Chapter V

Inventory of Water-Pollutions

by

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Introduction

C.I.P.S. Inventory Group

The general inventory of the pollutions of water and sediments of the coastal area of the sea and waterways in Belgium started two years ago. The activity of the two institutions (I.H.E. and I.R.C.) entrusted with this task is carried out in the frame of the conventions established between the Ministry of Scientific politics, and the Ministry of Public Health and Environment (M22) on the one hand, and the Ministry of Agriculture (M15) on the other hand. These works are noted in the National R-D Programme on the pollution of waters organised by the C.I.P.S. : the general coordination is assumed by Professor Nihoul.

Programmes

a) Optional Subjects

First, the results have to be put in correlation with those obtained by the teams, entrusted with the elaboration of the Mathematical Model of the Sea.

Afterwards, the inventory must take into consideration the whole of the surface waters in Belgium. In this respect, the inventory has been conceived independently of the existing data, those data being generally incomplete. The samplings are made on significant locations after an identical analytical scheme on the physical, chemical, bacteriological and hydrobiological points of view. The sampling net is gradually completed together with the progress of the work.

Finally, the global studies by regions or by sector activity are carried out on the basis of the results of the inventory and other data.

b) Proceedings

The proceedings are function of the available means. The number of inventoriated locations is especially limited as the determination of about 50 parameters is bound to each of them; some of those parameters asking for very delicate analysis. Perfection of the methods and presentation of the results must equally be assumed.

About 12 locations situated along the Belgian coast and at about a few hundred meters in the sea are inventoriated several times a year. The same thing is done for coastal wastes to this area, that is : 11 channels and some sewers.

About one hundred locations of the drainage basin of the Scheldt, Meuse and Yser have been sampled twice. They are distributed in a geographical point of view and according to the sector activities : big industries, bio-industries, agriculture. Use of water is also taken into consideration if it has to be used as drinking water.

Presentation of the results

a) In general

All the results are noted on record-cards so that the data specific to the sampling of one inventoriated location are easy to find again. One double of the record-cards is left at the documentation center of the C.I.P.S. This center and the Institutions collaborating to the inventory are able to supply a copy of each card to the persons concerned.

Half-yearly and annual activity reports are established. The first synthesis report was presented at the end of 1972 during "Days of the Sea" and during the "Days of the Sambre".

b) Synthesis report of 1973

The following synthesis report refers to the state of the inventory at the end of 1973; the results obtained in 1973 are put together with those of 1972. Nevertheless, the conclusions only are printed if no new determinations have been done in 1973, and the reader is sent back to the synthesis report of 1972 for detailed results.

The presentation of the results has been altered : for each of the chapters (I, Sea and II, Rivers) gathered this time in one volume, the I.H.E. results are assembled on one side (part A — water) and the I.R.C. ones on the other side (part B — sediments).

A short and global synthesis is shown as a conclusion hereafter.

c) Study of the drainage basin of the Yser

It has been foreseen that the results should be gathered and coordinated for a well defined sectorial activity or hydrographical drainage basin. A regional study on the drainage basin of the Yser is being published.

Different reasons justify the choice of this region for carrying out a first comprehensive study :

- the case of the Yser is relatively simple. It concerns a farming area of middle importance with cattle breedings but with little industrial activities;
- the drainage basin is not much extended;
- many analytical results were known before the inventory.

PARTICIPATIONS

Institute for Hygiene and Epidemiology (study of the water)
Have participed to the study under the direction of Mr. J. Bouquiaux and Mr. De Brabander :
- physical chemistry and nutrients : Mr. J. Van Dijck and Mr. H. Vandeputte
- special determinations : Miss Ch. Boelen and Mr. E. De Wulf
- heavy metals : Mr. R. De Boeck and Mrs. J. Verhoeven
- toxicology, hydrobiology : Mrs. C. Van der Wielen, Mr. G. Vanhooren
Under the direction of Mrs. S. De Maeyer and Mr. J. Barbette

- bacteriology : Mr. J.P. Dauby and Mr. M. Duboquet
Under the direction of Mr. L. Gordts
- pesticides : Mr. A. Vandezande

Institute for Chemical Researches (study of the sediments)
Have participed to the study under the direction of Mr. P. Herman
and of Mr. R. Vanderstappen
- physic and chemistry : Mrs. K. Meeus-Verdinne and Messrs. P. Haniset, G. Istas
- spectrochemistry : Mr. J. Cornil, Mr. G. Ledent, Mr. R. Vanderzeyp
and of Mr. G. Neirinckx
- hydrocarbons : Mr. P. Heimes, Mr. H. Stuelens
and of Mr. Th. Jacobs
- physical chemistry : Mr. R. Van Cauter.

Mr. M. Bultinck, manager Engineer (T.M.Z.A.K.) has been kind enough to assume the sampling of the Blankenberge sewers. The sampling of the sea has been carried out thanks to the collaboration of Mr. Van Cauwenberghe (manager Hydrographical service of the belgian coast). We thank them deeply.

Redaction of the present report :
- waters : Miss Ch. Boelen, Mr. J. Barbette and Mr. G. Vanhooren
- sediments : Mrs. K. Meeus-Verdinne.

RECORD CARDS

List of the numbers of cards for each watercourse - C1 to C305 (beginning of the inventory - end 1973)

Berwinne	C158	Mer	C11 to 22, 28 to 39, 54 to 65, 119 to 130, 169 to 180, 208 to 211
Bocq	C91	Marche-en-Famenne (ruisseau de -)	C303 to 305
Brugge-Zeebrugge kanaal	C81,221	Meuse	A to H, C8 to 10, 84 to 109, 153 to 159, 212 to 224, 260, 261, 289, 290
Dender	C43	Molignée	C89
Dijle	C270 to 288	Noortdevaart	C78, 218
Egouts de Blankenberge	C66 to 72, 110 to 116, 200 to 207, 262 to 268	Oostende-Brugge kanaal	C79, 219
Egouts de Nieuwpoort	C40	Ourthe	C106, 107, 167, 168, 232
Espierres	C51, 233, 234	Plassendaalkanaal	C73, 213
Grote Gete	C23 to 27	Port de Nieuwpoort	C76, 216
Hand samenvaart	C150	Port d'Oostende	C77, 217
Haringebeek	C143	Rebais	C132
Heidebeek	C139, 140	Rulles	C254 to 256
Hoëgne	C164, 229	Rupel	C45
Hoyoux	C101	Sambre	C94
Ieperlee	C147	Samson	C96
Julienne	C157	Schelde	C41 to 53, 291 to 302
Laclaireau	C257		
Leie	C47		
Lesse	C86		
Lovaart	C146		
Membrette	C137		
Mehaigne	C99, 235 to 240		

Schipdonkkanaal	C82, 222	Veurnekanaal	C75, 215
Semois	C1 to 7, 131 to 138	Vierre	C5
		Vresse (ruisseau de -)	C135
Spuikom de Blankenberge	C117, 118, 269	Yser	C74, 141 to 152, 181 to 199, 214, 241 to 253
Ton	C258, 259		
Vaart de Blankenberge	C80, 220		
Vesdre	C105, 160 to 166, 225 to 231	Zelzatekanaal	C83, 223

1.- Sea results

1.1.- Waters (I.H.E.)

The coastal zone has been inventoriated from the point of view "emission of the pollutants to the sea" as well as "pollution of the sea itself".

Where emissions are concerned, our analysis refers to samples taken in different coastal fairways as well as in the Blankenberge sewers. The fairways (11 samples) have been inventoriated in 1972 and 1973. The results of the chemical analysis agree remarkably; the bacteriological ones vary a little more from one year to another. Nevertheless, the chemical, bacteriological and hydrobiological analysis have given the same picture of these fairways, that is, a high grade of pollution at Oostende in front of the station, in the Noortedevaart channel, the Blankenberge channel and the Schipdonk channel; a situation of a scarcely less pollution in the Oostende-Brugge channel and a middle pollution level in the Zelzate channel and the three Nieuwpoort channels : Yser, Veurne and Plassendael channels.

Our analysis of the sewers are divided into four sampling campaigns which took place during 1972 and 1973; twice in winter, in February and twice in summer, in July. As could be expected for sewage water, the level of organic and faecal pollution is very high. A slight increase of pollution during the summer can be detected, but, the sewer flow being twice as high during this period, the situation is clearly less favorable where emission to the sea is concerned.

We have arranged five sampling campaigns of seawater samples situated 200 m in front of the line of low tide all along the coast.

Table 5.1

WATERS

Sewers of Blankenberge

		Winter						Summer					
		1972			1973			1972			1973		
		Min	Max	$\bar{X}$	Min	Max	$\bar{X}$	Min	Max	$\bar{X}$	Min	Max	$\bar{X}$
BOD	mg/ℓ	125	250	199	28	49	37	250	500	426	47.5	412	252
COD	mg/ℓ	140	296	230	310	473	368	500	896	758	444	940	548
MS	mg/ℓ	-	-	-	110	190	153	180	300	256	20	430	187
N_{tot}	mg/ℓ	43.1	54.6	50.2	14.2	14.6	14.5	80	112	103	14.8	17.6	17.1
N_{amm}	mg/ℓ	27.7	38.6	32.4	14.2	14.6	14.5	51	85	73	14.8	17.6	17.1
NO_2^-	mg/ℓ	-	-	-	-	-	-	-	-	-	0	0	0
NO_3^-	mg/ℓ	4.7	10.4	7.4	0	0	0	0	24	7.3	0.02	0.13	0.07
PO_4^{---}	mg/ℓ	3.55	4.2	3.8	12.7	15.3	14.1	61.8	117.4	91.8	17.2	17.5	17.4
F^-	mg/ℓ	0.31	0.61	0.41	0.55	0.66	0.59	0.48	0.75	0.53	0.39	0.84	0.55
Cl^-	mg/ℓ	1760	2160	2020	2500	3100		1060	1270	1110	1030	1210	1092
SO_4^{--}	mg/ℓ	326	396	372	302	458	410	205	298	232	195	323	272
Dét.	mg/ℓ	11.2	28.7	18.6	32.5	55	46.7	33	68	50	7.4	20.0	13.1
EH	mV	+ 24	+ 194	+ 90	- 36	+ 74	+ 12	- 56	- 20	- 38	- 111	- 61	- 89
Ag	ppb	-	-	-	-	-	-	< 5	< 5	< 5	< 0.8	12.5	< 4.5
Cd	ppb	-	-	-	< 2	< 2	< 2	< 10	< 10	< 10	< 1	1.4	< 1
Co	ppb	< 5	< 5	< 5	< 10	< 10	< 10	< 5	< 5	< 5	< 2	< 2	< 2
Cr	ppb	< 5	< 5	< 5	18	105	80	< 5	< 5	< 5	< 4	< 4	< 4
Cu	ppb	8	22	17	21	35	26	26	36	30	2	17	7.1
Fe	ppb	135	190	146	28	196	109	210	380	290	680	1210	927
Hg	ppb	0.59	7.8	1.87	0.15	0.29		0.23	13.5	2.58	-	-	-
Mn	ppb	102	155	129	< 10	443	132	30	92	61	80	100	85
Ni	ppb	< 5	< 5	< 5	4.1	7.5	5.7	16	32	22	< 2	< 2	< 2
Pb	ppb	13	20	17	43	163	105	58	100	80	9.3	14	11.5
Zn	ppb	-	-	-	38	1925	472	48	80	73	111	195	146
Output	m^3/h	116.5	133.3	121.7	126.4	149.5	135.2	196.2	211.5	202.3	181.5	226.3	211.4

Table 5.2

WATERS

Sea

		Number	Min	Max	$\bar{X}$
O_2	%	52	57.5	95.8	76.9
BOD	mg/ℓ	60	0.9	8.7	3.3
COD	mg/ℓ	60	1.6	9.5	4.7
MS	mg/ℓ	60	75	980	40.6
N_{tot}	mg/ℓ	60	0	4.15	1.65
NO_2^-	mg/ℓ	56	0	0.096	0.036
NO_3^-	mg/ℓ	56	0	11.9	3.59
PO_4^{---}	mg/ℓ	58	0	5.1	0.383
F^-	mg/ℓ	60	1.2	5.0	2.28
Cd	ppb	24	1	6	3.2
Co	ppb	60	inferior to the detection limit		
Cr	ppb	60	inferior to the detection limit		
Cu	ppb	59	4	32	14
Fe	ppb	60	8.5	360	149.7
Hg	ppb	46	0.03	0.76	0.16
Mn	ppb	60	5	270	73
Ni	ppb	60	inferior to the detection limit		
Pb	ppb	59	5	58	19
Zn	ppb	56	5	88	36

The twelve sampling stations are disposed from Oostduinkerke to Knokke. The pollution level doesn't change much from one month to another.

