Chapter V

Inventory of the water- and sediment pollution

by

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The inventory of the coastal zone and of the rivers, realised in 1974, has been assembled in an advancement report composed of eleven parts, a summary of which is given in the next pages.

New activities

Mr and Mrs Van der Ben, of the Royal Institute for Natural Sciences, have been associated to the inventory work. This made the following extensions possible :

- the study of the phytoplanktonic biomass of the mixing zone of the sea;
- the study of the contamination of marine organisms, caught on four breakwaters of the Belgian coast (vegetal and animal macro-specimens , diatomea).

Pursued inventory

- further study of the coastal zone;
- new studies of the river Meuse and of some rivers of its hydrographic bassin; idem for the rivers Ijzer, Schelde and Sure;
- a particular study of the rivers at the frontier point, only according to the water analysis (twenty-six places);
- a study of sediments of the Ghendt-Terneuzen Channel is going on.

Circumstantial results

It should be noted that all the results, just as the informations according to the places and data of the sampling are put on slips; exemplars of them exist in the Data Compiling Center. The complete list of the slips, kept since the beginning of the inventory and classified in alphabetical order of the sampling places, are given, for the coastal zone and per hydrograph basin, in an annex to the present report.

Studies

In 1973, a monography has been devoted to the river Ijzer; a second, that will be published during the first trimester of 1975, will refer to the river Vesdre.

I

Coastal zone

1.- Emissions (towards the sea)

1.1.- Chemical study of the water

(Based on work by J. BOUQUIAUX, K. DE BRABANDER, C. BOELEN, R. DE BOECK, H. VANDEPUTTE, J. VAN DIJCK, Mrs VERHOEVEN - Staff of the Institute of Hygiene and Epidemiology of the Department of Public Health; Mr. BULTYNCK, director of the T.V.Z.A.K.)

The study of the emission of pollutants into the sea concerned in 1974 the composition of the sewage, thrown out by the drains of Blankenberge and Nieuport during the whole month of July.

When the results 1974 of Blankenberge are compared with those of the summer 1972, we find a remarkable similitude for the organic pollution; on the other hand, the concentration of metals in the water varies from one year to the other : in 1974, the Cu- and Pb-contents are beneath the detection-limit, those of Cr, which are very constant, approach the 20 ppb.

In Nieuport the water undergoes a primary epuration and the organic pollution is not as important as in Blankenberge; for the metal contents there is a similitude, except for Cr that has not been found in Nieuport. By extrapolation of the pollutant load of July 1974, it was possible to make a crude estimation of the pollutants that are annually trained off into the sea by the drains of Blankenberge and Nieuport.

Table 1

	Blankenberge		Nieuwpoort	
	t/day	t/year	t/day	t/year
BOD	1.82	664	0.59	219
COD	3.76	1372	2.42	883
Susp. mat.	1.90	693	1.63	594
N_{tot}	0.46	168	0.45	165
N_{amm}	0.42	153	0.44	163
NO_2^-	0.038	14	0.185	67
NO_3^-	0.041	15	0.197	72
PO_4^{---}	0.094	34	0.070	26
Cl^-	7.045	2573	1.50	549
SO_4^{--}	1.065	389	0.87	316
Det. an.	0.060	22	0.0012	4
Cd	$0.109\ 10^{-3}$	0.040	-	-
Cu	-	-	-	-
Fe	$2.504\ 10^{-3}$	0.914	$2.72\ 10^{-3}$	0.992
Hg	$< 0.002\ 10^{-3}$	-	-	-
Mn	$0.495\ 10^{-3}$	0.18	$0.229\ 10^{-3}$	0.084
Ni	-	-	-	-
Pb	-	-	-	-
Zn	$1.571\ 10^{-3}$	0.573	$1.458\ 10^{-3}$	0.532

1.2.- Bacteriology

(Based on work by Mrs DE MAYER, J. BARBETTE, J.P. DAUBY, J. DEMANET, J.M. SEBA - Institute for Hygiene and Epidemiology)

This year the control of the emissions of bacteriological pollutants in the North Sea was entirely devoted to the analysis of the material thrown out by the drains of Nieuport and Blankenberge during the month of July.

On the basis of 10 samples for Nieuport and of 11 samples for Blankenberge those samples are mean samples taken over a period of 3 days or 72 hours, we proceeded to a counting of total, coliform, faecal coliform and faecal streptococcic germs. The number of germs found in the samples varied very little during the sampling period. There is a remarkable similitude between the number of germs in July 1973 and 1974, as it appears from the following table concerning the situation in Blankenberge.

Table 2

(col./100 mℓ)

	July 1973	July 1974
coliform germs	10^9	5.10^8
faecal coliform germs	5.10^8	10^8
faecal streptococcic germs	10^6	5.10^6

It is nearly impossible to make a repartition of the number of germs per equivalent inhabitants, there is too big a fluctuation of the inhabitants of the two stations during the observation period, and this makes the comparison with a stationary population impossible. According to these results, the influence of the primary epuration in Nieuport is not very important. The difference with Blankenberge is maximum of a factor 10 and negligible with regard to the number of germs in the sewage.

It should be noted that each of the samples corresponds to 72 h of sampling; owing to the working conditions it is unfortunately impossible to make analyses every day.

1.3.- Sediments

(Based on work by P. HERMAN, R. VANDERSTAPPEN, K. MEEUS-VERDINNE, P. HANISET, J. ISTAS, J. CORNIL, G. LEDENT, R. VAN DER ZEYP, G. NEIRINCKX, H. STRUELENS, P. HEIMES - Institute for Chemical Research of the Ministry of Agriculture)

The deposits in sea of the outlets (sewage systems and channels) have been recalculated for the drains of Blankenberge and Nieuport. The pollution by material in suspension and, in some degree, by the decantation mud, is very variable in the time, nevertheless we find important Ag-, Ba-, Bi-, Cu-, Hg- and Sn-contents in Blankenberge and Nieuport. From one year to the other the Pb- and Zn-values vary from very low to very high. The comparison of samples, taken in Blankenberge in summer and in winter, taking into account the variations of discharge and of material in suspension, reveals that the Cr-, Ni-, Cu- and Sn-contamination is more important during the summer.

The pollution of the "Spuikom" (where the overflow of the drain-system is discharged in periods of floods) is closely related with that of the sea in front of Blankenberge (most polluted place of the coast; there is a greater pollution of organic matter, of total sulphur and especially of crude).

2.- Immixture (mixing zone in the sea)

2.1.- Chemical study of the water

(Institute for Hygiene and Epidemiology, cf. § 1.1)

The first five series of samples, taken at the usual 12 sampling points have been completed by two new series bearing the numbers 6 and 7 and also taken at the same points. From the seven series of results one may draw the following conclusions :

Profile of the dissolved oxygen :

- increasing from Oostduinkerke till Middelkerke
- decreasing from Mariakerke till Heist
- increases lightly in Knokke.

The *nitrate* contents of the stations in the SW of Ostend are considerably below the average value. In Ostend they approach this value while in the NE we always find higher values, the difference being sometimes very important (as in Heist, for example).

For *phosphates*, on the other hand, we find only small deviations from the general average, except in Knokke.

Table 3

Mean concentrations of nutrients
(general average for the coastal zone)

	Units	Min	Max	$\bar{X}$	$\bar{X}$ [1]
N_{tot} [2]	mg N/ℓ	1	2.5	1.67	1.67
N_{amm}	mg N/ℓ	1	0.47	0.17	0.17
NO_2^-	mg NO_2^-/ℓ	0.04	0.07	0.05	0.015
NO_3^-	mg NO_3^-/ℓ	1.99	6.89	3.98	0.90
PO_4^{---}	mg PO_4^{---}/ℓ	0.20	1.00	1.22	0.38

1 Mean expressed in mg N/ℓ of mg P/ℓ .
2 Total nitrogen : organic nitrogen + ammoniacal nitrogen, with the exception of nitrites and nitrates.

