago, whereas cooperation on the ecological rehabilitation of the river started recently.

In section 5.4 some success criteria were defined. One may say that the cooperation on nautical affairs within the TSC and the PC is successful, for there is continuity and most of the (formal goals); good infrastructure, radar, marking etc. have been achieved. On the other hand, cooperation on the ecological functions has not been successful so far. The cooperation on the restoration of the Scheldt ecosystem that recently started in the ISC seems to be a positive development.

Name of cooperation	Types of actors cooperating	Form of cooperation	Goal of cooperation	Duration of cooperation	Territorial extent of cooperation	Part of natural system cooperation refers to	Function of natural system cooperation refers to
International Scheldt Commission (ISC)	National governments FR,WA,FL,BR,NE	Formal: based on Scheldt treaty	General (Sustainable development)	Permanent: since 1995	Scheldt basin	Aquatic ecosystem, terrestrial ecosystem	Diverse
Technical Scheldt Commission (TSC)	National governments FL,NE	Formal: based on ministerial agreement	Building of infrastructure + maintenance	Permanent: since 1940	Sea Scheldt, Western Scheldt	Infrastructure, water bed banks	Navigation
Permanente Commissarissen van Toezicht op de Scheldevaart (PC)	National governments FL,NE	Formal: based on treaty 1839	Joint building (marking) and pilotage	Permanent: since 1839	Sea Scheldt, Western Scheldt	Infrastructure (radar, marking)	Navigation
Belgian Dutch Commission for the transboundary non-navigable watercourses (BDC)	National and regional governments WA,FL,NE	Formal: based on ministerial agreement	Exchange of information, coordination	Permanent	Administrative areas: Provinces	Surface water	Diverse
Workinggroup groundwater BEU	National and regional governments WA,FL,NE	Formal: based on dercrees of the BEU	Exchange of information, coordination	Permanent	Administrative areas: BE, NE, Luxemburg	Groundwater	Diverse
Transboundary basin committees	National, regional and local governments FL,NE	Formal: based on the BEU and the BDC	Planning	Permanent: since 1993	Sub-basins	Aquatic ecosystem	Diverse
LIFE-project	National governments, Research institutes FR,WA,FL,BR,NE	Formal: based on research agreement	Research	Temporary: 1993-1995	Scheldt basin	Aquatic ecosystem	Diverse
ISG-DES (Description of the ecology of the Scheldt)	National governments, Research institutes FR,WA,FL,BR,NE	Informal	Research	Temporary: 1994-?	Scheldt basin	Water quality	Nature
EUREGION/ INTERREG-projects	Governments, NGOs, FR,FL,WA,NE	Formal	Research	Temporary	Diverse	Diverse	Diverse
Rhine Scheldt Delta (RSD)	National, regional and local governments, BE,FL,NE	Formal	Planning	Permanent	Administrative areas: Provinces	Terrestrial ecosystem	Diverse
Scheldt without frontiers	Environmental protection groups FR,BE,WA,FL,BR,NE	Formal: based on agreement	Agenda setting, research etc.	Permanent: since 1993	Scheldt basin	Aquatic ecosystem	Diverse

FR=France, BE=Belgium federal, WA=Wallonia, FL=Flanders, BR=Brussels, NE= the Netherlands

Table 6.1: ***Transboundary cooperation in the Scheldt basin***

6.3 Basin Committees

In this section the organization of basin committees in the Scheldt riparian states is shortly described. Apart from the transboundary basin committees discussed in the previous section, many intra-national basin committees have developed in the Scheldt basin. Basin committees can make an important contribution to sustainable development of the Scheldt river-basin. There are three important reasons for this. First, the territorial extent of cooperation in basin committees is hydrologically determined and therefore based on natural rather than administrative boundaries. Secondly, in basin committees cooperation takes place between all national, regional and local governmental actors, having tasks and competencies related to water management. These can be agencies having tasks and competencies in the fields of water management, land-use planning, nature and environmental management etc. In basin committees horizontal coordination (between the policy sectors) and vertical coordination (between the administrative levels) take place simultaneously. Thirdly, in most basin committees also the target groups of water policy, i.e. diverse NGOs are participating. Basin committees have developed in all basin countries.