The last series of analysis have been set up for TOC determination. The results of the latter confirm our previous belief; that is : the pollution level is higher North-East from Oostende than on the South-West coast and shows a slight increase from Heist onward.

Table 5.3

WATERS

The fairways and the channels

	O_2 %	COD mg/ℓ	BOD mg/ℓ	MS mg/ℓ	N_{tot} mg/ℓ	N_{amm} mg/ℓ	NO_2^- mg/ℓ	NO_3^- mg/ℓ	PO_4^{---} mg/ℓ	F^- mg/ℓ	Cl^- mg/ℓ	SO_4^{--} mg/ℓ
Plassendael	97	86	7.8	40	1.0	0	+	4.7	0.4	1.12	3800	554
	107	35	6.9	40	2.62	0	32.1	0.32	0.56		9800	260
Yser	46.7	59	5.2	35	6.4	2.4	+	3.6	1.1	0.47	152	158
	98.3	39	12.5	80	6.4	1.56	192	1.47	0.47		784	250
Veurne	77.8	86	5.5	40	0.83	0	+	1.94	0.95	1.11	4300	636
	167	86	12.6	110	3.62	0	2.8	0.48	0.19		3680	581
Nieuwpoort-Haven	63.4	129	1.8	220	1.4	0	+	0	0.25	1.33	16500	1902
	94	490	4.0	150	2.76	0.6	1.22	0.19	0.59		15600	972
Oostende	25.9	122	6.8	130	10.8	6.5	0	0	6.25	1.17	9800	1210
	60	796	10.5	380	12.2	3.4	0.05	5.41	10.56		13200	795
Noortede vaart	75.9	141	15.2	85	5.9	2.0	+	0	7.50	1.47	9600	408
	68.3	169	12.3	40	9.04	3.29	0.5	5.12	11.80		5300	758
Brugge kanaal	5.0	67	7.6	30	12.4	8.7	0	0	8.50	0.76	700	196
	14.1	63	0.3	130	12.1	8.1	2.35	8.96	15.84		1520	324
Blankenberge vaart	54.6	133	10	80	4.5	1.0	+	0	4.20	1.66	5550	718
	113.1	204	21.4	200	9.3	3.01	1.43	0.45	6.56		5700	744
Zeebrugge kanaal	138.2	204	7.6	180	1.5	0.0	+	0	0.40	2.50	14300	1846
	75.8	611	8.7	250	4.4	1.63	5.41	0.80	0.61		14800	981
Schipdonk	11.7	67	6	35	14.2	9.7	0	1.8	8.50	0.78	216	146
	60	86	9.7	40	10.7	5.6	0.10	1.18	5.76		800	214
Zelzate	101.2	141	16.2	45	8.2	4.6	+	0	7.00	1.37	4300	472
	66.6	584	10.3	340	11.06	7.5	1.33	0.42	1.41		11900	974

These conclusions can be drawn from all our chemical and bacteriological results.

As a conclusion, it can be said that many discharge outlets with a high level in pollutants can be found on the Belgian coast, the action of those pollutants on the pollution state of the coastal waters, being clearly marked.

Table 5.3

(continuation)

WATERS

The fairways and the channels

	Det. mg/ℓ	CN^- mg/ℓ	Ø OH* mg/ℓ	Ag ppb	Cd ppb	Co ppb	Cr ppb	Cu ppb	Fe ppb	Hg ppb	Mn ppb	Pb ppb	Zn ppb
Plassendael	0	0	0	-	-	< 5	< 5	9	69	0.5	40	10	50
	0	0	0.02	< 5	< 1	< 5	< 5	10	25	0.13	80	9	22
Yser	0	0	0	-	-	< 5	< 5	< 5	76	0.2	158	< 5	44
	8	0	0	< 5	< 1	< 5	< 5	8	37	0.3	245	6	21
Veurne	0	0	0	-	-	< 5	< 5	< 5	30	0.65	62	7	41
	2.2	0	0	< 5	< 1	< 5	< 5	8	45	0.15	200	9	23
Nieuwpoort-Haven	0	0	0	-	-	< 5	< 5	6	200	0.45	59	10	44
	0	0	0	< 5	< 1	< 5	< 5	10	46	0.05	95	9	29
Oostende	0	0	0.01	-	-	< 5	< 5	7	193	0.1	135	8	46
	0.9	0	0	< 5	< 1	< 5	< 5	115	37	0.05	125	11	32
Noortede vaart	0	0	0	-	-	< 5	< 6	< 5	55	0.15	145	7	35
	0	0	0	< 5	< 1	< 5	< 5	21	22	< 0.05	155	15	24
Brugge kanaal	0	0	0.095	-	-	< 5	< 5	< 5	160	0.05	206	12	39
	0	0	0	< 5	< 1	< 5	< 5	41	50	< 0.05	280	15	34
Blankenberge vaart	0	0	0	-	-	< 5	< 5	7	69	0.3	118	8	40
	0.5	0	0	< 5	< 1	< 5	< 5	11	25	< 0.05	190	9	32
Zeebrugge kanaal	0	0	0	-	-	< 5	< 5	5	132	0.5	113	10	39
	0	0	0	< 5	< 1	< 5	< 5	8	175	< 0.05	220	9	37
Schipdonk	0	0	0.40	-	-	< 5	< 5	6	102	9.4	255	7	42
	0	0	0.02	< 5	< 1	< 5	< 5	10	58	0.07	345	11	39
Zelzate	0	0	0	-	-	< 5	< 5	6	71	0.1	174	8	38
	0.5	0	0	< 5	< 1	< 5	< 5	8	45	0.62	1050	6	35

* Ø OH = phenols.

1.2.- Sediments - Suspended matters (I.R.C.)

1.2.1.- Emission

Suspended matters and sewer sludges can be considered as being particularly polluted, in Blankenberge and in Nieuwpoort, regarding Ag, Ba and Bi as well as Cu, Zn, Pb and Sn. The pollution of water seems to be especially important. Pollution due to fairways and channels discharging into the sea, may seem of little importance compared to the

Table 5.4

SUSPENDED MATTERS

Sewers

Chemistry		Blankenberge			Nieuwpoort
		Winter 1972 $\overline{X}$ 7 samples	Summer 1972 $\overline{X}$ 7 samples	Winter 1973 $\overline{X}$ 7 samples	Winter 1972 1 sample
P/F 110-550 °C	%	40.3	-	-	77.9
P_2O_5	%	0.7	8.3	-	1.8
Ag	ppm	> 175	> 32	> 26	24
Ba	ppm	2150	920	840	1300
Bi	ppm	610	790	150	40
Cr	ppm	68	30	16	24
Cu	ppm	150	> 65	> 120	308
Ga	ppm	1	0.5	< limit	0.6
Mn	ppm	82	160	6	168
Mo	ppm	< limit	7	5	2
Ni	ppm	9	15	4	10
Pb	ppm	800	770	37	136
Sn	ppm	66	96	36	75
Sr	ppm	-	490	103	110
V	ppm	12	12	5	9
Zn	ppm	4860	4120	132	2500
Zr	ppm	35	34	15	< limit

Be , Cd , Co , Ge , In , Li , Sb , Tl : < detection limit.

Table 5.5

Sludges of the sewers of Blankenberge

Chemistry		Pumping station				Spuikom			Sea Sed. [1]
		Winter 72	Summer 72	Winter 73		Summer 72		Winter 73	5 samples
					2	3	4	4	
< 37 μ	%	-	18.7	17	11.2	55.6	91.8	74.5	83.8
P/F 110 - 550 °C	%	-	0.43	0.48	1.52	6.04	8.1	0.7	8.5
P/F 550-1000 °C	%	-	3.22	2.6	2.14	8.2	9.43	4.2	9.3
Org. M.	%	5.5	2.2	6.03	3.14	5.3	6	6	3.56
Al_2O_3	%	3	2.3	3.05	2.48	5.37	10.5	7.87	8
Fe_2O_3	%	1.45	0.86	0.95	1.1	1.83	4.53	2.57	3.13
TiO_2	%	0.2	0.12	0.14	0.12	0.25	0.61	0.4	0.46
P_2O_5	%	0.8	0.91	-	-	-	-	-	-
CaO	%	5.4	1.82	4.62	2.47	6.4	13.51	10	14.2
MgO	%	0.25	0.17	-	-	1.16	1.76	-	1.52
K_2O	%	0.8	0.81	0.77	0.74	1.32	2.25	1.6	1.68
S_{tot}	%	1.16	1.01	1.7	1.3	0.92	1.53	1	0.64
Cl	%	< 0.01	< 0.01	0.03	< 0.01	0.25	0.25	0.14	0.19
Ag	ppm	> 40	> 10	> 16	> 12	20	2	0.5	2
Ba	ppm	1430	410	560	430	170	< limit	70	130
Bi	ppm	48	8	33	32	5	< limit	< limit	< limit
Co	ppm	3	1	1	1	15	4	3	5
Cr	ppm	41	11	11	8	34	130	36	77
Cu	ppm	79	> 22	> 64	> 50	48	35	14	31
Ga	ppm	1.5	0.5	3	3	2	4	7	8
Hg	ppm	0.13	0.02	0.42	0.12	0.33	0.71	0.73	0.52
Mn	ppm	230	110	160	120	210	660	430	860
Ni	ppm	27	7	5	12	11	28	12	20
Pb	ppm	320	87	56	110	55	76	35	125
Sn	ppm	50	16	31	36	7	8	1	12
Si	ppm	130	60	118	18	175	300	260	380
V	ppm	14	6	8	6	32	100	49	58
Zn	ppm	6000	1465	1285	1310	475	265	110	190
Zr	ppm	90	58	60	38	120	110	250	230

Be , Cd , Ge , In , Li , Mo , Tl , W : < detection limit.

1 off Blankenberge.

2 after grinding the waste.

3 at the overflowing mouth of the sewer.

4 the opposite side of this mouth.

Table 5.6

SEDIMENTS

Fairways (1972 and 1973)

First part

Chemistry		Nieuwpoort				Oostende		
		Channel Plassendael 1 s.	Channel Yser 1 s.	Channel Veurne 1 s.	Fairway 2 s.	Channel Noord Ede 1 s.	Ch. Brugge-Oostende 2 s.	Fairway 2 s.
Al_2O_3	%	5.87	5.9	5.07	6.05	9.5	7	9.25
Fe_2O_3	%	1.62	1.95	1.48	2.2	4.25	3.72	3.48
TiO_2	%	0.25	0.28	0.26	0.30	0.5	0.4	0.47
CaO	%	7.2	9.55	10.75	7.62	11.6	4.8	16
MgO	%	-	-	-	-	-	1.21	1.4
K_2O	%	1.25	1.56	1.35	1.33	1.67	1.40	1.51
S_{tot}	%	0.06	0.1	0.44	0.52	3.49	2.22	0.68
Cl	%	< 0.01	< 0.01	< 0.01	0.15	0.22	< 0.01	0.21
Ag	ppm	1	0.5	< limit	< limit	103	1	< limit
Ba	ppm	< limit	< limit	< limit	< limit	< limit	340	< limit
Co	ppm	3	10	3	4	4	8	4
Cr	ppm	50	54	23	43	31	90	66
Cu	ppm	130	190	6	26	66	130	36
Ga	ppm	3	2	3	4	2	4	4
Hg	ppm	0.02	0.08	0.01	0.55	0.35	0.05	0.31
Mn	ppm	150	700	300	410	320	390	455
Ni	ppm	14	43	12	18	16	28	19
Pb	ppm	100	200	17	46	90	100	53
Sn	ppm	7	12	< limit	< limit	8	7	3
Sr	ppm	140	185	295	380	220	110	335
V	ppm	43	72	56	47	47	53	69
Zn	ppm	45	86	60	105	614	650	195
Zr	ppm	48	150	199	180	150	140	250
Crude	$\frac{m\ell}{100g}$	0.003	0.004	0.002	0.06	0.074	0.25	0.01

Be , Bi , Cd , Ge , In , Mo , Sb , Tl : < detection limit.