Table 4

Mean heavy metal concentrations (µg/ℓ)

	Min	Max	$\bar{X}$
Cd	<1	<1	<1
Cu	13	19	14
Fe	81	153	136
Hg	0.09	0.24	0.14
Mn	54	100	68
Pb	14	22	18
Zn	27	49	39

Remark : the measurements are carried out by A.A.S. on decanted no filtered raw water.

The remark concerning the phosphate concentration applies also to Cu- and Pb-concentrations for which the deviation of the general average is very small. Contrary to what has been observed for nitrates, heavy metals are generally homogeneously distributed all along the Belgian Coast.

Superficial and deeper waters

In order to estimate the possible divergence between the values found in superficial and deeper waters, we took four double samples, no significant difference has been found.

2.2.- Bacteriology

(Institute for Hygiene and Epidemiology, cf. § 1.1)

The report mentions the results found in four sampling points, spread over the Belgian coast. These points are Lombardsijde, Mariakerke, Heist and Knokke.

2.2.1.- Bacteriological situation in the different stations

With reference to the faecal coliforms, the greatest number of germs has been found in the zone of Mariakerke in February, April, June, October and November (superficial and deeper waters) and also in August (deeper water).

In Lombardsijde we observed a serious increase of the number of germs in April and September.

In Heist we found a very high number of germs (superficial and deeper waters) in February.

2.2.2.- Bacteriological evolution as influenced by sampling period

There are two main contamination periods, the first one in spring, the other one in October-November. As no samples have been taken in September and October in Heist and Knokke, it is impossible to draw a conclusion concerning these two points.. The number of germs, found in samples of deeper water, seems also to be greater than in superficial water. This difference could be ascribed to the influence of the tides and particularly of the current in this part of the water.

The same observations can be made concerning the number of faecal streptococci, which are unquestionable factors of human pollution.

In any case, the regularly most contaminated zone, from a bacteriological point of view, seems to be the zone of Mariakerke. Knokke, on the other hand, notwithstanding the two higher values in April and October (superficial water) and in October (deeper water), has a low faecal coliform content and seems to be the less polluted zone.

Table 5

Faecal coliforms in superficial water

Stations	Febr.	April	May	June	July	Aug.	Sept.	Oct.	Nov.
Lombardsijde	200	1980	< 10	50	< 10	< 10	1100	290	880
Mariakerke	1200	1700	< 10	600	50	60	550	1100	1600
Heist	8200	400	10	300	50	< 20	-	1400	-
Knokke	800	150	10	< 10	10	< 10	-	320	-

Table 6

Faecal coliforms in deeper water

Stations	Febr.	April	May	June	July	Aug.	Sept.	Oct.	Nov.
Lombardsijde	600	800	10	50	< 10	< 10	1600	420	1440
Mariakerke	2200	3900	< 10	500	100	20	700	1800	3800
Heist	2800	150	30	300	100	20	-	1750	-
Knokke	2200	50	10	< 10	40	10	-	350	-

2.2.3.- Conclusions

a) The precise mechanism that governs the bacteriological situation of the water depends on different factors :

- the permanent and/or sporadic coastal supply with sewage. Nevertheless, nothing allows us to say that the touristic season has an influence on the pollution of the sea;

- the bacteriological effect of the sea-water on non-resistant germs;

- the influence of the general content (physical, chemical and biological) on the resistant germs.

b) The western part of the Belgian coast is more polluted at the beginning of the year.

c) On the other hand, the central part, with Mariakerke and Heist, is more polluted in October.

3.- Organisms on the breakwaters

Samples of mussels, periodically taken on four breakwaters by Mrs. Van der Ben have been studied. The results of the analyses were very irregular and to draw conclusions it will be necessary to expect the results of new samplings.

3.1.- Biomass

(Based on work by Mrs VAN DER BEN and Prof. I. ELSKENS, V.U.B.)

Estimation of the chlorophyll content of the sea-water of the Belgian coast in connection with the evolution of silica and NH_4^+ , NO_2^- , NO_3^- and PO_4^{---} ions. Every month samples have been taken at four of the twelve stations and inventorized by the group : Lombardsijde, Mariakerke, Heist and Knokke, both in superficial and deeper water.

3.1.1.- Results and discussion

Comparison between the stations

Water samples rarely have the same chlorophyll concentration at all stations and those differences are unequal from one station to another. Only the April concentrations, in superficial water, are alike in the four sampling points.

In function of the sampling period, the stations of Lombardsijde and Mariakerke present, in superficial and deeper waters, a comparable evolution with two classical maxima, the first one in the spring, the other one at the end of the summer.

On the contrary, the graphics concerning Heist and Knokke are not classical at all; they do not present a spring peak in the superficial