In the French part of the Scheldt basin there are three types of basin committees. In 1964 six basin agencies were created in France, one of them being the Artois-Picardie water agency, in which the French part of the Scheldt basin falls. The *Comité de bassin* is a de facto "regional water parliament". It consists of representatives of users, associations, local and regional governments and state representatives. It pronounces on the fixing of charges and an investment programme for the building of municipal and industrial waste water treatment plants, and sewerage networks. In the *Loi sur l'Eau* (Water act 1992), an integrated planning system for water management is introduced. According to this law, each of the six *Agences de l'Eau* has to make an SDAGE[9], an integrated water management plan. In the SDAGE of Artois-Picardie [Agence de l'Eau Artois-Picardie, 1994], the area of the basin agency is divided into 14 hydrologically defined unities (subbasins), 4 of them being part of the Scheldt basin. For these sub-basins SAGE[10] plans can be made. The operational SAGE plans are being prepared by the *Comités locales de l'Eau*, consisting of local authorities, user groups, riparian owners and associations, and state representatives. A third type of basin committees in France are the *Comités de rivière*. These committees, in which both government agencies and local interest groups are cooperating, prepare so-called *contrats de rivière*, containing an action programme. In one respect cooperation in de *Comités locales de l'Eau* on the development of SAGE-plans is similar to cooperation in the *Comités de rivière* on *contrats de rivière*. Both types of cooperation are initiated by so-called bottom-up processes and therefore voluntary. However, there are some major differences. First, a *contrats de rivière* is valid during a five-year period, whereas there is no period of validity defined for SAGE plans. Second, the SAGE plans have to be in conformity with the SDAGE and therefore they are, by definition, integrated plans. A *contrat the rivière* might deal with only some aspects of water management, such as the ground water quality. Therefore the

[9]Schéma Directeur de l'Aménagement et de Gestion des Eaux

[10]Schéma de l'Aménagement et de Gestion des Eaux

approach is not by definition an integrated one. Finally, the SAGE-plans are legally-binding. If agencies are not acting in conformity with these plans, one can protest at the administrative tribunal. The *contrats de rivière* are not legally-binding.

In Wallonia there are *comités de rivière* preparing *contrats de rivière* as well. In the Walloon part of the Scheldt basin there are two basin committees. Till 1993, there were no rules on the contents of the contracts and the composition of the basin committees. In 1993 a ministerial decree [Ministry of Wallonia, 1993], containing such rules, was made. The contracts are very comprehensive and address attention to all environmental, water and nature aspects in the sub-basin, for which the contract is made [Tricot, 1994].

In Flanders the idea of basin committees was launched in 1990. Flanders is split up in 10 sub-basins, eight of them being part of the Scheldt basin [Wel, 1994]. Four basin committees have been started now. The other four will be installed in the near future. National, regional and local governments as well as diverse NGOs are represented in the basin committees. Basin committees advise governments on water policy in the basin and produce yearly basin reports. The main aim of the basin committees is to develop integrated water management in Flanders.

In the Dutch part of the basin no real basin committee exist. However, voluntary cooperation has developed between all governmental organizations relevant to an integrated development of the Dutch part of the Scheldt estuary. in 1992 an not legally-binding agreement between all the involved parties was convened. The parties prepared an integrated water policy plan for the Western Scheldt [Core Working Party for the Western Scheldt, 1991], including a concrete plan of action, which is being carried out at present. In 1994 a discussion started whether it would be useful to extend the 'basin committee' with representatives of NGOs.

A problem one faces when determining the success of basin committees, is that most basin committees are quite new. The *Comités locales de l'Eau* in France are being developed now, just like the Bekkencomités in Flanders. Well organized *contrats de rivières* in Wallonia only started in 1993. The Working Party for the Western Scheldt was successful in preparing a policy document and an action programme. It is too early to say whether the basin committees succeed in realizing a more comprehensive approach to water management problems in the subbasins.

