




TAKING
COOPERATION
FORWARD

TRANSNATIONAL TRAINING ON SUSTAINABLE REMEDIATION

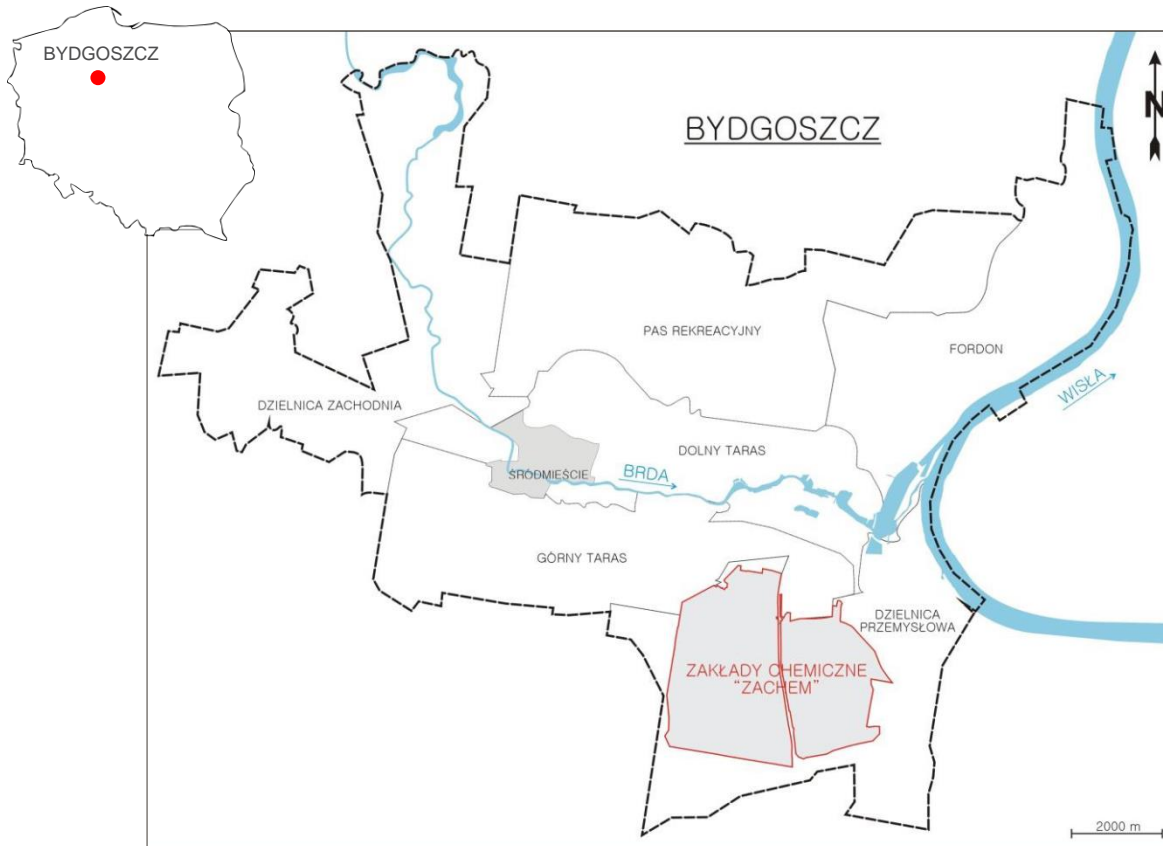
 ReSites Meeting, Bydgoszcz 10 May 2017

 **COMPREHENSIVE ASSESSMENT OF THE SOIL AND WATER ENVIRONMENT IN
THE AREA OF THE FORMER 'ZACHEM' CHEMICAL PLANT IN BYDGOSZCZ**

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GENERAL DESCRIPTION OF THE „ZACHEM”

„Zachem” Chemical Plant JSC in Bydgoszcz city



occupies an area of strong anthropogenic transformation
which constitutes over 11% of the city



HISTORICAL BACKGROUND OF THE ‚ZACHEM’



from 1945 - DAG Fabrik Bromberg

1945-1948 - State Gunpowder Factory in Łęgnowo

1948-1951 - NitroFactory LabelŁęgnowo

1951-1959 - Chemical Plant No. 9 in Łęgnowo

1959-1971 - Chemical Plant in Bydgoszcz

1971-1976 - Chemical Plant ‚Zachem’ in Bydgoszcz

1976-2003 - Chemical Plant ‚Organika-Zachem’ in Bydgoszcz

2003-2012 - Chemical Plant ‚Zachem’ JSC in Bydgoszcz

2012-2014 - Kapuściska Infrastructure JSC



HISTORICAL BACKGROUND OF THE 'ZACHEM'

Dynamit - Aktien Gesellschaft Fabrik Bromberg

included nitrocellulose ($C_6H_7N_3O_{11}$), smokeless powder and nitroglycerin ($C_3H_5N_3O_9$), TNT ($C_7H_5N_3O_6$), dinitrobenzene ($C_6H_4N_2O_4$), V1 missiles, as well as aerial bombs, artillery shells and powder charges

Polish plant produced for the military and civil needs (after 1948)

TNT ($C_7H_5N_3O_6$), pentaerythritol tetranitrate ($C_5H_8N_4O_{12}$) and tetryl ($C_7H_5N_5O_8$) for the military and civil needs. It also produced dyes, dyeing intermediates, pigments and phenol (C_6H_6O), as well as dinitrotoluene (DNT $C_7H_6N_2O_4$), nitrobenzene ($C_6H_5NO_2$), aniline (C_6H_7N) and products from the recycled PVC

