PAŃSTWOWY INSTYTUT GEOLOGICZNY

ATLAS GEOCHEMICZNY POBRZEŻA GDAŃSKIEGO

Część I

GEOCHEMICAL ATLAS OF GDAŃSK REGION

Part I

1 : 250 000

Józef Lis, Anna Pasieczna

Sfinansowano ze środków
NARODOWEGO FUNDUSZU
OCHRONY ŚRODOWISKA
I GOSPODARKI WODNEJ

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Część I: gleby, osady wodne, wody powierzchniowe

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Part I: soils, water sediments, surface waters

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SUMMARY

INTRODUCTION

Realisation of the "Geochemical Atlas of the Gdańsk Region" was initiated in 1997 by the order of the Ministry of Environmental Protection, Natural Resources and Forestry. The National Fund for Environmental Protection and Water Management provided a financial support. The survey area approximates 2,200 km^2.

Part I of the Atlas presents chemical conditions of surficial Earth's environments within the Gdańsk region. This region is very much diversified in respect of its land use. Maritime economy, development of industrial plants of different branches, influence of urban centres (Gdańsk, Gdynia, Malbork, Elbląg, Tczew, Pruszcz Gdański and Starogard Gdański), and transport constitute local pollution sources. Maritime economy combines activities of large seaports in Gdańsk and Gdynia, navigation, fishery and shipbuilding industry. The region concentrates industrial activities of such branches as petrochemical, phosphoric fertilisers, food, electromechanical, fish canning, energy, and others (H. Obarska-Pempkowiak, 1994). The area of the Vistula River delta (Żuławy) is subject to intensive agricultural use, and a seaside zone serves the recreation purpose.

In respect of physiography and geography, the area covered by this survey belongs to the Pobrzeże Gdańskie (Gdańsk Coastland). It includes a few lower order units: a part of the western postglacial upland (Pobrzeże Kaszubskie) and a part of the eastern postglacial upland (Wysoczyzna Elbląska) – both surrounding the Vistula R. delta, the Hel Spit (Mierzeja Helska) and a part of the Vistula Spit (Mierzeja Wiślana) (J. Kondracki, 1998). A vast agglomeration of Gdańsk–Sopot–Gdynia developed within the western part of the survey area.

The Vistula R. delta is the lowest region in Poland. In respect of its origin it is the Vistula River deltaic plain, where fluvial accumulation has separated some area partly situated below sea level. This depression area, which has to be permanently drained, covers approximately 465 km^2 (equal to 28% of the total delta surface area) (B. Augustowski, 1976). The minimum relief attains –2.2 m b.s.l. (K. Banach, P. Kowalik, 1996).

A dense pattern of canals (including those navigable) is a characteristic feature of landscape within the area; in addition, drainage ditches with water facilities are popular there. Improvement of channels resulted in shortening of many permanent water courses and directing them into artificial canals – which caused unnatural changes in the landscape.

Very fertile soils in the Vistula R. delta are mostly composed of humus-rich alluvial soils and peats, both developed on aggraded alluvium. The economic activity in this region dates back to the XIV century, when the land melioration and constructing of flood embankment was started along with the water pumping out from depressed area. That was the way how the depressed area was substantially drained. A total length of drainage canals approximates 3 thousands of kilometres, and that of drainage ditches – 17 thousands of kilometres. There is a frequent practice that roads are built up on the flood embankment crowns along the canals. Ground waters are shallow in the area; in part they are saline and polluted. Shallow (1.2 m) residual lake (Jezioro Drużno) occurs in the eastern part of the Vistula R. delta; the lake is almost entirely overgrown with wetland vegetation (J. Kondracki, 1998).

FIELD WORK

Sampling of surficial environments under this survey was carried out in the summer season of 1997. A sampling pattern followed a 1×1 km grid.

Topographic maps at the scale of 1:25,000 were used to locate any sampling sites. Suitable sampling data forms were used to record observations dealing with land development (Plate 2), land use (Plate 3), type of surface water body, petrographic character of sampled material, and location of the site.

Plates 2 and 3 show the locations of soil sampling sites while Plate 28 shows the distribution of sampling sites for water sediments and surface waters.

The soil samples (approx. 1,000 g each) were collected at a depth of 0.0–0.2 m using an 80 mm hand penetrometer.

The water sediment samples, approx. 1,000 g each and composed of possibly finest material, were collected from different surface water bodies such as rivers, streams, ditches, and stagnant water reservoirs of different sizes.

The surface water samples were collected from different surface water bodies such as rivers, streams, ditches, and stagnant water reservoirs.

It was a rule that both the surface water samples and the water sediment samples were collected at the same sampling site. In the field, the water samples for examination of cations were filtered through 0.45 μm MILIPORE filters and, after placing in 20 ml flask, acidified with HCl. As refers to samples for examination of anions (500 ml each), they were filtered first, then transported to the laboratory in a cooled containers. Acidity and conductivity of waters were the two field measurements.

PREPARATION AND STORING OF SAMPLES

After preliminary drying in the field, the samples of soils and water sediments were transported to the sample storehouse – where they were exposed to complete drying at a room temperature. Then, the soil samples were screened through a 2 mm screen while water sediments through a 0.2 mm screen; both screens were nylon-made. Finally, the screened material was quartered and placed in polyethylene containers to form 100 g samples.

LABORATORY WORK

Chemical analyses were made at the Central Chemical Laboratory of the Polish Geological Institute, Warsaw.

For this purpose, a method was adapted consisting in extracting of the soil and water sediment samples in aqua-regia for one hour at a temperature of 95°C in aluminium thermostatic block.

An Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES) method was employed to define such elements in soils and water sediments as: Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Ni, P, Pb, S, Sr, Ti, V, and Zn.

The Hg content both in the soil and water sediment samples was measured using Cold Vapour Atomic Absorption Spectrometry (CV-AAS).

Soil acidity measurements were performed in aquatic environment; this measurements followed a standard in common use in soil science (Norma, 1975).

The surface water samples were examined for Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Ni, P, SiO_2, Sr, Ti, and Zn using the ICP-AES method, while for K, Li, and Na – using a method of Flame Atomic Absorption Spectrometry (FAAS). A High Performance Liquid Chromatography (HPLC) method was the means for measuring the contents of Br, Cl, F, HCO_3, NO_2, NO_3, and SO_4 in water samples.

The analytical methods applied along with detection limits of the measured elements are listed in Tables I and II. Details of analytical methods applied for the purpose of this Atlas, of inter-laboratory comparisons, and of experiments carried out for comparing different ways of solid sample extraction are discussed in works by E. Górecka *et al.* (1993); E. Grabiec-Raczak & A. Klębek (1993) and K. Jakimowicz-Hnatyszak & P. Pasławski (1996).

DATA BASES

Three separate computer data bases were established: a sampling sites co-ordinate database, a field observation database, and an analytical database.

Determinations of sampling sites co-ordinates were made with the use of a sampling site location map (the scale of 1:25,000) and a digitizer. The sampling site co-ordinate database provided a basis for generating all geochemical maps.

Field data, listed in suitable sampling data forms, were entered into the field observation database, in which each particular observation was given a numerical code (identical with that on the sampling data form). Based on that database some subsets were statistically computed; the computation followed different environmental criteria (such as concentrations of elements in cultivate soils, forest soils, urban soils, sediments and waters of particular surface water bodies, etc.).

The results of chemical analyses, provided by the laboratory, were filed in the analytical database. It contains 167 238 laboratory determinations made on 6386 samples.

CONSTRUCTION OF GEOCHEMICAL MAPS

A topographic map at the scale of 1:200,000 was used as a base map. Statistical calculations of data sets and sub-sets for different soil, water sediments and surface water environments were done using the STATGRAPHICS software package. Arithmetic and geometric means, median, and maximum and minimum values were derived. Respective values for particular environments are listed in Tables III–VI. The obtained values constitute a base applicable for determining suitable parameters required for the generation of geochemical maps.