Table 5.6

SEDIMENTS

Fairways (1972 and 1973)

Second part

Chemistry		Blankenberge	Zeebrugge	Heist	Locations of the maxima
		2 s.	1 s.	Channel Schipdonk 2 s.	
Al_2O_3	%	10.6	4.66	7.98	Ch. Blankenberge
Fe_2O_3	%	3.8	1.6	3.7	Ch. Noord Ede
TiO_2	%	0.63	0.24	0.55	Ch. Blankenberge
CaO	%	4.3	3.72	4.53	Ch. Noord Ede
MgO	%	1.65	-	0.8	-
K_2O	%	1.97	1.05	1.72	Ch. Blankenberge
S_{tot}	%	0.19	0.65	0.7	Ch. Noord Ede
Cl	%	0.03	0.1	0.01	Ch. Noord Ede
Ag	ppm	< limit	< limit	1	Ch. Noord Ede
Ba	ppm	250	< limit	270	Ch. Brugge-Oost.
Co	ppm	8	4	6	Ch. Yser
Cr	ppm	85	45	130	Ch. Schipdonk
Cu	ppm	12	150	87	Ch. Yser
Ga	ppm	12	3	3	Ch. Blankenberge
Hg	ppm	0.17	0.2	0.43	F. Nieuwpoort
Mn	ppm	285	240	300	Ch. Yser
Ni	ppm	31	12	32	Ch. Yser
Pb	ppm	53	160	140	Ch. Yser
Sn	ppm	< limit	9	10	Ch. Yser
Sr	ppm	115	75	100	F. Nieuwpoort
V	ppm	76	34	32	Ch. Blankenberge
Zn	ppm	95	275	960	Ch. Schipdonk
Zr	ppm	305	260	430	Ch. Schipdonk
Crude	$\frac{m\ell}{100g}$	0.007	0.028	0.27	Ch. Schipdonk

Table 5.7

SEDIMENTS

Coastal zone (immixtion)

(5 campaigns 1971 to 1973)

Chemistry		Number	Min	Max	$\bar{X}$	Observations
< 37 μ	%	54	0	92	48.8	
P/F 110 - 550 °C	%	54	0.21	15.41	4.81	
P/F 550-1000 °C	%	54	1.44	16.95	7.61	
Org.M.($K_2Cr_2O_7$)	%	54	0.04	5.8	2.37	
Al_2O_3	%	54	2.28	10.83	6.03	
Fe_2O_3	%	54	0.53	3.96	2.16	
TiO_2	%	54	0.05	0.55	0.30	
P_2O_5	%	3	0.07	0.30	0.17	
CaO	%	54	3.61	16.41	10.60	
MgO	%	54	0.14	2.15	0.97	
K_2O	%	54	0.85	1.97	1.40	
Na_2O	%	3	1.03	2.24	1.51	
S_{tot}	%	54	0.02	1.27	0.5	
Cl^-	%	54	0.01	0.25	0.14	
Ag	ppm	54	< limit	2	0.7	$\bar{X}$ on 17 samples, 37 samples < limit
Ba	ppm	7	56	140	110	$\bar{X}$ on 7 samples (aug. 1972)
Bi	ppm	54	< limit	16	10	$\bar{X}$ on 2 samples, 52 samples < limit
Co	ppm	54	0.3	14	3	
Cr	ppm	54	4	120	47	
Cu	ppm	54	0.6	58	16	
Ga	ppm	54	0.8	22	7	
Ge	ppm	54	0.7 !	8	3 !!	$\bar{X}$ on 20 samples, 34 samples < limit
Hg	ppm	54	0.01	1.24	0.31	
Mn	ppm	54	70	1488	556	
Ni	ppm	54	0.4	27	12	
Pb	ppm	54	10	280	88	
Sn	ppm	54	0.3	18	8	
Sr	ppm	54	115	660	301	
V	ppm	54	0.8	105	32	
Zn	ppm	54	15	271	120	
Zr	ppm	54	33	370	180	
Crude	$\frac{m\ell}{100g}$	30	< limit	0.22	0.10	$\bar{X}$ on 9 samples, 13 samples < limit

pollution of waterways, but when compared to the amounts of marine sediments, very high figures can be observed in S_{tot} , Ag , Cu as well as important amounts in Hg , Pb , Zn and hydrocarbons in some of these emettors. Other channels are less polluted, like the Blankenberge, Veurne and Plassendael channels.

1.2.2.- Immixtion

Sediments sampled in the sea offer a very interesting characteristic : their amounts of elements, pollutants or not, are very closely bound to their content in fine particles. By analysis of the granulometry of the samples, it has been possible to classify them in sands and clays by means of a triangular diagram, ordinarily used for soils.

Each of these categories contains well distinct amounts from those of the other category, for all determined elements : in sands, low amounts; in clays : more important amounts. On about 1000 analysis, only 1 % of the amounts has been recorded as being either too high in sands, or too low in clays. Once this distinction established, a mere graphic, giving in ordinate the contents in fine particles of the 54 samples taken in the sea, and in abcissa, the locations of the samples, has been enough to obtain a localization of the sludges and of the pollution. Working that way, it has been possible to notice that all samples taken in Blankenberge, Wenduine, Knokke and particularly in Oostende have a fine granulometry and that these places are consequently more polluted. On the other hand, all the samples taken in Oostduinkerke are of coarse granulometry and the pollution of this place is very low.

If a sub-marine map of the sludges could be established, we should have a better idea of the belgian coast pollution.

Sand samples have also been taken on beaches at low tide, their amounts agree very well with those of the sediments taken in open sea : they are very coarse sands with no pollution.

The pollution degree of sediments of the coastal zone is higher than that of sediments taken in open sea (*cf. Rapport de synthèse, II)* about twice for Hg , five times for Mn , six times for Zn and eight times for Pb as an average. For copper and chromium, the opposite can be observed, there is twice more copper and chromium in open sea.

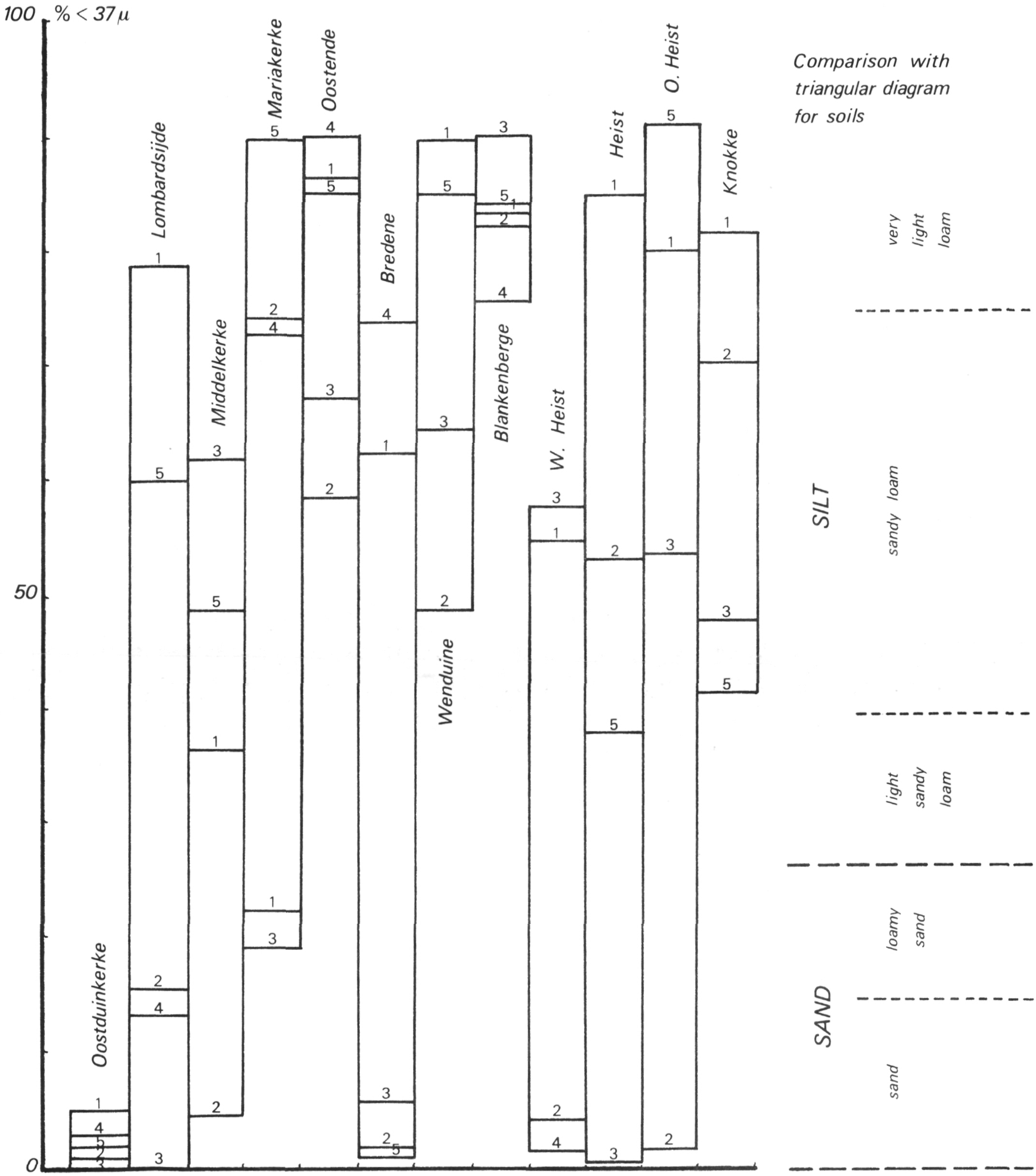

fig. 5.1.- Proportion of fine particles (< 37 μ) in sea sediments. Dates of the campaigns : 1 , 29-9-71 ; 2 , 30-11-71 ; 3 , 3-2-72 ; 4 , 1-8-72 ; 5 , 11-1-73 .

