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Results of the expedition

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Finnish Environment Institute (SYKE), Finland, and
the Southeast Finland Centre for Economic Development,
Transport and the Environment

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1 Introduction

The Polish–Finnish joint expedition to study the possible effects of the two Polish phosphogypsum waste stacks was carried out from 1 to 3 July 2013. The study was based on a decision of the Ministers of the Environment of Poland and Finland about two weeks earlier.

The aim of the joint expedition was to assess the potential leakage of phosphorus and other pollutants from the waste stacks to the surrounding waters and to the Baltic Sea by using joint sampling and comparable chemical standard methods in accredited laboratories in both countries. Additionally, hydrological conditions in the areas around the stacks were visually inspected by a Finnish hydrologist in co-operation with local Polish experts.

The report includes the Finnish results of the chemical analyses of the joint sampling and also describes the general hydrological conditions in the study areas. Because the report is based on just one sampling event in both areas, the results can give only qualitative information on the possible effects of the phosphogypsum stacks on the surrounding waters. The calculation of quantitative loads based on one sampling without information on flow and hydrogeological conditions is not possible.

2 Background information

At the 41st Meeting of the Heads of Delegation (HOD 41/2013) of the Helsinki Commission (HELCOM), a document (3/17) was submitted containing information on industrial phosphate fertiliser production. The document stated that production of phosphate fertilisers presents a significant potential for nutrient pollution of the Baltic Sea, if the discharges and emissions are not adequately managed. Currently, out of about 15 mineral fertiliser production facilities in the Baltic Sea catchment area, 7 industrial sites are producing phosphate mineral fertilisers or have onsite phosphogypsum waste-handling facilities. Four of these facilities also have active generation of phosphogypsum as a by-product of the main production lines (e.g. phosphoric acid production), while the other three facilities have stopped generation of phosphogypsum. The management of the waste-material stack to prevent leakage of phosphorus remains an issue at most of the facilities.

Phosphogypsum is generated in high volumes and excess volumes require disposal. The design and construction of gypsum-disposal areas are done so as to keep both the gypsum and the stack effluents within a closed system. To avoid pollution of the subsoil and groundwater by contaminated phosphogypsum leachate and runoff (process water and rainwater), stringent preventive measures are necessary, such as seepage collection ditches, intercept wells, natural barriers and lining systems.

Furthermore, to prevent or minimize pollution of the surrounding area and aquatic systems, it is necessary to make provisions for any effluent overflow. The effluent requires appropriate treatment such as immobilization of soluble P_2O_5 and trace elements by neutralization, before it can be released from the system. Besides using control measures during the build-up of a gypsum stack, the runoff from gypsum stacks will require treatment for decades after the plant has ceased production.

Although most facilities satisfy the requirements of the HELCOM recommendations, significant leaching into the surrounding waters may still occur, since reporting from some facilities lacks information on how the phosphogypsum stacks are isolated to prevent leakages and on measured nutrient concentrations in the waters surrounding the storage areas. During HELCOM's Balthazar project in 2011, exceptionally high phosphate phosphorus concentrations were measured in the Luga River in North-West Russia, close by a phosphogypsum stack (HELCOM 2012).

To ensure that the fertilizer production industry in the Baltic Sea region does not generate excessive pollution, regular monitoring of groundwater and surface waters in the vicinity of respective industrial sites and the phosphogypsum stacks should be continued and reported to HELCOM.

In June 2013 the John Nurminen Foundation released a report, prepared by Pöyry Finland, on the phosphorus leakage risk from phosphogypsum stacks in Gdańsk and Police in Poland (Pöyry 2013). According to the report, there may be significant phosphorus leakages originating from both waste stacks. The report also includes recommendations for measures to reduce leakages and improve monitoring of the waste stacks.

In consequence of the above, the Minister of the Environment in Poland, Mr Marcin Korolec, and the Minister of the Environment in Finland, Mr Ville Niinistö, agreed on a joint Polish–Finnish field mission to the two Polish phosphogypsum sites (Gdańsk and Police). The mission was successfully carried out from 1 to 3 July 2013.

3 Hydrological conditions and arrangements in the study areas

3.1

Gdańsk

The phosphogypsum stack in Gdańsk covers an area of approximately 0.34 km^2 (Pöyry 2013) and is 41 m high (Fig. 1). The stack is located along the bank of the river Martwa Wisla (Dead Vistula), a branch of the Vistula River, which is fully bypassed. The distance between the stack and the Martwa Wisla is approximately 50 m. The part of the river between Gdańsk Bay and the stack is about 6.5 km. The width of the river channel varies from approximately 200 m to 500 m. A system of dams blocks direct inflow to the Martwa Wisla from the Vistula and from the channels located on the south bank of the Martwa Wisla near the stack (e.g. Kanal Piaskowy, see Fig. 3). The waters of the Martwa Wisla are mostly stagnant, but sea-level fluctuations, differences in water density, local wind conditions and fresh water inflow affect currents and water levels in the river (Krzyminski 1999). Thus, the Martwa Wisla does not exhibit characteristics of a typical river. During the expedition, flow measurements were not carried out, but there was no visible flow in the Martwa Wisla. The river depth at the sampling sites was 3.8 m at sampling point 1 (stack) and about 6 m at sampling point 2 (the pontoon bridge).

Figure 1. Phosphogypsum stack in Gdańsk

The area around the stack is provided with a drainage system through which water that is collected in ditches can be pumped back onto the stack surface. Water is distributed by gravity over the stack surface from two retention tanks located at the top of the stack. One tank has a capacity of 4–5 m^3. Irrigation of the stack surface with water which comes from surface runoff increases evapotranspiration, so that during dry periods the moisture conditions of the soil are better. The average discharge of the Vistula River is 1 080 m^3s^{-1} and the size of the catchment is 194 424 km^2 (Buszewski et al. 2004). Thus, the average runoff in the drainage basin is 175 mm annually (5.6 $l\ s^{-1}$ km^{-2}). Because of the irrigation system, runoff from the stack area is likely less than the average runoff in the whole Vistula drainage basin.

On 1 July the entire stack surface was covered with vegetation up to a height of approximately 0.5–1.5 m. The average annual precipitation (1991–2010) recorded at the precipitation station at Świbno, located about 4 km from the stack, is 577 mm. The highest precipitation occurs in the summer months (data from Instytut Meteorologii i Gospodarki Wodnej). During the winter season, some precipitation occurs in the form of snow. In the period 1991–2010 the highest annual precipitation, 714 mm, was recorded in 2007. There are no evaporation measurements available from the area around the stack.

The outflow of water from the stack area is controlled by the drainage system. The system is meant to counter the effects of the outflow of water from the stack, and is based on the assumption that annual total evaporation equals precipitation. During the high-flow periods (e.g. snow melt season in spring), water accumulates in the ditches, while in the summer season excess water not taken up in vegetative processes evaporates. The bottom of the stack is not provided with a synthetic barrier that would prevent water infiltration into shallow aquifers and no hydraulic barrier has been installed to prevent the outflow of groundwater through the river bank. However, the external edge of the bank on the northern side of the stack is provided with a subsurface drainage system that collects permeating water and prevents its flow into the Martwa Wisła. In the drainage system, water is collected in holding pits and is pumped to the top of the stack (or to the ditches). There is no information on possible confined aquifers in the area that would lead to groundwater flow out of the stack area.

On the sampling day, 1 July 2013, no surface runoff was observed from the stack to the surrounding waters. During the summer season the ditch on the northern side of the stack is normally dry, as water is collected in the ditch on the southern side. On the southern side, the drainage system includes, for instance, the so-called inner ditch and dike system. All ditches diverging from the stack (originally used as a drainage system for the crop fields) are blocked with 5 m thick clay plugs. These plugs are within a distance of 150–300 m from the stack. As stated by a representative of the company, water from these ditches can be pumped back onto the stack. No visible flow was observed in these ditches on 1 July 2013. This area seems to be below the water level in the Martwa Wisla. There is a dam between the Mellioration ditch and Kanal Piaskowy that prevents direct flow. No information is available about the water-level differences between the ditch and the channel.

3.2 Police

The phosphogypsum stack in Police covers an area of approximately 2.7 km^2 (Pöyry 2013), of which 1.8 km^2 is designated for phosphogypsum disposal (Fig. 2). About 0.4 km^2 of this area is in active use. Most of the area is covered by vegetation. The parts of the stack not in active use are systematically covered with vegetation. The aim of the protection measures is to limit erosion of slopes, diminish secondary dusting and

Figure 2. Phosphogypsum stack in Police

reduce rainwater intrusion into the stack. Sludge from the company's wastewater plant is used for protecting the stack. The stack is located on the western bank of the Oder River, just upstream of the Szczecin Lagoon. The annual average precipitation in the area is 529 mm (WMO, Szczecin, 1971–2000) and is highest during the summer months. Evaporation has not been measured near the site.

A hydraulic barrier surrounds the stack. The technology used for water protection is in the form of a system of depression ditches, where the water level is kept under the water level of the Oder River and nearby channels. A ditch system collects leakages from the stack, rain water from the landfill area, and water that infiltrates into both the natural ditches and the artificial reservoirs surrounding the dump. This water from the ditch system is then pumped to the local wastewater treatment plant (WWTP). The bottom of the leachate ditches is around 2 m below the average water level outside the banks. The top of the flood banks, on the other hand, are 2.5 m above the average water level outside the stack area. By using a pump system the company keeps the water level in the ditches around 1.5 m below the water level outside the banks. As there is no vertical protective barrier under the embankments, water is, theoretically, leaking through the banks from the Oder and surrounding channels into the stack area. The distance of the ditches from the stack varies by location, but it is over 150 m in every direction (buffer zone). The distance of the ditches to the surface waters outside the embankments is about 30 m or more.

About 2 million m^3 of water is pumped annually from the ditch system to the WWTP (e.g. Pöyry 2013). By multiplying the area of the stack (270 ha) with runoff, it is possible to estimate which part of this volume originates from the stack area. By using higher than average runoff (200 mm) it would mean that over 70% of the water pumped from the stack area to the WWTP originates outside the stack area. This indicates that the hydraulic barrier is working as expected. Information about confined aquifers in the area that would lead to groundwater flow out of the stack area was not available. During the visit on 3 July 2013 no surface runoff from the stack to the surrounding waters was observed.