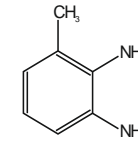
Chemical Plant in Bydgoszcz (from the 60s)

the production of isocyanates, dienes and polycarbonates, the polyurethane complex; flexible polyurethane foams, the electrolysis of brine, phosgene (CCl_2O), dinitrotoluene (DNT $C_7H_6N_2O_4$), toluene diamine (TDA $C_7H_{10}N_2$), toluene diisocyanate (TDI $C_9H_8N_2O_2$) and epichlorohydrin (EPI C_3H_5ClO) as well as rigid polyurethane foams

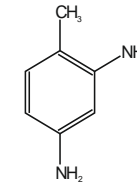
Basic and most important products manufactured in the Plant

toluene diisocyanate (TDI), allyl chloride (C_3H_5Cl), epichlorohydrin (EPI), hydrochloric acid (HCl), sodium hydroxide (NaOH) and sodium hypochlorite (NaClO)

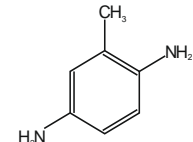
ISOMERS OF TDA - $C_7H_{10}N_2$



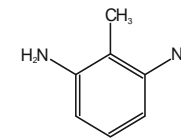
tolueno - 2,3 - diamine



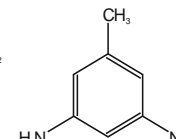
tolueno - 2,4 - diamine



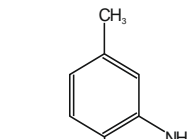
tolueno - 2,5 - diamine



tolueno - 2,6 - diamine

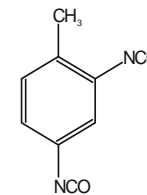


tolueno - 3,5 - diamine