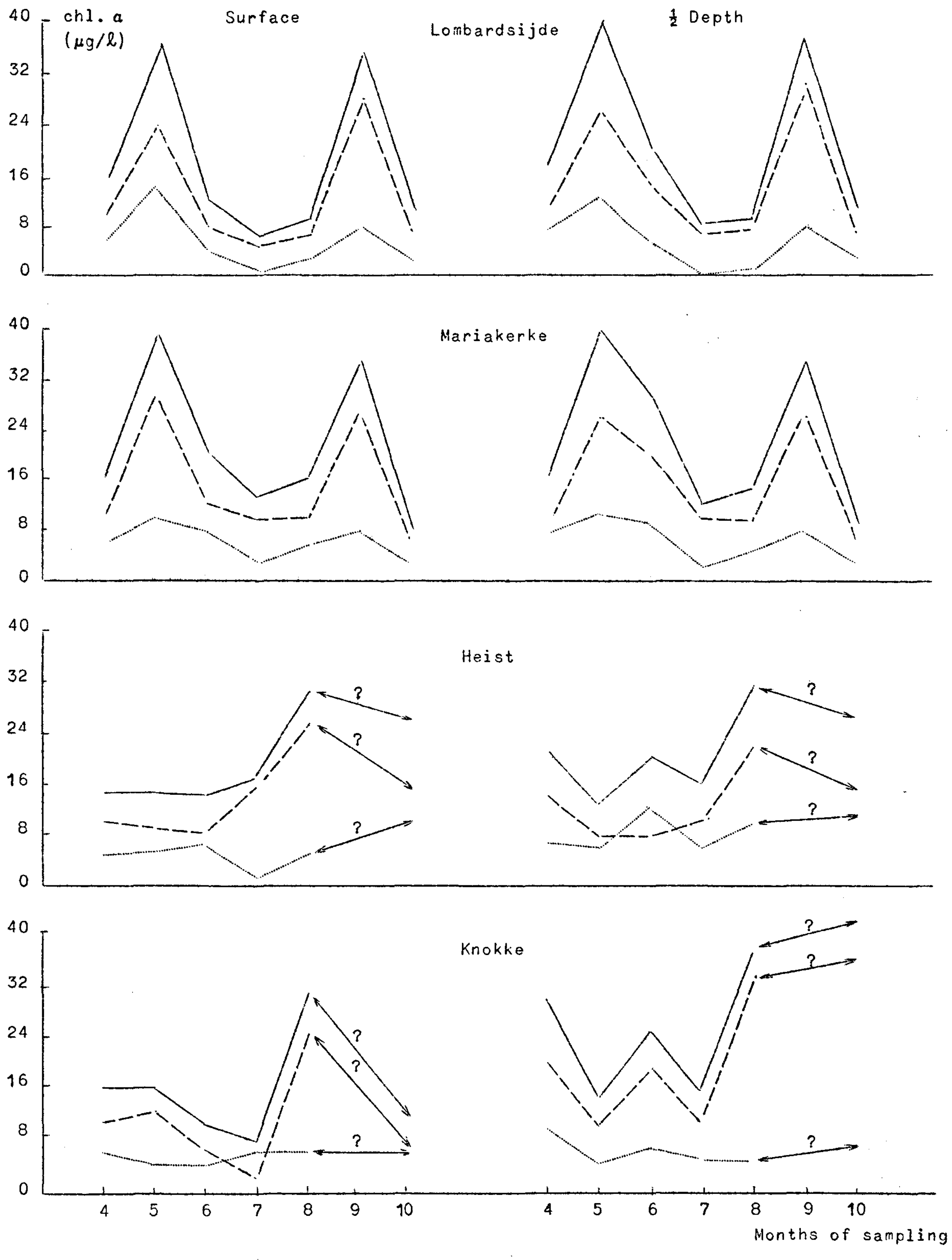

fig. 1.

Variation of the chlorophyll-a content between April and October 1974 (monthly campaigns).

——— total plankton – – – – net-plankton ········· nanoplankton water; the superficial water of Heist had a particularly constant chlorophyll content for the sampling period of April, May and June.

Comparison between the superficial and the deeper waters

The chlorophyll-a concentration coming from the total plankton are often greater in the deeper than in the superficial waters; the greatest differences are found in Knokke (April, June, July and principally October).

Comparison between the chlorophyll contents given by the nano- and net-plankton

The calculation of the chlorophyll-a concentration relations nanoplankton/netplankton, during the period April to August, led to very variable results : in 11 cases out of 40 this relation is nearly 0.5 . The other values vary between 0.5 and 6 on the one hand (13 cases out of 40) and between 0.5 and 0.1 on the other hand (16 cases out of 40).

3.1.2.- Chemistry

Globally, the general chemical situation of the waters, during the period April to August, may be described as follows :

Nitrates : important falling of the concentration between April and July, with local anomalies in Heist (deeper water) and Knokke (deeper water). The situation is less clear in August.

Ammonia : the ammonia-content falls lightly during the same period. August may be considered as a period with a low ammonia-content.

Nitrites are found everywhere in small quantities.

Phosphates : as for the nitrates they fall from April till July and vary in August. The phosphate content becomes a bit higher in all stations during the month of June (except in the deeper water in Lombardsijde and in the superficial water in Heist).

Silice : varies strongly according to the sampling period, but the variations are in the same way in all stations (except in Lombardsijde (superficial water) and Heist (superficial water), where the peak does not appear in June.

3.1.3.- Conclusions

As the number of campaigns does not even cover a complete annual cycle, it is evident that every serious interpretation of the results is impossible at this moment. Actually there seems to be a different behaviour of the water in the SW and the NE zones :

- in the SW-zone (Lombardsijde and Mariakerke), the chlorophyll content according to the sampling periods evolves on the classical way;
- in the NE-zone (Heiste and Knokke) this evolution seems to be subjected to important perturbations.

3.2.- Organisms on the breakwaters

(Mr. VAN DER BEN; I.C.R.: quantitative analyses of heavy metals; I.H.E.: bacteriology and pesticides)

Four campaigns with, for each of them, collecting of seven organisms on four breakwaters (Nieuport, Raversijde, Heist and Knokke).

3.2.1.- Collected organisms

1) Plants : green algae : *Ulva lactuca* L.
brown algae : *Fucus spiralis* L.
red algae : *Porphyra umbilicalis* (L.)
diatoms : *Navicula grevillei* AG. and *Navicula mollis* SM mixed (Diatoms of the "Schizonema-type")

2) Animals : starfish : *Asterias rubens* L.
mussels : *Mytilus edulis* L.
winkles : *Littorina littorea* L.

At this moment we cannot take into consideration the diatoms (Navicula) and starfish, samples of them having been taken only once.

3.2.2.- Results and discussion

a) Only the results concerning the analysis of the specimen caught during the first three campaigns were available at the end of 1974 and are discussed in this paper.

Table 7

	Hg				Cu			
	n	min	max	$\bar{X}$	n	min	max	$\bar{X}$
Ulva lactuca	12	0.03	0.23	0.13	12	5.8	12.5	8.3
Fucus spiralis	6	0.03	0.22	0.08	6	2.3	7.7	5.3
Porphyra umbilicalis	3	0.03	0.03	0.03	3	10.1	34.4	22.1
Navicula	1	-	-	0.21	1	-	-	85.9
Asterias rubens	1	-	-	0.34	1	-	-	6.1
Mytilus edulis	12	0.14	0.77	0.45	12	6.3	20.6	9.7
Littorina littorea	13	0.13	0.41	0.24	13	40.1	138.7	62.7

	Pb				Zn			
	n	min	max	$\bar{X}$	n	min	max	$\bar{X}$
Ulva lactuca	12	3.13	13.88	6.39	12	24.2	89.5	45.5
Fucus spiralis	6	1.13	8.12	4.58	6	95.4	328.4	192.6
Porphyra umbilicalis	3	2.03	3.66	2.79	3	67.0	140.3	103.16
Navicula	1	-	-	20.4	1	-	-	127.4
Asterias rubens	1	-	-	3.9	1	-	-	210.2
Mytilus edulis	12	4.30	14.13	6.97	12	120.5	316.9	191.2
Littorina littorea	13	0.51	4.42	2.78	13	46.8	134.9	79.03

The lowest mean contents are always found in plant (material : Hg and Pb in *Phorphyra*, Cu in *Fucus*, Zn in *Ulva*; the highest mean contents are especially detected in animal material : Hg, Pb and Zn in mussels, Cu in winkles (which naturally contain copper in their hemocyanine). Nevertheless, two high means are found in plants : Pb in *Ulva* and Zn in *Fucus*.

b) When we only consider the plants (Naviculae excepted) we find the highest concentration of elements that do not play a physiological role (Hg and Pb) in *Ulva lactuca*; we find the lowest concentration in *Porphyra*.

c) When we only consider the animals, mussels have the highest concentrations of those two metals.

These results are discussed in function of the literature and the water- and sediment-contents of the same coastal zone.

3.2.3.- Tentative of conclusions

- The absolute levels, found for Hg, Cu, Pb and Zn are superior to what could be considered as normal, but do not seem to be excessive. Nevertheless a comparison with the literature is difficult due to the different levels of drying.

- The increasing contamination from the SW to the NE-stations, detected by the other teams of the Inventory Group, is found again in the organism, with a greater contamination however in Heist (Leopold channel) than in Knokke where some minima are revealed.

- Heavy metals are strongly concentrated by the organisms and truly reflect the situation of those metals in the water, especially with regard to the elements that do not play a physiological role. The best contamination detection are the algae. The species that should be specially studied are *Ulva lactuca*, *Fucus spiralis*, *Porphyra umbilicalis* and *Mytilus edulis*.

- Concerning the bacteria in the mussels and the pesticides in *Ulva lactuca* it is necessary to wait for more results.

3.3.- Sediments

(I.C.R., cf. § 1.3)

The pollution degree of the coastal zone and the correlation between this pollution and the proportion of fine particles of sediments have been confirmed. The part of the coast NE from Ostend is more polluted (especially Blankenberge and Ostend). On the whole, the sediments, samples of which have been taken in 1974, include less fine particles and since the pollutant contents are relatively lower than the preceeding years. Sediment pollution in the neighbourhood of the breakwater, also function of the quantity of fine particles, is very small.