In chapter two, a hydrographic classification of the Scheldt river basin was made. Table 6.2 gives for each subbasin the existing or planned basin committees.

Hydrographic basin	Basin committee
Upper Scheldt/ Haut-Escaut	Comité de l'Eau Artois-Picardie (FR) Comité locale de l'Eau pour la Scarpe (FR) Comité de rivière pour la Marque (FR) Comité de rivière pour la Selle (FR) Bekkencomité Bovenschelde (FL)
Leie/Lys	Comité de l'Eau Artois-Picardie (FR) Comité locale de l'Eau pour la Lys (FR) Comité de rivière pour la Lawe (FR) Leiebekkencomité (being founded, FL)
Dender/Dendre	Denderbekkencomité (FL) Comité de rivière pour la Dendre (WA)
Zenne/Senne	Dijlebekkencomité (being founded, FL)
Dijle/Dyle	Dijlebekkencomité (being founded, FL) Comité de rivière pour la Dyle (WA)
Demer	Demerbekkencomité (FL)
Nete	Netebekkencomité (FL)
Upper Sea Scheldt	Bekkencomité Bovenschelde (FL)
Lower Sea Scheldt	Beneden-Scheldebekken (being founded, FL)
Canal Gent-Terneuzen	Bekkencomité Polder- en Gentse Kanaalbekken (being founded, FL)
Western Scheldt	Bestuurlijk Overleg Westerschelde (NE)

FR=France, WA=Wallonia, FL=Flanders, NE=the Netherlands

Table 6.2: ***Basin committees in the Scheldt basin***

6.4 Factors influencing the extent of cooperation in the Scheldt basin

This section gives some empirical evidence for the importance of the factors discussed in section 5.5. Successively the hydrologic-economic patterns of incentives and disincentives, the foreign and domestic policy considerations, the factors influencing communication and the existence of common goals and perceptions are discussed.

Hydrologic-economic patterns of incentives and disincentives
The Scheldt river is a successive river. France is the upstream country, Belgium the midstream and the Netherlands the downstream country. Within the basin however, some tributaries are contiguous rivers and for some tributaries the hydrologic sequence can be different. For some tributaries France is the downstream country, whereas Belgium is the upstream country. The importance of the hydrologic sequence, upstream-downstream relationships or externalities is frequently expressed in interviews with civil servants of water

agencies in the riparian states. The Dutch, being in a downstream position, strongly emphasize the importance of international cooperation. One respondent mentioned that France was very interested in international cooperation on the water quality of the Scheldt for it suffers from pollution stemming from Wallonia.

The socio-economic demands on the river by the basin countries influence their willingness to cooperate. A good example is the importance of the harbour of Antwerp to the Flemish economy. Flanders, having an upstream position is dependent on the Dutch willingness to deepen the Western Scheldt. Therefore, Flanders put a lot of effort in negotiations on the deepening of the Western Scheldt. Another important socio-economic demand on the river is the discharge of domestic and industrial waste water. The downstream countries, suffering from pollution by the upstream riparians feel strong incentives to cooperate.

The importance of financial-economic factors can also be illustrated by the large amount of cooperation that has developed in the EUREGIONS. A respondent involved in many of these projects said that the main reasons for the success of these projects is the large financial support of the EU. If this support will stop, most cooperations will stop as well according to him. Some cooperations fail for reasons of competition. An example is a Euregion project aiming at better cooperation between the harbours in the 'EUREGION Scheldemond'.

Foreign policy considerations

Foreign policy considerations are of great importance as well. Of course, international law is an important factor for cooperation in the Scheldt basin. The ECE river treaty (1992), the North Sea conferences and the generally accepted "polluter pays principle" influenced the negotiations on the water quality for the Scheldt.