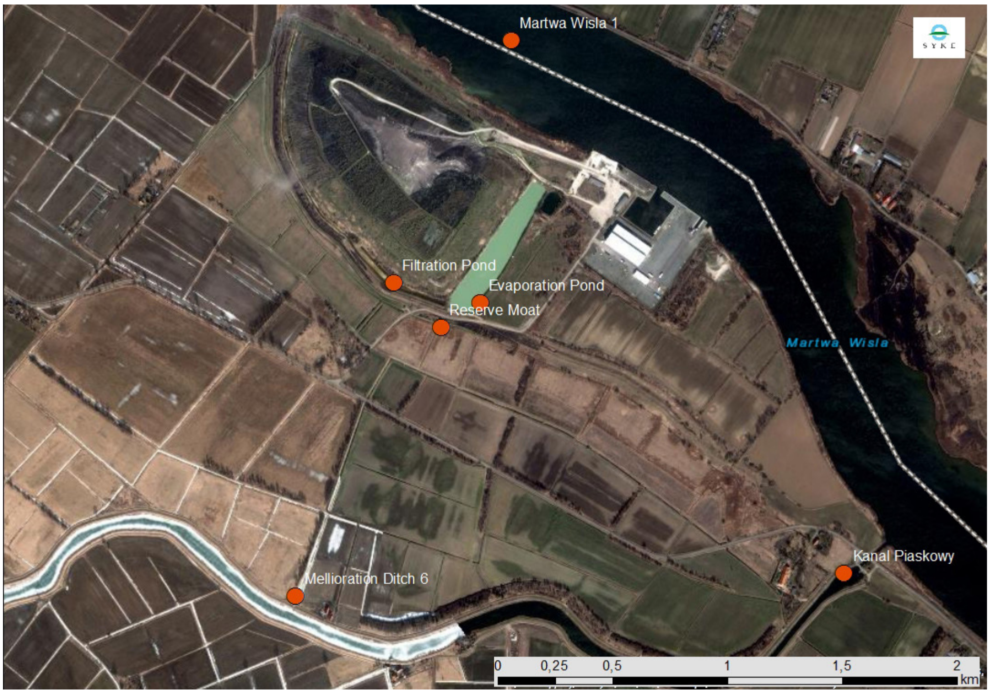

Figure 3. Location of sampling sites in the vicinity of the phosphogypsum stack in Gdańsk.

There is no vertical protective barrier under the embankments to prevent flow out, if the water level were to rise higher inside the embankments compared to the water level in the Oder River. This scenario is, however, unlikely as pumps are used to prevent water level rise in the ditches, and in the case of a pump failure, there is another, independent pump system for back up (according to the company representative). The company is also monitoring the soil surface to get information on possible upheavals and instability of the stack area.

4 Water sampling and chemical methodology

4.1

Sampling stations and sampling procedure

The joint sampling agenda was agreed in the meetings held at the Voivodeship regional Inspectorate for Environmental Protection in Gdańsk (VIEP Gdańsk) on 1 July 2013 and at the Voivodeship Inspectorate for Environmental Protection in Szczecin (VIEP Szczecin) on 3 July 2013 (Annexes 1 and 2). Altogether, 10 sampling sites were included in the sampling programme in Gdańsk and seven in Police (Table 1, Figs. 3 to 5). The sampling was conducted according to the plans with one minor exception: Sampling site Police 5 was moved outwards from the shoreline, because the research vessel was unable to reach the originally planned site due to the low water depth.

To get an overview of the concentrations of different substances at the Wislinka (Gdańsk) stack area, three sampling sites were chosen (Evaporation Pond, Filtration Pond and Reserve Moat, Figs. 3 and 4). Furthermore, based on the published report (Pöyry 2013) there was an indication of possible southward surface runoff from the Wislinka stack, possibly transporting phosphorus and other substances to Kanal Piaskowy. To assess this possibility, two sampling sites were chosen to the south (Melioration Ditch) and southeast (Kanal Piaskowy) of the stack. In Police one sampling site was chosen, located in the stack area (Retention Pond). This is the site where wastewaters from the treatment plant are discharged into the river.

Figure 4. Location of all sampling sites in Gdańsk.

The idea behind choosing sampling sites in the rivers was to get an overview of how concentrations change along the course of the river, alongside and downstream from the stack. In Gdańsk the closest sampling site to the river mouth (Martwa Wisla 5) was regarded as the reference site because that water in the Martwa Wisla mostly originates from Gdańsk Bay, and concentrations were lower downstream from the stack. In Police the sampling site Police 1, located upstream from the stack, was considered the reference site (Fig. 5).

River water samples in Gdańsk were taken with a Limnos sampler and the other samples from ditches and pools were taken with a scoop. In Police, samples of river water were taken with a Ruttner sampler and the sample from the wastewater re-

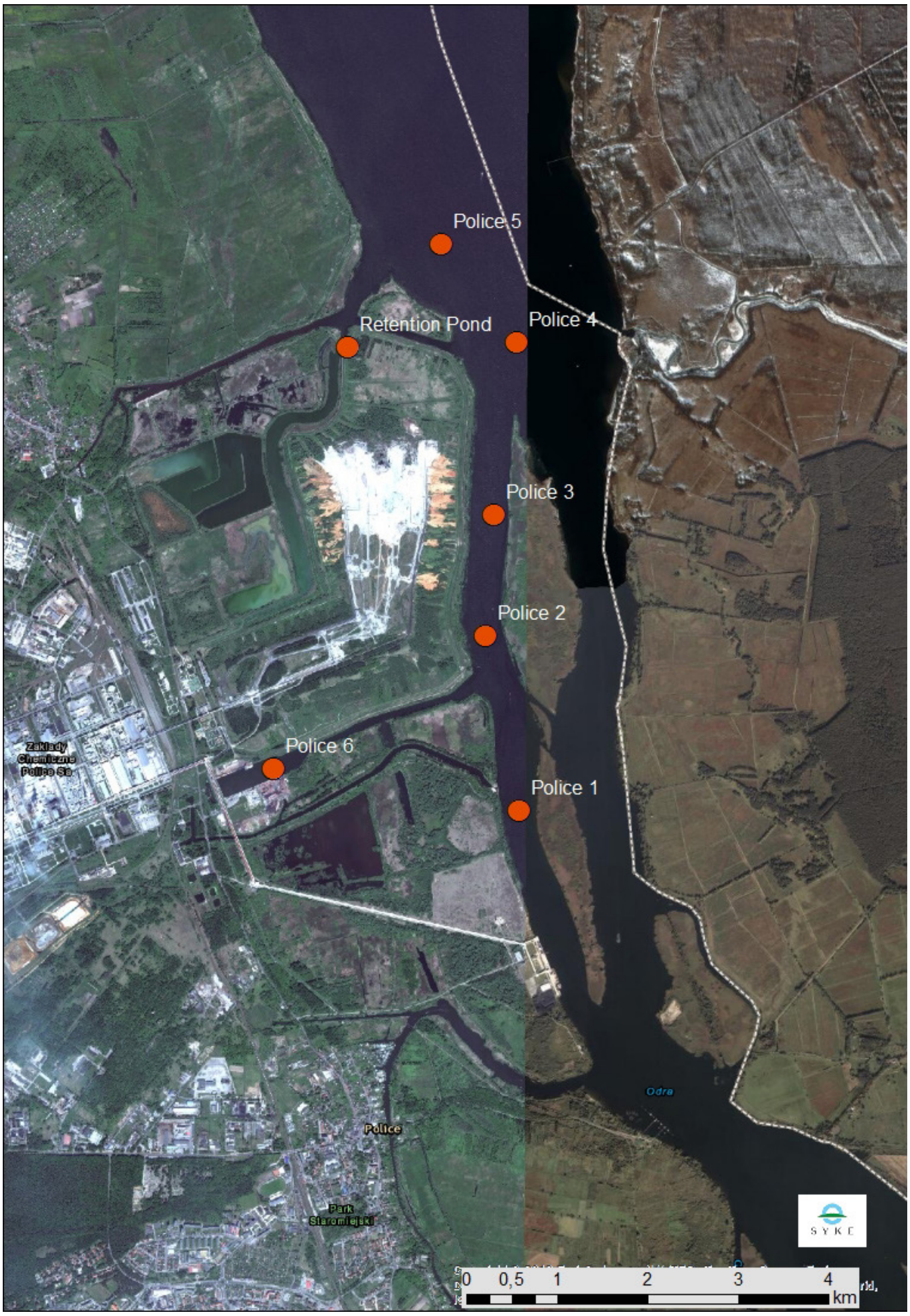

Figure 5. Location of sampling sites in Police.

Table 1. Sampling sites in Gdańsk and Police.

Location	Sampling site	Latitude	Longitude	Type of sample
Gdansk	Evaporation Pond	54°19'8.26"	18°50'43.96"	Wastewater
Gdansk	Filtration Pond	54°19'9.47"	18°50'34.95"	Wastewater
Gdansk	Reserve Moat	54°19'7.02"	18°50'38.57"	Wastewater
Gdansk	Melioration Ditch 6	54°18'44.61"	18°50'18.54"	Ditch water
Gdansk	Kanal Piaskowy	54°18'46.64"	18°51'35.73"	Canal water
Gdansk	Martwa Wisla 1	54°19'30.15"	18°50'46.51"	River water
Gdansk	Martwa Wisla 2	54°20'32.77"	18°49'31.71"	River water
Gdansk	Martwa Wisla 3	54°21'41.20"	18°46'54.34"	River water
Gdansk	Martwa Wisla 4	54°21'18.21"	18°40'37.55"	River water
Gdansk	Martwa Wisla 5	54°23'32.45"	18°40'25.02"	River water
Police	Police 1	53°34'26.00"	14°35'15.69"	River water
Police	Police 2	53°34'54.45"	14°35'3.50"	River water
Police	Police 3	53°35'22.35"	14°35'4.97"	River water
Police	Police 4	53°35'55.23"	14°35'4.88"	River water
Police	Police 5	53°36'12.14"	14°34'45.77"	River water
Police	Police 6	53°34'26.19"	14°33'52.60"	River water
Police	Retention Pond	53°35'55.23"	14°34'12.31"	Wastewater

tention pond with a scoop. In Gdańsk, water from the samplers was poured directly into the sampling bottles, whereas in Police sub-samples were taken and put into one large container, mixed and distributed into bottles.

Samples from the rivers were taken at a depth of 1 m, whereas leachate and wastewater samples were taken at a depth of 0.1 m.