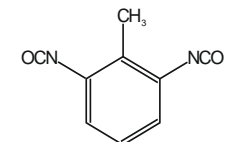


tolueno - 3,4 - diamine

ISOMERS OF TDI - $C_9H_8N_2O_2$

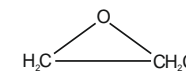


tolueno - 2,4 - diisocyanate

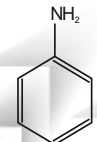


tolueno - 2,6 - diisocyanate

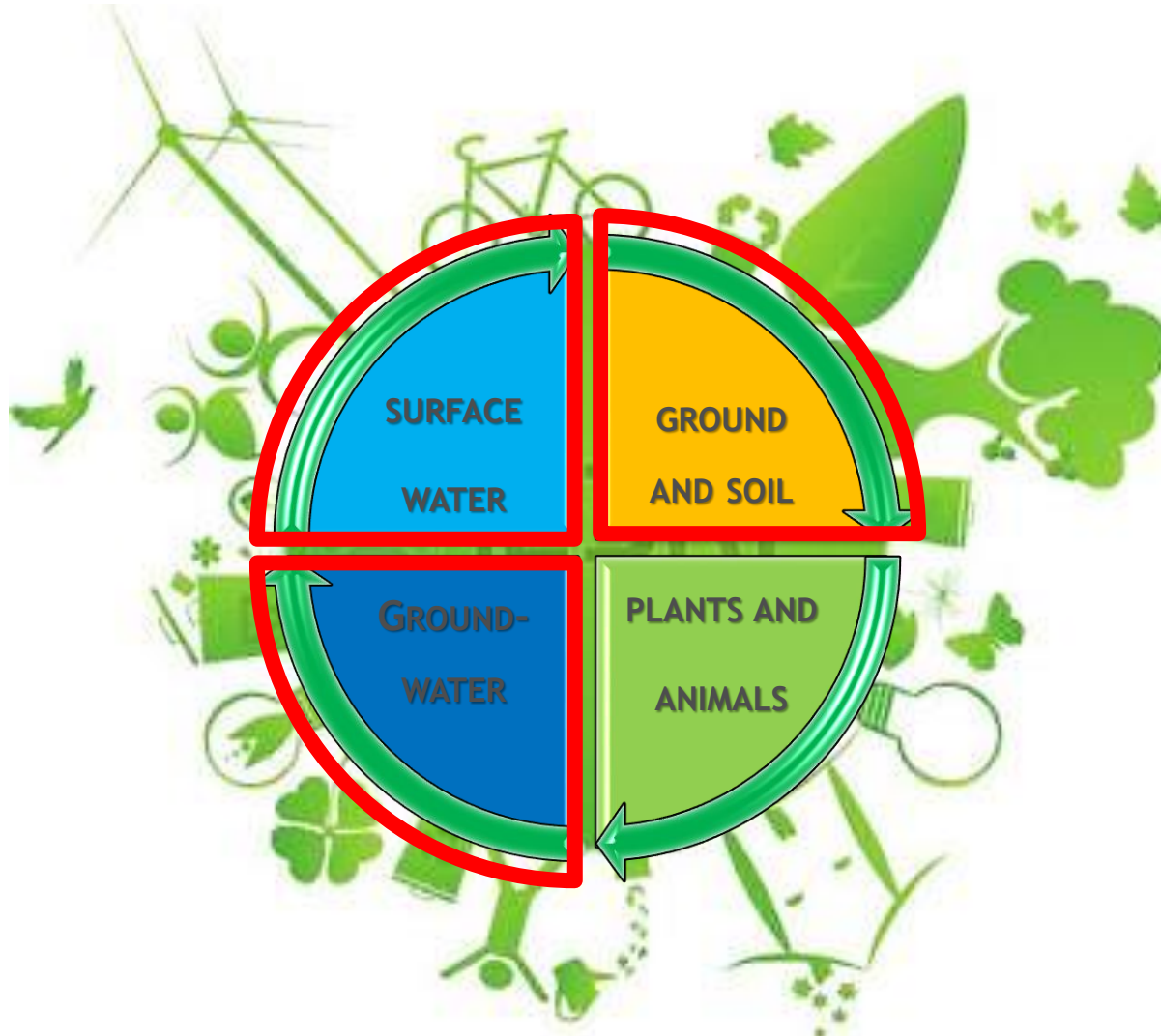
EPI - C_3H_5ClO



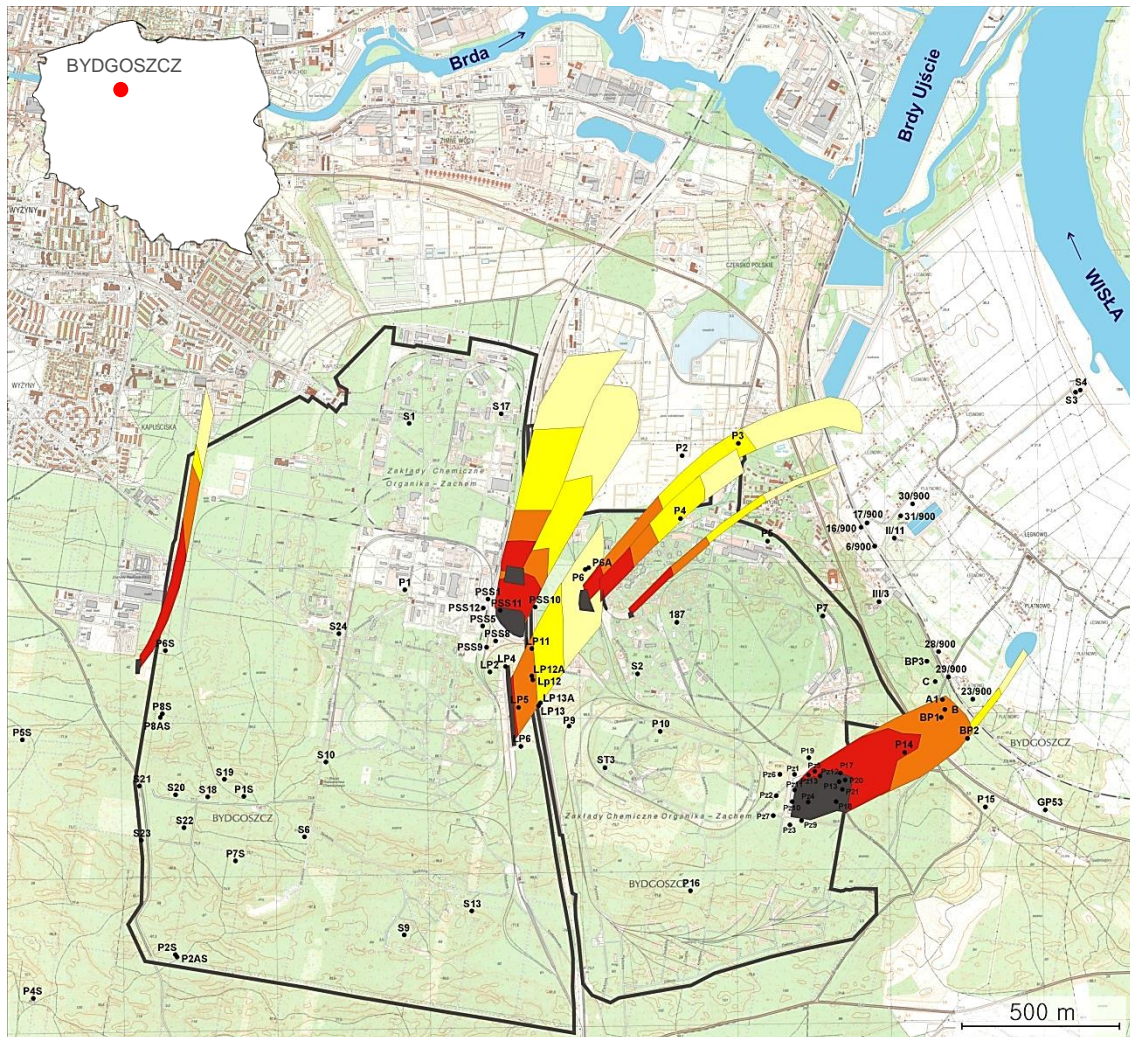
ANILINE - $C_6H_7NH_2$



CURRENT STATE OF THE ENVIRONMENT



CURRENT STATE OF THE ENVIRONMENT



The quality of groundwater has a **mosaic character**

in the area of the Chemical Plant are zones of clean water but also zones of groundwater highly contaminated as a result of industrial activities.

Zones of strongly contaminated groundwater by coexisting organic and inorganic substances occur within contaminant plumes which are **genetically assigned to the surface sources of contamination.**

Main inorganic contaminants: Cl^- and Na^+ .

Main organic contaminants: phenol, AOX substances, diphenyl sulfone, hydroxybiphenyl, octylphenol and ethoxylated octylphenol esters and chlorinated ethenes and methanes.