Table 5.8

SEDIMENTS

Coastal area of the sea
Comparison of the sediments classified according to their granulometry
(5 campaigns, 1971 to 1973)

		Sand				Silt				Observations
		n	Min	Max	$\bar{X}$	n	Min	Max	$\bar{X}$	
Al_2O_3	%	18	2.3	4.5	1.2	34	5.7	10.8	7.73	2 samples silt : 3.16 and 3.9
Fe_2O_3	%	18	0.53	1.35	0.74	36	1.45	3.96	2.85	
TiO_2	%	18	0.05	0.22	0.11	36	0.25	0.55	0.4	
CaO	%	18	3.61	8.96	5.53	36	9	16.41	12.74	
MgO	%	18	0.14	0.65	0.29	36	0.8	2.14	1.32	
K_2O	%	18	0.85	1.25	1.04	36	1.02	2	1.59	
	%	17	0.02	0.32	0.11	36	0.38	1.27	0.89	1 sample sand : 0.48
Co	ppm	18	0.3	2	1	36	2	14	4	
Cr	ppm	18	4	23	13	36	32	120	58	
Cu	ppm	18	0.6	10	3	36	4	58	23	
Ga	ppm	17	0.8	3	2	36	3	22	9	1 sample sand : 12
Hg	ppm	16	0.01	0.2	0.08	36	0.1	1.24	0.52	2 samples sand 0.38 and 0.44
Mn	ppm	18	70	330	136	36	340	1500	747	
Ni	ppm	17	0.4	7	4	36	8	27	17	1 sample sand : 15
Pb	ppm	17	10	39	24	36	40	280	122	1 sample sand : 59
Sn	ppm	16	0.3	4	2	36	4	18	10	2 samples sand : 16 and 7
Sr	ppm	17	115	220	147	36	223	660	382	1 sample sand : 240
V	ppm	18	0.8	17	7	36	17	105	44	
Zn	ppm	16	15	61	38	35	60	271	166	2 samples sand : 178 and 217 1 sample silt : 36
Zr	ppm	18	33	270	135	36	88	370	203	

On the other hand, no development of sea sediments pollution has been observed since 1971.

2.- River results

2.1.- Basin of the Meuse

Table 5.9

WATERS

Meuse - French border

		5-6-72	6-4-73	17-7-73	26-9-73
O_2	%	99.8	105.3	102.3	97.6
COD	mg/ℓ	15	12	8	16
BOD	mg/ℓ	5.1	7.5	2.5	2.5
MS	mg/ℓ	10	10	10	10
N_{tot}	mg/ℓ	2.46	2.76	1.76	4.6
N_{amm}	mg/ℓ	0	0.05	0.05	0.06
NO_2^-	mg/ℓ	neg.	0.06	0.03	0.014
NO_3^-	mg/ℓ	6.24	6.93	2.8	1.29
PO_4^{---}	mg/ℓ	0.27	0.33	0.42	0.39
F^-	mg/ℓ	0.36	0.039	0.063	0.45
Cl^-	mg/ℓ	14	16	18	20
SO_4^{--}	mg/ℓ	36	38	38	44
Det.	mg/ℓ	0	0	0.3	0
CN^-	mg/ℓ	0	0	0	0
Ø OH	mg/ℓ	0	0	0	0
Ag	ppb	< 0.05	< 0.8	< 0.8	
Cd	ppb	5.5	± 1	< 1	
Co	ppb	3	< 2	< 2	
Cr	ppb	2.6	< 4	< 4	
Cu	ppb	13	9	9.5	
Fe	ppb	112	360	150	
Hg	ppb	0.09	0.18	0.32	
Mn	ppb	34	117	90	
Ni	ppb	25	< 2	< 2	
Pb	ppb	7	13.5	4.5	
Zn	ppb	170	165	50	

Table 5.10

WATERS

Meuse - Liège

		Flémalle-Haute		Liège		Herstal	
		27-4-72	19-9-72	24-4-72	19-9-72	24-4-72	19-9-72
O_2	%	94.3	84.4	88.1	71.9	87.0	68.0
COD	mg/ℓ	8	4	8	8	4	8
BOD	mg/ℓ	4.8	2.7	4.5	6.8	6.4	9.2
MS	mg/ℓ	15	15	55	40	25	25
N_{tot}	mg/ℓ	1.62	1.23	2.14	1.65	3.14	0.2
N_{amm}	mg/ℓ	0	0	0.22	0	0	0.06
NO_2^-	mg/ℓ	neg.	0.09	neg.	0.09	neg.	0
NO_3^-	mg/ℓ	8.40	1.17	4.80	1.17	9.48	3.46
PO_4^{---}	mg/ℓ	0.28	5.02	0.46	4.5	0.54	1.0
F^-	mg/ℓ	1.43	1.42	1.37	1.53	0.99	1.66
Cl^-	mg/ℓ	3.6	46	34	36	36	32
SO_4^{--}	mg/ℓ	59	72	46	68	47	64
Det.	mg/ℓ	0	0.7	0	0.7	0	0.7
CN^-	mg/ℓ	0	0	0	0	0	0
Ø OH	mg/ℓ	0	0	0	0.1	0.03	0
Cd	ppb	11.0	9	11.1	12.1	8.7	10
Co	ppb	< 2	-	4	-	< 2	-
Cr	ppb	3.6	< 2	2	6	6	11
Cu	ppb	25	7	25	8	28	11
Fe	ppb	158	255	312	875	752	552
Hg	ppb	0.14	0.65	0.13	0.53	0.12	0.35
Mn	ppb	74	136	123	223	136	223
Ni	ppb	43	10	17	8	± 10	8
Pb	ppb	4	20	11	73	5	48
Zn	ppb	210	538	355	469	255	398

2.1.1.- Waters

A detailed study of the Meuse and of each of its affluents at the confluence point has been thoroughly studied by a serie of samplings

Table 5.11

WATERS

Meuse - Netherlands border

		19-9-72	14-3-73	19-7-73	13-9-73
O_2	%	79.7	92.6	65.5	85.7
COD	mg/ℓ	4	7	4	19
BOD	mg/ℓ	12.5	6.8	4.6	7
MS	mg/ℓ	15	10	10	10
N_{tot}	mg/ℓ	0.03	2.89	4.08	
N_{amm}	mg/ℓ	0.03	0.74	1.78	2.5
NO_2^-	mg/ℓ	0	0.14	0.48	0.29
NO_3^-	mg/ℓ	3.9	2.36	7.80	5.1
PO_4^{---}	mg/ℓ	0.7	1.1	5.6	
F^-	mg/ℓ	0.45	1.36	0.012	0.2
Cl^-	mg/ℓ	32	38	74	90
SO_4^{--}	mg/ℓ	32	57	82	90
Det.	mg/ℓ	1.3	1.5	0.4	0.6
CN^-	mg/ℓ	0	0	0	0
Ø OH	mg/ℓ	0	0	0	0
Ag	ppb	-	-	< 0.8	
Cd	ppb	19.2	< 2	1.7	
Co	ppb	-	< 2	< 2	
Cr	ppb	19.2	< 4	< 4	
Cu	ppb	11.7	47	10	
Fe	ppb	617	18	320	400
Hg	ppb	0.29	-	0.41	0.13
Mn	ppb	155	102	100	77
Ni	ppb	< 5	5	< 2	
Pb	ppb	30	90	10	
Zn	ppb	434	501	200	

made on each border and in the area of Liège. The division of the river Meuse in three zones, from the french border to above Liège, Liège, and from Liège to the Netherlands border meets a physical reality.

As a matter of fact, the hydrobiological, bacteriological and chemical studies concur to say that the river Meuse is less polluted above Liège, indicates the presence of a big agglomeration and an important industrial zone in Liège, and develops towards a less pollution degree from Liège to the Netherlands border.

We have completed the study of the affluents by a serie of samplings in the Mehaigne, an agricultural river with a low chemical and bacteriological pollution level, the latter being remarkably constant along its whole course. But, as could be expected for an agricultural river, very high concentrations of pesticides are to be found, more specially lindane and its α-isomere.

The Vesdre, an other affluent has been inventoriated systematically twice. The results of the two series agree, and a positive correlation can be observed between the organic and microbiological levels, with a maximum below Verviers, a decrease as far as above the agglomeration of Liège and finally an increase in the agglomeration. On the other hand, if the hydrobiological investigation confirms an increase of pollution below Verviers, no regeneration but on the contrary a constant degradation is to be found up to Chênée. Finally, a high contamination due to lindane has been found all along the Vesdre and a contamination due to heavy metals, especially Cd and Pb , at Chênée.

The pollution of the Meuse at the exit of Belgium is always higher that the level at the entrance in our territory. Its affluents have usually the same pollution level as the Meuse, or at least, they have no influence on it except the Sambre and the Vesdre.

2.1.2.- Sediments

Sediments of the basin of the Meuse cannot be classified according to their granulometric characteristics, as it has been done for sediments taken in the sea in order to give an idea of their concentration in polluting or non polluting elements.

A relationship can be seen between their amount in particles $< 37\ \mu$ and the amounts in different elements in the least polluted area of the Meuse, that is above Tihange, but elsewhere a far more important accumulation of pollutants even in samples containing less fine particles can be noticed in certain points.

Table 5.12

WATERS

Laclaireau, Ton - Rulles

		Laclaireau, Ton			Rulles		
		Ethe	Dampicourt	Harnoncourt	Habay-la-Neuve	Downstream Mellier (distillery)	Upstream Semois
O_2	%	102.8	11.3	63.5	109.8	109.5	117.0
COD	mg/ℓ	4	7	42	4	11	14
BOD	mg/ℓ	5	8.1	7.2	9.4	9.9	7.9
MS	mg/ℓ	10	10	30	10	10	10
N_{tot}	mg/ℓ	0.94	1.76	4.08	1.21	1.87	1.47
N_{amm}	mg/ℓ	0.02	0.38	1.29	0.1	0.12	0.77
NO_2^-	mg/ℓ	0	0.45	0.13	0	0.06	0.06
NO_3^-	mg/ℓ	3.37	5.86	8.00	0.87	2.55	2.40
PO_4^{---}	mg/ℓ	0.14	0.85	2.58	0.74	0.51	0.41
F^-	mg/ℓ	0.06	0.76	0.10	0.09	0.11	0.07
Cl^-	mg/ℓ	6	10	170	6	8	10
SO_4^{--}	mg/ℓ	14	28	165	4	8	9
Det.	mg/ℓ	0	0.3	0	0	0	0
CN^-	mg/ℓ	0	0	0	0	0	0
Ø OH	mg/ℓ	0	0	0	0	0	0
Cd	ppb	± 1	± 1	< 1	< 1	± 1	< 1
Co	ppb	< 2	< 2	< 2	< 2	< 2	< 2
Cr	ppb	< 4	< 4	< 4	< 4	< 4	< 4
Cu	ppb	12	3	17	10	9	6
Fe	ppb	130	290	1900	360	680	560
Hg	ppb	0.16	< 0.02	0.29	0.09	0.15	0.15
Mn	ppb	20	90	620	40	110	60
Ni	ppb	< 2	< 2	4	< 2	< 2	< 2
Pb	ppb	38	12	9	11.5	15.5	8
Zn	ppb	55	17	83	± 20	± 25	± 10
Ag	ppb	± 0.8	± 0.8	< 0.8	< 0.8	< 0.8	± 0.8

Table 5.13

WATERS

Mehaigne

		Dhuy	Mehaigne	Branchon	Ambresin	Huccorgne	Wanze
O_2	%	129.7	84.6	99.0	106.9	90.0	95.0
COD	mg/ℓ	7	4	7	11	11	7
BOD	mg/ℓ	10.2	4.8	7.0	6.7	6.3	6.1
MS	mg/ℓ	10	10	10	10	10	10
N_{tot}	mg/ℓ	3.09	3.93	2.54	2.01	2.95	-
N_{amm}	mg/ℓ	0	0.07	0	0.13	0	0.06
NO_2^-	mg/ℓ	0.04	0.02	0.06	0.04	0.01	0.03
NO_3^-	mg/ℓ	1.23	1.85	2.48	2.48	3.21	12.6
PO_4^{---}	mg/ℓ	0.66	0.73	1.06	0.96	0.96	1.12
F^-	mg/ℓ	0.83	0.50	0.62	0.50	0.80	0.43
Cl^-	mg/ℓ	56	56	54	58	26	54
SO_4^{--}	mg/ℓ	70	64	66	62	63	65
Det.	mg/ℓ	0	1.07	0.2	0.2	0.7	0.4
CN^-	mg/ℓ	0	0	0	0	0	0
Ø OH	mg/ℓ	0.01	0.01	0.01	0.01	0	0
Ag	ppb	< 2	< 2	< 2	< 2	< 2	< 2
Cd	ppb	1.2	± 0.5	± 0.6	< 1	< 0.5	± 1
Co	ppb	< 2	< 2	< 2	< 2	< 2	< 2
Cr	ppb	<10	<10	<10	< 10	< 10	< 10
Cu	ppb	7.5	3.7	8	3	4.5	6
Fe	ppb	57	63	43	< 20	33	30
Hg	ppb	0.11	< 0.05	0.12	0.12	< 0.05	0.08
Mn	ppb	64	124	28	± 10	16	12
Ni	ppb	± 3	± 3.6	3.5	< 2	4	6
Pb	ppb	< 6	8	< 5	8	< 5	± 5
Zn	ppb	37	50	<10	15	± 21	± 20