The Polish samples for total phosphorus analyses were put into 1 l glass bottles and were preserved with 2 ml of H2SO4 (reagent from Poland). The Finnish samples were put into 100 ml plastic bottles and were preserved with 1 ml of H2SO4 (4 mol l-1) (reagent from Finland). The samples for orthophosphate analyses were filtered with Sartorius Stadim, cellulose nitrate, pore size 0.45 µm, by Polish authorities and kept in 1 l glass bottles (Poland) and 0.5 l plastic bottles (Finland). The samples for other analyses were put into 1 l glass bottles (Poland) and 1 l plastic bottles (Finland) without preservatives. All samples were stored and transported at temperatures ranging from 0 °C to 5 °C.

4.2
Laboratory analyses

It was agreed that the samples were to be analysed at the same time in Polish and Finnish laboratories in VIEP Gdańsk and Szczecin and in SYKE, respectively. The phosphate samples were examined in the laboratories in Poland and Finland on 5 July 2013 and total phosphorus on 8 July 2013. Other parameters were analysed between 5 July 2013 and 12 July 2013.

It was agreed that the main focus of the research should be on phosphorus and phosphate concentrations. In addition, it was agreed to measure the following other parameters: conductivity, aluminium (Al), iron (Fe), calcium (Ca), fluoride (F), manganese (Mn), potassium (K), sulphate (SO_4), total sulphur (TOTS), total nitrogen (TOTN), ammonium nitrogen (NH_4-N), nitrate+nitrite nitrogen (NO_{23}-N), pH, cadmium (Cd), nickel (Ni). The purpose of measuring these additional parameters was to detect signs of leakages from the gypsum stacks. The analytical methods of Polish and Finnish laboratories are shown in Annexes 4 and 5.

5 Results of water quality analyses

5.1

Comparison of Polish and Finnish results

The laboratory results of the Finnish water quality analyses are shown in Annex 6. The Polish results are not shown here, but basically they were (well) consistent with the Finnish results taking into account differences in analytical procedures. Both the Finnish and Polish results can be found on HELCOM's website (https://portal.helcom.fi/Archive/Shared%20Documents/HOD%2044-2013_4-1%20FI-PL%20Joint%20Polish-Finnish%20sampling%20of%20phosphogypsum%20sites%20in%20Gdansk%20and%20Police.pdf).

5.2

Gdańsk (Wislinka)

The concentrations of different substances were high in the Wislinka phosphogypsum stack area (Annex 6). The water samples taken from the sites, Melioration Ditch 6 and Kanal Piaskowy, outside the embankment around the phosphogypsum stack contained significantly elevated concentrations of orthophosphate. In the sample from Melioration Ditch 6 (0.8 km from the stack), the PO4-P concentration was 48.3 mg l^{-1} and in the sample from Kanal Piaskowy (1.2 km from the stack), it was 5.5 mg l^{-1}. For comparison purposes, the phosphorus concentration in untreated municipal wastewater is typically at the same level as the measured concentration in Kanal Piaskowy. The source of these very high concentrations cannot be anything else other than contaminated surface or groundwater flow originating from the phosphogypsum stack. The fact that phosphorus-containing leakage from the stack is so widespread makes it very challenging to estimate the pathways of phosphorus to the Martwa Wisla and to carry out preventive measures in the area.

The most outstanding observation in the chemical results from the Martwa Wisla river was the remarkably high concentration of orthophosphate phosphorus (808 µg P l^{-1}) near the Wislinka phosphogypsum stack (Fig. 6A). This is over five times the concentration of the reference site in the Gdańsk harbour. Also, the total phosphorus concentration at the site Martwa Wisla 1 was high (879 µg l^{-1}) and was over three times the concentration at the reference site (Fig. 7).

There are only a few reported monitoring results available from the Martwa Wisla near the stack. Total phosphorus concentrations were slightly above 1 000 µg l^{-1}, both upstream and downstream from the stack in April and September 2012 (Pöyry 2013). All these values point to the Wislinka phosphogypsum stack as a source of orthophosphate and total phosphorus in the Martwa Wisla.

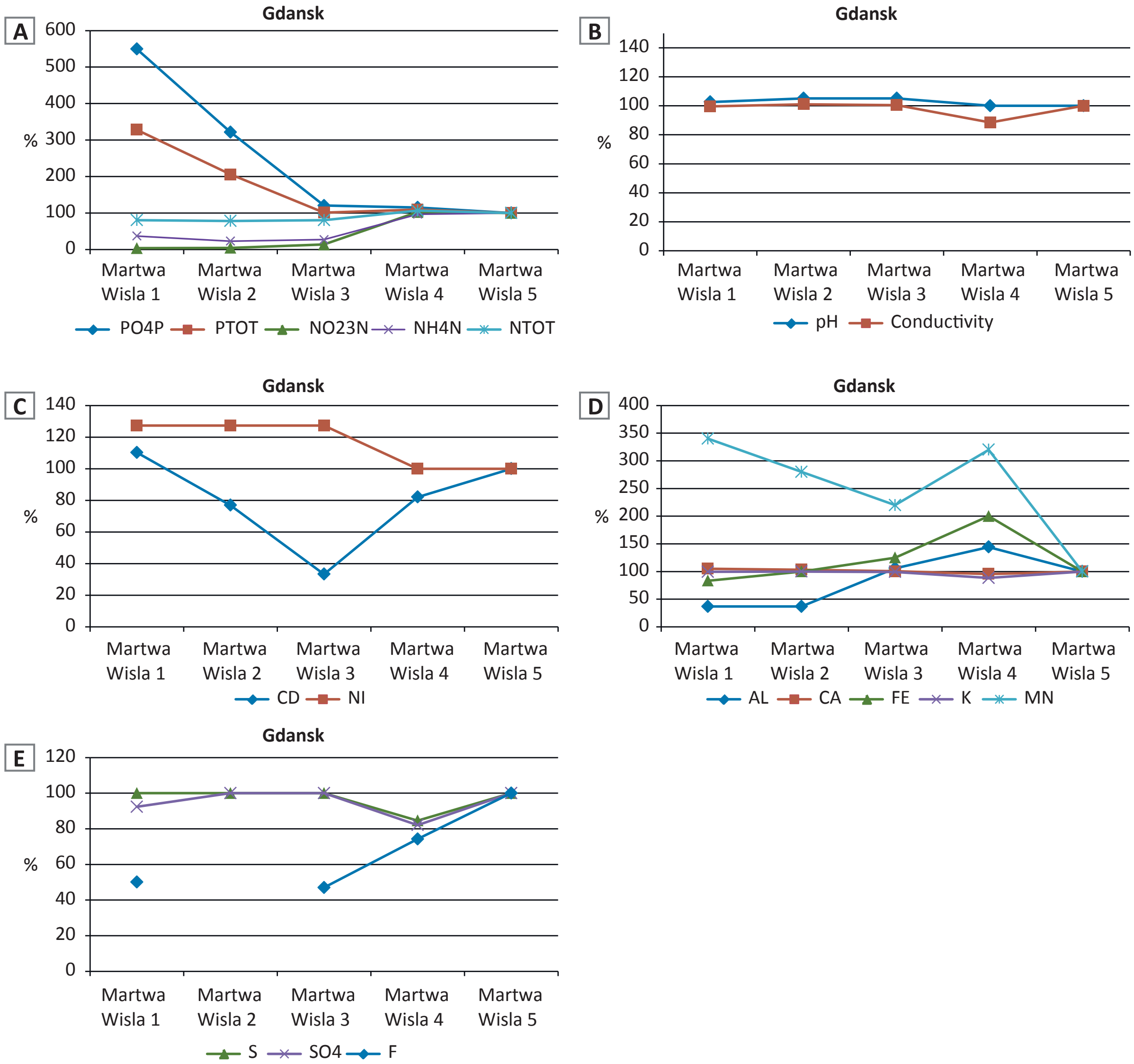

Figure 6. Proportional (%) changes in concentrations in the Martwa Wisla in the vicinity of the Wislinka gypsum stack (Martwa Wisla 1) to the Gdańsk harbour (Martwa Wisla 5, reference site).

Some of the phosphate-P may also originate (as a consequence of long-lasting phosphorus-saturated leakage) from bottom sediments of the Martwa Wisla. Based on the available data, it is not possible to assess the role of sediments in releasing or binding phosphate, and this should be a subject of further studies.

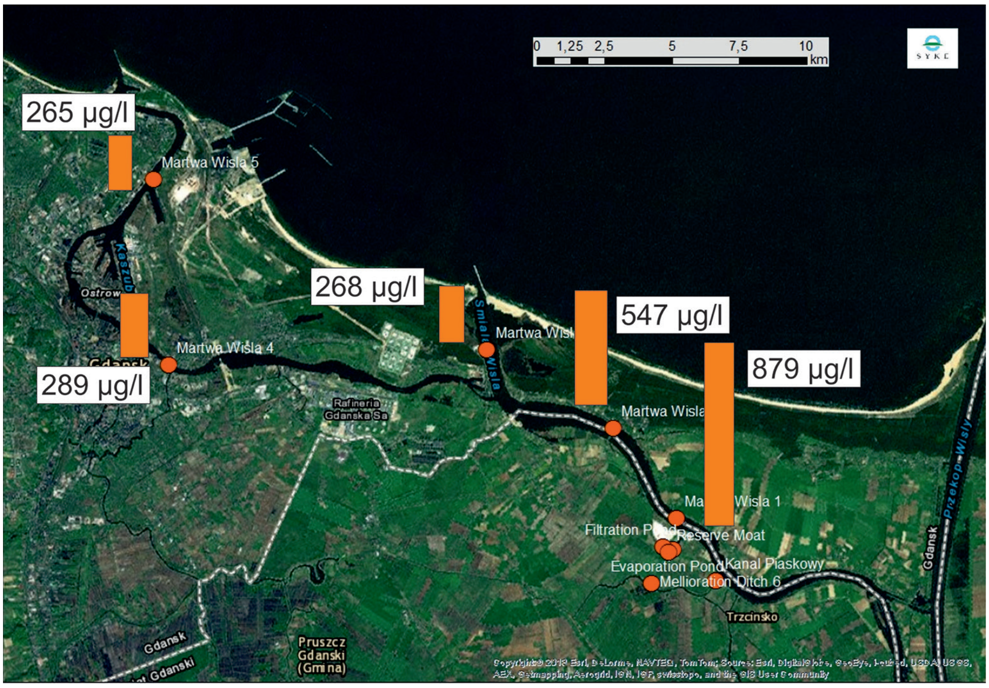

Figure 7. Total phosphorus concentrations (µg/l) at five sampling sites in the Martwa Wisla.