CURRENT STATE OF THE ENVIRONMENT

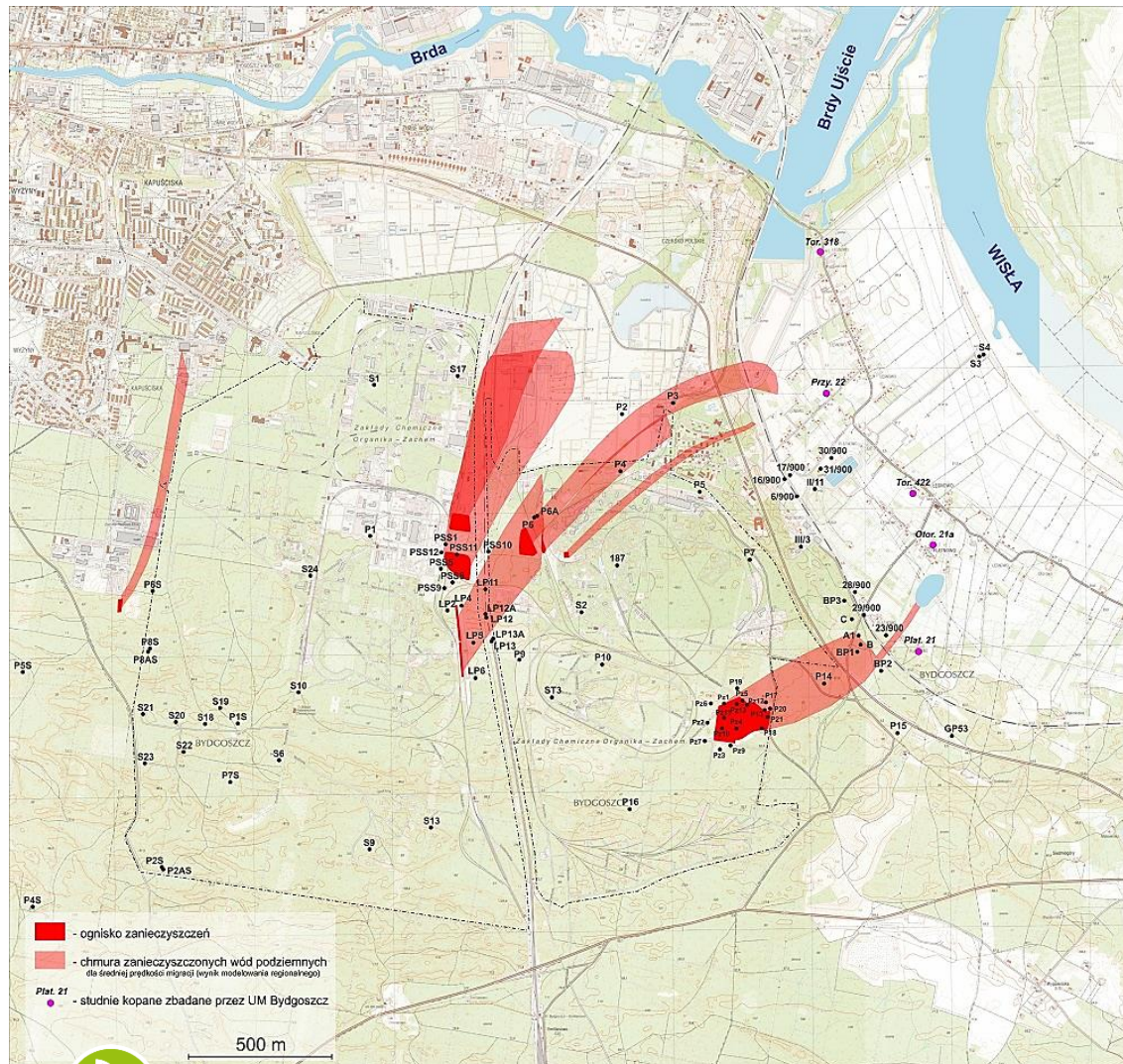


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CURRENT STATE OF THE ENVIRONMENT



CURRENT STATE OF THE ENVIRONMENT



- 1) Large area of Chemical Plants (about 1600 ha)
- 2) Long history of activity
- 3) Accumulation of technical infrastructure components
- 4) „Hazardous” for human production profile
- 5) Identification of the most severe contamination sources



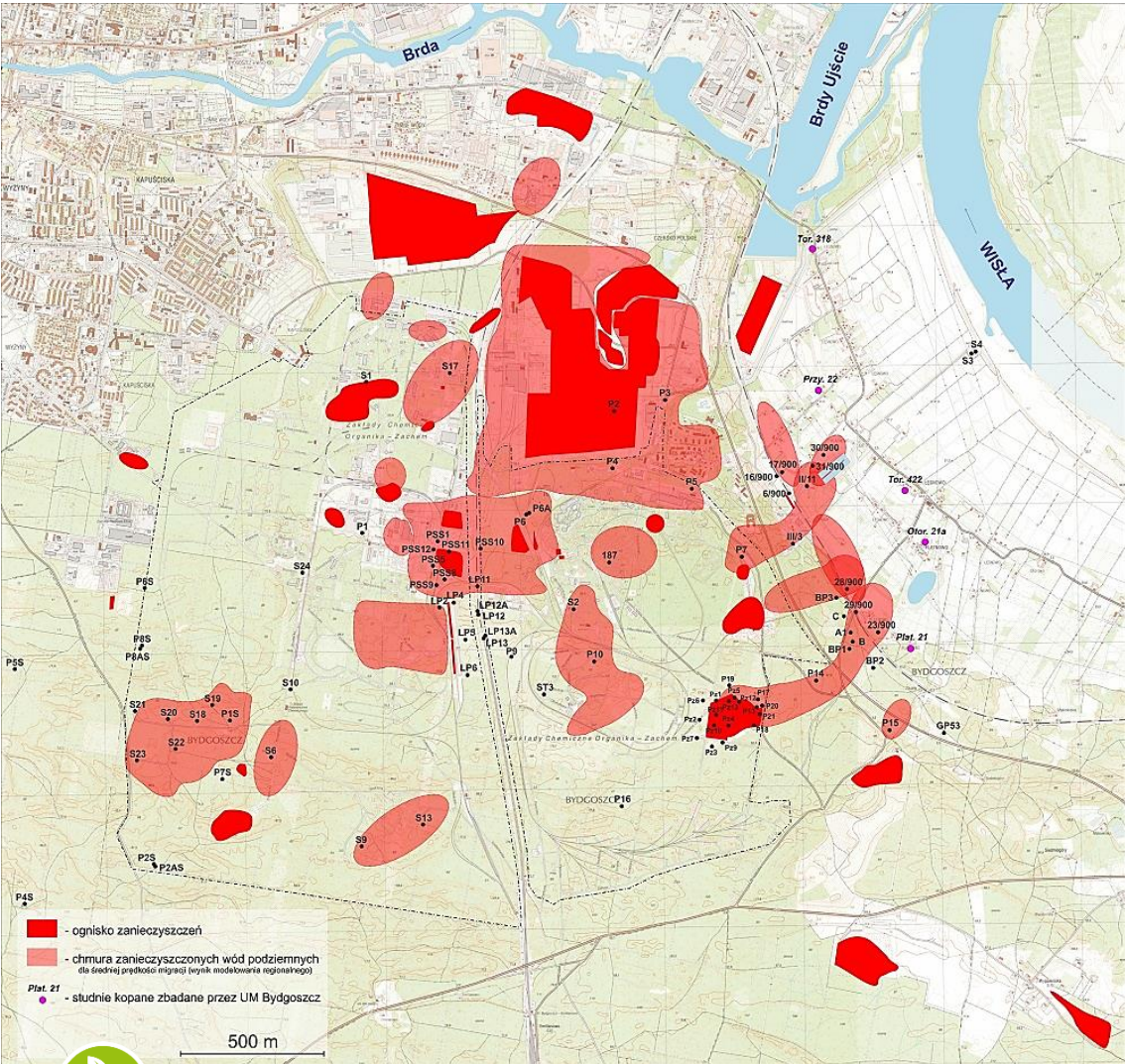
- 1) INDUSTRIAL WASTE SITE ‚ZIELONA’ AMONG WITH ACCOMPANYING
CONTAMINATION PLUME OF GROUNDWATER
PHENOL, CHLOROORGANIC COMPOUNDS, INORGANIC CONSTITUENTS,
SODIUM SULPHITE POLLUTED BY PHENOL