Table 8

Sediments - Synthesis of the results
Coastal zone (immixture)
(6 campaigns from 1971 till 1974)

	Units	n	min	max	$\bar{X}$
< 37 µ	%	67	0	92	42.06
P/F : 110 - 550 °C	%	66	0.21	15.41	4.29
550-1000 °C	%	66	1.44	16.95	7.20
Org. mat. ($K_2Cr_2O_7$)	%	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	62(17)	< limit	2	0.7
Ba	ppm	7	56	140	110
Bi	ppm	65(63)	< limit	16	10
Co	ppm	65	0.3	14	3
Cr	ppm	65	4	120	42
Cu	ppm	65	0.6	58	14
Ga	ppm	65	0.8	22	6
Ge	ppm	65(20)	0.7 !!	8	3 !!
Hg	ppm	57	0.01	1.77	0.48
Mn	ppm	65	70	1488	496
Ni	ppm	65	0.4	27	11
Pb	ppm	65	10	280	80
Sn	ppm	65	0.3	18	7
Sr	ppm	54	115	660	301
V	ppm	65	0.8	105	29
Zn	ppm	65	15	271	120
Zr	ppm	65	33	370	176
Crude	mℓ/100g	96	0	0.22	0.008

Be, Cd, In, Li, Mo, Sb, Tl : inferior to the detection limit.
() : number of results used for the calculation of the mean value.

Table 9

Comparison of the sediments classified according to their granulometry
(6 campaigns from 1971 till 1974)

	Un.	Sand				Mud				Remarks
		n	min	max	$\overline{X}$	n	min	max	$\overline{X}$	
Org. mat.	%	18	0	0.8	0.2	36	1.02	58	3.4	
Al_2O_3	%	18	2.3	4.5	1.2	34	5.7	10.8	7.73	2 samp. mud : 3.16 & 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	*
S_{tot}	%	17	0.02	0.32	0.11	36	0.38	1.27	0.89	1 samp. sand : 0.48
Co	ppm	26	0.3	2	1	39	2	14	4	
Cr	ppm	26	4	23	12	39	32	120	56	
Cu	ppm	26	0.6	10	2	39	4	58	22	
Ga	ppm	25	0.8	3	2	39	3	22	8	1 samp. sand : 12
Hg	ppm	18	0.01	0.28	0.08	37	0.11	1.77	0.68	2 samp. sand : 0.38 & 0.45
Mn	ppm	26	70	330	126	39	230	1500	725	
Ni	ppm	25	0.4	7	3	39	4	27	16	1 samp. sand : 15
Pb	ppm	25	10	39	22	39	40	280	120	1 samp. sand : 59
Sn	ppm	24	0.3	4	2	39	1	18	9	2 samp. sand : 16 & 7
Sr	ppm	17	115	220	147	39	223	660	382	1 samp. sand : 240
V	ppm	26	0.8	17	7	39	17	105	44	
Zn	ppm	16	15	61	38	35	60	271	166	2 samp. sand : 178 & 217 1 samp. mud : 36
Zr	ppm	26	33	270	138	39	88	370	201	*

* For K_2O and Zr : partition less sharp.

II

Rivers

1.- Hydrographic basin of the river Meuse

1.1.- Chemistry of the water

(Institute for Hygiene and Epidemiology, cf. § 1.1, part I)

1.1.1.- River Meuse at the Dutch frontier

According to the analyses effectuated up to this day, the Meuse at the point where it leaves Belgium, carries an organic charge that may become important at certain moments, and a rather large quantity of nutrients. The large fluctuations of the chloride and sulphate contents are probably due to an up-river pollution. The metal-pollution is rather important; the Cd-content is, moreover, alarming owing to the high toxicity of this metal; the Fe- and Zn-contents are nearly always very high. The pesticide concentrations are low.

1.1.2.- Other frontier-points

In 1974 we started a study of all the frontier points.

1.1.3.- Tributaries

The *direct tributaries of the river Meuse* have characteristics that are similar to the characteristics of the Meuse in Hastière. None of them presents pesticides in demonstrable quantities. They are weakly or not polluted, except a light organic charge in the Semois.

The same situation appears in the *tributaries of the Sambre* (except that in these we find traces of lindane), while the *Sambre*

Table 10

Frontier points - Bassin of the Meuse

	Date	O_2 %	COD mg/ℓ	BOD mg/ℓ	S.M. mg/ℓ	N_{tot} mg/ℓ	N_{amm} mg/ℓ	NO_2^- mg/ℓ	NO_3^- mg/ℓ	PO_4^{---} mg/ℓ
French frontier - Meuse and tributaries										
Houille in Felenne	10-06-74	102.7	4	5.6	12	4.1	0.05	-	0.90	0.40
Viroin in Mazée	10-06-74	85.2	11	0.3	4	2.1	0.05	-	1.92	0.67
Meuse in Hastière	10-06-74	100	15	5.0	16	3.4	< 0.005	-	1.05	0.15
Semois in Bohan	24-06-74	98.9	18	16.8	20	-	0.05	0.04	0.77	0.89
Sambre and tributaries										
Hantes in Leval Chaudev.	11-06-74	87.1	11	7.5	12	4.2	0.26	0.26	11.3	0.52
Hantes in Montig. St-Chris.	11-06-74	100.9	18	6.5	16	3.3	0.05	0.14	10.3	0.46
Thure in Bersillies	11-06-74	87.1	7	5.7	12	3.4	0.23	0.26	10.8	0.95
Sambre in Erquelinnes	11-06-74	24.5	33	8.0	12	4.7	2.01	0.04	0.07	1.07
Chiers and tributaries										
Ton in Lamorteau	24-06-74	50.1	134	5.2	30	-	0.57	0.29	2.62	2.15
Chiers in Torgny	24-06-74	49.5	7	4.4	15	-	0.19	0.55	7.87	0.67
Ton in Harnoncourt	24-06-74	77.5	4	9.7	15	-	0.43	0.28	3.97	1.17
Dutch frontier - Meuse and tributaries										
Geer in Kanne	25-06-74	-	17	10.7	10	4.0	3.30	0.05	0.03	4.08
Geer in Kanne	18-07-74	77.4	16	5.0	10	9.4	9.40	<0.01	4.2	37.7
Warmbeek in Achel	18-07-74	86.1	24	7.0	15	7.1	7.1	<0.01	< 0.01	1.23
Warmbeek in Achel	01-10-74	89.7	24	4.5	-	3.3	0.18	0.17	12.4	0.28
Itterbeek in Kinrooi	01-10-74	119.2	10	3.3	-	7.8	0.17	0.17	16.65	0.28
Dommel in Neerpelt	19-06-74	85.6	21	4.2	40	2.2	0.57	0.31	3.90	1.72

itself has an important organic charge and a deficit of dissolved oxygen; this is confirmed by the presence of free ammonia, representing more than 40 % of the total nitrogen.