Sets of sampling sites, with known co-ordinates and attributable element contents provided a basis for the construction of geochemical maps. The maps (Plates 5–27, 29–80) were constructed using the SURFER for Windows software and adapting a kriging method with a linear variogram model and a 2000 m search radius. A presentation of cartographic image makes use of a pixel method (with each pixel 2 mm on a side). Concentration levels followed a division into percentiles (15, 25, 50, 75, 90, 95, 97, and 99%), representing the participation of pixels of given element concentration.

As to the pH map, the soil acidity ranges were selected in line with soil science criteria (strongly acidic, acidic, slightly acidic, neutral, and alkaline).

OUTLINE OF GEOLOGICAL STRUCTURE; SOIL MATRICES

A considerable part of the survey area lies within the Peri-Baltic Depression being a part of the pre-Cambrian Platform. A fragment of this depression is the area where the Vistula R. delta has developed. A north-western sector of the map sheet, forming a postglacial upland, belongs to the Łeba Elevation (B. Kozerski, A. Majorkowski, 1976).

Cretaceous and Tertiary sediments constitute a direct substratum of the Quaternary which covers the sheet area. The Quaternary substratum is diversified to large extent.

The **Tertiary** formation of Miocene age frequently crops out on the surface in the cliff zone of the western postglacial upland, mostly between Gdańsk and Gdynia (Plate 1). The profile of Miocene sediments contains several overlapping series of sands and clays, and silts with interbeddings of brown coal (J.E. Mojski, 1979a). These sediments are of fresh water, lacustrine, and swampy origin (J. Sylwestrzak, 1976).

A complex of **Quaternary** sediments is characterised by very much differentiated thickness (10–200 m) and by the abundance of lithological types (A. Makowska, 1979, 1999; M. Michałowska, M. Masłowska, 1998; J.E. Mojski, 1979a). Most stable thickness of Quaternary sediments (from 70 to 100 m) occurs within the Vistula R. delta. A considerable part of the column within the Vistula R. delta is composed of the Holocene while outside this area a predominant part is played by the Pleistocene.

A profile of ***Pleistocene*** sediments belonging to the Podlasian and the South Polish Glaciations and of separating interglacial sediments is known from boreholes only (A. Makowska, 1979; J.E. Mojski, 1979a).

A complete development of the formation belonging to the Middle Polish Glaciation occurs in the Vistula R. delta, where it is covered by younger sediments.

Sediments of the Eemian Interglacial overlie glacial till; they are well known in a number of exposures occurring in the eastern margin of the Vistula R. delta (Plate 1). They are represented by marine clays, silts, and sands with abundant faunal remains, and fluvial and lacustrine sands and clays.

Sediments of the North Polish Glaciation that developed as different facies (glacial till, fluvioglacial and ice-dammed lake deposits) form a present-day surface of the eastern and western margins of the Vistula R. delta. In the profile of these sediments there are two to four glacial till horizons with underlying fluvioglacial sediments. Clays, silts, and ice-dammed lake sands are the lowest sediments. They expose on the ground surface in the vicinity of Malbork and Elbląg.

Fluvioglacial sands and gravel separate glacial till horizons. The exposures of the oldest sands occur within the scarp zone of the postglacial upland in the western part of the survey area and also in the scarp zone in the east (A. Makowska, 1979; J.E. Mojski, 1979a). Younger sands, frequently limy, crop out in the Vistula valley. Large areas of the postglacial upland are overlain by youngest sands and gravel, that were deposited in the period of disappearance of the last ice sheet.

The oldest glacial tills form beds of variable thickness (from several to 25 m). They are known in borehole logs and in outcrops in the marginal region of the Vistula R. delta in the western part of the map sheet in addition to the scarp zone of the Vistula valley in the south (A. Makowska, 1973; J.E. Mojski, 1979a). In the east they expose along the escarpment of the postglacial upland (A. Makowska, 1979). These glacial tills are sandy or clayey, sometimes they contain detached blocks of red clay. In many places the younger glacial tills form strings of end moraines and are most wide-spread formation of the upland which builds up the western shore of Gulf of Gdańsk. Clayey tills are dominant though sandy ones occur in places; they contain a variable load of boulders. Gneisses, granites, and crystalline shists of Scandinavian origin dominate in the composition of boulders. The thickness of till is ranging from 2 to 10 m. It is characteristic that tills are delimed to a depth of approx. 1 m and contain a load of detached blocks of Tertiary rocks (J.E. Mojski, 1979a).

Eolian sands, also those in dunes that developed at the close of the Pleistocene and in the Holocene, occur within the Mierzeja Wiślana Spit and the Hel Spit as well. They form covers of very diversified surface, several to dozen or so meters thick. Dunes form elongated banks running parallel to the coastline. Their width can reach 500 m and they are as high as 45 m (A. Makowska, 1979). Depressions between dunes are sometimes filled with peats.

The largest areas of the ***Holocene*** occurrence include the Vistula R. delta and the Reda River and the Płutnica River valleys. As different facies (weathering, slope-wash, fluvial, marine, lacustrine, and organic types) of the Holocene formation interfinger with each other, the determination of the complete stratigraphic column is difficult. Its most complete column occurs within the Vistula R. delta, where its thickness is between 10 and 20 m (J.E. Mojski, 1990).These deposits play a small part in the postglacial uplands. Their occurrence within the uplands is local and confined to the scarp zones of the river valleys and to depressions in ground surface.

Clays, sands and gravel in the margin of dunes within both the Mierzeja Wiślana and the Hel Spits are classified among marine sediments.

Lacustrine sediments (clays and silts, and lake marl) occur in many places of the postglacial upland of the western Vistula delta margin and in the Reda R. valley. In some places they developed as carbonates reaching the thickness of 9.5 m (J.E. Mojski, 1979a). Beds of the lake marl can also be found in the Radunia R. valley. Terraces surrounding the Vistula Lagoon (Zalew Wiślany) and Lake Drużno are also built up of lacustrine silty-clayey and sandy sediments.

Lacustrine sediments within the Vistula R. delta are overlain by fluvial sandcover, the thickness of which can reach 10 m. The sand cover is composed of medium- and fine-grained sands, silty and clayey in places (J.E. Mojski, 1979a). Fluvial sands, silts, and gravel fill in the valleys of all contemporary rivers. Sands and gravel provides material which builds up the Nogat R. and the Szkarpawa R. deltas.

Muds belonging to the youngest Holocene occupy vast areas within the Vistula R. delta. They represent flood deposits, whose thickness is ranging from 0.5 to 14 m (A. Makowska, 1973; J.E. Mojski, 1979a). They are composed of silts with admixture of sandy, clayey, and organic fractions.

Alluvia, also representing flood deposits, occur in patches both in the Vistula R. delta region and on the uplands. Predominantly they are composed of fine-grained sands, silts or clays, with admixture of organic sediments; also, they contain peaty alluvia.

The largest spatial occurrences of peat are known between the Nogat R. and Lake Drużno, where they became 10 m thick and are subject to extraction on an industrial scale (A. Makowska, 1973). The thickness of peat is considerably reduced in the western part of the Vistula R. delta and in the valleys of the Dzierzgoń, Reda, and Płutnica Rivers.

There are gyttjas in the eastern border of Lake Drużno, that represent an old bottom deposit. A part of urban areas (in Gdańsk, Gdynia, and Tczew) is covered with made grounds.

*

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Alluvial soils (sandy, silty, and clayey) within the Vistula R. delta, that developed on alluvium and mud, are of considerably high usable value. Therefore, the Vistula R. delta takes a proper place among important agricultural regions, an its area under cultivation occupies approx. 77% of total delta area (M. Matusik, R. Szczęsny, 1976). Alluvial soils are characteristic because of the high content of floatable particles (<0.02 mm) in the range of 31–78% and the high concentration of organic carbon, equal to 1.18–2.62% (K. Czarnowska, E. Turemka, 1977; H. Dąbkowska-Naskręt, 1996; K. Kopański, Z. Kawecki, 1994).