- 2) INDUSTRIAL WASTE SITE ‚LISIA’
PAHS, BTEX, INORGANIC CONSTITUENTS, POST-PRODUCTION PITCHES
SODIUM SULPHITE POLLUTED BY PHENOL

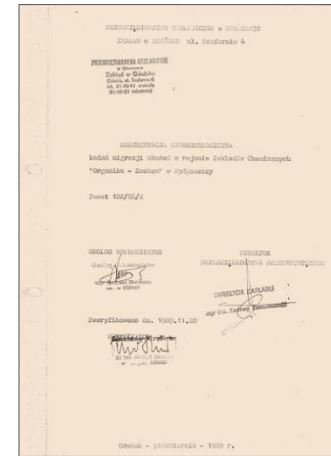
- 3) INDUSTRIAL WASTE SITE FROM EPI PRODUCTION
PHENOL, NITRO-ORGANIC COMPOUNDS, INORGANIC CONSTITUENTS,
PRODUCTION WASTES, SLUDGES AND ASHES FROM POWER PLANT

- 4) OTHER OBJECTS





ENVIRONMENTAL RESEARCH FROM 80S



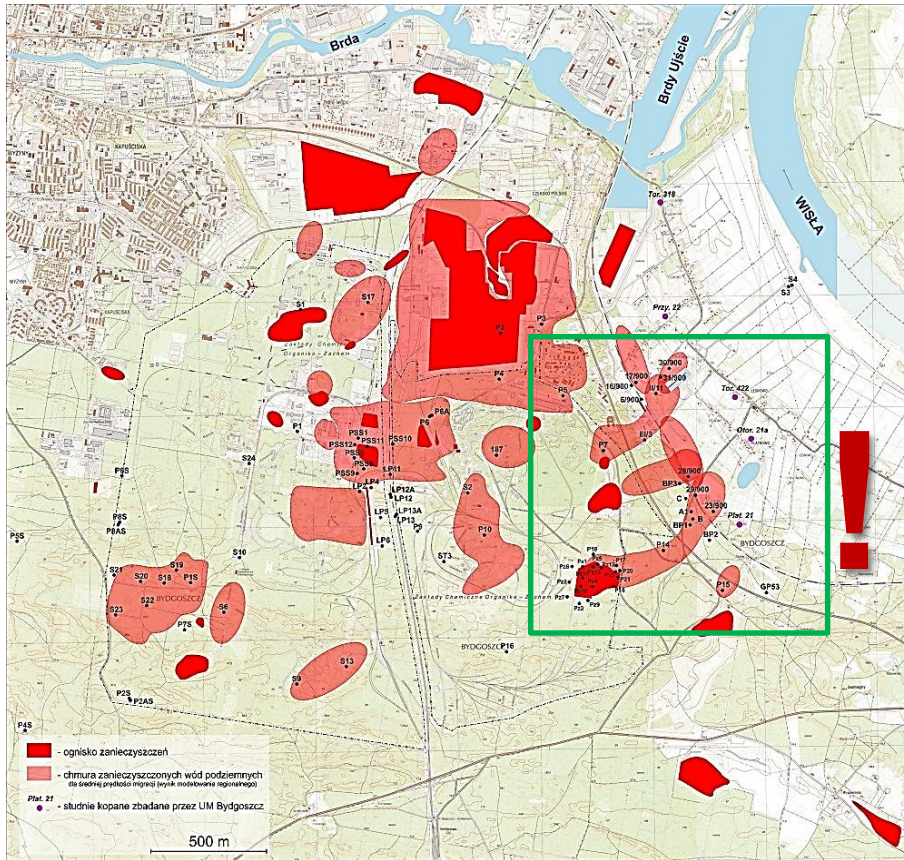
HEAVY METALS:
 CR, HG, MN, AS, PB, ZN

INORGANIC COMPOUNDS:
 CL⁻, SO₄²⁻, NA⁺, B³⁺, CYANIDES

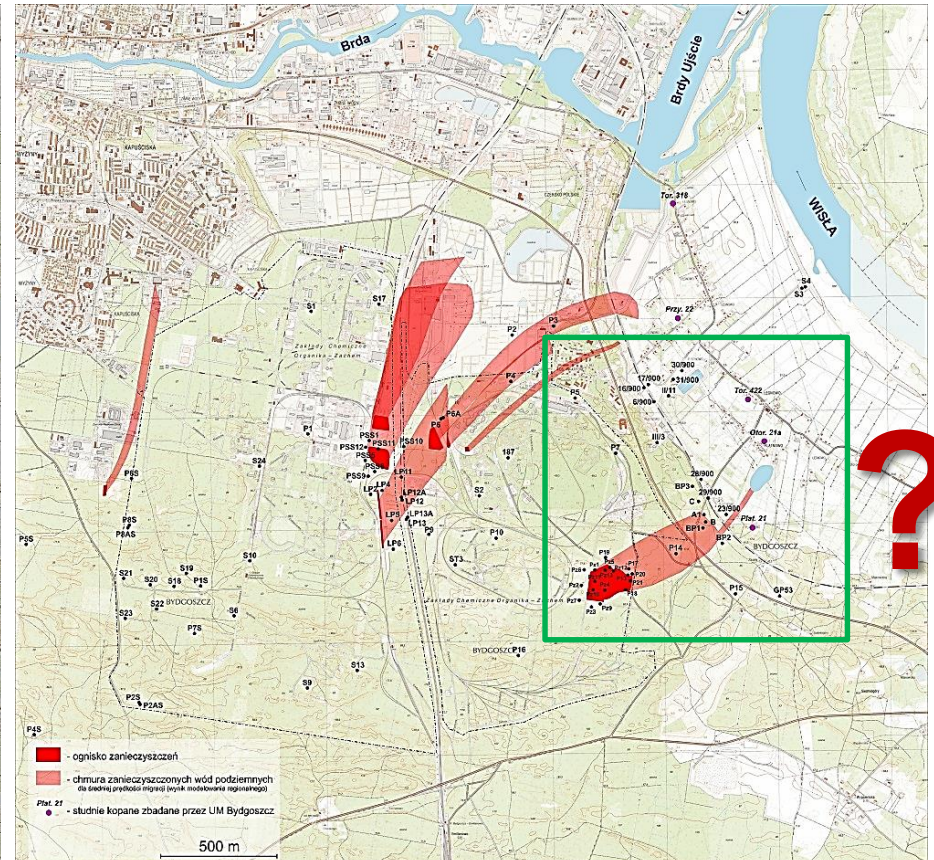
ORGANIC COMPOUNDS:
 PHENOL, ANILINE, NITROBENZENE