Table 5.14

WATERS

Vesdre, Hoëgne

		Membach		Surdents		Ensival		Pepinster		Hoëgne	
		9-72	5-73	9-72	5-73	9-72	5-73	9-72	5-73	9-72	5-73
O_2	%	95.2	95.9	89.7	98.3	85.4	87.0	64.5	81.4	96.3	96.4
COD	mg/ℓ	2	7	64	4	15	53	98	122	4	4
BOD	mg/ℓ	4	3	9	3	11	10	10	9	4	5
MS	mg/ℓ	5	20	10	20	10	30	40	30	5	20
N_{tot}	mg/ℓ	0.25	0.56	0.27	0.58	1.55	7.11	0.2	8.2	0.09	2.8
N_{amm}	mg/ℓ	0.25	0.40	0.27	0.53	1.55	2.27	0.2	3.36	0.09	0
NO_2^-	mg/ℓ	0	0.06	0.04	0.01	0.18	0.21	0.66	0.002	0	0.01
NO_3^-	mg/ℓ	0.96	3.82	1.68	1.15	2.05	0.42	1.51	0	1.88	1.39
PO_4^{---}	mg/ℓ	0.3	0.08	0.4	0.07	0.7	0.96	2.3	0.53	0.2	0.2
F^-	mg/ℓ	0.29	0.83	0.22	0.23	0.25	0.25	0.2	0.18	0.16	0.18
Cl^-	mg/ℓ	16	10	16	10	20	16	22	18	12	10
SO_4^{--}	mg/ℓ	26	27	32	48	44	28	58	103	20	26
Cd	ppb	4.2	4	2.9	3	7.5	4	7.1	29	6.8	± 1
Co	ppb	-	6	-	2	-	2	-	6	-	3
Cr	ppb	10.1	<10	20	<10	47.9	<10	49.8	<10	<2	<10
Cu	ppb	112	47	9	15	11	31	20	37	4	6
Fe	ppb	650	90	306	138	445	260	495	420	327	74
Hg	ppb	0.13	< 0.05	0.18	< 0.05	0.07	< 0.05	0.7	< 0.05	1.55	< 0.05
Mn	ppb	223	104	177	184	200	480	218	805	82	60
Ni	ppb	12	15	18	4.5	12	6.5	15	15.5	< 5	4
Pb	ppb	15	20	16	22	30	101	27	104	10	8
Zn	ppb	264	38	192	46	150	65	165	105	110	21

Table 5.15

WATERS

Vesdre, Ourthe

		Forêt		Chênée			Ourthe Chênée		Ourthe Angleur		
		9-72	5-73	4-72	9-72	5-73	4-72	9-72	4-72	9-72	5-73
O_2	%	84.3	93.8	71.4	66.4	94.5	96.9	97.6	97.6	96.7	99.0
COD	mg/ℓ	26	4	37	30	15	4	8	8	19	7
BOD	mg/ℓ	14	6	0.4	5	6	3	2	4	6	5
MS	mg/ℓ	120	40	45	60	30	5	15	20	25	10
N_{tot}	mg/ℓ	1.03	2.8	4.2	0.42	4.2	1.12	0.21	2.74	0.19	-
N_{amm}	mg/ℓ	0.67	0.6	0.34	0.42	1.21	0	0.15	0	0.19	-
NO_2^-	mg/ℓ	0.1	0.02	-	0.15	0.01	neg.	0.02	-	0.04	0.02
NO_3^-	mg/ℓ	1.91	2.1	4.32	1.87	1.95	1.80	1.71	1.08	1.68	1.95
PO_4^{---}	mg/ℓ	0.4	0.23	0.38	0.9	0.34	0.01	0.3	0.54	0.5	1.22
F^-	mg/ℓ	0.21	0.18	0.22	0.21	0.44	0.12	0.14	0.01	0.19	0.16
Cl^-	mg/ℓ	16	18	26	14	14	16	14	22	18	16
SO_4^{--}	mg/ℓ	40	38	74	58	46	16	14	23	24	28
Cd	ppb	3.7	10	106	40	140	4.1	10.6	29	57.2	-
Co	ppb	-	4	7	-	4	< 2	-	3	-	-
Cr	ppb	21.5	<10	40	13.2	<10	8.4	9.4	20	9.8	-
Cu	ppb	10	9	36	23	49	45	3	65	17	-
Fe	ppb	650	160	528	638	178	832	312	902	460	-
Hg	ppb	1.4	< 0.05	1.00	0.86	0.07	0.15	0.6	0.14	1.04	-
Mn	ppb	282	510	450	305	310	83	86	160	141	-
Ni	ppb	8	4	22	15	5	± 10	± 5	14	10	-
Pb	ppb	21	8	32	100	96	6	9	15	31	-
Zn	ppb	165	31	513	1545	102	213	50	290	398	-

For instance, the river Ourthe at Angleur, a very polluted river, where sediments are relatively coarse, shows higher amounts in many polluting elements than the fine sediments from Liège where the Meuse is most polluted and higher amounts than the fine sediments from the Mehaigne, a non polluted river.

Nevertheless for a same place, a better idea of the pollution state can be given with a fine sample than with a coarse one. Besides we must remember that some samples are taken from embankments and are essentially very fine sedimentation sludges (for instance in Liège) while in some other cases (for example the Ourthe at Angleur) the sediment is probably mixed with earth coming from the erosion of the banks.

So, a relationship between pollution and presence of fine sludges cannot be established, as it has been done for the sea sediments because in rivers, the texture of a sample depends on different influences. When possible, we are trying to take fine sludges, real sedimentation sludges, these being more representative.

In this study, the basin of the Meuse has been divided into three parts : (i) from Heer to Tihange, (ii) from Flémalle-Haute to Herstal, (iii) below Herstal, according to the observed state of pollution. In the first section, low amounts of pollutants are observed especially above Namur. The amounts are much higher in the second section and they decrease in the third section without equalling those of the first section. The pollution in the region of Liège is clearly different from that of the other parts of the Meuse.

A study of the sediments of all the affluents of the Meuse just before their confluence point has also been done.

Among the affluents of the first section, the Molignée, the Samson can be considered as being non polluted.

The sediments of the Lesse, the Bocq and the Mehaigne are usually non polluted, but high amounts of Sn and Co can be found in the Lesse, and some bismuth, which is usually below the detection limit, can be traced in the Bocq and the Mehaigne.

The Hoyoux has high amounts of in Fe_2O_3 , Ba , Sn as well as Mo , and high amounts in Zn and Pb .

Table 5.17

SEDIMENTS

Meuse : from Heer to Tihange

Chemistry		Number	Min	Max	$\bar{X}$	Locations of the maxima
< 37 μ	%	14	12.8	61.5	40.3	Heer
P/F 110 - 550 °C	%	18	3.77	9.41	6.5	Namèche
P/F 550-1000 °C	%	18	5.8	10.9	9.1	Namèche
Org.M.($K_2Cr_2O_7$)	%	18	2.44	9.33	5.48	Tihange
Al_2O_3	%	18	5.2	8.9	7.18	Yvoir
Fe_2O_3	%	18	2.77	4.23	3.7	Heer
TiO_2	%	18	0.37	0.65	0.52	Poilvache
CaO	%	18	7.27	16.52	10	Namèche
MgO	%	18	0.57	6.72	1.69	Namèche
K_2O	%	18	1	1.84	1.4	Poilvache
S_{tot}	%	18	0.06	0.38	0.22	Namèche
Ba	ppm	18	< limit	360	234	Andenne, $\bar{X}$ on 5 samples
Co	ppm	18	6	11	9	Heer
Cr	ppm	18	34	120	61	Andenne
Cu	ppm	18	35	134	82	Poilvache
Ga	ppm	18	3	12	6	Andenne, Tihange
Ge	ppm	18	< limit	4	2	Anseremme, $\bar{X}$ on 7 samp.
Hg	ppm	18	0.06	0.68	0.3	Namèche
Mn	ppm	18	503	2000	1011	Annevoie
Ni	ppm	18	23	44	33	Yvoir
Pb	ppm	18	67	240	128	Andenne
Sn	ppm	18	7	22	14	Tihange
Sr	ppm	18	5	45	28	Heer
V	ppm	18	30	56	40	Namèche, Tihange
Zn	ppm	18	346	1500	833	Tihange
Zr	ppm	18	200	610	402	Namèche
Crude	$\frac{ml}{100g}$	17	0	0.533	0.11	Namèche

Cl, Ag, Be, Bi, Cd, Li, Mo, Sb, Tl : < detection limit.

Table 5.18

SEDIMENTS

Meuse : from Flémalle-Haute to Herstal

Chemistry		Number	Min	Max	$\overline{X}$	Locations of the maxima
< 37 μ	%	6	87	90.2	88.5	Ougrée
P/F 110 - 550 °C	%	6	8.5	10.3	9.34	Ougrée
P/F 550-1000 °C	%	6	10.77	14.56	13	Liège
Org.M.($K_2Cr_2O_7$)	%	6	10.33	15.64	14.1	Ougrée
Al_2O_3	%	6	9.73	13.24	11.08	Herstal
Fe_2O_3	%	6	5	10.2	7.63	Ougrée
TiO_2	%	6	0.48	0.72	0.6	Herstal
CaO	%	6	9.11	15.81	13.4	Liège
MgO	%	4	1.53	1.84	1.69	Ougrée
K_2O	%	6	1.44	1.92	1.7	Herstal
S_{tot}	%	6	0.45	1.03	0.71	Herstal
Ag	ppm	6	2	5	3	Herstal
Ba	ppm	6	365	620	459	Herstal
Bi	ppm	6	18	83	40	Herstal
Cd	ppm	6	< limit	240	233	Herstal, $\overline{X}$ on 4 samples
Co	ppm	6	9	24	15	Herstal
Cr	ppm	6	98	560	260	Herstal
Cu	ppm	6	> 90	>110	-	high everywhere
Ga	ppm	6	7	13	11	Herstal
Hg	ppm	6	1.02	1.69	1.35	Liège
Mn	ppm	6	985	1950	1522	Liège
Mo	ppm	6	3	7	6	Ougrée
Ni	ppm	6	49	110	79	Herstal
Pb	ppm	6	285	380	328	Herstal
Sn	ppm	6	32	270	187	Herstal
Si	ppm	6	115	325	185	Flémalle-Haute
V	ppm	6	71	180	122	Herstal
Zn	ppm	6	2500	4470	3575	Liège
Zr	ppm	6	220	372	282	Flémalle-Haute
Crude	$\frac{ml}{100g}$	6	0.12	0.45	0.24	Herstal

Cl, Be, Ge, In, Li, Sb, Tl : < detection limit.