Diverse linkages of issues were made during negotiations on the water quality of the Scheldt basin. First, the linkage of the agreement on the water quality of the river Scheldt to the deepening of the Western Scheldt can be mentioned. Furthermore, negotiations on the water quality of the Scheldt and Meuse and the water quantity of the Meuse were linked. Even linkages with transboundary issues outside the field of water management were made, such as the linkage between the deepening of the Western Scheldt and the route for a new high speed train from Flanders into the Netherlands. The importance of reciprocity is more often emphasized in interviews. A French respondent stressed the importance of equal efforts of all basin countries to reduce pollution in the basin.

Domestic policy-making and consensus formation

Domestic policy-making processes influence the international cooperation on the water management of the Scheldt basin. This can be illustrated by the negotiations between Flanders and the Netherlands on the deepening of the Western Scheldt and the negotiations on the water quality in the Scheldt basin. Some Dutch respondents pointed out the lack of freedom Belgian civil servants have to face during the negotiations. Due to the Belgian system, in which each minister does not only have a civil service, but also his own cabinet consisting of politicians, there is a far reaching power of politics. If there is no agreement at the political level, it is hardly possible to cooperate at the administrative level. A second example are the interdependencies between Dutch ministries and Dutch local communities.

The Dutch Ministry of Transport, Public Works and water Management decides on the dredging works in the Western Scheldt, but needs permits of the municipalities, based on the local land-use plans.

Factors influencing communication

In the Scheldt river basin, the social-economic and cultural differences between the riparian states are relatively small compared to for example transboundary rivers between the United States and Mexico. Nevertheless, some respondents pointed out differences in environmental awareness. A Flemish researcher said that especially in Flemish municipalities environmental awareness is poorly developed. However, there is no evidence that it is worse than in the other basin countries. Sometimes, a common culture can explain the development of cooperation. The Dutch part of the Scheldt basin, south of the Western Scheldt is bordering on Flanders. People living in this area traditionally looked to Flanders rather than to the Netherlands. In this area numerous transboundary projects have developed. On the other hand, differences between cultures can explain less successful cooperation. One environmentalist said that cooperation between Dutch and French environmental groups is difficult, for the cultures are different. Because of the bad economic situation, the French environmentalists have an eye for the problems industry faces in the northern part of France. Dutch environmental protection groups do not show that much understanding for polluters.

A Dutch respondent thought that a lack of knowledge on the developments in integrated water management frustrates transboundary cooperation. Especially for the French and Dutch, unfamiliarity with the administrative structures in Belgium after the latest state reforms was a complicating factor in international relations. According to some respondents, the long history of conflicts between Flanders and the Netherlands, causing mutual distrust influences the willingness to cooperate.

Most respondents affirmed the importance of informal contacts between scientists and civil servants in the basin countries. A lot of these contacts have been established during informal meetings between water agencies, symposia, informal working groups and so on. Although many people think these contacts are useful to exchange information and enhance mutual understanding, the importance of these informal contacts can hardly be assessed.

Existence of common goals and perceptions

Common goals and perceptions can be important incentives to cooperate. As an example the cooperation between environmental protection groups in the project "Scheldt without frontiers" can be mentioned. All these groups aim at an ecological rehabilitation of the Scheldt basin, and are coordinating their actions now. On the other hand, the absence of common goals can hinder cooperation, as could be seen in the EUREGION-project, where competing harbours tried to cooperate.

7. Concluding remarks

The conclusions that are drawn in this chapter are based on research on cooperation in the Scheldt basin. Some of them apply to cooperation in other river basins as well. The high population density and huge industrial complexes in the Scheldt basin have led up to a heavily polluted river system. Rehabilitation and a more sustainable development of this system asks for a comprehensive approach to this problem, which can only be realized by extensive cooperation between all relevant actors.

A lot of positive developments can be identified. In all riparian states basin committees aiming at an integrated water management for a hydrologically defined area, have been founded. Recently, the climate for international cooperation has improved. A treaty on the restoration of the Scheldt river has been signed by all riparian states, and Flanders and the Netherlands came to an agreement on the deepening of the Western Scheldt. Furthermore, a large network of contacts between water agencies and research institutes has developed.