COMPARISON OF ENVIRONMENTAL RESEARCH



STATE OF THE ENVIRONMENT 80s



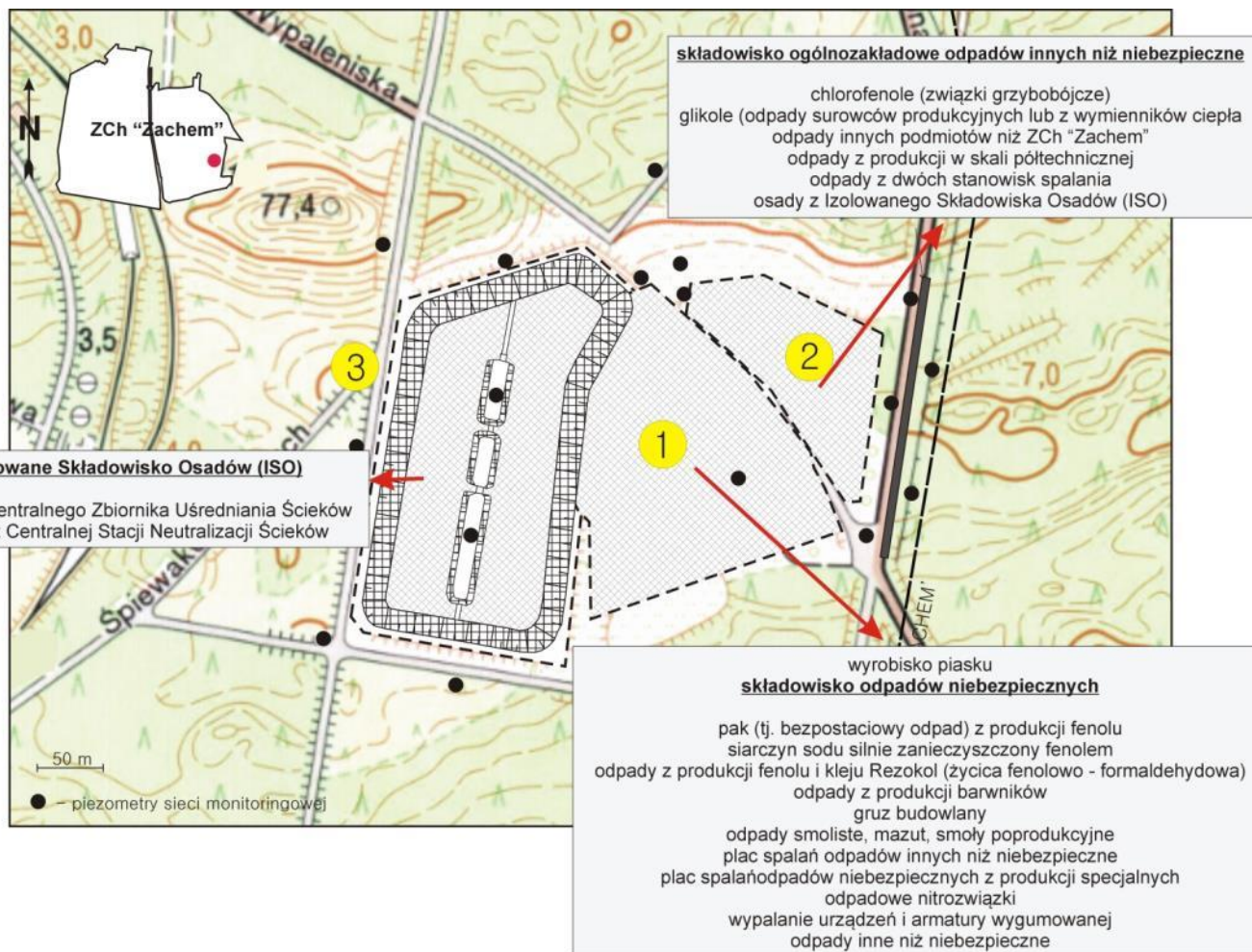
STATE OF THE ENVIRONMENT AFTER 2010

Surprising disappearance of contamination?

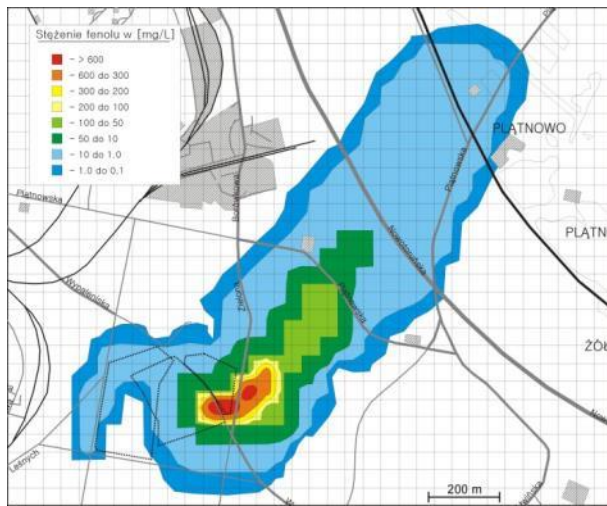
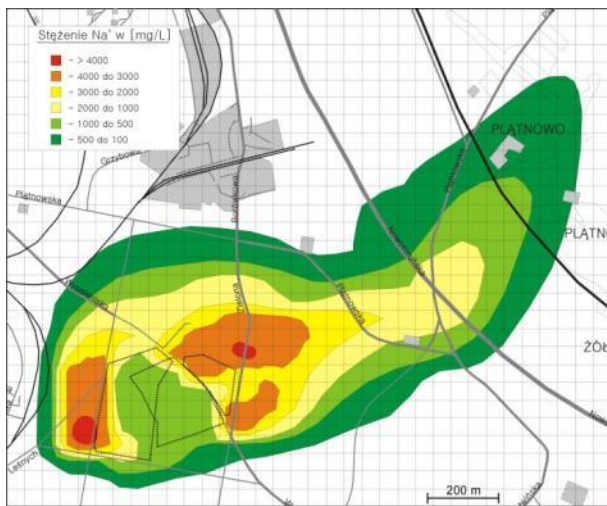
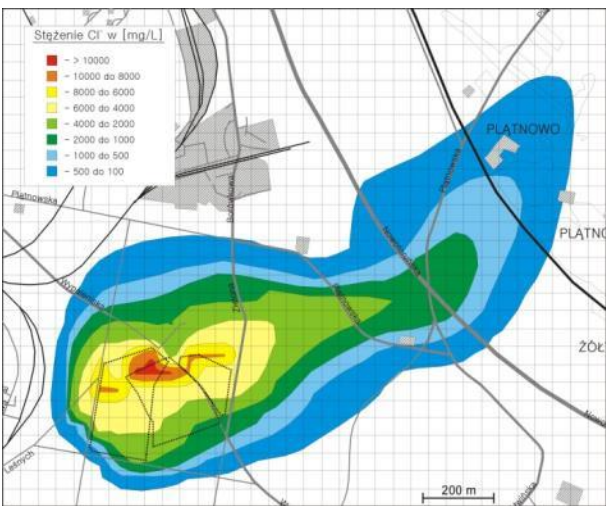
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INDUSTRIAL WASTE SITE 'ZIELONA'



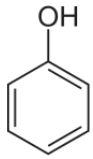
HYDROGEOLOGICAL NUMERICAL MODELLING



Contaminated area more than 15 times bigger than the Main Square!

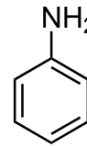


POLLUTANTS

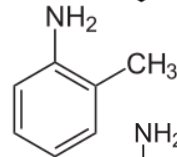


phenol C_6H_5OH (hydroxybenzene)

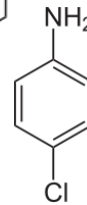
aniline $C_6H_5NH_2$ (phenylamine)



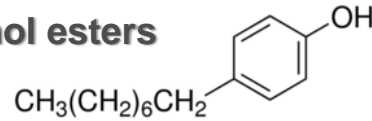
toluidine $CH_3C_6H_4NH_2$ (methylaniline)



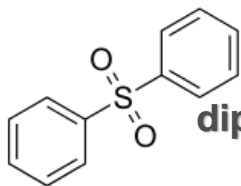
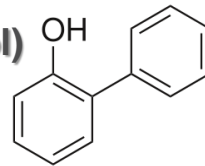
chloroaniline $ClC_6H_4NH_2$



octylphenol $CH_3(CH_2)_7C_6H_4OH$
and ethoxylated octylphenol esters



hydroxybiphenyl $C_{12}H_{10}O$ (phenylphenol)



diphenyl sulfone $C_{12}H_{10}O_2S$



CURRENT STATE OF THE ENVIRONMENT

The use and production of various substances both organic and inorganic ones was not without the effect on the condition of soil and water environment. The pollutants were detected in the past and are now being detected within all of the components of natural environment - particularly in soils and groundwater.