In January of this year we took a new series of samples in the *Rulles*, the *Laclaireau* and the *Ton*. The influence of the paper-mill of

Table 10

(continuation)

	Cl^- mg/ℓ	SO_4^{--} mg/ℓ	Det.an. mg/ℓ	Cd ppb	Co ppb	Cr ppb	Cu ppb	Fe ppb	Hg ppb	Mn ppb	Ni ppb	Pb ppb	Zn ppb
French frontier - Meuse and tributaries													
Houille	8	14	0	< 1	< 5	11	8	300	0.15	40	6	13	85
Viroin	16	22	0	< 1	< 5	10	< 5	270	<0.01	55	16	22	175
Meuse	20	42	0.08	1	< 5	17	< 5	420	<0.01	92	12	5	237
Semois	10	16	0.16	-	-	13	-	-	0.24	95	-	-	70
Sambre and tributaries													
Hantes	24	28	0.08	< 1	< 5	< 5	< 5	390	<0.01	40	< 5	< 5	187
Hantes	22	34	0	< 1	< 5	< 5	< 5	120	<0.01	40	12	< 5	200
Thure	16	30	0.05	< 1	< 5	9	< 5	260	<0.01	71	< 5	< 5	225
Sambre	34	64	0.12	< 1	< 5	10	9	200	<0.01	128	8	< 5	235
Chiers and tributaries													
Ton	152	128	0.17	-	-	13	-	-	0.19	550	-	-	100
Chiers	44	44	0.04	-	-	17	-	-	0.13	145	-	-	70
Ton	12	96	0.15	-	-	8	-	-	0.03	35	-	-	240
Dutch frontier - Meuse and tributaries													
Geer	44	68	0.03	2.2	< 5	22	7	2300	<0.01	95	48	13	130
Geer	106	68	0.18	1.3	< 5	2.5	2.5	75	<0.02	36	17	17	225
Warmbeek	82	83	0.25	< 1	< 5	2.5	4.5	1280	<0.02	80	26	15	250
Warmbeek	46	98	0.04	< 1	< 5	< 0.5	5	960	0.03	250	< 3	6	120
Itterbeek	38	56	0.03	< 1	< 5	< 0.5	< 2	590	0.03	60	< 3	< 4	40
Dommel	46	58	0.04	5.4	1	29	8.4	380	0.21	75	16	10	1230

Harnoncourt on the pollution level of the *Ton* is evident. It is expressed by a considerable increase of the organic charge and of the chlorides-, sulphates- and Mn-concentrations, by an oxygen deficiency, and also by the presence of 80 ng/ℓ of lindane and of 12 ng/ℓ of its δ isomer.

The conclusions drawn concerning the *Rulles* in 1973, saying that this river was clear, are confirmed by the new samples. Downstream the *Mellier*, on which a wood distillery has been constructed, we find small quantities of phenol-products.

In December 1973 new series of samples has been taken in the *Mehaigne*. For the two campaigns we find a small organic pollution that increases in Ambresin and Huccorgne. The oxygen-saturation is only lightly affected by this pollution. The nitrates are very high on the whole flow of the river, except in the neighbourhood of Ambresin where they decrease, especially in spring. We never found high phosphate concentrations. In winter we note higher chloride-concentrations and also an important increase of sulphates. Important lindane-concentrations have been found, especially in Branchon, as in 1973.

This year a very detailed study has been made of the *Vesdre*. The results of this study will be published in a special report.

At the frontier with the Netherlands, two series of results refer to the *Yeker* and the *Warmbeek*. In July the *Yeker* is strongly polluted by nutrients (39 mg/ℓ of NO_3^-), while in June the nutrient pollution is more normal; the Fe, Ni and Cr-contents allow to suppose a contamination by a discharge. Pesticides are not found in it. The *Warmbeek* presents a light organic pollution and a small concentration of lindane and of its α-isomer.

The *Itterbeek* is caracterized by a light supersaturation of dissolved oxygen and a rather high nitrates content, while the *Dommel* is principally polluted by Cd, Cr and Zn.

1.2.- Pesticides

(Mr. GORDTS and Mr VANDEZANDE : I.H.E.)

Some pesticides are not taken into account because they are not demonstrable in the basin of the river Meuse. It concerns Aldrin, Heptachlor, pp' DDT, DDE, DDD, α- and β-endosulfan, endrine, HCB and β-HCH.

No pesticides at all have been found in the *Laclaireau*, *Chiers*, *Semois*, *Houille*, *Thure*, *Sambre*, *Yeker*, *Dommel*, *Warmbeek* and *Meuse*. Attention must be drawn to the fact that only one sample has been taken on each river, at the frontier.

In the *Ton*, lindane has only been found in Harnoncourt (80 ng/ℓ).

An exception should be made for the *Mehaigne* where relatively high concentrations of lindane were found. From Huy to Ambresin the lindane-concentration increases linearly with a maximum of 840 ng/ℓ ; downstream from this place the concentration decreases and at the confluence with the *Meuse* we still find 60 ng/ℓ . We find a higher concentration in summer (840 ng/ℓ) than in winter (95 ng/ℓ). This is probably due to the fact that the river runs through an agricultural area.

Concerning the *Vesdre* we refer to the special report.

1.3.- Hydrobiology

(G. VAN HOOREN and H. DE SCHUTTER, I.H.E.)

1.3.1.- River *Meuse* at the French frontier

The new results of 22.9.1973, found in Heer, confirm a former conclusion, namely a low degree of pollution of the *Meuse* where it enters Belgium (*Mathematical Model, Annual Report, III,* chapter V).

1.3.2.- River *Meuse* at the Dutch frontier

Referring to the results of 1972-1973 (*Mathematical Model, Annual Report, III,* chapter V), the water of the *Meuse* is liable to periodical pollutions that are not necessarily related to seasons. After the small pollution period of July-August 1973, the situation is becoming worse and arrives at a maximum in December 1973, January, February and March 1974 (α-mesosaprobe). Then follows a restoration period till June 1974, ending with a moderate pollution.

1.3.3.- Tributaries

Ton and *Laclaireau* : the results of 1973 are confirmed, here too the *Laclaireau* is a pure river, but after its confluence with the *Ton* it is highly polluted in Dampicourt, a pollution that still increases in the neighbourhood of Harnoncourt (α-meso- till poly-saprobe).

Semois and tributaries : in the surroundings of Habay-la-Neuve the *Semois* is very pure. In Rulles, however, we observe an important pollution.

Mehaigne : this river presents the characteristics of an organic pollution. The situation varies between a moderate and a high pollution but is not alarming. The worst situation is observed in the neighbourhood of Mehaigne and the pollution degree decreases towards the confluence with the *Meuse*.

Vesdre : downstream from Eupen the *Vesdre* is little polluted. The saprobity index varies between a β-meso- and an α-meso-saprobe situation, according to the places and the data. In Pepinster, however, the pollution is important.

In general the results correspond with those found in 1972 (*Mathematical Model, Annual Report, III,* chapter V).

1.4.- Bacteriology

(Institute for Hygiene and Epidemiology, cf. § 1.1, part I)

1.4.1.- River *Meuse* at the Dutch frontier

In 1974 the *Meuse* has been examined three times on faecal pollution at the point it leaves Belgium.

Table 11

Dates	Places	Total germs /mℓ	Coliforms /100 mℓ	Faecal coliforms /100 mℓ	Faecal streptococci /100 mℓ
25-6-74	Lanaye	252.000	780.000	18.000	200
18-7-74	Lanaye	281.000	670.000	4.000	700
10-9-74	Lanaye	99.000	200.000	6.000	550

Compared with last year the pollution was much more important in June and July. At that moment a stem of Salmonella bredeney has indeed been isolated. On the contrary, the sampling of September indicates a considerable regression of the coliforms.

1.4.2.- Other points of river *Meuse*

As, for most of the points, we only dispose of one result, it is difficult to draw conclusions after this first year of sampling.

1.4.3.- Tributaries

We note, however, that the *Sambre* is considerably more polluted than the *Meuse*. On the *Hantes*, Salmonella panama has been isolated in Leval-Chaudeville.

Semois and *Chiers* are still little polluted.