Cooperation on water management issues between Flanders and the Netherlands has developed best, whereas cooperation between France and Belgium and within Belgium between Wallonia and Flanders is poorly developed. Regarding user functions, such as the nautical function, cooperation started early and is well organized. Regarding the nature function cooperation is starting now.

Five interrelated and partly overlapping groups of factors influencing cooperation and agreement in international river basins have been distinguished: hydrologic-economic patterns of incentives and disincentives, foreign policy considerations, domestic policy-making, factors facilitating communication and the existence of common goals and perceptions. An additional distinction can be made between factors that indeed can explain cooperation to a high degree but can hardly be manipulated, such as international law and the hydrologic sequence of basin countries, and factors that can be manipulated, such as the existence of extensive international networks. Civil servants of water agencies affirmed that the hydrologic sequence of the basin countries and their social-economic demands are factors that can explain the willingness to cooperate on water management issues to a high degree. The linkage of issues regarding water management and other policy sectors, both inside and outside the Scheldt basin, characterized cooperation for decades. The existence of a common culture and common goals and perceptions appeared to be relevant factors as well.

Because the interests, perceptions and goals of cooperating actors are often diverging, the success of cooperation depends highly on the perspective one chooses. It would be useful to assess the success of cooperation using different perspectives. By comparing cases of successful and less successful cooperation more knowledge factors promoting successful cooperation can be gathered. For prescriptive rather than descriptive research, the factors that can be manipulated are most interesting.

References

A. Literature

Agence de l'Eau Artois-Picardie (1990); *Livre Blanc* (in French).

Agence de l'Eau Artois-Picardie (1991): *Le VIème Programme d'Interventions de l'Agence de l'Eau Artois-Picardie 1992-1996* (in French).

Agence de l'Eau Artois-Picardie (1994); *SDAGE, Schéma Directeur d'Aménagement et de Gestion des Eaux du bassin Artois-Picardie* (in French).

Argyle, M. (1991); *Cooperation, The basis of sociability.* London/ New York.

Axelrod, R. (1990); *The evolution of Co-operation.* 2 nd impression (first impression 1984), London.

Bruijn, J.A. de, W.J.M. Kickert, J.F.M. Koppenjan (1993); *Inleiding: beleidsnetwerken en overheidssturing,* In: Bruijn, J.A. de, W.J.M. Kickert, J.F.M. Koppenjan (red.), *Netwerkmanagement in het openbaar bestuur, over de mogelijkheden van overheidssturing in beleidsnetwerken* (in Dutch), Rotterdam/Delft, 1993.

Bruijn, J.A. de, A.B. Ringeling (1993); *Normatieve kanttekeningen bij het denken over netwerken.* In: Bruijn, J.A. de, W.J.M. Kickert, J.F.M. Koppenjan (red.) (1993); *Netwerkmanagement in het openbaar bestuur, over de mogelijkheden van overheidssturing in beleidsnetwerken* (in Dutch). Rotterdam/Delft, 1993.

Claessens, J. (1993); *Beneden Zeeschelde Slibbalans 1992,* nr. AZ/93.3 (in Dutch), Ministerie van de Vlaamse Gemeenschap, Departement Leefmilieu en Infrastructuur, Administratie Waterinfrastructuur en Zeewezen, Antwerpse Zeehavendienst.

Claessens, J. (1994); *Beneden Zeeschelde Slibbalans 1993,* nr. AZ/94.2 (in Dutch), Ministerie van de Vlaamse Gemeenschap, Departement Leefmilieu en Infrastructuur, Administratie Waterinfrastructuur en Zeewezen, Antwerpse Zeehavendienst.

Commission of the European Communities (1992); *Towards Sustainability; a European Community programme of policy and action in relation to the environment and sustainable development* ('Fifth Action programme').

Core Working Party for the Western Scheldt (1991); *Policy Plan for the Western Scheldt* (in Dutch). Rijkswaterstaat, Middelburg.