5.3
Police

In Police a cargo ship entered the canal before the sampling was conducted at site 6. This caused mixing of bottom sediments and, as a consequence, a noticeable increase in suspended particles in the water. Therefore, it was decided not to include data originating from the sampling station Police 6 in further analyses of the results.

In the Oder River both total phosphorus (Fig. 9) and phosphate phosphorus concentrations increased somewhat along the course of the river alongside the stack (Fig. 8A). The most obvious increase was in cadmium concentrations at the site Police 5 (Fig. 8C), indicating a possible effect from the local WWTP. The origin of excess cadmium may, however, be the phosphogypsum stack, because waters collected from the area and pumped to the WWTP for treatment contain high concentrations of Cd.

The Polish monitoring results for the Oder from 2008 to 2012 show (4 annual samplings, data originating from VIEP Szczecin), in most cases, higher phosphorus concentrations downstream of the phosphogypsum stack than upstream of it. For the whole period, the mean value of the data from 2008 to 2012 for total phosphorus upstream of the stack is 181 µg P/l, and 219 µg P/l, downstream of the stack. This indicates leakages from the stack despite the existing water protection system consisting of the hydraulic barrier.

The company monitors the quality of groundwater in the stack area. Samples are taken four times a year from 9 piezometers. The location of the piezometers with respect to the stack and the collector ditch are shown on the map in Annex 7. The results from the period 2010–2012 (data received from VIEP Szczecin) show both spatial and temporal variations in PO_4 concentrations for each of the piezometers. The highest concentrations have been measured in the piezometers located on the flood bank between the collector ditch and the Oder River (numbers 3 and 4). At those sites, PO_4 concentrations have varied between 0.3 mg l^{-1} (Piezometer 4, 9/2010) and 5.35 mg l^{-1} (Piezometer 3, 9/2011 and 12/2011).

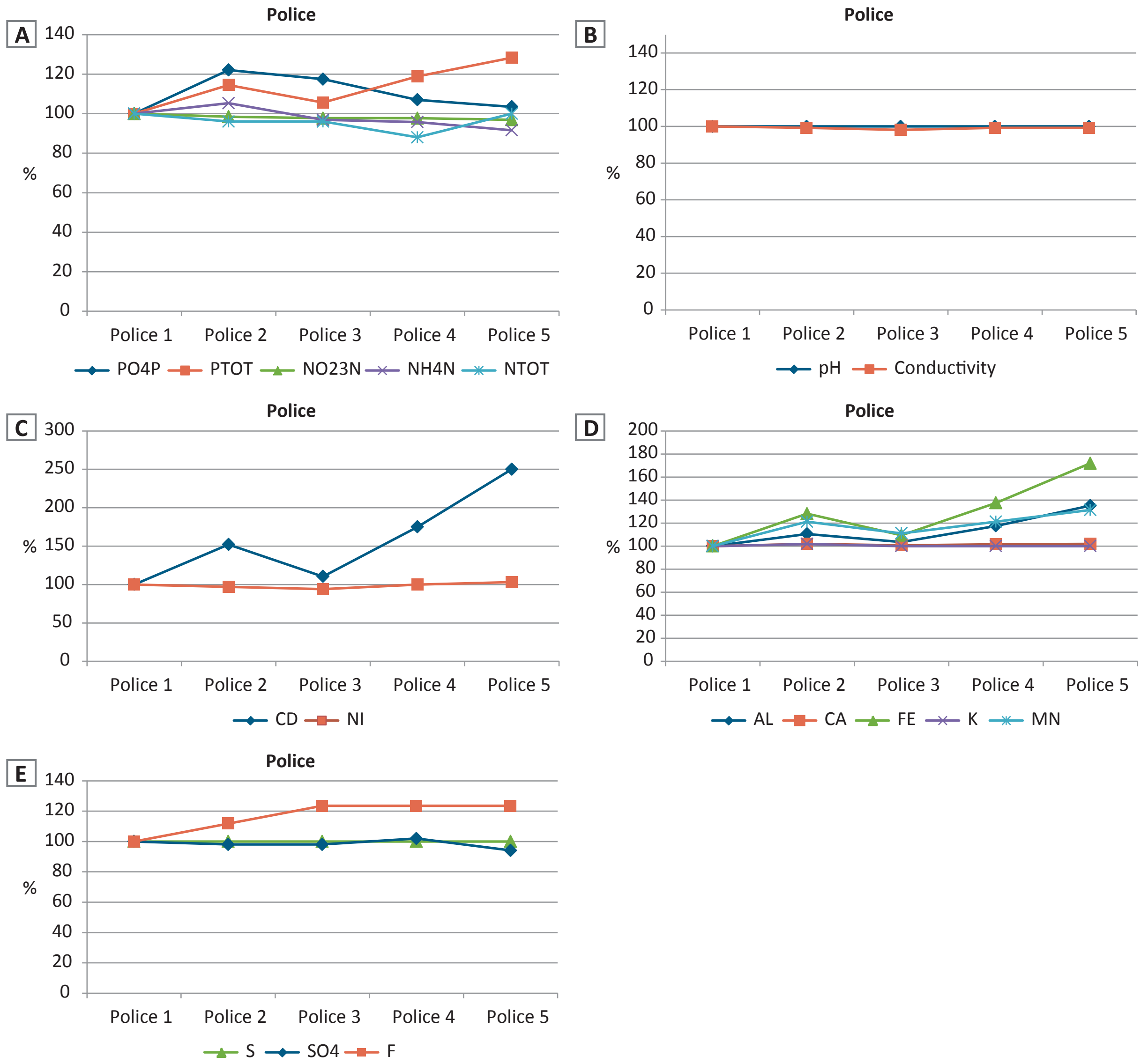

Figure 8. Proportional (%) changes in concentrations in the Oder River from upstream of the Police gypsum stack (Police 1, reference site) to a downstream sampling site (Police 5).

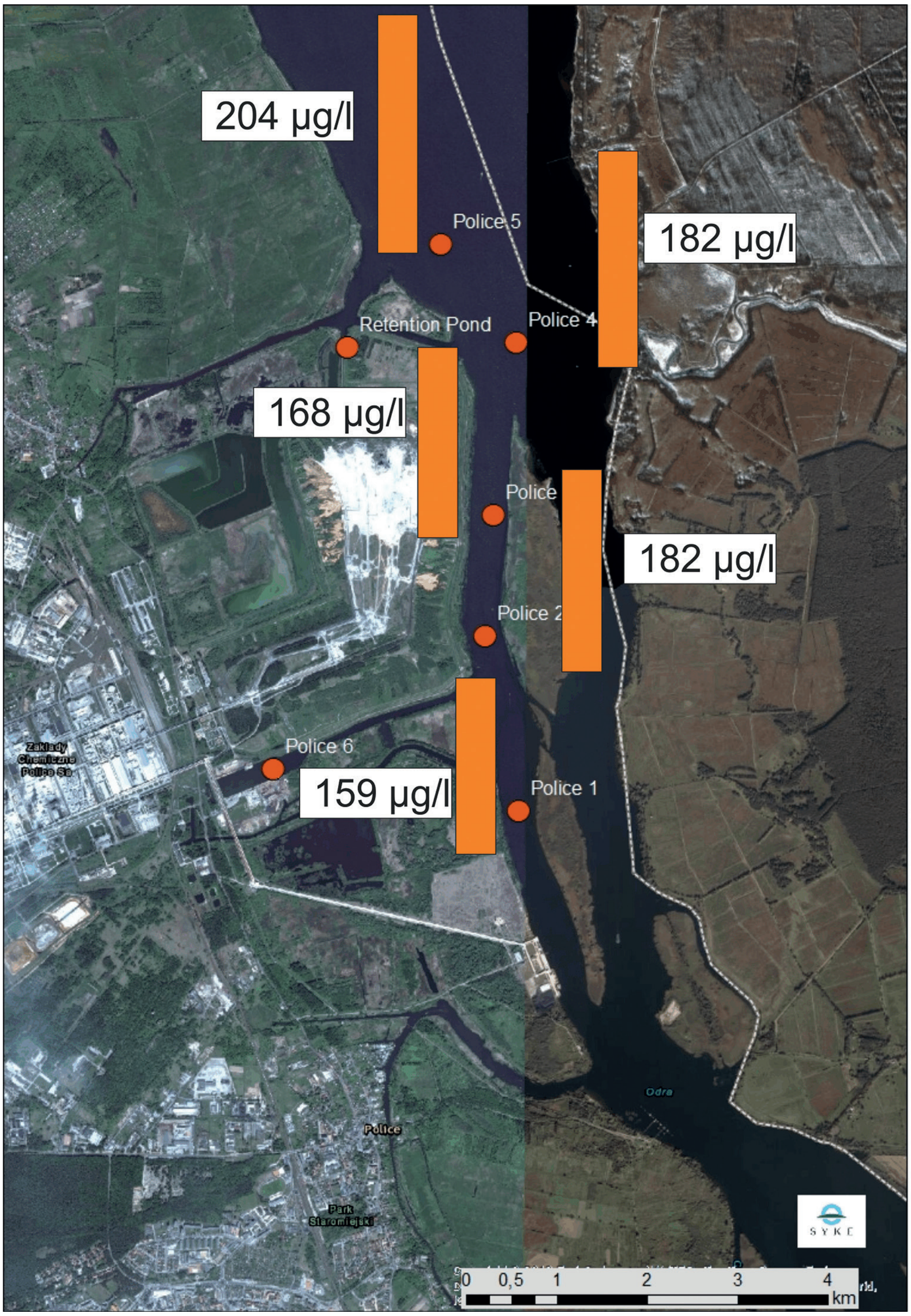

Figure 9. Total phosphorus concentrations (µg P/l) at five sampling sites in the Oder River.

6 Conclusions and proposed further studies

6.1

Gdańsk

According to the results of the joint expedition on 1 July 2013, the primary and most evident reason for the sharp increase in phosphorus concentrations in the river Martwa Wisla is the local phosphogypsum stack. The highest concentrations were measured at the two sites closest to the stack. Additionally, the treated wastewaters of the City of Gdańsk and the exchange with bottom sediments may affect the phosphorus concentrations in the river. However, the roles of the different sources and sinks cannot be quantified on the basis of the available data.