Laclaireau and *Ton* : this year a new series of samples has been taken in the rivers *Laclaireau* and *Ton*. Such as last year the faecal pollution of *Laclaireau* is very small. After its confluence with the *Ton*, the pollution strongly increases; this appears specially in front of the paper-mill of Harnoncourt. Salmonella Typhi-murium has been isolated in Dampicourt.

The *Rulles*: at its source, the *Rulles* is little polluted; this pollution considerably increases from the distillery of Marbehan. In Marbehan, Salmonella infantis and S. brandenburg have been isolated.

The *Mehaigne* : this river presents an important pollution. There are more faecal streptococci than Esch. coli. Four stems of Salmonella have been isolated : S. manchester, S. brandenburg, S. worthington and S. derby.

At the Dutch frontier, the *Yeker* carries a lot of coliforms.

1.5.- Sediments

(Institute for Chemical Research, cf. § 1.3, part I)

The sediments of the rivers accumulate the pollution and generally this accumulation does not depend on the granulometry, contrarily to what is observed in the sea where the proportion of particles smaller than 37 µm gives an idea of the quantity of pollutants.

Among the sediments of the *Ourthe*, for instance, some of them, rather rough (45 %, < 37 µm), are very polluted (Angleur), while others, very small (85 %, < 37 µm), are considerably less polluted (Chênée).

It is worth remembering that there exists a very good concordance between the conclusions drawn from the water analysis (instantaneous pollution) and those drawn from the sediments (integrated pollution).

1.6.- Research work

1.6.1.- River *Meuse*

According to the degree of pollution, the course of the *Meuse* has been divided into three parts (*Mathematical Model, Annual Report, III*).

a) from Heer (French frontier) to Tihange : small pollution;

b) from Flémalle-Haute to Herstal : highest degree of pollution (region of Liège, confluence with the Ourthe);

c) downstream from Herstal : the pollution decreases but does not reach the degree of the first section again.

1.6.2.- Frontier points

The new results concern the frontier points of the course of the *Meuse* : Heer and Lanaye. They confirm that the *Meuse* is more polluted when it leaves our country than when it enters it.

1.6.3.- Tributaries

This year several tributaries have been studied : *Laclaireau, Ton, Rulles* (tributary of *Semois*), *Mehaigne, Ourthe* and *Vesdre*. The study of *Laclaireau* and *Ton* allowed to say that a paper-mill had little influence on the pollution of sediments, except on Mn (the water analysis revealed on organic pollution and a higher Fe- and Mn-concentration). The pollution of the sediments in the *Ton* is due to its tributary the *Chavette*.

Rulles : the contribution to the sediments of the *Rulles* from the *Mellier*, a tributary contaminated by a wood saw-mill, is very clear, although of rather little importance : crude, Pb, Hg, total S, Cu, organic matter. The analysis of the water samples, taken at the same place (downstream from the confluence), reveals only an increase of the COD.

The little degree of pollution of the sediments of the *Mehaigne* is constant on the whole course of the river, just as that of the water, except in the neighbourhood of its confluence with the *Meuse* (sugar works) where we find small Sn, Zn and crude-contents in the sediments.

The sediments of the *Ourthe*, polluted upstream from its confluence with the *Vesdre* (among others by Cr), undergo the influence of this affluent particularly for Cd, Cu, Hg, Zn and crude, the contents of which reach record levels. There is also a considerable increase of water pollution, especially when the metal concentrations are concerned.

The pollution of the *Vesdre* justified a more detailed study for the whole course of this river. In 1974 the number of samples has been multiplied in order to make it possible to publish a report similar to that made for the Yser. This study will group the results of the inventory since 1972, the nature of the activities and the characteristics of the hydrographic basin. The study will be published at the beginning of 1975.

2.- Hydrographic basin of the river *Scheldt*

2.1.- Chemistry of the water

(Institute for Hygiene and Epidemiology, cf. § 1.1, part I)

2.1.1.- River *Scheldt* and tributaries at the French frontier

At the French frontier, several small tributaries, such as the *Grande Honnelle*, the *Aunelle*, the *Hogneau* and the *Trouille* join the *Scheldt*; they have a mean or even small organic pollution.

The *Trouille* is lightly supersaturated with dissolved oxygen. The nitrate-concentrations are always higher than 10 mg/ℓ .

The *Aunelle*, contrarily to the other tributaries, is lightly polluted with pesticides.

Table 12

Frontier points - Basin of the Scheldt

	Date	O_2 %	COD mg/ℓ	BOD mg/ℓ	S.M. mg/ℓ	N_{tot} mg/ℓ	N_{amm} mg/ℓ	NO_2^- mg/ℓ	NO_3^- mg/ℓ	PO_4^{---} mg/ℓ
French frontier										
Grande Honnelle in Autreppe	11-06-74	93.6	15	10	8	2.6	0.45	0.39	11.0	1.13
Aunelle in Marchipont	11-06-74	96.3	7	5	8	2.2	0.07	0.29	13.9	1.17
Hogneau in Quiévrain	11-06-74	77.4	15	10	8	2.7	0.63	0.72	10.0	0.22
Channel of Condé in Hensies	11-06-74	90.0	37	11.5	12	2.4	0.18	0.27	9.7	0.43
Trouille in Civry	11-06-74	126.5	15	8.9	12	2.4	0.05	0.26	13.8	0.92
Scheldt in Bléharies	17-06-74	24.4	51	27	20	-	17.2	1.7	2.1	2.15
Channel Espierres	17-06-74	15.9	66	2.8	200	-	9.5	0.2	0.34	1.75
Espierres in Leers Noord	17-06-74	0	904	320	1050	-	22.0	0.3	0.47	5.21
Lys in Ploegsteert	02-07-74	0.	7.6	40	4	8.4	5.6	< 0.005	< 0.01	4.9
Lys in Ploegsteert	20-08-74	0	82	16	30	7.0	6.25	0.20	0.32	1.93
Lys in Ploegsteert	01-10-74	0	40	8.4	35	7.2	1.94	0.03	< 0.01	3.36
Dutch frontier										
Scheldt in Doel	19-06-74	22.8	472	7.6	570	5.6	4.7	0.97	3.3	2.24

The *Condé canal* has the same characteristics as the other rivers, but a higher organic pollution and important quantities of PCB (more than 1500 ng/ℓ).

The metal pollution is negligible in the *Aunelle* and the *Hogneau*, but we find Cr and Ni in the *Grande Honnelle* and high Cr and very high Pb concentrations in the *Trouille*.

On the other hand, the situation of the *Scheldt* at the French frontier is far frop being satisfactory. We find an important deficiency of dissolved oxygen, high COD and BOD values, a great quantity of ammoniacal nitrogen, but a low metal pollution (except 20 ppb Ni and Pb), and finally an important pesticide concentration (> 5000 ng/ℓ).