A frequent excessive moisture played an important part in soil-forming processes occurring within the Vistula R. delta. Depressions, where water table was high, were affected by bogginess which led to development of peats; the latter are in places accompanied by soils that developed from gyttjas (A. Kowalkowski *et al.*, 1994; T. Witek, 1976).

The morainic plateau in the west of the map sheet is dominantly covered with soils with prevailing sandy or silty fractions (Plate 4). In the eastern upland region the dominant type of soils is clayey, mixed with clayey sands, slightly clayey sands, and loose sands (Raport, 1997a). Sandy soils cover the surface of both the Mierzeja Wiślana and the Hel Spits.

SOURCES OF ENVIRONMENTAL POLLUTION

Land fills. A largest load of industrial wastes is produced at the Gdańsk Phosphoric Fertilisers Plant, which dumps gypsum (phosphogypsum, being a by-product in the process of phosphoric acid production) at the landfill in Wiślinka (Raport, 1979b).

A considerable amount of sediments and slurries produced at the Gdańsk Refinery is burnt on the spot. Slugs and ashes produced at the thermal-electric power stations and local boiler houses are in part utilised in road surfacing and aggregate production. A part of these wastes finds their way to industrial waste sites – where mostly slugs and fly-ashes are dumped. A number of smaller plants dump their industrial wastes on dumping sites situated within premises of their own. However, a part of industrial wastes finds its way also to the municipal landfills.

Waste waters. Pollution of waters and water sediments in the Vistula, Nogat, and smaller rivers as well as in the Gulf of Gdańsk, Puck Bay, and the Vistula Lagoon is connected with point sources (discharge of sewage) and areal surface flow.

Due to high industrialisation of the Gdańsk agglomeration, the lowest river courses transport a high load (by percent) of industrial effluents. The majority of plants have different-type treatment plants of their own (mechanical-biological, mechanical-chemical), however, a part of untreated process effluents finds its way to the Reda and the Martwa Wisła Rivers, and to harbour basins. Especially hazardous effluents are discharged by ports and shipyards in Gdynia and Gdańsk, the Gdańsk Refinery, and the thermal-electric power plants.

Municipal sewage is disposed to surface water bodies after mechanical-biological and chemical treatment, but approx. 20% of total sewage volume is disposed untreated (Raport, 1997b, 1998).

Pollution of atmospheric air. Pollution of atmospheric air with dusts and gases is caused by activity of the industry – mostly in the field of power engineering (fuel combustion, industrial processes), ports, and transport. The thermal-electric power plants in Gdańsk and Gdynia and the Gdańsk Refinery are the most effective emitters of SO_2, NO_2, and dusts. In the last year the emission of gaseous and dusts pollution is systematically decreasing, as more and more absorbing and gas-cleaning equipment is being installed (H. Obarska-Pempkowiak, 1994). However, monitoring of atmospheric pollution – conducted in monitoring stations – indicates that concentrations in air of some tested constituents exceed permissible values.

GEOCHEMICAL MAPS

pH ACIDITY

Soils within the postglacial upland on the west (mostly forest soils), and both the Hel and the Mierzeja Wiślana Spits are strongly acidic and acidic. Soils in the delta of the Vistula R. are characterised by a strong differentiation of acidity, from acidic to alkaline. Neutral soils are noted in the urban areas.

There is a weak differentiation of surface waters in respect of their acidity. 85.15% of samples tested was classified among weakly alkaline waters, 13.52% – among slightly acidic, 0.94% – among acidic, and 0.39% – among alkaline.

CONDUCTIVITY

The measurement of electrical conductivity of surface waters provides information on a degree of water mineralization (salinity). A considerable variability of that parameter is observed in the survey area, which indicates that waters are fresh to slightly saline. A highest salinity was measured in waters of the Martwa Wisła R. (to as much as 7.98 mS/cm) and in waters its catchment area. This salinity is connected with the direct influence of sea water from the Gulf of Gdańsk. Waters occurring within the postglacial uplands are dominantly fresh. Waters of the Vistula R. delta area are changing from semifresh to brackish. The latter occur in the form of point-type anomalies; possibly they are connected with the presence of relict seawaters. Table VII presents approximate mineralisation of surface waters computed from conductivity – using a formula proposed by C. Kolago (*vide* A. Macioszczyk, 1987):

$$M = C \cdot \gamma$$

where:

M – total mineralisation of water, g/dm^3

C – a factor (assumed to be 0.72)

γ – conductivity of water, mS/cm

Ag SILVER

The silver content in soils does not exceed 1 ppm. Individual samples with concentrations >1 ppm (to as much as 11 ppm) are representative for the urban soils in Gdańsk, Gdynia, and Elbląg. On the average, the silver content (dissoluble in aqua-regia) in water sediments does not exceed 1 ppm. The elevated Ag content, from 1 to 16 ppm, was noted in dozen or so samples collected in the urban areas.

Al ALUMINIUM

The elevated content of aluminium in soils in the Vistula R. delta distinctly distinguishes this area in the cartographic image of Al representation. A strong differentiation of geochemical background of aluminium is ranging widely from 0.15 to 1.50% in this area. It is likely that the peak Al content (>1.50%) is connected with the presence of clayey alluvium. As to the geochemical background of aluminium in soils of the postglacial upland area, it is markedly less differentiated (between 0.15 and 0.70%). Still smaller Al content (<0.15%) is a characteristic feature of sandy soils within both the Mierzeja Wiślana and the Hel Spits. The image of differentiation of the Al geochemical background in water sediments is almost identical. Maximum Al contents reach 3.33% and are markedly lower than that in recent deltaic sediments of the Rhine and Meuse Rivers at the Net herlands – where Al was found to be in the concentrations of 4.0–5.3% (G.A. Van den Berg *et al.*, 1998).

Surface waters contain small concentrations of aluminium, usually not higher that 0.05 mg/dm^3.

As ARSENIC

The geochemical background of arsenic in soils and water sediments is low (<5–10 ppm), though it is considerably differentiated in the delta of the Vistula R. Elevated concentrations of this element are observed mostly in places of peat accumulation. These concentrations are characteristic for organic soils, for which the average As content is defined at 93 ppm (A. Kabata-Pendias, H. Pendias, 1999).

Arsenic reaches slightly higher concentrations (>10 ppm) also in sediments of water courses that drain deltaic areas of the Szkarpawa and Nogat Rivers. Much higher As concentration are traced in soils and waters sediments within the Reda R. valley, where their connection with peats occurring here is likely.

It is a rare case that arsenic in surface waters occurs in excess of 0.05 mg/dm^3. There were several samples that contained arsenic in elevated concentrations reaching 0.29 mg/dm^3.

B BORON

The average contents of boron in surface waters within the survey area are higher (0.13 mg/dm^3) than those for the whole of Poland –0.04 mg/dm^3 (J. Lis, A. Pasieczna, 1995). A marked differentiation of boron contents is particularly observed in the Vistula R. delta. High boron concentrations are noted in waters of the Martwa Wisła R. (from 0.09 to 0.80 mg/dm^3; 0.50 mg/dm^3 on the average) and in water courses of its left-side catchment area. This may indicate the influence of seawater, that periodically invades these surface water bodies. The Martwa Wisła R. is in contact with waters in the Gulf of Gdańsk – and this is the reason for saline character of its waters.

The boron content in the Vistula R. waters is much lower, equal to 0.08 mg/dm^3. The very low boron contents (<0.05 mg/dm^3) are characteristic for waters in the postglacial upland making the western margin of the Vistula R. delta. A local increase in B content is observed in surface waters in the vicinity of the sewage treatment plant and in the region of the slug and ash disposal site.