The hydrology of the Martwa Wisla is complex with low current speeds and varying current directions. In order to realistically estimate the leakages of phosphorus and other substances in the river, a comprehensive study of mass balances of the whole catchment of the Martwa Visla, including the phosphogypsum stack, should be done. The study should also include investigating the role of sediments, and the exchange of water and substances between the Martwa Wisla and Gdańsk Bay. To be able to provide reliable estimates for substance inputs from the Martwa Wisla to Gdańsk Bay, intensive sampling and flow measurements in the Martwa Wisla and off the mouths of its two outlets into Gdańsk Bay are needed. Intensive conductivity and salinity measurements extending from the mouth areas of the Martwa Wisla to the easternmost end of the river would help to estimate the water exchange between the Martwa Wisla and Gdańsk Bay, as well as within the Martwa Wisla.

Despite the irrigation system, it is unlikely that annual actual evapotranspiration would equal annual precipitation, especially during wet years, in the Wislinka stack area. In the forthcoming studies it would be necessary to ensure that there is enough storage capacity for runoff in case of high annual precipitation and low actual evapotranspiration. There is no bottom lining and neither vertical nor hydraulic barriers in the drainage system to prevent infiltration when water is stored inside the area. The water samples taken outside the embankment around the phosphogypsum stack were seen to contain significantly elevated concentrations of orthophosphate, indicating that leakage from the stack is widespread. However, on the basis of the information currently available there is no reliable method to estimate the amount of infiltration and the capacity of the drainage system to collect such runoff. It is also unclear how much of the possible runoff would flow into the Martwa Wisla and how much would flow in other directions. These issues need further studies.

6.2
Police

According to the results of the joint sampling, the phosphorus concentrations in recipient waters are much lower in Police than in Gdańsk. Evidently the substantial flow in the Oder River effectively dilutes the potential leakages into the river. Additionally, in Police the hydraulic barrier may prevent leakages from the stack, as compared to the conditions in Gdańsk, where no such barrier exists.

As seen in the present joint sampling, the phosphorus concentration increases somewhat from the station upstream of the stack towards the stations downstream of the stack. The Polish monitoring results for the period 2008–2012 also indicate an average increase in phosphate and total phosphorus concentrations from the station upstream of the stack towards the one downstream, even though the two stations show a lot of variation in the concentrations, and the downstream station does not uniformly show higher concentrations than the upstream one. In any case, leakages from the stack into the Oder River cannot be ruled out.

It is recommended that a more comprehensive monitoring study of both surface and ground waters in Police should be performed to ensure that leakages from the stack can be prevented by the existing protection measures under all hydrological conditions. It is also suggested that the present monitoring frequency (4 times per year) in the Oder River should be permanently increased to at least 12 times per year at representative stations both upstream and downstream from the stack. In addition, the water flow of the Oder between the stack and the nearby island should be continuously monitored. These activities would enable a reliable estimation of the potential phosphorus load into the Baltic Sea caused by the stack.

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Annex 1. Sampling of surface water from around a phosphogypsum waste heap in Wiślinka

The joint Polish-Finish sampling in the vicinity of Wislinka phosphogypsum site was carried out on 1.07.2013 in accordance with the decision of HELCOM HOD 41/2013 (LD 164).

The joint sampling was preceded by a joint meeting at the premises of the Voivodship Inspectorate for Environmental Protection in Gdańsk. The meeting was attended by participants from Polish and Finish sides. The List of participants is contained in Annex 1.

The meeting was chaired by the Voivodeship Inspector of Environmental Protection in Gdańsk, Mr Zbigniew Macczak.

The meeting adopted the following Agenda:

AGENDA

1. Sampling date and time

01. 07. 2013, from 9.00 a.m. till the end of the day

2. The sampling points

1. at the level of phosphogypsum storage area in Wiślanka – waters from the middle of the channel of the Martwa Wisła (the Dead Vistula river),
2. water body of the heap
3. internal ditch of the heap
4. external ditch of the heap
5. pump station Wislinka 12
6. mouth of the Kanal Piaskowy to Martwa Wisła
7. waters of the Martwa Wisła at the level of pontoon bridge in Sobieszew – a permanent measurement point by the Voivodship Inspectorate for Environmental Protection (VIEP), established for the purposes of national water monitoring,
8. waters of the Martwa Wisła where it joins the Wisła Śmiała (the Bold Vistula river)– the first point of the outflow of the waters of the Martwa Wisła with the waters of the Baltic Sea,
9. waters of the Martwa Wisła at the level of the Siennicki bridge – a permanent measurement point by VIEP, established for the purposes of national water monitoring,
10. the Martwa Wisła estuary to the Bay of Gdańsk – a permanent measurement point by VIEP, established for the purposes of national water monitoring.

The map of sampling points is enclosed.

3. Sampling containers and devices for their storage and transportation:

For the total phosphorus analysis:
PL: glass bottles of 1 l capacity - preserved with 2 ml of H_2SO_4 (PL's own acid)
FI: plastic bottles of 100 ml capacity - preserved with 1 ml of H_2SO_4 (FI's own acid)

For dissolved orthophosphate analysis:
PL: glass bottles of 1 l capacity; samples filtered by the following filter: Sartorius Stadim, Celulose Intrate, Pore Size 0.45 µm
FI: no bottles; the samples filtered by PL laboratory were hand over to FI

For other parameters:

In addition, to phosphorus and phosphate following other parameters will be measured: Conductivity, Aluminium (Al), iron (Fe), calcium (Ca), fluoride (F), manganese (Mn), potassium (K), sulphate (SO4-S), total sulphur (TOTS), total nitrogen (TOTN, ammonium nitrogen (NH4-N), nitrate+nitrite nitrogen (NO23N), pH, cadmium (Cd), nickel (Ni). The aim of these additional parameters is to verify signs of phosphorus/phosphate leakages and link them to the gypsum stacks.

PL: glass bottles of 1 l capacity without preservation
FI: plastic bottles of 1 l capacity without preservation

All the samples taken were stored and transported at the temperature ranging from 0°C to 5°C. The samplers were in the possession of a cooling device ensuring that the temperature ranging from 0°C to 5°C is maintained from the moment of taking a sample until its delivery to the laboratory.

4. Sampling methodology:

ISO-5667-6:2003, PN-EN ISO 5667-3: 2013

5. Sampling:

Some samples were jointly taken with the use of Limnos Sampler (numbers: 1, 7, 8, 9, 10). Other samples were jointly taken with the use of a scoop (numbers: 2, 3, 4, 5, 6). All samples were distributed in portions to bottles for the analysis by the laboratory of VIEP in Gdańsk and by Finland.

Finnish hydrologist evaluated water flow paths and directions in order to gain the knowledge of how estimate in a suitable way the total amount of water flowing from the gypsum stack areas into nearby rivers.

6. The objective of the sampling:

Determination of the total phosphorus, dissolved orthophosphate and other parameters concentration in the samples of water taken.

Polish laboratories have an implemented Quality Management System according to ISO – 17025 "General requirements for the competence of testing and calibration laboratories", confirmed with the accreditation certificate issued by the national accreditation body: Polish Centre for Accreditation www.pca.gov.pl.

The laboratory of SYKE is test laboratory T003 accrediated by the FINAS accredation service (ANNEX 3) and area of competence T003 ANNEX 3).

7. Sampling methodologies:

a) in water:

VIEP Laboratory		
	Methodology	**Method of sampling and sample preservation ISO-5667-6:2003**
Total phosphorus	PN-EN ISO 6878:2006, type 7 – spectrophotometric method with ammonium molybdate	1 l glass bottle. The sample preserved with H_2SO_4 (2 ml)
Dissolved orthophosphate	PN-EN ISO ISO6878:2006, type 4 – spectrophotometric method PN-EN ISO 15681-2:2006 - manual analysis method	1 l glass container. Sample was filtered with a membrane filter (cellulose nitrate filter) of 47 mm diameter and 0.45µm pore size.
Finnish Environment Institute SYKE Laboratory		
	Methodology	**Method of sampling and sample preservation**
Total phosphorus	In-house method IC103, CFA technique, modified SFS-EN ISO 15681-2	100 mL plastic LDPE bottle. The sample is preserved with 1 mL of H_2SO_4 (4 mol/L).
Dissolved orthophosphate	In-house method IC103, CFA technique, modified SFS-EN ISO 15681-2	PL bottles (the samples filtered by PL laboratory were hand over to FI)

8. The phosphate samples will be examined in the laboratory (PL and FI): 05.07.2013 and total phosphorus on 08.07.2013. Other parameters will be analysed between 05.07.2013 and 12.07.2013.

9. The laboratory examination results regarding phosphous and phosphate will be sent in an electronic version both to the Inspection and Administrative Ruling Department in the Chief Inspectorate of Environmental Protection, the Finnish Ministry of the Environment and SYKE in the form of official reports on the examination on: 12.07.2013. The parties did not agree on the issue that the laboratory examination results regarding other parameters will not be included in the official report and it will be the subject of further discussions on the higher level.

10. The parties involved in the sampling will try to elaborate joint conclusions at the latest on 15.07.2013.

11. Chief Inspectorate of Environmental Protection and the Finnish Ministry of the Environment will prepare joint announcement on: 17.07.2013.

Annex 2. Sampling of surface water and wastewater from around a phosphogypsum dump site in Police

The joint Polish–Finnish sampling in the vicinity of Police phosphogypsum site was carried out on 3.07.2013 in accordance with the decision of HELCOM HOD 41/2013 (LD 164).

The joint sampling was preceded by a joint meeting at the premises of the Voivodeship Inspectorate for Environmental Protection in Szczecin (VIEP Szczecin). The meeting was attended by participants from Polish and Finnish sides. The meeting was chaired by the Voivodeship Inspector of Environmental Protection in Szczecin, Mr Andrzej Miluch. The list of participants is contained in Annex 1.

The meeting adopted the following Agenda:

AGENDA

The meeting agreed on a range and rules of the common sampling of both surface water nearby the phosphgypsum dump operating by Grupa Azoty Zakłady Chemiczne „Police" S.A. and treated wastewater discharged from the company's wastewater treatment plant.

The goal of the common sampling is to take samples of surface water and wastewater in order to determine total phosphorus, dissolved orthophosphates and other parameters concentration in the samples taken.

During the meeting it was agreed that samples are taken simultaneously and analyzed at the same time by Polish and Finnish experts - VIEP Szczecin and SYKE, respectively.