During the former years we already mentioned the catastrophic situation of the *Espierres* and the new samples confirm the high pollution

Table 12

(continuation)

	Cl^- mg/ℓ	SO_4^{--} mg/ℓ	Det.an. mg/ℓ	Cd ppb	Co ppb	Cr ppb	Cu ppb	Fe ppb	Hg ppb	Mn ppb	Ni ppb	Pb ppb	Zn ppb
French frontier													
Grande Honnelle	28	63	0.10	≤ 1	< 5	15	< 5	290	<0.01	50	18	5	200
Aunelle	26	47	-	< 1	< 5	≤ 5	< 5	200	<0.01	<15	< 5	< 5	181
Hogneau	28	57	0.05	< 1	< 5	< 5	9	330	<0.01	55	< 5	< 5	231
Channel of Condé	64	156	0.02	< 1	1	11	13	150	<0.01	142	≤ 5	< 5	212
Trouille	28	51	0.04	< 1	< 5	41	< 5	260	<0.01	21	< 5	100	225
Scheldt	110	167	0.01	1.2	8.5	12	8	590	0.27	315	24	20	400
Channel Espierres	180	146	0.20	2.4	2.4	12	24	4000	0.63	250	30	95	495
Espierres	236	293	4.72	-	-	210	-	-	0.04	495	-	-	630
Lys	92	120	0.27	0.8	3.5	< 2	7	430	0.02	190	25	6	80
Lys	114	69	0.10	< 1	< 2	< 5	< 3	100	0.05	190	10	< 5	30
Lys	76	158	0.80	< 1	< 5	13	13	290	0.38	180	8	10	100
Dutch frontier													
Scheldt	8700	1172	1.39	1.5	4	-	41	5900	0.30	430	26	32	160

COD of about 1000 mg/ℓ , more than 1000 mg/ℓ material in suspension, 200 ppb of Cr, 4000 ppb of Fe, and nearly 2000 ng/ℓ of PCB.

The situation of the *Espierres canal* is better although the pollution degree is important.

Finally we took three samples of the water of the *Lys* and in none of them found any trace of dissolved oxygen. At the French frontier this river seems to be in a permanent state of anaerobiose, with COD values varying between 40 and 80 mg/ℓ . The metal pollution on the contrary is relatively low; the situation is the same for pesticides, the quantities of which are inferior to the detection limits.

2.1.2.- River *Scheldt* at the Dutch frontier

At the Dutch frontier the situation of the Scheldt is worse than at the French frontier, with a COD value of nearly 500 mg/ℓ . The metal concentrations, on the other hand, are nearly the same, except for Fe which has a concentration of 6000 ppb , ten times the value found at the French frontier.

We did not find any trace of pesticides at the Dutch frontier.

2.2.- Pesticides

(Mr GORDTS and Mr VANDEZANDE, I.H.E.)

Some pesticides are not taken into account because they are not demonstrable in the whole Scheldt basin (Aldrin, pp' DDT, DDD, α- and β-endosulfan, endrine and HCB).

2.2.1.- Tributaries of the river *Scheldt*

No pesticides have been found in the *Hogneau*, the *Espierres canal*, the *Lys* and the *Trouille*

The *Espierres* is undoubtedly the most polluted river. This confirms the results mentioned in the *Annual Report III* (α- and γ-HCH, 400 ng/ℓ). On 15.10.73 lindane and its β- and δ-isomers have been found in Estaimpuis and in Espierres (700 ng/ℓ , 365 ng/ℓ , 750 ng/ℓ). A great concentration of dieldrin has also been found (905 ng/ℓ). At the frontier-point on the *Espierres* we found PCB (1800 ng/ℓ) and also dieldrin (50 ng/ℓ).

In the *Condé canal* PCB has been found many times (1730 ng/ℓ). This could indicate some industrial pollution.

Concerning the *Dyle* we refer to the *Annual Report III*.

2.2.2.- River *Scheldt*

Generally the *Scheldt* is low polluted with pesticides (*Annual Report, III*). In Doel (Dutch frontier), no pesticides have been found but at the French frontier captan has, exceptionally, been found in a high concentration (5850 ng/ℓ) . This is probably due to an accidental contamination. We also observe the influence of the tributary *Espierres* in Helkijn (Lindane, β- and δ-HCH : 160 ng/ℓ , 80 ng/ℓ , 95 ng/ℓ) .

2.3.- Hydrobiologie

(Mr VAN HOOREN, Mrs DE SCHUTTER, I.H.E.)

2.3.1.- River *Scheldt*

The results of the immersed slides show clearly that the *Scheldt* has a high degree of pollution at the place where it enters in Belgium. Contrarily to the chemical results, the hydrobiologic results show that the pollution decreases gradually till Ghent.

2.3.2.- Tributaries of the river *Scheldt*

Espierres : from a hydrobiological point of view, this river is heavily polluted, as there exist no more vegetal and animal organisms. Due to the preponderating presence of bacteria, bacteriophytes such as *Sphaerotilus natans* and *Zoogloea-ramigera*, the environment can be considered as hypersaprobe.

Dyle : during the period from 19.8.1973 to 3.10.1973, samples of plankton have been taken over the whole course of the *Dyle* and analyses have been made.

Where the results of the plankton analyses do not give a clear idea of the situation of the *Dyle*, the results of the immersed slides may be considered as characteristic.

At already a few kilometers from its source the *Dyle* is polluted. This pollution increases gradually and attains a first maximum in Gastuche (downstream a paper-mill). In Florival we observe a serious reduction of the biological development on the immersed slides, probably due to toxic effect of the water. Downstream from Louvain the pollution degree is extraordinarily high and we observe a tendency to hypersaprobity. In Wijgmaal a predominant population of Mycophytae shows an obvious hypersaprobe environment. After dilution of the *Dyle* with the water from the *Demer*, this hypersaprobe situation decreases, although the tendency to hypersaprobity continues to exist till the confluence with the *Zenne*.

As compared with the fluctuation of the chemical pollution index according to Prati and Pavanello (Annual Report II) the slidings of saprobity index numbers, taking into account the tendency to hypersaprobity nearly agree. Nevertheless, the optimistic picture of the pollution, given by the pollution index of Froti, does not seem to agree with the reality.

2.4.- Bacteriology

(I.H.E., cf. § 1.1, part I)

As for the Meuse, we started in 1974 with a study, at the frontier points, of the tributaries of the river Scheldt.

2.4.1.- River *Scheldt* and tributaries at the French frontier

At the French frontier the *Scheldt* receives a lot of little tributaries such as the *Grande Honnelle*, the *Aunelle*, the *Hogneau* and the *Trouille*. On their entering in Belgium these small rivers have already a high degree of pollution; especially when coliforms are concerned.

The *Espierres* and the *Lys* have a very important, if not catastrophic degree of pollution. In Leers-Nord Salmonella brandenburg has been isolated in the *Espierres*.

2.4.2.- River *Scheldt* at the Dutch frontier

The situation of the *Scheldt* in Doel is, of course, dependent on the faecal pollution of all its tributaries.

2.5.- Sediments

(I.C.R., cf. § 1.3, part I)

At the end of 1973 a complete study has been made of the course of the *Scheldt* and samples of sediments have been taken in the *Espierres*, the *Dyle* and the *Ghent - Terneuzen canal*.

2.5.1.- River *Scheldt*

The study of the *Scheldt* confirmed the former observations. The pollution of the Scheldt sediments, observed at the French frontier point, increases considerably after the confluence with the *Espierres* (*e.g.* crude, Cr, Hg, Cu and organic matter) and at Kerkhove (Pb, Zn, Sr). The same can be observed for the water.

The pollution downstream from Ghent to Doel is high and constant, except for Cr and Zn the contents of which diminish in the sediments.

2.5.2.- Tributaries of the river *Scheldt*

It is confirmed that the contribution of the *Dendre* and of the *Rupel* maintain the pollution level of water and sediments, but do not aggravate it.

The pollution of the sediments of the *Espierres*, already very important at the frontier, increases till the confluence with the *Scheldt* and this explains the influence on the pollution of the river. The sediments of the *Espierres canal* are also polluted but not in as high a degree as in the river.

The *Dyle*, which is not polluted at its source, has, on its course, several polluted zones, the pollution being observed as well in the water as in the sediments. Out of these zones the pollutant contents of the sediments are low.