Ba BARIUM

There is close similarity in cartographic representations of barium distributions in soils, water sediments, and surface waters. Worthy of noticing are low barium contents in surficial environments within the postglacial uplands. A weak differentiation of the barium geochemical background in soils is reflected by its narrow range from <16 to 53 ppm (24 ppm on an average). Still lower barium concentrations are observed in soils of both the Mierzeja Wiślana and the Hel Spits (<16 ppm; 5 ppm on the average). The geochemical background between <27 and 72 ppm is representative for water sediments within the uplands. In addition, surface waters in the discussed area show weak distribution in respect of barium content (from 27 to 87 μg/dm^3); sites with barium content exceeding 159 μg/dm^3 are scarce.

As concerns soils, the geochemical background of barium of the Vistula R. delta is contained in the limits of 54 to 123 ppm, with 74 ppm as an average and a large number of maximum in excess of 151 ppm. The concentrations between 72 and 238 ppm (with peak values in excess of 308 ppm) make the geochemical background of barium in water sediments. The distribution of maximums in barium concentrations in soils and water sediments is very similar and reflects likely differentiation in the lithology of deltaic sediments.

A firm differentiation in barium contents occurs also in water courses within the Vistula R. delta (from <2.65 to 123.6 μg/dm^3, with maximums in excess of 277.9 μg/dm^3). Peak barium contents were noted in waters of the Święta R. (from 41 to as much as 263 μg/dm^3, with 102 μg/dm^3 on the average).

Despite the considerable differentiation of barium content in waters within the survey area, average contents are close to respective averages in surface waters in the whole territory of Poland (J. Lis, A. Pasieczna, 1995) and are 54 and 55 μg/dm^3, respectively.

Be BERYLLIUM

The beryllium contents in soils and waters sediments of the survey area are low (from <0.5 to 2.2 ppm, with <0.5 on the average). A distinct increase and differentiation in this element contents is noticed within the Vistula R. delta area. This can be connected with easy sorption of beryllium by organic matter present in mud.

Br BROMINE

On the average, there is low concentration of bromine in waters within the area under this survey (<0.10 mg/dm^3). Against such the background, the bromine anomalies (from 0.40 to 13.00 mg/dm^3, and an average value of 7.40 mg/dm^3) can be distinguished in waters of the Martwa Wisła R., the same deals with water courses of its drainage basin. The high Br concentrations (>2.10 mg/dm^3) are also traced in waters of the Szkarpawa and Nogat Rivers within the shore of the Vistula Lagoon. The influence of seawaters on land waters is the explanation to such conditions.

Ca CALCIUM

The valleys of the Reda and Płutnica Rivers within the western postglacial upland are distinguishable by visibly elevated calcium contents in soils (>0.79%), in water sediments (>1.13%), and in surface waters (>109.2 mg/dm^3). Beds of lacustrine chalk occurring to the west of the survey area and subjected to extensive extraction since the mid of the XIX century (J.E. Mojski, 1979a) are the likely source of enrichment of alluvial soils and water sediments in calcium. The lowest calcium contents are noted in soils of both the Mierzeja Wiślana and the Hel Spits (0.03%, on an average).

The geochemical background of calcium in all environments of the Vistula R. delta is much higher and much more differentiated. The marked Ca concentrations in soils, water sediments, and surface waters within the Vistula R. delta are attained between Tczew and Pruszcz Gdański and in the region of Lake Drużno in the south eastern part of the survey area. These high concentrations should be linked with the occurrence of peats and limy gyttjas. The average Ca content in the peaty formation is 1.17% while 0.55% in clayey soils and 0.18% in sandy soils.

As compared with the average Ca contents in cultivated soils in the whole territory of Poland (0.18%), cultivated soils in the survey area contain more calcium (0.47%, on the average). Well know are also such phenomena – as those connected with the enrichment of urban and industrial soils with calcium (0.51% and 0.81%, on an average) due to the dust fallout (with dust coming from burning of coal). The lowest Ca contents occur in forest soils (0.03%, on the average).

Cd CADMIUM

The average contents of cadmium in soils of the survey area are not higher than 0.5 ppm. The elevated contents (>0.5 ppm) have character of distinct anthropogenic anomalies and are confined to the urban areas in Gdańsk, Gdynia, and Pruszcz Gdański.

The geochemical background of cadmium in water sediments is diversified; this particularly deals with the Vistula R. delta area. Distinct anomalies (>1.2 ppm), most likely of anthropogenic origin, are generally observed near and within such towns as Gdańsk, Nowy Dwór Gdański, Nowy Staw, Stegna, and Elbląg. Maximum Cd content was found in drainage ditch sediment near the landfill at Wiślinka, where phosphogypsum is dumped as a by-product.

The Cd contents in surface waters in excess of 3 μg/dm^3 (being a detection limit for analytical method employed) were traced at scarce points only.

Cl CHLORINE

A cartographic representation shows that in surface waters the smallest chlorine contents (<53 mg/dm^3) occur within the postglacial upland area surrounding the Vistula R. delta and within a southern part of the delta itself. A study of chlorine contents in river waters in Latvia are cited here for comparison; rivers covered by that study drain sediments of similar lithological development and contain chlorine in concentration of 9.2 to 33.6 mg/dm^3 (M. Klavis *et al.*, 1996).

The chlorine background in waters of the northern part of the Vistula R. delta is higher (>53 mg/dm^3) and much more differentiated. Its content in waters of the Martwa Wisła R. ranges between 68 and 3.470 mg/dm^3, with 2.004 mg/dm^3 on the average. Saline surface waters in the Gdańsk region, including those in the Martwa Wisła R., harbour basins, and the Motława R. mouth are in contact with ground waters and by this contact affect negatively the Quaternary water-bearing horizon to such degree that chlorine ion in this aquifer reaches as high concentration as 3.500 mg/dm^3 (B. Kozerski *et al.*, 1992).

Comparative data indicates that waters in the Vistula R. contain chlorine in amount of 33 to 165 mg/dm^3, with 56 mg/dm^3 on the average. High Cl contents are also observed in waters of the Szkarpawa R. and the Nogat R. deltas, within shores of the Vistula Lagoon, as well as in a littoral zone of Puck Bay. These anomalies should be explained by the influence of seawater on land waters.

Co COBALT

Though the geochemical background of cobalt in soils is low (<1–8 ppm), it is close to Co concentrations of 4,7 ppm – as determined by K. Czarnowska and B. Gworek (1987) for soils in northern Poland. The cartographic image indicates that the lowest and weak differentiation of Co geochemical background (<6 ppm) distinguishes the postglacial uplands and spits in contrast to higher and more differentiated Co background within the Vistula R. delta.

Similar geochemical conditions are also observed in water sediments. Maximum content of cobalt (278 ppm) was traced in sediment of the Martwa Wisła R. within the seaport in Gdańsk. An area between the Tina R. and the Dzierzgoń R. valleys, covered with muds and peats, can be distinguished because of elevated cobalt contents (>7 ppm) in water sediments and in soils as well. This fact can be linked with easy absorption of cobalt and its retention by organic matter and clayey fraction in soils and sediments.

Surface waters contain low cobalt concentrations (<5 μg/dm^3), and its maximums in excess of 18 μg/dm^3 occur in some waters within the Vistula R. delta area.

Cr CHROMIUM

The area of the postglacial uplands and of both spits are characterised by the low chromium background in soils and waters sediments (<11.8 ppm and <12.1 ppm, respectively). The cartographic image exposes the Vistula R. delta due to a higher level of chromium background and its more advanced differentiation. Both cases seem to be connected with the presence of peaty muds in the substratum, and sometimes with larger inserts of organic matter entrapped in muds.

Of anthropogenic origin are undoubtedly the high chromium concentrations in urban soils in Gdańsk (to as much as 266 ppm), Gdynia, and Rumia, in water sediments of the Martwa Wisła R. in the Gdańsk Port (up to 314 ppm), in sediments of the Zagórska Struga northwards of Rumia (170 ppm), and in sediment of the Leniwy Canal near the ash dump site at Rewa (up to 84 ppm).