1. Number of participants

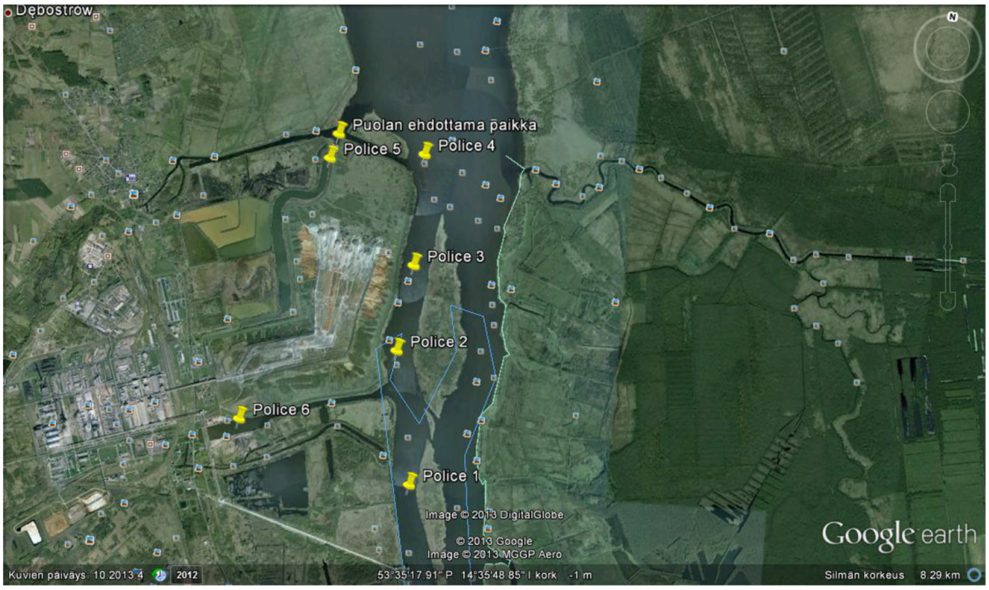
The participants are: VIEP Szczecin staff, delegates from the Chief Inspectorate for Environmental Protection and experts from Finland, according to the Annex 1. On request of the controlled entity, the representative of the company is also present during sampling.

2. Sampling date and venue

The joint sampling is carried out on 3rd of July 2013 on seven sampling sites located in the vicinity of Grupa Azoty Zakłady Chemiczne „Police" S.A. according to the Finnish proposal. The exact location of the agreed sampling points are presented on the map and coordinates are listed in the Annex 2. Changes in location of sampling sites or choosing a new one during common sampling were allowed when necessary.

Wastewater management

The aim of the survey is to evaluate the potential threat to the water environment caused by the phosphogypsum dump. According to the official statement of the Grupa Azoty Zakłady Chemiczne „Police" S.A. implemented protection measures efficiently protect nearby waters against pollution from the phosphgypsum dump. Having a lower water level in the dump area in comparison with the level of the Oder river and surrounding channels is proven to be an effective solution applied for years. Additionally, a buffer zone of about 200 meters has been established around the dump area to protect water environment. Floodbank with drainage system protects



the dump area against inflow of surface waters (such as backflow, floods). The total length of floodbank is 6.7 km. The geological structure of the bottom of the dump is also a factor of great importance. According to experts' opinion based on research of hydrogeological conditions, under the weight of the heap peat in the ground constituted an isolation layer minimizing thread of infiltration, which naturally isolates the dump from surrounding waters.

Inspection activity of VIEP in Szczecin

Wastewaters from the industrial company Grupa Azoty Zakłady Chemiczne „Police" S.A., treated in the mechanical-chemical wastewater treatment plant (technological wastewaters, leachate from the phosphogypsum dump, leachate from iron sulphate stockpile, domestic watewaters, municipal wastewaters from Police and wastewaters receipted from outer delivers) are discharged into the Oder River according to the integrated permit (decision issued by the Westernpomeranian Voivode of 27.02.2004, signature: SR-Ś-6/6619/1/04). The monitoring station - Zastawka na Kanale Jasienickim – is the point where quality of wastewater must be checked on the regular basis as determined in the integrated permit.

Simultaneously, inspection of the plant is carried out by VIEP in Szczecin on the 3rd of July 2013 in order to check wastewater management and compliance with legal provisions. Samples of treated wastewaters (taken during 24-hours) will be taken during the inspection and parameters listed in the integrated permit (Annex 3) will be determined in the samples. On request, the inspection report with results of 24 h measurements can be made available for the Finnish side.

Sampling of surface water and wastewater

Water sampling in the vicinity of Zakłady Chemiczne „Police" S.A. on 3rd of July 2013 will be carried out in the following sampling points:

1. Point located in the Police Channel (Kanał Policki) at the level of Długi Ostrów island **(Police 1)**,
2. Point located in the Police Channel (Kanał Policki) at the level of Karw Wielki island, in the mouth of the Barkowy Channel (Kanał Barkowy) **(Police 2)**,
3. Point located in the Police Channel (Kanał Policki) at the level of the northern part of Karw Wielki island **(Police 3)**,

4. Point located in the Police Channel (Kanał Policki) at the level of the mouth of the Gunica river where river flows into the Roztoka Odrzańska **(Police 4)**.
5. Point located in the barge harbour in the Barkowy Channel (Kanał Barkowy), where according to the integrated permit both rain waters and cooling waters are discharged **(Police 6)**.

The meeting agreed that samples will be taken from the following sampling points:

- Zastawka na Kanale Jasienickim, where wastewaters after treatment are discharged from the retention pond to the receipient water body (wastewater)
- the mouth of the Gunica River into the Roztoka Odrzańska - Police 5 (surface water)

Due to technical reasons PL made the following proposal: to take samples of wastewaters from the retention pond in the monitoring point Zastawka na Kanale Jasienickim, where wastewaters after treatment are discharged from the retention pond to the receipient water body and change location of the point Police 5 from the retention pond to the mouth of the Gunica River. The proposal was accepted by FI.

Load calculations

The meeting took note that the results of measurements will provide information on concentration levels of analyzed parameters only at the moment of sampling. On the basis of this data it is impossible to calculate pollutants loads in discharged wastewater as well as pollutants loads in surface water, carried by the Oder river. According to both the relevant PL legal provisions and the HELCOM PLC rules (*Guidelines for the compilation of waterborne pollution load to the Baltic Sea* PLC-WATER), loads should be calculated on the basis of 24-hours sampling. To calculate annual loads such samples must be taken several times a year. The estuary of the Oder river has complex hydrology. In the area South of Zakłady Chemiczne„Police" S.A. the Oder river is split by the chain of islands into the Policki Channel (so-called Wąski Nurt) and the main current of the Oder River (so-called Szeroki Nurt). Samples will be taken only in the Police Channel, alongside the river bank where the phosphogypsum dump is located. Determination of both momentary and daily flows of water in the Oder river requires complicated and time-consuming model calculations, what makes impossible to evaluate pollutants loads in the river directly.

It has been agreed that due to the above mentioned hydrological conditions of both river and channels, it would be impossible to calculate reliable loads on the basis of the joint measurement results.

4. Sampling methodology

All samples are taken on the basis of a one-time sample that make possible to assess short-time concentration of parameters.

PL samplers take all surface water samples 1 meter below a water surface with the use of Ruttner bathometer.

In order to ensure that samples are homogenous and comparable, a joint sample of water as well as wastewater will be taken to one big container, mixed and distributed to containers provided by the participating laboratories for further analysis. (During the joint Polish–Finnish sampling in the vicinity of Wislinka phosphogypsum dump site carried out on 1.07.2013 it was decided that samples are taken not to one big container, but distributed directly to containers provided by the participating laboratories for further analysis. It may affect the results of the analysis.)

All samples from each sampling points will be analysed taking into consideration the parameters listed in the Annex 3.

5. Schedule

The date of opening containers with samples and starting analysis in all participating laboratories has been fixed on **05.07.2013** and total phosphorus on **08.07.2013** (to be confirmed, as well as regarding to Wislinka phosphogypsum dump site). Other parameters will be analysed between **05.07.2013** and **16.07.2013**. Simultaneously, VIEP Szczecin will open containers with additional set of samples and start analysis on **04.07.2013** according to applied methodology (accreditation AB 177).

The laboratory examination results regarding phosphorus and phosphate will be sent in an electronic version both to the Inspection and Administrative Ruling Department in the Chief Inspectorate of Environmental Protection, the Finnish Ministry of the Environment and SYKE in the form of official reports on the examination on: **12.07.2013** (phosphates and phosphorus) and **16.07.2013** (other parameters). FI did not agree on PL proposal that the laboratory examination results regarding other parameters should not be included in the official report. Therefore, this issue will be the subject of further discussions at higher level.

The parties involved in the sampling will try to elaborate joint conclusions at the latest on **15.07.2013**.

Chief Inspectorate of Environmental Protection and the Finnish Ministry of the Environment will prepare joint announcement on: **17.07.2013**.

6. Parameters and methodologies

The complete list of parameters with applied methodologies is presented in the annex 4.

The range of parameters relating to wastewaters is longer than the list of obligatory parameters which have to be monitored by the company according to the integrated permit.

In compliance with the binding norm analyses of orthophosphates have to be carried out within 24 hours since sampling.

Samples which should be preserved will be preserved with concentrated acid in the premises of VIEP in Szczecin after having finished sampling in situ. Each side will preserve their samples with the use of their own acid H_2SO_4 (similarly to samples taken in the vicinity of Police phosphogypsum site).

Samples intended for filtering will be filtered with filters provided by VIEP Szczecin laboratory. The filters are used in water monitoring analysis according to the applied methodology.

7. Accreditation certificates

The samples will be taken by VIEP Szczecin laboratory staff with the use of their own equipment.

Representatives from the laboratory of VIEP Szczecin, which has an accreditation certificate for both sampling and analyses, will take part in joint sampling. The scope of accreditation of VIEP Szczecin is provided in Annex 5.

Representatives from SYKE will participate in the joint sampling from the FI side. The laboratory of SYKE has a certificate of accreditation.

Both sides confirmed that sampling was carried out according to the above mentioned agenda.

On request additional information on site monitoring results for 2012 (in paper form) was hand over to FI experts

List of participants taking part in the joint sampling and control activity

Regional Inspectorate for Environmental protection in Szczecin:

Andrzej Miluch – Westernpomeranian Regional Inspector for Environmental Protection,
Marzena Michalska – Chief Executive Officer,
Elżbieta Mikos – Nawłatyna – Senior inspector,
Małgorzata Landsberg – Uczciwek – Head of Environmental Monitoring Division,
Anna Robak – Bakierowska – Senior specialist,
Monika Cieszyńska – Head of Sampling Division,
Jacek Gocławski – Specialist,
Szymon Narożański – Expert,
Przemysław Szopiak – Senior administrator.