Conditions of contamination of the natural environment with toxic substances (often mutagenic and carcinogenic) are particularly significant in relation to the potential impact on the natural heritage in the area of Plant, ie.

**the Backwoods of Bydgoszcz
 "Valley of the Lower Vistula" Nature 2000.**



PRIORITY LIST OF THE ACTIONS

1) STARTING THE BARRIER

LIMITING MIGRATION OF POLLUTION FROM INDUSTRIAL WASTE SITE
,ZIELONA' INTO INHABITED AREAS (ŁĘGNOWO, OTOROWO, PLAŃNOWO)

2) CREATING AND CURRENT SERVICE OF THE INTEGRATED MONITORING NETWORK OF SOIL AND WATER ENVIRONMENT

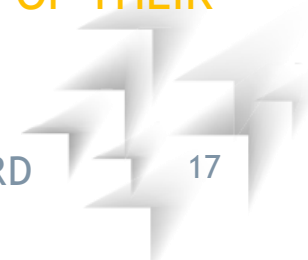
IN THE AREA OF THE ,ZACHEM' CHEMICAL PLANT IN BYDGOSZCZ

3) IMPLEMENTATION OF EFFECTIVE REMEDIATION

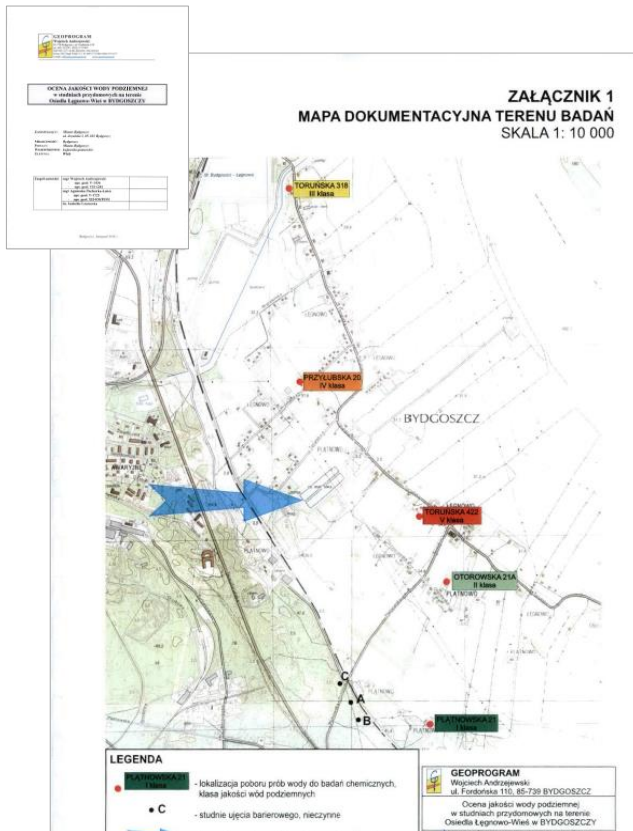
OF THE SOIL AND WATER ENVIRONMENT IN THE AREA OF ,ZIELONA'
INDUSTRIAL WASTE SITE ALONG WITH A CONTAMINATION PLUME

4) DETAILED RESEARCH

FOR DIFFERENT SOURCES OF POLLUTION AND THEN PERFORMANCE OF THEIR
REMEDICATION PROJECTS



REAL THREAT TO LIFE AND HEALTH



ŁĘGNOWO

ŁĘGNOWO I

founded in 1954
1 985 inhabitants

ŁĘGNOWO II

founded in 1977
814 inhabitants

STRONG CONTAMINATION OF SHALLOW GROUNDWATER:

Total organic carbon (TOC): **32,6 mg/dm³**

Organic compounds: phenol, anilinae, Toluidine, phenanthrene (PAHs)





Inhabitants of BRDYUJŚCIE

Inhabitants of ŁĘGNOWO



Inhabitants of HUTNICZA St.

Inhabitants of OTOROWO



Inhabitants of PŁĄTNOWO

Inhabitants of AWARYJNE Hous. Est.



- 1. OCCURRENCE OF EXTREMELY HAZARDOUS ORGANIC POLLUTANTS (CARCINOGENIC AND MUTAGENIC) WITH RELATIVELY VERY HIGH CONCENTRATIONS (INDUSTRIAL WASTEWATER LEVELS)**
2. HIGH NUMBER OF THE SUPPOSED POLLUTANTS SOURCES (27 OBJECTS IN „ZACHEM“ CHEMICAL PLANT ONLY)
- 3. DEFICIENCIES IN THE POLLUTION STUDIES FOR THE ENVIRONMENTAL COMPONENTS (ESPECIALLY RISKS FOR HUMAN HEALTH AND BIOTA)**
4. IDENTIFICATION OF THE 7 PLUMES OF POLLUTANTS IN GROUNDWATER FROM POLLUTION SOURCES (MAINLY INDUSTRIAL WASTE SITES)
- 5. SERIOUS HAZARD FOR INHABITANTS DUE TO POLLUTION OF SHALLOW GROUNDWATER (DUG WELLS) AND SURFACE WATER**
6. EXTREMELY HIGH COSTS OF THE REMEDIATION (UP TO 500 MLN EUR)



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