Chromium in surface waters occur in low concentrations (<4 μg/dm^3). A high Cr concentration (as high as 230 μg/dm^3) was noted in a sample of water collected from a ditch within the port in Gdańsk

Cu COPPER

The representations of spatial distribution of copper in soils and in water sediments resemble each other. A distinct pollution of these two environments with copper (of anthropogenic origin) is observed in the urban areas of Gdańsk, Gdynia, Tczew, and Elbląg. Maximum Cu content (3.483 ppm) was traced in sediment of the Martwa Wisła R. in the Gdynia Port. There were also 2.9 ppm of Cd, 314 ppm of Cr, 5,607 ppm of Pb, and 4,010 ppm of Zn in this sample. A point-type anomaly near Rokitnica, to the north-east of Pruszcz Gdański calls for explanation – as soil contains Cu and Zn in concentrations of 2,771 ppm and 1,800 ppm, respectively, and sediment from a nearby ditch contains Cu and Zn in amount of 245 and 426 ppm, respectively.

Surface waters contain small amount of copper (<5 μg/dm^3), however, a sample from a ditch in the port area in Gdańsk revealed as high Cu concentration as 275 μg/dm^3.

F FLUORINE

The geochemical background of fluorine in surface waters of the survey area is within the limits representative for that environment (0.1 mg/dm^3 on the average). Similar fluorine concentrations (0.09 mg/dm^3) were noted in stream waters in Germany, in area covered with Quaternary sediments (H. Fauth *et al.*, 1985). The fluorine concentrations in river waters in Poland are defined at the level of 0.22 mg/dm^3 (A. Kabata-Pendias, H. Pendias, 1999), and in river waters in the Czech Republic – at 0.21 mg/dm^3 (J. Vesely, V. Majer, 1994).

Waters in the western part of the Vistula R. delta expose themselves in the cartographic image due to elevated concentrations of fluorine, the maximums of which exceed 1.47 mg/dm^3. In particular, this deals with the Motława R. drainage basin. Similar field of elevated fluorine contents is situated in waters of the eastern part of the Nogat R. delta and at the mouth of the Elbląg R. to the Vistula Lagoon. High concentrations were also noted in the area of Gdańsk (within the drainage basin of the Martwa Wisła R.). There were also traced some point-type anomalies (>2 mg/dm^3 F).

Fe IRON

There is weak differentiation of geochemical background of iron in soils within the postglacial upland areas, where its concentrations are within the limits of <0.46 and 1.98%. Still smaller Fe content (<0.46%) characterises sandy soils of the Mierzeja Wiślana Spit and the Hel Spit as well.

Soils of the Vistula R. delta are easily distinguishable in the cartographic image of iron distribution due to markedly elevated iron contents. A distinct differentiation of the iron background is in the range of <1.26 and 3.29%, and the average equals 1.70%.

Of similar character is the differentiation of geochemical background of iron in water sediments. The highest average iron concentrations (>2%) occur in alluvia of the Linawa, Święta, and Tina Rivers. Investigation of recent deltaic sediments in the Rhine and Meuse deltas in the Netherlands showed similar range of iron concentrations (2.7–4.1%) (G.A. Van den Berg *et al.*, 1998).

Iron in surface waters of the survey area is noted in a wide range from <0.01 to as much as 408.67 mg/dm^3, with 0.29 mg/dm^3 on the average. Waters within the Vistula R. delta show elevated iron contents, with a large number of maximums in excess of 7.40 mg/dm^3.

HCO_3 CARBONATES

In their geochemical background within the western postglacial upland, the hydrocarbonates in surface waters show distinct lower concentrations. The strikingly differentiated HCO_3 background within the Vistula R. delta displays a large number of anomalies (>677.1 mg/dm^3); they are of point-type character and their connection with the accumulation of organic mud is likely. The lowest HCO_3 contents were noted in lake waters (165 mg/dm^3 on the average) and in small water bodies such as small lakes and ponds (av. 108 mg/dm^3) and the Vistula and Radunia Rivers (av. 175 and 172 mg/dm^3, respectively).

Hg MERCURY

Mercury in soils forms a low (<0.05–0.09 ppm) and relatively weak differentiation of its geochemical background. Visibly higher Hg concentrations can be observed within the eastern part of the

Vistula R. delta, where the concentrations of >0.15 ppm are sometimes attained. The cartographic image of mercury in water sediments is very similar. Higher Hg contents occur within the eastern part, where more than 0.29 ppm Hg was traced in places.

With such conditions in the background, anthropogenic anomalies of >0.28 ppm in soils and of >0.55 ppm in water sediments are markedly distinguished in the urban areas. Such anomalies have been found in soils of Gdańsk, Sopot, Gdynia, Tczew, Malbork, Nowy Dwór Gdański, and Elbląg. Maximum Hg contents, equal to 5.50 and 3.85 ppm occur in soils of the Gdańsk Port. Mercury anomalies in water sediments appear in the areas of Gdańsk, Gdynia-Orłowo, Puck, Pruszcz Gdański, and Malbork. Peak Hg concentrations in water sediments were traced in ditches in the Gdańsk Port area (6.75 ppm) and in Gdynia-Orłowo (8.60 ppm).

K POTASSIUM

The average contents of potassium in surface waters within the survey area are slightly higher than those for the whole territory of Poland (8.0 and 5.0 mg/dm^3, respectively). Elevated concentrations (>18.2 mg/dm^3) distinguish surface waters affected by seawaters such as those in the Martwa Wisla R. (from 8.7 to 85.2 mg/dm^3, with 44.0 mg/dm^3 on the average) and in its drainage basin, water courses flowing into Puck Bay and those flowing to the Vistula Lagoon. Waters of the Vistula R. contain potassium in amount between 4.2 and 11.2 mg/dm^3 (av. 4.9 mg/dm^3). Still smaller K contents were determined in lake waters (from 0.7 to 31.9 mg/dm^3, with 4.1 mg/dm^3 on the average).

A cartographic presentation of the Vistula R. delta show a number of point-type potassium anomalies (>51.4 mg/dm^3). They group in the area between the Vistula and Nogat Rivers. Usually, the K contents in these anomalies are higher than 100 mg/dm^3, but its maximum reaches 1,370 mg/dm^3. At the same time the sodium content is relatively low (57 mg/dm^3 on the average) in these places, whereas there are high average concentrations of phosphorus (2.82 mg/dm^3), iron (1.21 mg/dm^3), and HCO_3 (455.62 mg/dm^3). It is unclear why the concentrations of potassium and other constituents are so high.

Coefficient of enrichment of chemical constituents in anomalous points are, as compared with the average contents in the whole of the survey area – as follows: K (18.8), P (14.1), Fe (4.2), Mn (2.6), Cl (2.3), HCO_3 (2.2), Li (2.0), B (1.8), conductivity (1.8). Comparatively, waters of the Martwa Wisla R., undoubtedly affected by seawaters from the Gulf of Gdańsk, are characterised by the following set of constituents arranged in the same way: Br (74.0), Cl (36.4), Na (16.5), SO_4 (10.2), Mg (8.9), K (5.5), B (3.8), P (3.5), Sr (2.7), Li (2.6), conductivity (7.5).

A spatial distribution of point-type potassium anomalies in water is most often consistent with the maximums of concentrations of some elements, mostly of iron, manganese, and phosphorus in soils and water sediments. These facts suggest that relict seawaters could be the primary source of potassium and that this element was absorbed from seawater by clayey muds (at low Eh) that were enriched with organic matter. Sodium and chlorine ions present in the relict waters were removed from the environment due to their mobility. Change in physicochemical regime due to development of the Vistula R. delta set potassium (being connected with the solid phase) in motion and caused a gradational passage of this element to ground waters and surface waters as well.

A groundwater study in the Vistula R. delta confirm the presence of salt seawaters (so-called "young relict" waters) in sediments of both the Pleistocene and the Holocene (B. Kozerski, M. Pruszkowska, 1996), and their origin is being related to the period of delta development. In addition, analyses of mineral composition of shallow ground waters (stagnant and being in frequent contact with surface waters) revealed that in the central part of the delta they contain amount of chlorides, fluorides, iron, and manganese over standards (K. Banach, P. Kowalik, 1996) – which confirms analyses of surface waters, that were carried out for the purpose of this survey.