Table 5.19

SEDIMENTS

Meuse : below Herstal

Chemistry		Number	Min	Max	$\bar{X}$	Locations of the maxima
< 37 μ	%	2	57.5	76	67	Visé
P/F 110 - 550 °C	%	2	5.21	14.70	10	Visé
P/F 550-1000 °C	%	2	8.45	10.75	9.6	Lanaye
Org.M.($K_2Cr_2O_7$)	%	2	12.33	17.45	14.9	Visé
Al_2O_3	%	2	6.8	9.76	8.3	Visé
Fe_2O_3	%	2	4.85	5.51	5.18	Visé
TiO_2	%	2	0.43	0.7	0.56	Visé
CaO	%	2	9.76	13.50	11.63	Lanaye
MgO	%	1	-	-	1.22	
K_2O	%	2	1.23	1.51	1.37	Visé
S_{tot}	%	2	0.48	0.53	0.5	Visé
Ba	ppm	1	-	-	320	
Bi	ppm	1	-	-	24	
Co	ppm	2	10	12	11	Lanaye
Cr	ppm	2	100	175	137	Visé
Cu	ppm	2	82	170	126	Lanaye
Ga	ppm	2	4	11	7	Visé
Hg	ppm	2	1.1	1.73	1.43	Lanaye
Mn	ppm	2	970	1150	1060	Lanaye
Ni	ppm	2	50	55	53	Lanaye
Pb	ppm	2	180	260	220	Lanaye
Sn	ppm	2	37	53	45	Visé
Sr	ppm	2	40	50	45	Lanaye
V	ppm	2	59	64	62	Visé
Zn	ppm	2	1530	1580	1555	Lanaye
Zr	ppm	2	310	450	380	Visé
Crude	$\frac{m\ell}{100g}$	2	0.085	0.45	0.26	Visé

Cl, Ag, Be, Cd, Ge, In, Li, Mo, Sb, Tl : < detection limit.

The Sambre can be considered as being very polluted in many elements.

In the second section the only affluent is the Ourthe shortly after the junction with the Vesdre. The confluence of these two rivers forms at

Table 5.20

SEDIMENTS

Mehaigne

Chemistry		Number	Min	Max	$\bar{X}$	Locations of the maxima
P/F 110 - 550 °C	%	7	2.7	8	4.8	Dhuy
P/F 550-1000 °C	%	7	0.9	5.1	2.72	Wanze
Org.M.($K_2Cr_2O_7$)	%	7	3.2	8.7	5.38	Dhuy
Al_2O_3	%	7	6.64	8.46	7.71	Dhuy
Fe_2O_3	%	7	2.43	3.26	2.97	Branchon
CaO	%	7	1.01	6	2.60	Wanze
K_2O	%	7	1.23	1.73	1.57	Huccorgne
S_{tot}	%	7	0.08	0.62	0.29	Dhuy
Ag	ppm	7	< limit	3	0.8	Mehaigne, $\bar{X}$ on 6 samples
Ba	ppm	7	135	277	173	Wanze
Co	ppm	7	3	8	6	Huccorgne
Cr	ppm	7	42	110	78	Mehaigne
Cu	ppm	7	18	36	25	Wanze
Ga	ppm	7	7	18	14	Mehaigne, Huccorgne
Hg	ppm	7	< 0.01	0.6	0.21	Wanze, $\bar{X}$ on 4 samples
Mn	ppm	7	430	1500	778	Wanze, $\bar{X}$ on 4 samples
Ni	ppm	7	16	41	27	Huccorgne
Pb	ppm	7	110	170	140	Ambresin
Sn	ppm	7	< limit	9	8	Wanze, $\bar{X}$ on 5 samples
Sr	ppm	7	35	65	50	Dhuy
V	ppm	7	24	78	56	Huccorgne
Zn	ppm	7	121	350	176	Wanze
Zr	ppm	7	530	1010	888	Ambresin
Crude	$\frac{ml}{100g}$	7	0.01	0.08	0.04	Wanze

Cl, Be, Bi, Cd, Ge, Mo, Sb, Tl : < detection limit.

Angleur a very polluted river which certainly contributes to the increase of pollution of the Meuse as can be seen in Liège and below this town. The Hoëgne which joins the Vesdre is also polluted (Pb and Zn).

In the third section, the affluents Julienne and Berwinne are not polluted (except for high amounts in Sb in the Berwinne).

Table 5.21

SEDIMENTS

Vesdre (3 campaigns 1972-1973)

Chemistry		Number	Min	Max	$\overline{X}$	Locations of the maxima
< 37 μ	%	13	9	53	42	Ensival
P/F 110 - 550 °C	%	13	1.85	14.34	7.21	Ensival
P/F 550-1000 °C	%	13	3.3	7.6	5.13	Forêt-Trooz
Org.M.($K_2Cr_2O_7$)	%	13	2.5	23	11.2	Ensival
Al_2O_3	%	13	9.6	13.52	11.8	Forêt-Trooz
Fe_2O_3	%	13	4.2	4.86	4.47	Surdents
TiO_2	%	13	0.6	0.77	0.67	Chênée
CaO	%	13	1.42	4.65	3.07	Forêt-Trooz
K_2O	%	13	1.36	3.74	2.21	Forêt-Trooz
S_{tot}	%	13	0.22	2.2	0.85	Surdents
Ba	ppm	13	190	420		Pepinster
Bi	ppm	13	< limit	100	50	Ensival, $\overline{X}$ on 8 samples
Cd	ppm	13	< limit	650	-	2 samples at Chênée
Co	ppm	13	15	25	18	Ensival
Cr	ppm	13	85	520	250	Ensival
Cu	ppm	13	> 70	>230	-	Chênée
Ga	ppm	13	8	23	15	Chênée
Ge	ppm	13	< limit	3	2	Membach, Surdents, $\overline{X}$ on 6 s.
Hg	ppm	13	0.08	3	0.64	Chênée
In	ppm	13	< limit	8	-	2 samples at Chênée
Mn	ppm	13	450	1200	695	Membach
Ni	ppm	13	66	115	94	Ensival
Pb	ppm	13	250	670	430	Chênée
Sb	ppm	13	-	50	-	Membach 1 sample
Sn	ppm	13	17	725	161	Surdents
Sr	ppm	13	20	55	39	Ensival
V	ppm	13	55	110	91	Forêt-Trooz
Zn	ppm	13	515	2780	1531	Chênée
Zr	ppm	13	350	760	537	Chênée
Crude	$\frac{m\ell}{100g}$	13	0.03	1.35	0.47	Ensival

Cl, Ag, Be, Li, Mo, Tl : < detection limit.

Two affluents, the Sambre and the Ourthe are therefore very polluted, the Hoyoux is polluted.

We have specially turned our attention to the river Ourthe so that sediments have been taken twice in the Ourthe above the confluence point with the Vesdre and along the whole course of the Vesdre. This has enabled us to confirm a very high pollution state in the sediments of the Vesdre in several places of its course, and to a lesser degree in those of the Ourthe.

Besides a study of the whole course of the Mehaigne, from source to mouth, has enabled us to confirm the very low amounts in all the pollutants found previously just before the confluence point with the Meuse.

Other sediments studies of rivers converging towards the basin of the Meuse are in progress. It concerns the Rulles, Ton, Laclaireau and the brook of Marche en Famenne.

2.2.- Basin of the Scheldt

2.2.1.- Waters

The course of the Scheldt has been inventoriated twice during the past three years, at an interval of one year and a half. Our bacteriological, chemical and hydrobiological studies show clearly that the organic and faecal pollution is already very important in the Scheldt when entering Belgium.

This pollution increases and reaches a maximum below the confluence with the Espierres which has higher concentrations in many parameters than those found in sewers. The Espierres has a very important effect on the pollution level of the Scheldt downstream; besides, the Espierres throws large quantities of chromium and lindane on the Scheldt.

The Leie is a second and indubitable source of organic and faecal pollution of the Scheldt.

On the other hand the Dender, which has a pollution level equal to that of the Scheldt, seems to have but a limited or almost limited part on the pollution level of the Scheldt. The same thing can be said again for the Rupel.

Table 5.22

WATERS

Scheldt

		Vaulx		Warcoing		Helkeijn		Kerkhove		Zwijnaarde	
		1-72	5-73	1-72	5-73	1-72	5-73	1-72	5-73	1-72	5-73
O_2	%	55.2	41	54.0	40.1	49.6	28.8	29.8	3.8	32.3	0
COD	mg/ℓ	70	54	70	47	154	101	168	216	108	91
BOD	mg/ℓ	9	43	9.5	72	26	13	72	30	5	10
MS	mg/ℓ	30	200	20	150	60	160	120	580	530	80
N_{tot}	mg/ℓ	9.5	15.3	10.1	23.7	12.9	25.7	13.8	26.2	13.2	22.7
N_{amm}	mg/ℓ	5.2	15.3	5.7	20.2	6.7	21.5	7.8	23.2	5.9	16.5
NO_2^-	mg/ℓ	neg.	0.50	neg.	0.44	neg.	0.38	neg.	0.14	neg.	0.02
NO_3^-	mg/ℓ	9.5	2.9	9.8	2.4	4.8	1.5	2.4	0.1	9.2	0.02
PO_4^{---}	mg/ℓ	2.0	1.82	2.3	3.49	1.9	14.14	12.0	19.3	7.6	22.3
F^-	mg/ℓ	0.03	0.81	0.05	0.9	0.25	10	0.25	6.6	0.10	5.0
Cl^-	mg/ℓ	90	102	88	96	96	112	104	132	78	132
SO_4^{--}	mg/ℓ	185	196	188	191	183	244	215	281	175	197
Det.	mg/ℓ	0	0.14	0	0.24	0	1.7	1.3	2.5	0.35	1.32
CN^-	mg/ℓ	0	0	0	0	0	0	0	0	0	0
Ø OH	mg/ℓ	0	0	0.01	0	0.2	0	0.06	0	0.04	0
Cd	ppb	-	15	-	23	-	12	-	8	-	6
Co	ppb	< 5	< 5	< 5	13	< 5	< 5	< 5	7	< 5	7
Cr	ppb	< 5	<100	< 5	<100	400	645	920	387	< 5	225
Cu	ppb	11	24	24	84	14	16	63	12	9	12
Fe	ppb	90	80	100	360	150	183	150	206	250	120
Hg	ppb	0.31	-	0.25	-	0.31	-	0.8	-	0.16	-
Mn	ppb	485	176	470	364	520	285	500	309	650	255
Ni	ppb	13	58	11	91	17	146	21	102	12	120
Pb	ppb	34	23	26	60	28	40	20	37	10	30
Zn	ppb	392	265	80	333	80	130	82	46	63	56

Table 5.23

WATERS

Scheldt

		Wetteren		Dender-monde	Temse		Hoboken		Doel	
		1-72	5-73	5-73	1-72	5-73	1-72	5-73	1-72	5-73
O_2	%	46.0	0	0	24.4	0	40.8	0	54.7	8.5
COD	mg/ℓ	30	80	110	92	133	114	179	144	376
BOD	mg/ℓ	9.6	60	84	16	6	8.8	40	4.0	7.6
MS	mg/ℓ	80	90	230	370	65	490	170	230	245
N_{tot}	mg/ℓ	62.7	23.7	20.5	54.0	15.6	49.3	15.7	56.0	7.2
N_{amm}	mg/ℓ	48.5	18.8	16.5	32.5	12.2	29.1	11.2	28.0	6.8
NO_2^-	mg/ℓ	neg.	0.02	0.02	neg.	0.02	neg.	0.01	neg.	0.12
NO_3^-	mg/ℓ	0	0.08	0.01	1.8	0.01	5.4	0.005	3.0	0.09
PO_4^{---}	mg/ℓ	6.0	17.2	13.3	7.3	12.2	2.8	10.8	1.9	3.7
F^-	mg/ℓ	4.3	5.5	6.2	3.12	3.5	2.9	4.0	3.4	3.1
Cl^-	mg/ℓ	200	194	236	300	608	110	1030	4900	7700
SO_4^{--}	mg/ℓ	285	309	266	164	253	280	300	774	118
Det.	mg/ℓ	0.3	1.48	1.08	0	1.38	0	1.40	0	0.62
CN^-	mg/ℓ	0	0	0	0	0	0	0	0	0
Ø OH	mg/ℓ	0.09	0	0	0.19	0	0.05	0	0	0
Cd	ppb	-	6	15	-	20	-	40	-	23
Co	ppb	< 5	20	10	< 5	17	< 5	13	< 5	10
Cr	ppb	< 5	<100	<100	< 5	<100	< 5	< 100	< 5	290
Cu	ppb	< 5	< 10	92	< 5	76	6	84	5	108
Fe	ppb	285	131	228	188	423	88	411	40	234
Hg	ppb	0.09	-	-	0.02	-	0.07	-	0.11	-
Mn	ppb	480	345	394	414	267	400	315	358	345
Ni	ppb	8	98	120	17	120	14	142	8	120
Pb	ppb	10	30	25	5	20	10	35	5	45
Zn	ppb	38	106	219	29	104	47	150	50	140