Chief Inspectorate for Environmental Protection:

Ewa Martynko-Pluta – Specialist,
Andrzej Podściański – Specialist.

Finnish experts:

Antti Raike – Finnish Environment Institute (SYKE),
Jyrki Vuorinen – The Centre for Economic Development, Transport and the Environment (ELY - centre),
Jarkko Koskela – Finnish Environment Institute (SYKE).

Annex 3. The list of analyzed parameters

Table.3.1. Parameters analyzed in surface waters

No	Parameter
1	Conductivity
2	Aluminium
3	Iron
4	Calcium
5	Fluorides
6	Total Fluorine
7	Manganese
8	Potassium
9	Sulphate
10	Total Kjeldahl Nitrogen
11	Ammonium Nitrogen
12	Nitrate Nitrogen
13	Nitrite Nitrogen
14	pH
15	Cadmium
16	Nickel
17	Total Phosphorus
18	Ortophosphates

Table.3.2. Parameters analyzed in wastwaters according to the integrated permit

L.p.	Parametr
1	pH
2	Ammonium Nitrogen
3	Total Phosphorus
4	Iron
5	Fluorides
6	Suspended matters
7	Chemical Oxygen Demand (Cr)

Annex 4. Analitycal methods

Table. Analytical methods applied by

Finnish Environment Institute SYKE Laboratory

	Methodology	**Method of sampling and sample preservation**
Total phosphorus	In-house method IC103, CFA technique, modified SFS-EN ISO 15681-2	100 mL plastic LDPE bottle. The sample is preserved with 1 mL of H_2SO_4 (4 mol/L).
Dissolved orthophosphate	In-house method IC103, CFA technique, modified SFS-EN ISO 15681-2	PL bottles (the samples filtered by PL laboratory were hand over to FI)

VIEP Szczecin Laboratory

	Methodology	**Method of sampling and sample preservation ISO-5667-6:2003**
Total phosphorus (surface water & wastewater)	PN-EN ISO 6878:2006, type 7 – spectrophotometric method with ammonium molybdate	0.5 l glass bottle. The sample preserved with H_2SO_4 (1 ml)
Dissolved orthophosphate (only surface water)	PN-EN ISO ISO6878:2006, type 4 – spectrophotometric method PN-EN ISO 15681-2:2006 - manual analysis method	0.25 l plastic container. Sample was filtered with a membrane filter (cellulose acetate filter) of 47 mm diameter and 0.45µm pore size.

VIEP Szczecin Laboratory (other parameters)

No	Parameter	Method	Comment
1	Conductivity	PN-EN 27888:1999	In situ
2	Dissolved Aluminium	PN-EN ISO 15586:2005	Sample filtered in a laboratory with a cellulose nitrate filter of 0,45 µm porosity. After filtration sample is preserved with nitrate acid to have pH < 2.500 mL polyethylene container.
3	Dissolved Iron	PN-EN ISO 15586:2005	Sample filtered in a laboratory with a cellulose nitrate filter of 0,45 µm porosity. After filtration sample is preserved with nitrate acid to have pH < 2.500 mL polyethylene container.
4	Dissolved Calcium	PN-EN ISO 14911:2002	Sample filtered in a laboratory with a cellulose acetate filter of 0,45 µm porosity. 250 mL polyethylene container.
5	Dissolved Fluorine	PN-EN ISO 10304-1:2009	Sample filtered in a laboratory with a cellulose acetate filter of 0,45 µm porosity. 250 mL polyethylene container.
6	Total Fluorine	PN-78/ C-04588.03	250 mL polyethylene container.
7	Dissolved Manganese	PN-EN ISO 15586:2005	Sample filtered in a laboratory with a cellulose nitrate filter of 0,45 µm porosity. After filtration sample is preserved with nitrate acid to have pH < 2. 500 mL polyethylene container.
8	Dissolved Potassium	PN-EN ISO 14911:2002	Sample filtered in a laboratory with a cellulose acetate filter of 0,45 µm porosity. 250 mL polyethylene container.
9	Dissolved Sulphates	PN-EN ISO 10304-1:2009	Sample filtered in a laboratory with a cellulose acetate filter of 0,45 µm porosity. 250 mL polyethylene container.
		PN-ISO 9280:2002	Sample filtered in a laboratory with an ashless filter paper of small porosity. 500 mL polyethylene container.
10	Total Kjeldahl Nitrogen	PN-73/ C-04576.12	Sample preserved with nitrate acid to have pH 1- 2. 500 mL polyethylene container.
11	Dissolved Ammonium Nitrogen	PN-EN ISO 11732:2007	Sample filtered in a laboratory with a cellulose acetate filter of 0,45 µm porosity. 250 mL polyethylene container.
12	Dissolved Nitrate Nitrogen	PN-EN ISO 13395:2001	Sample filtered in a laboratory with a cellulose acetate filter of 0,45 µm porosity. 250 mL polyethylene container.
13	Dissolved Nitrite Nitrogen	PN-EN ISO 13395:2001	Sample filtered in a laboratory with a cellulose acetate filter of 0,45 µm porosity. 250 mL polyethylene container.
14	pH	PN-90/ C-04540.01	In situ
15	Cadmium	PN-EN ISO 15586:2005	Sample filtered in a laboratory with a cellulose nitrate filter of 0,45 µm porosity. After filtration sample is preserved with nitrate acid to have pH < 2. 500 mL polyethylene container.
16	Nickel	PN-EN ISO 15586:2005	Sample filtered in a laboratory with a cellulose nitrate filter of 0,45 µm porosity. After filtration sample is preserved with nitrate acid to have pH < 2. 500 mL polyethylene container.

Annex 5. Analytical methods applied by the Finnish Environment Institute (SYKE) Laboratory

Parameter	Code	Test Method
Aluminium	AL-990X	In-house method IC207, ICP-OES -technique, SFS-EN ISO 11885:2007
Ammonium Nitrogen	NH4N-333X	In-house method IC107, modified SFS-EN ISO 11732:2005
Cadmium	CD-445X	In-house method IC204, modified SFS-EN ISO 17294-1 and SFS-EN ISO 17294-2, ICP-MS technique
Calcium	CA-1002KX	In-house method IC207, ICP-OES -technique, SFS-EN ISO 11885:2007
Conductivity	COND-318X	SFS-EN 27888:1994
Dissolved Phosphate Phosphorus	PO4P-638X	In-house method IC103, CFA technique, modified SFS-EN ISO 15681-2
Fluoride	F-457K	SFS-EN ISO 10304-1:2007
Iron	FE-1056X	In-house method IC207, ICP-OES -technique, SFS-EN ISO 11885:2007
Manganese	MN-1055X	In-house method IC207, ICP-OES -technique, SFS-EN ISO 11885:2007
Nickel	NI-441X	In-house method IC204, modified SFS-EN ISO 17294-1 and SFS-EN ISO 17294-2, ICP-MS technique
Nitrate + Nitrite Nitrogen	NO23N-405X	In-house method IC 104, modified SFS-EN ISO 13395:1997
pH	PH-307X	SFS 3021:1979
Potassium	K-1001KX	In-house method IC207, ICP-OES -technique, SFS-EN ISO 11885:2007
Sulphur	S-1310X	In-house method IC207, ICP-OES -technique, SFS-EN ISO 11885:2007
Sulphate	SO4-330K	SFS-EN ISO 10304-1:2007
Total Nitrogen	NTOT-323X	In-house method IC104, modified SFS-EN ISO 11905-1:1998
Total Phosphorus	PTOT-315X	In-house method IC103, CFA technique, modified SFS-EN ISO 15681-2

Annex 6. Analytical results the Finnish Environment Institute (SYKE) Laboratory

Location	Sampling site	Sampling depth (m)	AL-990X (µg/l)	CA-1002KX (mg/l)	CD-445X (µg/l)	COND-318X (mS/m)	F-457K (µg/l)	FE-1056X (µg/l)	K-1001KX (mg/l)	MN-1055X (µg/l)	NH4N-333X (µg/l)	NI-441X (µg/l)	NO23N-405X (µg/l)	NTOT-323X (µg/l)	PH-307X	PO4P-638X (µg/l)	PTOT-315X (µg/l)	S-1310X (µg/l)	SO4-330K (mg/l)
Gdańsk	Evaporation pond	0,1	87000	2070	2000	1190	230000	64000	174	22000	18000	2200	17500	43000	2,4	6050000	7010000	450000	8500
Gdańsk	Filtration pond	0,1	59000	1750	1400	985	120000	31000	155	16000	95000	1600	101000	200000	2,5	3970000	4270000	470000	6500
Gdańsk	Reserve Moat	0,1	29000	1520	1200	939	35000	15000	88,3	20000	12000	1500	6150	33000	2,9	4160000	4100000	340000	4800
Gdańsk	Melloration Ditch 6	0,1	<25	85,2	0,18	364	990	140	23,7	490	510	6,9	3	2100	7,4	48300	49700	42000	140
Gdańsk	Kanal Piaskowy	0,1	<25	97,9	0,030	553	<500	70	33,8	390	49	2,6	3	890	8,1	5490	5170	78000	240
Gdańsk	Martwa Wisla 1	1,0	<25	96,1	0,043	880	<500	100	53,5	170	110	1,4	4	740	8,0	808	879	130000	360
Gdańsk	Martwa Wisla 2	1,0	<25	94,6	0,030	892	<500	120	53,8	140	68	1,4	5	720	8,2	473	547	130000	400
Gdańsk	Martwa Wisla 3	1,0	36	92,1	0,013	887	<500	150	53,4	110	81	1,4	16	740	8,2	177	268	130000	400
Gdańsk	Martwa Wisla 4	1,0	49	87,5	0,032	781	<500	240	47,5	160	290	1,1	120	980	7,8	169	289	110000	330
Gdańsk	Martwa Wisla 5	1,0	34	91,6	0,039	883	660	120	53,8	50	300	1,1	117	920	7,8	147	265	130000	400
Police	Police 1	1,0	57	55,6	0,048	52,0	<500	320	5,4	99	95	3,3	1300	2500	7,9	86	159	17000	51
Police	Police 2	1,0	63	56,7	0,073	51,6	<500	410	5,5	120	100	3,2	1280	2400	7,9	105	182	17000	50
Police	Police 3	1,0	59	56,0	0,053	51,0	<500	350	5,4	110	92	3,1	1270	2400	7,9	101	168	17000	50
Police	Police 4	1,0	67	56,5	0,084	51,6	<500	440	5,4	120	91	3,3	1270	2200	7,9	92	189	17000	52
Police	Police 5	0,5	77	56,7	0,12	51,6	<500	550	5,4	130	87	3,4	1260	2500	7,9	89	204	17000	48
Police	Police 6	1,0	63	60,3	0,046	55,2	<500	380	6,3	140	180	3,3	1300	2700	8,0	144	236	18000	55
Police	Retention Pond	0,1					14000	480			3700				7,7		295		