Li LITHIUM

The average contents of lithium in surface waters of the survey area reach 10 µg/dm^3. As concluded from the cartographic image, the lowest Li contents are met in waters within the postglacial uplands (<6.8 µg/dm^3). Low and very low Li contents are observed in waters of the Radunia (4 µg/dm^3 on the average), the Vistula (av. 8 µg/dm^3), the Nogat and Stary Nogat Rivers (av. 9 and 7 µg/dm^3, respectively), and in lake waters (av. 4 µg/dm^3). Rivers that drain the Vistula R. delta contain average lithium content between 12 and 18 µg/dm^3. The lithium differentiation in waters of small water courses and ditches within uplands is poor (<1–12 µg/dm^3) while considerably higher in ditch waters within the Vistula R. delta (4–28 µg/dm^3). Such differentiation of lithium background in waters clearly demonstrates some anomalous fields (>27.5 µg/dm^3) of spatial or point-type character. An anomaly, the source of which is seawater invading land waters, includes the Martwa Wisla R. (from 8 to 38 µg/dm^3; av. 26 µg/dm^3) and its drainage basin (to as much as 222 µg/dm^3). Similar contents of marine-origin lithium were noted in waters of the Szczecin Lagoon and its drainage basin (J. Lis, A. Pasieczna, 1998), where Li concentrations were as high as 647 µg/dm^3). As in the case of potassium, the relict seawater can be the source for lithium point-type anomalies. The maximum content of lithium (284 µg/dm^3) was determined in water from a ditch near a dumping site westwards of Rewa within the Pobrzeże Kaszubskie Coastland.

Mg MAGNESIUM

There is close similarity between the distribution of magnesium in soils and water sediments within the survey area. Soils within the uplands and both spits are characterised by low and weakly differentiated geochemical background of magnesium, which is within the limits of <0.01–0.25% and <0.01–0.10%, respectively. The magnesium geochemical background over the Vistula R. delta area is higher and markedly differentiated (within the limits of 0.05 and 0.40%). Such the background provides a basis for differentiation of a number of anomalies; it is likely that they are connected with a local lithological differentiation of deltaic sediments. Attention should be directed to elevated Mg concentrations in soils in the western part of the Vistula R. delta.

The cartographic representation of Mg differentiation in water sediments is almost identical with that for soils. Particularly low Mg contents characterise sediments of lakes (0.10–0.11% on the average) and alluvia of the Martwa Wisla and Szkarpawa Rivers (0.11%). As to other rivers, their alluvia contain magnesium at the average level from 0.13% (the Vistula) to 0.29% (the Tina).

The pattern of regional differentiation of magnesium in surface waters is similar to that dealing with soils and waters sediments. Also in this case the geochemical background is low within the uplands and considerably more differentiated and at higher level over the Vistula R. delta. The lowest Mg concentrations characterise waters in small unnamed water bodies and lakes (av. 7.2 and 9.5 mg/dm^3, respectively), in the Radunia R. (av. 7.9 mg/dm^3) and the Vistula R. (av. 10.6 mg/dm^3). Waters in other rivers contain magnesium within average limits of 12.1 and 18.9 mg/dm^3. Similar conditions are noted in surface waters in Latvia, that drain Quaternary sediments and contain low magnesium concentrations of 9.7–29.5 mg/dm^3 (M. Klavis *et al.*, 1996).

An anomaly of marine origin has been distinguished in waters of the Martwa Wisla R. (from 11.1 to 224.4 mg/dm^3; av. 130.4 mg/dm^3) and its drainage basin, with the maximum of 236.0 mg/dm^3 defined for waters in the Wyjściowy Canal (practically in waters of the Gulf of Gdańsk). The effect of seawaters on the increase of magnesium content (>30 mg/dm^3) can be clearly seen in water courses within the shores of the Vistula Lagoon.

Similar effect of seawater in the region of Szczecin (J. Lis, A. Pasieczna, 1998) is reflected by visibly higher Mg contents in waters of the Szczecin Lagoon (to 54.3 mg/dm^3; av. 23.7 mg/dm^3) and its shores, in waters of the Świna R. (to 45.5 mg/dm^3) and its basin (to 166 mg/dm^3), and in waters of the Dziwna R. (to 136.2 mg/dm^3).

Mn MANGANESE

The weakly differentiated manganese background is within the limits of 3 to 500 ppm (av. 156 ppm). Still lower Mn contents were recorded within the spits (from <1 to 100 ppm; av. 12 ppm). Soils in the Vistula R. delta show a marked differentiation of the Mn geochemical background, with Mn between 100 and 1000 ppm (473 ppm on the average) and reveals a number of anomalies with Mg contents >990 ppm.

The regional Mn differentiation in water sediments is almost identical with that representing soils. Again, as in the case of soils in the delta of the Vistula R., a number of point-type anomalies were recorded, with Mn concentrations in excess of 2000 ppm. The lowest Mn contents were noted in sediment of lakes (av. 102 ppm) and small unnamed reservoirs (av. 112 ppm), and in alluvia of the Martwa Wisla (av. 134 ppm) and Nogat Rivers (av. 150 ppm). Alluvia of other rivers are characterised by diversified Mn contents (from 226 to 797 ppm on the average). Sediments in small water courses (mostly drainage ditches) contain Mn concentrations being strongly dependent on geographic situation. Within the uplands the Mn contents are changeable from<100 to 500 ppm, while in the Vistula R. delta area the Mn range is wider, within the limits of <100 to 1000 ppm. The Mn contents in deltaic sediments of the Rhine and Meuse Rivers, cited here for comparison, follow a narrow range between 800 and 1200 ppm (G.A. Van den Berg *et al.*, 1998).

The cartographic representation of manganese distribution in surface water is close to the image of this element's distribution in soils and water sediments and results from the action of the same environmental factors. The lowest Mn contents on record deal with lake waters (av. 47 µg/dm^3), small unnamed water bodies (av. 93 µg/dm^3), the Martwa Wisla R. (av. 35 µg/dm^3), the Vistula R. (av. 43 µg/dm^3), and the Radunia (av. 66 µg/dm^3). Manganese occurs in other rivers in diversified concentrations, from 226 µg/dm^3 (on the average) in the Nogat R. to 910 µg/dm^3 in waters of the Święta R. A strongly differentiated Mn background in waters within the Vistula delta reveals the occurrence of numerous anomalies, with maximum concentrations exceeding 4 572 µg/dm^3. The Vistula R. delta appears distinguishable.

A drainage ditch in the Tuga R. basin northwards of Nowy Dwór Gdański is that site where the peak Mn concentration was recorded (46 635 µg/dm^3). Similar phenomenon of the occurrence of waters strongly enriched with manganese was recorded within a swampy ground at the Odra R. mouth (to 15 802 µg/dm^3) and around Odra Bay (to 10 507 µg/dm^3) (J. Lis, A. Pasieczna, 1998).

Na SODIUM

The value of geochemical background of sodium within the morainic uplands (<12.8 to 64.9 mg/dm^3) is close to the majority of surface waters in Poland (<16 mg/dm^3) or to weakly polluted river waters in the Czech Republic (15.2 mg/dm^3) as reported by J. Vesely and V. Majer (1994).

Water courses within the Vistula R. delta are very diversified in respect of sodium – which concentrates within the limits of <12.8 to 139.0 mg/dm^3. The influence of seawater is reflected by the high Na concentrations reaching 1810 mg/dm^3 (av. 579.3 mg/dm^3) in the Martwa Wisla R., 1893.4 mg/dm^3 in the Wyjściowy Canal and in drainage basins of both, and in waters of the Vistula Lagoon shores. Anomalies of marine origin are also observed in waters courses within the shore of Puck Bay.