Table 5.24

WATERS

Dyle

		Houtain le mont (source)	Loupoigne	Ways	Thy	Court-St-Etienne	Limal	Gastuche ab. papermill	Gastuche bel. papermill	Florival
km		0	3.6	6.8	9.4	13.9	22.0		30.1	
O_2	%	86.6	88.6	69.8	80.6	88.3	18.9	16.8	42.3	59.4
COD	mg/ℓ	4	12	15	15	23	35	38	58	31
BOD	mg/ℓ	2.2	4.5	8	5.2	3.6	7.8	6	4.2	4.6
TOC	mg/ℓ	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	2	4	12	9
MS	mg/ℓ	8	16	36	36	28	20	16	60	68
N_{tot}	mg/ℓ	0.63	2.33	2.19	0.86	2.11	2.33	1.80	4.03	2.72
N_{amm}	mg/ℓ	0.1	0.24	1.7	0.86	0.40	0.81	0.98	4.03	1.22
NO_2^-	mg/ℓ	0.16	1.25	1.70	2.43	1.53	0.98	2.69	3.07	1.73
NO_3^-	mg/ℓ	29.4	25.17	20.64	21.27	17.42	21.9	13.0	11.8	10.0
PO_4^{---}	mg/ℓ	0.53	1.42	2.38	1.50	1.58	0.99	1.58	2.84	0.86
F^-	mg/ℓ	0.2	0.22	0.22	0.18	0.16	0.18	0.28	0.22	0.18
Cl^-	mg/ℓ	52	54	52	56	54	56	54	50	44
SO_4^{--}	mg/ℓ	56	62	64	62	57	131	113	113	188
Det.	mg/ℓ	0.8	1.7	2.1	0.3	0.5	1.2	0.3	6.3	1.9
CN^-	mg/ℓ	0	0	0.003	0	0	0.002	0	0	0
Cd	ppb	2.5	0.8	1.2	0.8	1	0.6	0.6	1	1.6
Co	ppb	1.2	± 1	2.8	< 1	1.5	2.5	4	2	4
Cr	ppb	< 3	< 3	< 3	< 3	< 3	6	< 3	3.3	< 3
Cu	ppb	4	< 1	4.5	2.6	6.5	5	4	4	12.5
Fe	ppb	41	44	74.5	142	83.5	48	122.5	107	2000
Hg	ppb	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Mn	ppb	<20	< 20	<20	31	< 20	38.5	< 20	< 20	177
Ni	ppb	3	2	3.5	3.5	7	50	140	95	103.5
Pb	ppb	26	6	10	16	12	6	18	10	600
Zn	ppb	20	45	70	90	60	75	95	105	75
Index		0.9	1.4	2.4	1.8	1.5	2.8	2.6	3.8	3.3

Table 5.25

WATERS

Dyle

		Korbeek Dyle	Heverlee	Leuven Stella	Leuven exit	Wijgmaal	bel. Demer	Muizen	Mechelen	Mechelen	Sennegat
km		44.9	49	53.7	56.5	57.4	65.9	82.4	85.5	85.4	92.3
O_2	%	23.2	15.1	7.2	19.6	19.6	0	0	0	0	0
COD	mg/ℓ	65	65	35	35	50	96	69	108	69	127
BOD	mg/ℓ	8	6	6.4	6	6	9	9	24	19.2	27.2
TOC	mg/ℓ	14	11	9	11	11	18	15	25	22	26
MS	mg/ℓ	44	40	12	24	32	44	8	72	24	28
N_{tot}	mg/ℓ	4.66	3.78	1.74	3.90	0.99	4.79	6.27	6.63	3.62	7.49
N_{amm}	mg/ℓ	1.29	1.05	1.23	1.07	0.99	2.72	3.21	3.29	3.62	7.49
NO_2^-	mg/ℓ	2.62	0.64	1.4	1.12	1.12	0.61	0	0	0	0
NO_3^-	mg/ℓ	11.13	21.16	6.3	5.04	3.9	1.6	0.21	0.47	0.21	0.88
PO_4^{---}	mg/ℓ	4.77	4.22	3.27	2.94	3.45	3.76	4.31	4.12	5.02	5.87
F^-	mg/ℓ	0.40	0.66	0.22	0.25	0.33	0.66	0.44	0.79	0.66	0.66
Cl^-	mg/ℓ	58	66	46	48	48	560	568	522	576	360
SO_4^{--}	mg/ℓ	98	98	90	94	94	97	101	98	105	120
Det.	mg/ℓ	3.4	0.3	0	0	0.4	0	0	0	1.1	1.9
CN^-	mg/ℓ	0.001	0.003	0	0	0	0	0.001	0	0.001	0
Cd	ppb	18.4	0.8	7	6.2	5.4	1.6	4.5	6	2	1
Co	ppb	2.5	2.8	1.2	± 1	2	1.2	< 1	1.5	1.5	2
Cr	ppb	15	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Cu	ppb	9	7	9	6.5	34	2	2	17	6.5	2.5
Fe	ppb	600	700	550	350	470	2500	2170	2230	2000	2000
Hg	ppb	± 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	± 0.01	< 0.01	0.05	0.06
Mn	ppb	< 20	27	< 20	< 20	< 20	31	115	238	54	285
Ni	ppb	50	75	38	30	34	63.5	75	120	25	26
Pb	ppb	44	44	36	20	38	14	26	26	36	18
Zn	ppb	70	70	50	70	45	70	70	70	50	60
Index		3.7	3.5	2.8	2.5	2.8	4.7	4.5	6.1	5.6	6.9

Table 5.26

WATERS

Espierres

		Estaimpuis		Espierres		
		5-73	10-73	1-72	5-73	10-73
O_2	%	23.2	0	-	2.1	2
COD	mg/ℓ	1410	1740	2980	500	1552
BOD	mg/ℓ	680	475	680	400	340
MS	mg/ℓ	1260	1500	1340	630	1320
N_{tot}	mg/ℓ	8.7	52.3	23.5	8.6	32.6
N_{amm}	mg/ℓ	5.8	25.7	4.2	5.6	13.8
NO_2^-	mg/ℓ	10.1	0.14	-	0.08	0.16
NO_3^-	mg/ℓ	4.08	0.18	4.9	0	0.24
PO_4^{---}	mg/ℓ	22.2	103	13.8	0.4	114
F^-	mg/ℓ	8.3	125	0.1	1.8	125
Cl^-	mg/ℓ	180	314	424	176	232
SO_4^{--}	mg/ℓ	810	349	440	668	488
Det.	mg/ℓ	6.8	5.6	4.3	5.1	3.9
CN^-	mg/ℓ	0	0	0	0	0
Ø OH	mg/ℓ	0.65	pos.	0.41	1.5	pos.
Ag	ppb	< 2	-	-	< 2	-
Cd	ppb	40	6	-	8.7	11
Co	ppb	6	22	10	5	117
Cr	ppb	8300	1161	12000	2060	2096
Cu	ppb	84	92	150	53	212
Fe	ppb	500	3770	270	172	8580
Hg	ppb	< 0.05	-	0.33	< 0.05	-
Mn	ppb	380	218	615	490	424
Ni	ppb	58	107	47	15	427
Pb	ppb	4	55	66	24	40
Zn	ppb	81	84	80	59	187

We have sampled the whole course of the Dyle in a very detailed manner.

That river has a low pollution level at its source, but it increases quickly after passing through industrial areas especially in Ways, Gastuche and Florival. Besides a toxic effect on aquatic life can be detected in those places. A second pollution area starts in Leuven and goes on till the entrance of Mechelen where a clear degradation of the situation can be observed. This degradation increases in a continuous way from below the Demer up to the confluence with the Senne.

The outlines of the organic and microbiological pollution are remarkably parallel on the whole course of the Dyle.

Finally a linear increase of the pollution due to pesticides can be observed up to Leuven with a stabilization downstream. A battery works situated in Florival is responsible for the high concentrations of Pb that are found downstream.

Finally the situation in the Scheldt seems to deteriorate again with time as a decrease was noted in 1973 compared to the situation observed in 1971.

2.2.2.- Sediments

The study of the sediments of the Scheldt (from the French border to Zwijnaarde) and of the suspended matters (from Wetteren to Doel) has enabled us to determine the development of the pollution all along the river, as well as the pollution of some affluents. Low amounts in pollutants are observed at the French border and at Warcoing and they increase below the confluence with the Espierres, an indubitably polluted river, and particularly at Kerkhove. The amounts decrease at Zwijnaarde.

The study of the suspended matters, below Gent, shows that the amounts of pollutants increase after the confluence point with the Dender at Temse. At Hoboken, a slight decrease of the pollution can be noted in spite of the industrialisation of the river banks and of the contribution of the Rupel waters. The amounts in pollutants decrease very strongly at Doel.

A sampling campaign of sediments has been carried out all along the Scheldt; it will give a better idea of the river pollution, especially below Gent.

Table 5.27

SEDIMENTS

Scheldt (Vaulx to Zwijnaarde)

Chemistry		Number	Min	Max	$\overline{X}$	Locations of the maxima
< 37 μ	%	4	24	66	52.5	Warcoing
P/F 110 - 550 °C	%	4	1.8	9.9	4.45	Kerkhove
P/F 550-1000 °C	%	4	3	8.5	5.4	Kerkhove
Org.M.($K_2Cr_2O_7$)	%	4	2.5	11	5.3	Kerkhove
Al_2O_3	%	5	3.7	8.9	6.9	Warcoing
Fe_2O_3	%	5	1.6	3.3	2.7	Vaulx
TiO_2	%	5	0.2	0.6	0.47	Warcoing
P_2O_5	%	2	0.5	0.66	0.59	Kerkhove
CaO	%	5	2.6	11.2	6.95	Helkijn
MgO	%	5	0.3	0.9	0.58	Warcoing
K_2O	%	5	1.1	1.8	1.47	Kerkhove
S_{tot}	%	4	0.1	0.54	0.38	Vaulx, Zwijnaarde
Co	ppm	5	2	8	5	Kerkhove
Cr	ppm	5	54	> 1000	332	Kerkhove, $\overline{X}$ on 4 samples 1 sample > 1000
Cu	ppm	5	54	> 80	35	Kerkhove, $\overline{X}$ on 4 samples 1 sample > 80
Ga	ppm	5	4	9	6	Kerkhove
Hg	ppm	4	0.09	1.28	0.4	Kerkhove
Mn	ppm	5	230	414	342	Kerkhove
Ni	ppm	5	12	37	25	Kerkhove
Pb	ppm	5	24	571	187	Kerkhove
Sn	ppm	5	5	25	14	Helkijn
Sr	ppm	5	54	679	208	Kerkhove
V	ppm	5	14	40	31	Kerkhove
Zn	ppm	5	61	1750	501	Kerkhove
Zr	ppm	5	250	490	421	Helkijn
Crude	$\frac{m\ell}{100g}$	5	0	0.376	0.09	Helkijn

Cl, Ag, Be, Bi, Cd, Ge, Li, Mo, Sb, Tl : < detection limit.