The first contamination is observed in Ways. Afterwards, in the region of Wavre, from Limal to Gastuche, we find a characteristic Hg, Mo, crude and principally Cr and Ni pollution, probably due to paper-mills. In Florival the influence of an important accumulator factory finds an expression in the very high Pb-contents of the sediments (very abundant Pb and Fe in the water, local suppression of the aquatic life). The agglomerations of Louvain and, particularly, of Mechelen, contribute to the increase of the pollution level. The pollutant contents are particularly high in the sediments in Muizen and Mechelen (broad arm of the Dyle); they diminish then till the confluence with the *Zenne*.

In the *Ghent-Terneuzen canal*, a study is undertaken on the sulfur-components in the sediments. The sulfur components are abundant and seem associated — in a stable way — with the organic matter.

3.- Hydrographic basin on the river *Yser*

3.1.- Chemistry of the water

(I.H.E., cf. § 1.1, part I)

The new results confirm former conclusions : important eutrophication, especially in summer (*cf.* monography concerning the river *Yser*, 1973).

The situation is very similar in the *Berghes canal* and the *Duinkerke canal*, but with a considerably higher organic charge. The metal pollution is nearly the same as in the *Yser*. It is of little importance, except for Cr in the *Duinkerke canal*.

The *Yser* and its tributaries are not polluted by pesticides; only the *Yser* reveals some traces of dieldrin.

3.2.- Hydrobiology

(Mr VAN HOOREN and Mrs DE SCHUTTER, I.H.E.)

During the year 1974 samples have been taken four times in the basin of the river *Yser*.

Compared with 1973, the *Heidebeek* reveals a considerably higher coliform pollution but a lower faecal Streptocci pollution.

The situation is nearly the same in the *Berghes* and *Duinkerke canals*.

4.- Hydrographic basin of the river *Rhine*

4.1.- Chemistry of the water

(I.H.E., cf. § 1.1, part I)

During the year 1974 samples have been taken of the river *Sûre* in Martelange.

The analysis of those samples revealed a quasi-inexistant pollution degree; only one abnormality : the presence of 17 ppb of Cr. No pesticides have been found. According to the same samples there seems to be little bacteriological pollution in the river *Sûre*.

III

General conclusions

1.- Progress of works

The first task of the inventory group is an analytical one. The whole question is to improve gradually the description of the pollution degree of the Belgian superficial waters.

Within this cadre, the advancement may be presented under three aspects :

1) The *determination of new parameters*, which were not yet considered until to-day, what is the case for the immixion zone of the sea where, thanks to the work done by the newly associated team Van der Ben, it was possible to start with the study concerning the phytoplanktonic biomassa and with that of the bio-indicators.

Attention should also be drawn on a comparative inventory of the deeper water on the twelve places where, in 1971, superficial samples had been taken. No significant difference has been found.

2) The study of samples taken at *new places* that had not yet been inventorized. It concerns especially some tributaries of the river Meuse, the rivers at the frontier-points, the sediments of the Ghent - Terneuzen canal and, for the sea, the sediments in the neighbourhood of the breakwaters. On the whole nothing special has to be mentioned.

3) *Repeated measurements* at previously inventorized places in order to collect a reasonable number of data allowing to describe a situation based on means and to follow its evolution. This "further work", concerned the twelve places where samples were taken in the immixion zone of the sea, the outlets of the coast and some rivers.

The second task of the inventory group, which is a synthetical one, consists of establishing balances starting from the whole lot of the analytical data and of making their interpretation. Those balances can be found in each of the ten advancement reports in the form of *tables of mean and extreme values*. In another connection we already said that a monography of the pollution of the Vesdre, especially with heavy metals and pesticides, will be published in 1975.

Since a long time the problems of a *balance of "inputs" in the immixion zone of the sea* is exercising our minds. The solution of this problem comes up against the difficulty presented by the measurement of the outlets. We hope that a new approach, based upon the study of the discharge in the sea of the rainwater, will allow us to progress. According to recent information, this 'input" should reach some two hundred million of m^3 per year.

2.- General synthesis of the results

It is impossible to give in a few lines a general idea of the results and once more we refer to the ten reports.

At the best we can try to synthesize the results concerning the *immixture zone of the sea* which, in opposition to the rivers, is characterised by a coherent whole.

The pollution level of this zone, previously defined as superior to a normal pollution and to that found in "open sea" has been confirmed not only by the campaigns but also by the contamination of marine organisms found on the breakwaters. In this case of course it concerns only a tendency deduced from the first results.

The new acquisitions of 1974 also allow to confirm that the pollution degree is higher from the NE of Ostend to Blankenberge. On the other hand, according to a cycle unfortunately still incomplete, the evolution of the biomass should be different and even abnormal in this part of the immixture zone.

Concerning the bio-indicators of the pollution, the macroscopic algae seem to give the best results.

For the *rivers* we merely point out that the pollution of the *Mehaigne* is typical for the agricultural activities and that the detailed hydrobiologic study of the *Dyle*, made in 1974, was particularly instructive.

3.- Further studies

Concerning the *coastal zone* :

- continuation of the actual research and determination of all kinds of other information allowing the elaboration and publication of a general study, as complete as possible, at the end of 1975.

Concerning the *rivers* :

- publication of two monographies, the first one concerning the Vesdre at the beginning of 1975, the other one concerning the Dyle after a study of this river during the year 1975.
- the inventory of the rivers at the frontier points.

IV

Appendix

List of record cards

1.- Sea and coastal area

Immixtion area, approaches of breakwaters, beaches, fairways and channels, sewers emitting in the sea.

- Blankenberge (sea, channel, sewers, Spuikom), - Bredene (sea), - E. Heist (sea), - Heist (sea, breakwater, beach, Channels of Schipdonk and Zelzate), - Knokke (sea, breakwater, beach), - Lombardsijde (sea), - Mariakerke (sea), - Middelkerke (sea), - Nieuwpoort (breakwater, fairway, channels of Plassendaal, Veurne, Ijzer, sewers), - Oostduinkerke (sea), - Oostende (sea, fairway, channels of Brugge-Oostende, Noord Eede), - Raversijde (breakwater - Wenduine (sea), - Zeebrugge (W. Heist) (sea, beach, channel).

2.- Water courses, by basins and rivers

2.1.- Basin of the Meuse

Albert (channel), Berwinne, Bocq, Chiers, Dison (river of), Dommel, Geer-Jeker, Hantes, Helle, Hoegne, Houille, Hoyoux, Itterbeek, Julienne, Laclaireau, Lesse, Mangombroux (Biez of), Marche-en-Famenne (river of), Membrette, Mehaigne, Meuse-Maas, Molignée, Ourthe, Rebais, Rulles, Ruyff, Sambre, Samson, Semois, Thure, Ton, Vesdre, Vierre, Viroin, Vresse (river of).

2.2.- Basin of the Scheldt

Aunelle, Condé (channel), Dendre-Dender, Dijle, Escaut-Schelde, Espierres, Espierres (channel), Ghent-Terneuzenchannel, Gete (Grote), Haine, Hofstade (lake of), Hogneau, Honnelle (grande), Lys-Leie, Rupel, Trouille.

2.3.- Basin of the Yser

Bergues-Veurnechannel, Blankaart, Dunkerke-Nieuwpoort channel, Handzamevaart, Hanebeek, Haringebeek, Heidebeek, Ieperkanaal, Ieperlee, Kemmelbeek (Grote), Lovaart, Poperingevaart, Robaartbeek, Warmbeek, Yser-Ijzer.

2.4.- Basin of the Rhine

Sûre.

Comment

All the record cards can be transmitted when requested to the "Centre de Documentation (Liège University), I.H.E. (Bruxelles) or I.R.C. (Tervuren).