Economic Commission for Europe (ECE) (1992); *ECE River Treaty,* Helsinki

Ellemers, J.E. (1987); *Veel kunnen verklaren of iets kunnen veranderen: krachtige versus manipuleerbare variabelen.* In: Lehning, P.B., J.B.D. Simonis (red.) (1987); *Handboek beleidswetenschap* (in Dutch). Boom, Meppel.

Frey, F.W. (1993); The Political Context of Conflict and Cooperation Over International River Basins. *Water international,* Vol. 18 (1993) 54-68, IWRA.

Grijns, L.C., J. Wisserhof (1992); *Developments in Integrated Water Management: A survey of Policy, Management, and Research* (in Dutch, summary in English), Delft Studies in Integrated Water Management 1. Delft University Press, 1992.

Helsinki Rules, approved by the 52nd Conference of the International Law Association, Helsinki, 1966.

D'Hondt, P., T.G. Jacques (1982); Gesuspendeerde materie in de Schelde (in Dutch). *Water* 4, pp 133-135.

Hoogweg, P.H.A., F. Colijn (1992); Management of Dutch estuaries. The Ems-Dollard and the Western Scheldt. *Water Science and Technology*, Vol. 26, No. 7-8, 1992, IAWPRC.

IMDC (1993); *Gedrag van paticulair materiaal in het Schelde estuarium* (in Dutch) Eindrapport in opdracht van de BMM (Ministerie van Volksgezondheid en Leefmilieu). International Marine & Dredging Consultants

Internationale Scheldewerkgroep (1988); *Actieplan voor verbetering van de waterkwaliteit van de Schelde* (in Dutch).

International Scheldt Group (ISG) (1994); *Water quality management in the Scheldt basin (interim progress report 1993)*. Report AX/94/013.

International Scheldt Group (ISG) (1994); *Water quality management in the Scheldt basin (appendices 1993)*. Report AX/94/014.

Jong, J. de, P.T.J.C. van Rooy, S.H. Hosper (1994); Living with water: at the cross-roads of change. *Living with water, International Conference on Integrated Water Resources Management*, Amsterdam, the Netherlands, 26-29 September 1994. IAWQ, EWPCA,NVA.

Klap, V., Heip, C. (1991): *De Schelde. Een evaluatie van het beleid, de functies en de waterkwaliteit*, Verslag in opdracht van de commissie Havenvraagstukken van de Raadgevende Interparlementaire Beneluxraad (In Dutch/French).

LeMarquant, D.G. (1977); *International rivers, the politics of cooperation*. Westwater Research Centre, University of British Columbia.

Loi sur l'Eau (water act) 1992.

Ludikhuize, D. (1989); *Scheldt river basin study*, International centre of water studies, ICWS-report 89.09.

Maartense, V.J., S.V. Meijerink, P.A.J. Verlaan (1994); *Voorstel casus: De slibproblematiek in de Beneden-Zeeschelde en de haven van Antwerpen* (in Dutch), december 1994.

Maldegem, D.C. van, H.J.P. Mulder and A.Langerak (1993); A cohesive sediment balance for the Scheldt estuary. *Netherlands Journal of Aquatic Ecology*, 27 (2-4), pp 247-256.

Maldegem, D.C. van (1991); *De slibbalans van het Schelde estuarium*, RWS/DGW Nota GWAO-91.081.

Mariotti, A., C. Lancelot and G Billen (1984); Natural isotopic composition of nitrogen as a tracer of origin for suspended organic matter in the Scheldt estuary. *Geochim. Cosmochim.* Acta 48, pp 549-555.

Meire, P., E. Kuijken (1988); Saeftinge, mud flats and salt marches: the ecological importance of tidal areas along the river Scheldt (in Dutch, summary in English). *Water*, Nr. 43, nov/dec 1988 214-222.

Ministère de l'Environnement (1990); *Plan national pour l'Environnement/plan vert* (in French).

Ministère de la Région wallone (1985); *Décret du 07.10.1985 sur la protection des eaux de surface contre la pollution* (in French).

Ministerie van de Vlaamse Gemeenschap (1989); *Milieu Natuurlijk!, MINA-plan 2000, Analyse en voorstellen voor een vernieuwd Vlaams Milieu en Natuurbeleid* (in Dutch), Brussel, 1989.