Ni NICKEL

The content of nickel (dissoluble in aqua-regia) in soils of the survey area is low (from <2 to 47 ppm , with 9 ppm an the average), but at the same time its cartographic image is considerably differentiated, in particular within the Vistula R. delta area. The limits of <2 to 11.5 ppm define the average nickel contents in soils of the uplands; the respective value for spits is usually lower than 5 ppm (av. <2 ppm). The differentiated background over the Vistula R. delta allows for pointing out anomalies with the maximum concentrations of >29.1 ppm.

The behaviour of nickel in water sediments is very similar to that in soils in respect of spatial distribution in both environments and their respective concentration levels. The lowest Ni contents are observed in lacustrine sediments (av. 4 ppm) and in alluvia of the Radunia R. (av. 5 ppm) and the Martwa Wisla R. (av. 5 ppm). Similar nickel contents in water sediments of rivers within the Gdańsk region (6–7 ppm) were found during a monitoring study (I. Bojakowska, G. Sokołowska, 1994). Among remaining rivers the Tina is that one which has alluvia with the highest nickel content (18 ppm).

A too high detection limit of nickel (10µg/dm^3) is the reason that the nickel geochemical background in surface waters could not be defined. According to A. Kabata-Pendias & H. Pendias (1999) in waters of unpolluted rivers the nickel concentrations are 1 to 5 µg/dm^3; however, in waters of many rivers in Europe its concentrations can reach a level of 75 µg/dm^3.

In individual samples of water the nickel contents was defined at >10 µg/dm^3. A distinct anomalous anthropogenic pollution with nickel (130 µg/dm^3) was detected in strongly acidic water (pH = 2.58) in a ditch within the Port in Gdańsk . The SO_4 ion (3599 mg/dm^3) is most likely the main acidizing factor. In addition, this water contained the abundance of other metals: Al – 61.3 mg/dm^3, Ca – 506 mg/dm^3, Cr – 230 μg/dm^3, Cu – 275 μg/dm^3, Fe – 216 mg/dm^3, Li – 118 μg/dm^3, Mg – 114 mg/dm^3, Mn – 5601 μg/dm^3, Sr – 2326 μg/dm^3, Ti – 1310 μg/dm^3, V – 130 μg/dm^3, and Zn – 5306 μg/dm^3. A case was recorded that high nickel concentrations (to as much as 940 μg/dm^3) in acid waters (pH in the range of 2.91 to 4.67) in several ditches in the Vistula R. delta coexisted with high contents of Co (to 365 μg/dm^3), Fe (to 408.67 mg/dm^3), Mn (to 22 544 μg/dm^3), SO_4 (to 2324 mg/dm^3), Sr (to 2233 μg/dm^3), and Zn (to 1889 μg/dm^3; it is likely that their geological nature is connected with the occurrence of iron- and manganese-rich swampy sediments.

NO_2 NITRITES

The average nitrite contents in surface waters covered by this survey are low (<0.01 mg/dm^3); however, against such the background numerous anomalies (>0.10 mg/dm^3) are observed. Usually the anomalies are of point-type character, sometimes they are spatial, and the maximums of both exceed 1 mg/dm^3. Frequently they are confined to the urban areas. Waters in areas of urban development as well as industrial one contain nitrites in amount between <0.01 and 3.38 mg/dm^3 (with 0.03 mg/dm^3 on the average). The influence of agriculture upon nitrite contents in waters is visibly smaller (the average for rural areas approximates 0.01 mg/dm^3). Water in small water courses (ditches) and small reservoirs is characterised by considerable variability of nitrite contents (from <0.01 to several mg/dm^3), while waters in lakes and larger rivers contain more flatten range of concentrations (from <0.01 to tenth fractions of mg/dm^3). It is worth noting that among larger rivers the highest nitrate concentrations in water were found in the Vistula R. (from <0.01 to 0.20 mg/dm^3, with 0.04 mg/dm^3 on the average), the Martwa Wisla R. (from <0.01 to 0.41 mg/dm^3, with 0.07 mg/dm^3 on the average), the Fiszewka R. (from 0.06 to 0.18 mg/dm^3, with 0.09 mg/dm^3 on the average), the Nogat R. (from <0.01 to 0.56 mg/dm^3, with 0.06 mg/dm^3 on the average), and the Szkarpawa R. (from <0.01 to 0.38 mg/dm^3, with 0.05 on the average). These high or even over standard NO_2 concentrations can be connected with sewage disposal.

NO_3 NITRATES

As in the case of nitrites, also nitrates occur in waters of urban and industrial areas at elevated concentrations (av. 0.41 mg/dm^3) as compared with waters in areas under cultivation (av. 0.08 mg/dm^3). A comparative data dealing with land under cultivation in Finland indicates that the NO_3 contents in surface waters are 0.1–0.3 mg/dm^3 (P. Lahermo *et al.*, 1996). The nitrate contents in river waters (60 samples) in Latvia are ranging between 0.23 and 1.20 mg/dm^3 (M. Klavis *et al.*, 1996), while those in rivers (678 samples) and streams (7460 samples) in the Czech Republic are in the average – 13.0 and 11.1 mg/dm^3, respectively (J. Vesely, V. Majer, 1994).

The western part of the survey area in the region of Tczew, Pruszcz Gdański, Gdańsk, Gdynia, and Reda is that one, where the occurrence of NO_3 anomalies is most frequent. These anomalies are of point character, and their maximums reach the level of 10 mg/dm^3 and more. A rather extended anomaly of nitrates has been recorded in waters within the Elbląg region. In general, waters of larger rivers contain higher nitrate concentrations than that in small water courses (mostly drainage ditches). The highest average contents of NO_3 were noted in waters of the Vistula R. (1.97 mg/dm^3), the Radunia R. (1.05 mg/dm^3), and the Motława R. (0.99 mg/dm^3). Low nitrate concentrations are common in lake waters ((from <0.01 to 1.17 mg/dm^3, with 0.02 mg/dm^3 on the average). M. Klavis *et al.* (1996) have found that similar nitrate concentrations (within the limits of 0.30 to 2.20 mg/dm^3 occur in lake waters in Latvia.

P PHOSPHORUS

It has been found that the geochemical background of phosphorus in soils within the uplands is weakly differentiated and that its limits are <0.005 to 0.100% (with 0.047% on the average). Still lower phosphorus contents are representative for sandy soils within the spits (<0.050, with 0.012% on the average). The average phosphorus contents within the Vistula R. delta are doubled (av. 0.090%), and the cartographic image shows impressive differentiation, with a large number of anomalies exceeding the concentrations of 0.220%. Particularly high phosphorus contents occur in soils in the western part of the Vistula R. delta in the vicinity of Pruszcz Gdański and in surroundings of Lake Drużno – where peats and peaty muds are abundant.

The differentiation of phosphorus in waters sediments is similar to that in soils. Again, water sediments within the upland areas are represented by low P contents (from <0.005 to 0.160%), which differ them from water sediments within the Vistula R. delta with generally higher concentrations of phosphorus and with anomalies over 0.760%.

Waters of the surveyed area are phosphorus-rich (from <0.1 to 35.8 mg/dm^3, with 0.2 mg/dm^3 on the average). Waters within the uplands contain smaller phosphorus concentrations than waters within the Vistula R. delta (with exception of the Puck region, where an areal anomaly with P >0.97 mg/dm^3 was noticed). High phosphorus concentrations (to 35.8 mg/dm^3, av. 0.3 mg/dm^3) are characteristic for waters in small water courses (ditches) within the Vistula R. delta, where peak values in excess of 9.2 mg/dm^3 were recorded. Waters of larger rivers contain, on the average, 0.1–0.2 mg/dm^3 of phosphorus; the Martwa Wisla R. is the exceptional case as phosphorus in its waters is concentrated to 0.7 mg/dm^3 on the average. A liquid manure may be the source of maximum phosphorus concentrations in waters as an observation was made that most often the concentrations >10 mg/dm^3 occur in waters of ditches situated near the large farms.