DOCUMENTATION PAGE

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Title of publication	**Joint Polish–Finnish sampling of surface waters around the phosphogypsum waste stacks in Gdańsk and Police from 1 to 3 July 2013 – Results of the expedition**			
Publication series and number	Reports of the Finnish Environment Institute 3/2015			
Parts of publication/ other project publications	The publication is available only on the internet: www.syke.fi/publications | helda.helsinki.fi/syke			
Abstract	The report describes the results of the joint Polish–Finnish sampling expedition aimed at estimating the possible effects of the two Polish phosphogypsum stacks located in Wislinka (Gdańsk) and Police on the loading of the Baltic Sea and the nearby watercourses. The joint expedition was based on the agreement between the Polish and Finnish Ministers of the Environment in June 2013. The results indicate a clear effect of the phosphogypsum stack on phosphate and total phosphorus concentrations in the Martwa Wisla. The physical nature of the basin with no permanent flow into the sea weakens mixing and dilution and may cause a local enrichment of pollutants from external sources, compared with a normal river having a constant water flow into the sea. Our suggestion is that a comprehensive study should be carried out in the stack area of Wislinka, as well as in the Martwa Wisla and its catchment area, to be able to calculate water and phosphorus mass balances in the area, and the magnitude of inputs of phosphorus to the Baltic Sea caused by the stack. The role of sediments as sinks and sources of phosphorus and other pollutants in the Martwa Wisla should be studied as well. In Police the effects of the phosphogypsum stack were less obvious. This could be expected as a result of effective mixing and dilution due to the high flow in the Oder River. Additionally, measures have been implemented to prevent leakage, by means of a hydraulic barrier and by collecting runoff water and directing it to the local wastewater treatment plant (WWTP). However, the results of the present expedition and also the results of the local monitoring programme from 2008 to 2012 indicate that the effects of the phosphogypsum stack on the quality of the recipient water cannot be ruled out. In order to estimate possible leakages in Police we suggest that an intensive monitoring programme for both groundwater and surface waters would be initiated. The sampling frequency for monitoring the leakage from the phosphogypsum stack should be increased to at least 12 annual samples at both the upstream and downstream stations. In addition, the water flow of the Oder between the stack and the nearby island should be continuously monitored. This would enable a reliable estimation of the potential phosphorus load into the Baltic Sea caused by the stack.			
Keywords	The Baltic Sea, Poland, Finland, Gdańsk, Police, phosphogypsum waste stacks, sampling, loading, phosphorus, monitoring			
Financier/ commissioner				
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KUVAILULEHTI

Julkaisija	Suomen ympäristökeskus (SYKE)	*Julkaisuaika* Maaliskuu 2015
Tekijä(t)	Antti Räike, Jarkko Koskela, Seppo Knuuttila, Jouni Lehtoranta, Heikki Pitkänen, Maarit Risto ja Jyrki Vuorinen	
Julkaisun nimi	**Joint Polish–Finnish sampling of surface waters around the phosphogypsum waste stacks in Gdańsk and Police from 1 to 3 July 2013 – Results of the expedition** (Tutkimustulokset puolalaisten ja suomalaisten yhteisestä Gdańskin ja Policen kipsivuorten ympäristön vesinäytteenotosta 1.-3.7.2013)	
Julkaisusarjan nimi ja numero	Suomen ympäristökeskuksen raportteja 3/2015	
Julkaisun osat/ muut saman projektin tuottamat julkaisut	Julkaisu on saatavana ainoastaan internetistä: www.syke.fi/julkaisut | helda.helsinki.fi/syke	
Tiivistelmä	Puolan ja Suomen ympäristöministerit tekivät kesäkuussa 2013 sopimuksen yhteisestä tutkimushankkeesta, jonka tarkoituksena oli arvioida Puolassa Wislinkassa ja Policessa sijaitsevien kipsijätevuorien merkitys lähialueen vesistöjen ja Itämeren kuormittajina. Tutkimus toteutettiin ottamalla vesinäytteitä kipsivuorten alueelta ja niiden läheisistä vesistöistä. Näytteet analysoitiin sekä puolalaisissa että suomalaisissa laboratorioissa. Kuollut Veiksel (Martwa Wisla) on padolla varsinaisesta Veikselistä eristetty joen uoma, jossa veden virtaaminen Itämereen on rajoittunutta. Siksi siellä myös kuormituksen vaikutukset ovat helpommin havaittavissa. Korkeat kokonaisfosfori- ja fosfaattifosforipitoisuudet Kuolleessa Veikselissä osoittivat Wislinkan kipsivuoren aiheuttavan kuormitusta, mutta Itämereen päätyvän kuormituksen määrä on nykyisten tutkimustulosten perusteella mahdoton arvioida. Me suosittelemme että Wislinkan kipsivuoren alueella ja sen lähivesistöissä aloitettaisiin kattava vedenlaadun seuranta, mikä mahdollistaisi fosforitaseiden laskemisen. Fosforitaseiden avulla pystyttäisiin arvioimaan kuinka paljon kipsivuoresta peräisin olevaa fosforia virtaa Itämereen. Lisäksi Kuolleen Veikselin sedimentin merkitys fosfori- ja raskasmetallilähteenä tulisi selvittää. Policessa kipsivuoren vaikutukset Oderin vedenlaatuun eivät olleet yhtä selkeästi havaittavissa kuin Wislinkassa. Tämä johtuu veden virtaamisen aiheuttamasta kuormituksen sekoittumisesta ja laimentumisesta. Lisäksi Policessa on tehty tehokkaampia toimenpiteitä kipsivuoresta tulevan kuormituksen estämiseksi. Tällaisia toimenpiteitä ovat esimerkiksi hydraulinen eristäminen ja jätevuoresta tulevien suotovesien johtaminen jätevedenpuhdistamolle. Tämän tutkimuksen ja vuosina 2008 ja 2012 puolalaisten ympäristöviranomaisten tekemien seurantatulosten perusteella Policen kipsivuoren vaikutusta Oderin vedenlaatuun ei voi kuitenkaan sulkea pois, sillä kokonaisfosforipitoisuudet nousivat 5-28 % veden virratessa kipsivuoren ohi. Jotta Policen kipsivuoren mahdolliset päästöt saataisiin selville, pitäisi aloittaa kattava pinta- ja pohjavesien seuranta kipsivuoren alueella ja Oderissa. Näytteenottotiheyden tulisi olla vähintään 12 vuotuista näytettä sekä kipsivuoren ylävirralta että alavirralta. Myös kipsivuoren ja sen edustalla olevan saaren välisen joen uoman virtaama tulisi säännöllisesti mitata, jotta ainevirtaamat voitaisiin laskea luotettavasti.	
Asiasanat	Itämeri, Puola, Suomi, Gdańsk, Police, kipsivuoret, näytteenotto, kuormitus, fosfori, seuranta	
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<tr><td>Sammandrag</td><td colspan="4">I juni 2013 ingick Polens och Finlands miljöministrar ett avtal om ett gemensamt forskningsprojekt i syfte att bedöma vilken inverkan gipsavfallsbergen i Wislinka och Police i Polen har på belastningen i Östersjön och i vattendragen i det närliggande området. Undersökningen utfördes genom att man tog vattenprover i området kring gipsbergen och i närliggande vattendrag. Proverna analyserades i både polska och finska laboratorier.

Martwa Wisła (Döda Wisła) är en avskild förgrening av den egentliga floden Wisła med begränsad vattenföring till Östersjön. Därför är belastningens inverkan också mest påtaglig där. De höga halterna av totalfosfor och fosfatfosfor i Martwa Wisła visade att gipsberget i Wislinka orsakat belastning, men det är utifrån dagens forskningsresultat omöjligt att beräkna den belastning som hamnar i Östersjön.

Vi rekommenderar att man i området kring gipsberget i Wislinka och i närliggande vattendrag börjar med omfattande uppföljning av vattenkvaliteten, vilket möjliggör lägre fosforbalanser. Med hjälp av fosforbalanserna kan man beräkna hur stor mängd av den fosfor som härstammar från gipsberget som slutligen strömmar ut i Östersjön. Dessutom bör man utreda vilken roll sedimentet i Martwa Wisła har som fosfor- och tungmetallkälla.

Jämfört med Wislinka har gipsberget i Police inte så tydlig inverkan på vattenkvaliteten i Oder. Detta beror på att belastningen blandas upp och späds ut till följd av strömningen. Dessutom har man i Police vidtagit effektivare åtgärder för att förhindra belastning från gipsberget. Sådana åtgärder är t.ex. hydraulisk isolering samt avledning av lakvatten från avfallsberget till ett avloppsreningsverk. Om man ser till resultaten av denna undersökning och de polska miljömyndigheternas uppföljningsresultat från 2008 och 2012 kan man dock inte utesluta att gipsberget i Police har inverkan på vattenkvaliteten i Oder, för halterna av totalfosfor steg med 5–28 % när vattnet strömmade förbi gipsberget.

För att man ska kunna klarlägga eventuella utsläpp från gipsberget i Police, bör man börja med omfattande uppföljning av yt- och grundvattnen i området kring gipsberget och i Oder. En lämplig provtagningsfrekvens är minst 12 prover årligen såväl uppströms som nedströms i förhållande till gipsberget. Även vattenföringen i den flodfåra som går mellan gipsberget och ön utanför bör mätas regelbundet för att det ska vara möjligt att beräkna flödet av substanser på tillförlitligt sätt.</td></tr>
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JOINT POLISH–FINNISH SAMPLING OF SURFACE WATERS AROUND THE PHOSPHOGYPSUM WASTE STACKS IN GDAŃSK AND POLICE FROM 1 TO 3 JULY 2013

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