Ministerie van Openbare Werken (1977); *Sigmaplan voor de beveiliging van het Scheldebekken tegen stormvloeden op de Noordzee* (in Dutch). Ministerie van Openbare Werken, Bestuur der Waterwegen.

Ministerie van Verkeer en Waterstaat (1985); *Omgaan met Water* (in Dutch).

Ministerie van Verkeer en Waterstaat (1989); *Derde Nota Waterhuishouding* (in Dutch), Tweede kamer, 1988-1989, 21 250, nrs. 1-23.

Ministerie van Verkeer en Waterstaat, Rijkswaterstaat (1993); *Beheersplan voor de Rijkswateren 1992-1996* (in Dutch).

Ministerie van verkeer en Waterstaat, Rijkswaterstaat, Directie Zeeland (1993); *Regionota Zeeuwse Rijkswateren 1993-1996* (in Dutch).

Ministerie van verkeer en Waterstaat (1994); *Structuurschema Oppervlaktedelfstoffen, Deel 1- Ontwerp planologische kernbeslissing* (in Dutch).

Ministerie van Verkeer en Waterstaat (1994b); *Beheer en onderzoek van Rijkswaterstaat in de Westerschelde, Aanbevelingen van een riviewteam en conclusies van Rijkswaterstaat* (in Dutch), Nota AX 94.016. Rijkswaterstaat, Directie Zeeland.

Ministry of Transport, Public Works and Water Management (1989): *Third National Policy Document on Water Management, Water in the Netherlands: a time for action*, summary of the national policy document on water management.

Ministry of Wallonia (1993); *Ministeriële omzendbrief betreffende de toelaatbaarheidsvoorwaarden en de uitwerkingsmodaliteiten van de riviercontracten in het Waalse Gewest*, Belgisch Staatsblad, 26.05.1993.

Mitchell, Bruce (1990); *Integrated water management*. In: Mitchell, Bruce et al. (1990); *Integrated water management*. Belhaven Press, London, New York.

Onderzoekers Rijn-Schelde Delta (1994); *Rijn-Schelde Delta, een ruimtelijk economische verkenning* (in Dutch), Samenwerkingsverband "Onderzoekers Rijn-Schelde Delta", O-RSD.

Ovaa, B.P.S.A. (1991); *Schelde stroomgebied. Naar een samenhangend beheer van het riviersysteem van de Schelde in het perspectief van duurzame ontwikkeling*, deel I: tekst, (in Dutch, summary in French), Wageningen.

Ovaa, B.P.S.A. (1991); *Schelde stroomgebied. Naar een samenhangend beheer van het riviersysteem van de Schelde in het perspectief van duurzame ontwikkeling*, deel II: bijlagen (in Dutch), Wageningen.

Peerbolte, E.B. (1993); *Sea-level Rise and Safety, A consideration of safety impacts in low-lying coastal areas with particular reference to the Netherlands*. Delft Hydraulics, Marknesse, the Netherlands.

Pieters, T., Storm, C., Walhout, T., Ysebaert, T. (1991): *Het Schelde-Estuarium, Méér dan een vaarweg*, (in Dutch) Nota GWWS-91.081, Ministerie van Verkeer en Waterstaat, Directoraat-Generaal Rijkswaterstaat.

Postma, H. (1980); *Sediment transport and sedimentation*. In: E. Olaussen and I. Cato. Chemistry and biogeochemistry of estuaries, Wiley, pp 153-186.

Ravensbergen, G.J., Scheele, R.J. (1990); *De visserij op de Westerschelde, serie Westerschelde studies, studierapport 7,* R.U. Utrecht. Cited in: Klap, V., Heip, C. (1991): *De Schelde. Een evaluatie van het beleid, de functies en de waterkwaliteit,* Verslag in opdracht van de commissie Havenvraagstukken van de Raadgevende Interparlementaire Beneluxraad (In Dutch/French).