Table 5.28

SUSPENDED MATTERS

Scheldt (Wetteren to Doel)

Chemistry		Number	Min	Max	$\bar{X}$	Location of the maxima
P/F 110-550°C	%	4	7.5	15.3	11	Wetteren
Al_2O_3	%	3	1.2	14.5	9.04	Hoboken
Fe_2O_3	%	3	1.1	7.5	5.27	Temse
TiO_2	%	3	0.1	0.8	0.56	Temse
P_2O_5	%	4	< limit	1.5	1.23	Wetteren, $\bar{X}$ on 3 samples
CaO	%	3	0.5	4.2	2.26	Hoboken
MgO	%	3	0.7	1.7	1.2	Hoboken
K_2O	%	3	0.3	2.3	1.6	Hoboken
Ag	ppm	4	0.3	7.3	3.3	Temse
Co	ppm	4	< 0.4	14	10	Temse, $\bar{X}$ on 3 samples
Cr	ppm	4	25	1185	470	Wetteren
Cu	ppm	4	6	> 190	-	Hoboken, 3 samples > 60
Ga	ppm	4	1	14	7	Temse
Mo	ppm	4	< limit	10	6	Temse, $\bar{X}$ on 3 samples
Mn	ppm	4	36	448	291	Temse
Ni	ppm	4	4	109	52	Temse
Pb	ppm	4	30	385	189	Temse
Sb	ppm	4	< limit	48	48	Hoboken, $\bar{X}$ on 2 samples
Sn	ppm	4	3	25	16	Hoboken
Si	ppm	3	50	125	95	Hoboken
V	ppm	4	7	177	76	Temse
Zn	ppm	3	125	1600	947	Temse
Zr	ppm	4	12	176	120	Temse

Be, Bi, Cd, Ge, Ni, Tl : < detection limit.

Where affluents are concerned, the Espierres has particularly drawn our attention. Sediments have been sampled just before the confluence with the Scheldt, and they confirm the results of the first sampling : the Espierres is highly polluted especially in Cr .

Table 5.29

SEDIMENTS

Espierres

Chemistry		January 72	June 73
< 37 μ	%	30.5	42.3
P/F 110 - 550 °C	%	11.06	10.7
P/F 550-1000 °C	%	6.42	6.6
Org.M.($K_2Cr_2O_7$)	%	14.43	14.5
Al_2O_3	%	7.21	7.82
Fe_2O_3	%	2.88	4.16
CaO	%	7.9	8.19
K_2O	%	1.16	1.08
S_{tot}	%	1.75	2.56
Ag	ppm	2	4
Ba	ppm	-	233
Bi	ppm	< 20	8
Co	ppm	13	25
Cr	ppm	> 2000	> 2000
Cu	ppm	> 85	> 120
Ga	ppm	4	10
Hg	ppm	0.37	0.19
Mn	ppm	410	230
Ni	ppm	28	52
Pb	ppm	149	220
Sn	ppm	46	20
Sr	ppm	140	-
V	ppm	30	48
Zn	ppm	1500	985
Zr	ppm	420	310
Crude	$\frac{m\ell}{100g}$	-	0.32

Cl, Be, Cd, Ge, Mo, Sb, Tl : < detection limit.

The suspended matters of the Dender are also polluted, especially in Co and Cr ; much Mo and some Sb can be found in them.

The suspended matters from the Rupel are less charged in pollutants; nevertheless the amounts in Ni , Cu , Pb , Zn and Sb are high.

The Grande Gete and the Dyle, affluents of the Rupel, have also been selected for sampling of sediments. Sediments of the Grande Gete taken above and below sugar-works have not shown any possible influence due to these industries.

The study of the Dyle is in progress.

2.3.- Basin of the Yser

The research works that have been performed have been published : *De Yser, Inventaris van de waterverontreiniging in het stroomgebied van de Yser* (IHE-IRC), pp. 1-105, November 1973.

The situation in the Yser basin has been established by means of the following data :

1) the hydrographical situation;

2) the sources of pollution in the catchment area of the Yser and its affluents;

3) the study of the river water itself. The following parameters have been determined :

a) physical and chemical determinations : the parameters indicating organic waste charge, toxic substances and heavy metals;

b) pesticides : organochlorine, organophosphorus- and carbamate compounds;

c) hydrobiological determinations : the plankton, organism-development on glass microscope slides, toxicity tests;

d) bacteriological indicators of faecal pollution;

4) the study of sediments and suspended matter :

a) physico-chemical analysis : granulometry, macroscopic observations, ignition losses, mineralogy;

b) chemical analysis : organic substances, hydrocarbons and trace elements.

From the data of this inventory study on the pollution of the Yser some obvious conclusions can be made :

1) In the Yser itself no significant indication can be found about a true pollution by toxic substances, neither in the water nor in the sediments. However pesticide contents are higher than in most surface waters, they never exceed a "tolerance limit", whatever criterium is used from the literature for evaluating this.

At their confluence, the affluents of the Yser do not show any indication of possible sources of toxic substances upstream that would be able to exert a negative influence on the situation in the Yser itself.

2) Some important sources of organic pollution were clearly revealed : the sewage of Roesbrugge, the Eurofreez factory (discharging until 1970 in Roesbrugge's sewage and from 1970 through the Haringebeek), the city of Diksmuide via the "Handzamevaart" channel. As a consequence of the very minor currents their influence is very local, but nevertheless very pronounced, going as far as the development of an anaerobic situation at these sites.

3) The nutrient content of the Yser along its whole traject is extremely high, with phosphate values between 10 and 20 mg/ℓ .

From a review of the domestic, industrial and animal waste in the whole Yser basin in our country a relative importance of 1.4 and 20 respectively can be derived for the number of equivalents per inhabitant for these three sectors.

Knowing that the mineralisation of animal waste leads to important quantities of nitrate and phosphate, this could already be a first explanation for the high figures found for these nutrients in the Yser.

Moreover, the Heidebeek tributary has a very high charge in phosphates coming from France (up to 50 mg/ℓ).

A third reason for the very high "input" of nutrients in the Yser should be found in the high agricultural development of this region.

In order to be able to make an evaluation of the possible drainage of nitrogen and phosphorus from the land, data of an OECD paper giving the run-off as a function of the different cultures and surface conditions have been used.

4) The hydrobiological research data clearly reveal a eutrophication in the whole Yser, which is related with these high nutrient levels. Actually the trophic level is already beyond the eutrophication stage ("hypertrophy") and typical phenomena of autogeneous pollution occur, *i.e.* algal blooms, anaeroby, decomposition gases. In this the true reason for the deterioration of the Yser must be found. As it is a biological phenomenon showing cyclic characteristics depending on temperature, solar radiation, flow, salt content and other ecological factors this is undoubtedly the reason for the cases of massive fish-dying occuring regularly in this river.

5) From these previous conclusions it can be derived that the curing of the Yser is a question of combating the eutrophication phenomenon. This implicates :

a) a solution for the nutrient-inflow from France through the Heidebeek;

b) that the treatment process for domestic sewage in this region should include a so-called third step purification stage in order to obtain a maximum removal of the nutrients;

c) that the sewage waters from the cattle breeding especially those from the bio-industry should not be discharged without prior reduction of the nitrogen and phosphorus contents to an acceptable level;

d) an adaptation of the irrigation system when these curing measures do not lead to the desired results.

Indeed it is not impossible that from the use of fertilisers in periods of high rainfall the run-off of phosphorus and principally nitrogen compounds is too important for the low flow rate that is characteristic to the Yser. The water from the most important irrigation channels and brooks should then be collected to allow an efficient removal of these fertilisers.

3.- General synthesis

A short global synthesis is done here and some anomalies are mentioned. Other more complete synthesis are put ahead of the results.

3.1.- Sea

The results of the complementory campaign performed in 1973 confirm those obtained in 1972. The coastal sea zone, an immixtion zone, has a higher pollution state than the open sea, this pollution being far more marked eastwards, from and including Oostende. Where bacterial pollution is concerned, the influence of discharge outlets seems obvious.

For other pollution forms, it is not possible to specify the influence of the emittors on waters of the coastal area although these are usually far more polluted.

To estimate this influence is specially difficult, as the fairways' flow rates cannot be determined practically. In that field, it seems that the qualitative aspect only has to be considered. Some correlations have also been confirmed, for example those that have been noticed between the proportion of fine particles of a sediment and its pollution degree.

3.2.- Rivers — Complementory campaigns

As a whole, the results of complementory campaigns performed in 1973 lead to an increase of the number of data, to a better specification of the pollution state as described in 1972 and confirm the first results as well.

Are considered here : the very important pollution of the Scheldt, the Espierres pollution where amounts of Cr reach 3000 ppm , the presence of high amounts of Cd in the Vesdre and in sediments taken from some places of the Meuse (one of them being Chênée). The Yser case is fully developped in a study that has been published since; this river shows an advanced state of eutrophication.

3.3.- Rivers — New campaigns

The Mehaigne flows in a farming area and has a very low pollution in heavy metals. The pesticides content might be a bit higher than the usual average without being too high. This typical case of agricultural area will be better specified with a new campaign and with particular and more frequent samplings for Hg and the pesticides.

High amounts in Pb have been found in the Rulles (wood distillery); an increase of organic pollution (although it remains a low one) has been observed in the Ton (paper mills) but no anomaly in Hg could be detected.

High organic pollutions as well as pesticides such as lindane, heptachlore, DDVP, are found in the Dyle in the vicinity of Leuven. These pollutions change all along the river but they increase markedly towards the confluence point with the Demer, a particularly charged river. A local increase of the organic pollution is observed upstream at Gastuche (paper mills).

Irregularities in Pb and Fe can be detected in Florival (battery works); aquatic life does not exist anymore there but can be seen again a few kilometers downstream.

Those are very significant anomalies; expected or unexpected, it was necessary to specify their importance, in the frame of the general inventory.

The global view on the present pollution state of surface waters is therefore gradually completed.

4.- Conclusions

One hundred and fifty-nine significant locations have been studied for two years.

The ten thousand corresponding analytical data are easily available starting from the alphabetical list of waterways where the numbers of the result cards are noted for each river.

All the coordinates of time and space related to location and sampling are also noted on those cards (652 cards for water and 269 cards for sediments); they can be obtained by addressing either to the center for collecting data or to one of the participating Institutes. The interest of this inventory is obvious, not only on national but also on international ground.

For example, whenever an investigation has been made by the EEC or the OECD, we have always been able to give reference data for Belgium very quickly.

Other countries have undertaken similar studies. A first inventory called 'thousand points inventory' has just been performed in France; it has to be repeated during three consecutive years. This inventory is centered on the way of working of basin societies; flow rates are taken into consideration but fewer parameters are determined.

As the surfaces and the water volumes that are to be determined are relatively high, and the number of instantaneous samplings is rather low, a lack of representativity ensues, this being the main defect of the method.

Nevertheless, this way of proceeding seems to be the only one that leads to the knowledge of the pollution state of waters on the scale of the country, in a reasonable delay and with relatively modest means.

For this reason, the leaders of the project decided not to alter the chosen options as long as the inventory was not developped enough. Under some circumstances, the soundness of this choice may seem somewhat uncertain.

Actually, accurate steps in protection or in water treatment will never be based on the results of the inventory only.

In each separate case, more frequent and better locally distributed measurements will have to be repeated again. It will not be necessary to determine every parameter but we must be able to establish a correlation between analytical data and flow rates.

In the same line of idea, further measurements in the frame of this inventory should not perhaps be necessary if automated measurements networks were set up.

However, as a maximum of physical, chemical, bacteriological and hydrobiological parameters is measured and as the studies of sediments and water are done concurrently by means of the same methods for each significant location, together with great adaptability of the works organisation, the results have a particular scientific quality and an exceptional comparative value which is the very characteristic of this inventory.

The choice of many locations and the arrangement of results by regions are particularly easy for a better determination of the pollution state of the whole hydrographical network and of the sectorial influences as integrated in each river.

Even if the knowledge of pollution states involves political and economical implications, or if arrangements are to be taken practically, the main thing remains scientific information.

The Inventory Group endeavours to the performance of this task.