Rijn Schelde Delta (1989); *Rijn Schelde Delta, economisch kerngebied in Noord-West Europa.* (in Dutch) Een onderzoek in opdracht van de Voorzitters van de Kamers van Koophandel en Fabrieken voor Rotterdam en de Beneden-Maas, Zuid-Holland-Zuid, Westelijk Noord-Brabant, Midden- en Noord-Zeeland en Zeeuws-Vlaanderen.

Rooy, M.L. de (1993); *De Schelde, ecologie, watervervuiling en waterkwaliteitsbeleid in het Scheldestroomgebied, Grenzelose Schelde/ Escaut sans Frontières* (in Dutch). Stichting Reinwater.

Salomons, W. and W.D. Eysink (1981); Pathways of mud and particulate trace metals form rivers to the southern North Sea. In : *Holocene Marine Sedimentation in the North Sea Basin,* Editors : S.D. Nio, R.T.D. Schuttenhelm and T.C.E. van Weering, pp 429-450.

Stuurgroep Scheldeproject (1994); *Onderzoek Aansluitings- en integratiemogelijkheden in integraal waterbeheer (case-studie Schelde). Verslag van de openingsbijeenkomst op 21 maart 1994* (in Dutch). Ministerie van Verkeer en Waterstaat, RIKZ/AB-94.142x.

Termeer, C.J.A.M. (1993); *Een methode voor het managen van veranderingsprocessen in netwerken,* In: Bruijn, J.A. de, W.J.M. Kickert, J.F.M. Koppenjan (red.), *Netwerkmanagement in het openbaar bestuur, over de mogelijkheden van overheidssturing in beleidsnetwerken* (in Dutch). Rotterdam/Delft, 1993.

Treaty on the deepening of the Western Scheldt (1995).

Treaty on the Protection of the Scheldt (1995).

Tricot, B. (1994); *Les contrats de rivière en Région Wallone: un instrument de concertation avec la population* (in French), Ministère de la Région Wallone.

Vereeke, S. (1994); *Geactualiseerde slibbalans van het Schelde estuarium.* RWS/Directie Zeeland.

Wartel, S., E.Keppens, P.Nielsen, F. Dehairs, P. van den Winkel & L. Cornand (1993); *Bepaling van de verhouding marien en fluviatiel slib in de beneden Zeeschelde* (in Dutch). Ministerie van de Vlaamse Gemeenschap, Departement Leefmilieu en Infrastructuur, Administratie Waterinfrastructuur en Zeewezen, Antwerpse Zeehavendienst.

Wel. H. de (1994); *Organisatie van de rivierbekkenwerking in Vlaanderen* (in Dutch), AMINAL Bestuur Algemeen Milieubeleid (in Dutch).

Wessel, J. (1991); The feasibility of a river basin management approach to the sustainable development of water courses. In: *Proceedings of the International symposium on "Impact of Watercourse Improvements: Assessment, Methodology, Management Assistance".* Wépion, Belgium, 10-12 September 1991.

Wessel, J. (1992); Institutional and Administrative Aspects of International River Basins. In: *Proceedings of the Lustrum Symposium on Transboundary river basin management and sustainable development, Volume 1.* Delft University of Technology, Delft, the Netherlands, 18-22 May 1992. UNESCO, Paris, 1993.

Wisserhof, J. (1994); *Matching research and policy in integrated water management.* Thesis Delft University of Technology, Delft Studies in Integrated Water Management 4. Delft University Press, 1994, the Netherlands.

Wollast, R. and J.J Peters (1978); Biochemical properties of an estuarine system : the river Scheldt. *Biochemistry of estuarine sediments*; pp 279-293. Proc. UNESCO/SCOR, Editor: E.Goldberg, Melreux, 1976.

Wollast, R. and A. Marijns (1981); *Evaluation des contributions des differentes sources de matiere en suspension a l'envasement de l'Escaut* (in French). Rapport Final au Ministere de la Sante Publique : 152 pp.

World Commission on Environment and Development, WCED (1987), *Our common future (Brundtland-report)*.

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