Pb LEAD

The representations of spatial distribution of lead in soils and water sediments are very close to each other. The low lead background is characteristic for the upland areas (av. 12 ppm) and the spits (av. 5 ppm), while higher and more differentiated background is representative for the area of the Vistula R. delta (av. 13 ppm). A distinct anthropogenic pollution of these environments is visible within Gdańsk, Gdynia, Rumia, Reda, Puck, Władysławowo, Tczew, Malbork, and Elbląg. A range of Pb contents in urban soils is in the limits of <3 and 214 ppm (23 ppm on the average).

The peak Pb content in soil was recorded in the Gdynia Port. From the viewpoint of the land use, the lowest Pb contents are detected in forest soils (7 ppm on the average), the higher – in soils of farmland (av. 12 ppm), and the highest – in soils of urban and industrial areas (av. 23 and 45 ppm, respectively).

S SULPHUR,
SO_4 SULPHATES

Soils within the uplands and both spits reveals that their geochemical background is low and of poor differentiation (from <0.014 to 0.043%). The geochemical background of soils in the Vistula R. delta is distinctly higher and within the wider limits (from <0.014 to 0.117%). Against such the background the distinct anomalies are displayed; they are of lithological character which is connected with the abundance of formations organic matter-rich (mostly peats), occurring within the delta. One of the anomalies extends along the western shore of the Vistula R. delta between Tczew and Gdańsk. A large number of anomalies were also recorded in areas of the occurrence of peats. Sulphur anomalies of similar character, connected with swampy soils, have been noted in the region of the Szczecin Lagoon (J. Lis, A. Pasieczna, 1998).

Low sulphur contents distinguishes the upland areas surrounding the Vistula R. delta from the spatial representation of differentiation in the sulphur geochemical background in water sediments. These differences occurred to be suitable for characterising average sulphur contents in sediments of lower-order water courses (mostly ditches) and surface reservoirs (ponds, unnamed lakes) within the upland areas (from 0.003 to 8.617%; 0.070% on the average) in contrast to similar sediments from the Vistula R. delta (from 0.008 to 7.938%, and 0.152 on the average). In the case of rivers, the lowest sulphur contents are shown by alluvia of the Vistula (from 0.006 to 0.093%; av. 0.028%), the Martwa Wisla R. (from 0.006 to 0.340%; av. 0.039%), and the Radunia R. (from 0.014 to 1.079; av. 0.064%). Alluvia of remaining rivers contain sulphur in average concentrations from 0.090% (the Nogat R.) to 0.210% (the Stary Nogat R.). The differentiated geochemical background allows to observe a large number of intensive anomalies (>1.168% S) within the Vistula R. delta and in the Reda R. and Płutnica R. valleys. These anomalies, showing maximum concentrations in excess of 5% S, are most likely connected with local accumulations of organic matter in sediments.

In general, the sulphate contents in surface waters are low (av. 39 mg/dm^3), however, they are contained within wide limits (from <1 to 3973 mg/dm^3). Numerous anomalies of point and areal (>700 mg/dm^3) character, with maximums exceeding 1000 mg/dm^3 expose themselves against the low and weakly differentiated geochemical background. Frequently they are confined to regions of the occurrence of peatland. The highest sulphate content (3973 mg/dm^3) was determined in strikingly acidized water (pH = 2.58) from a ditch in the Gdańsk Port. The influence of seawater upon the SO_4 contents is reflected by high concentrations of this ion in the Martwa Wisla R. waters (from 32 to 565 mg/dm^3; 335 mg/dm^3 on the average) and its basin (to 1084 mg/dm^3).

SiO_2 SILICA

With respect to the silica distribution in surface waters, the west upland area is distinguishable from the cartographic image due to relatively low and weakly differentiated contents (<21.1 mg/dm^3). The average higher SiO_2 concentrations with maximums > 36.0 mg/dm^3 occur in waters of the Vistula R. delta. These high contents may originate from the decay of fine dispersive clayey fraction in the presence of organic colloids protecting the colloidal silicon compounds from being precipitated from the solution. The lowest SiO_2 contents were recorded in waters of lakes (av. 4.3 mg/dm^3) and small reservoirs (av. 4.1 mg/dm^3). River waters contain 4.4 mg/dm^3 of silica (the Fiszewka) to 20.7 mg/dm^3 (the Święta).

Sr STRONTIUM

The cartographic image of strontium distribution within the survey area is similar to that of calcium and sulphur. Its geochemical background in soils of the uplands and the spits is low and weakly differentiated (from <6.1 to 30.0 ppm). The geochemical background of soils within the Vistula R. delta is considerably higher and contained within wide limits (from <6.1 to 59.0 ppm). There are intensive anomalies of lithological type, that are linked with sediments enriched with organic matter (mostly peats) – abundant in the delta area. Characteristic anomalies of this type extents along the western shore of the Vistula R. delta from Tczew to Gdańsk and to the south of Lake Drużno. Anomalies connected with the occurrence of peats have also been noted in the valleys of the Reda and the Płutnica Rivers.

Water sediments in the upland areas surrounding the Vistula R. delta distinguish themselves from the cartographic representation of strontium background differentiation due to relatively low Sr concentrations. These differences are satisfactorily characterised by the average Sr contents in sediments of small water courses (mostly ditches) and small reservoirs (ponds, unnamed lakes) within the upland areas (from 2 to 303 ppm; av. 15 ppm) as compared with similar sediments in the area of the Vistula R. delta (from 3 to 935 ppm; av. 31 ppm). As concerns rivers, the lowest Sr concentrations were shown by alluvia of the Vistula R. (from 4 to 31 ppm; av. 13 ppm) and the Radunia R. (from 5 to 128 ppm; av. 15 ppm). Alluvia of remaining rivers contain, on the average, 17 ppm (the Martwa Wisla R. and the Stary Nogat R.) to 55 ppm (the Tina R.). A number of intensive anomalies (>100 ppm Sr) within the Vistula R. delta can be pointed out on the differentiated geochemical background. A maximum Sr concentration (935 ppm) was detected in sediments from a ditch within the Gdańsk Port. The Sr concentrations higher than the Sr averages also occur in valley sediments of the Reda and Płutnica Rivers.

As to the Sr contents in surface waters, they are differentiated in the same way as those in soils and water sediments. There are conspicuous anomalies in the differentiated geochemical background, that are of point and areal character (>700 μg/dm^3) and reach the maximums over 1169 μg/dm^3. The most expressive strontium anomaly in waters covers the same area as that occupied by the Sr anomalies in soils and water sediments in the western part of the Vistula R. delta, between Tczew and Gdańsk. The influence of seawater on the Sr contents is expressed by the high concentrations in the Martwa Wisla R. waters (from 329 to 1345 μg/dm^3; av. 942 μg/dm^3) and its drainage basin (to 2326 μg/dm^3). The elevated contents of strontium in waters within the shores of the Vistula Lagoon are also of the same origin.

A similar increase in the Sr contents or its anomalous concentrations resulting from the influence of seawater was also noticed over the Odra Bay and within the Świna R. drainage basin (the Island of Wolin) (J. Lis, A. Pasieczna, 1998).

Ti TITANIUM

The areal distribution of titanium in soils and water sediments of the surveyed area is quite different from that of other elements. The geochemical background of titanium within the Vistula R. delta is low and weakly differentiated – from <43 to 98 ppm in soils and from <66 to 122 ppm in water sediments. The Ti background in soils and water sediments within glacial formations encircling the delta is characterised by considerable variability of concentrations (from <43 to 186 ppm in soils and from 66 to 202 ppm in water sediments), with numerous maximums that are >242 ppm in soils and >254 ppm in water sediments. Within the Vistula R. delta area the visibly anomalous Ti contents in soils were recorded eastwards of Pruszcz Gdański and in the area of Gdańsk. The lowest Ti contents are observed in soils that developed on sandy formation of the Mierzeja Wiślana Spit.

As to Ti contents in surface waters covered by this survey, they were most often below the detection limit of this element (<5 μg/dm^3). Titanium in the range of 5 to 33 μg/dm^3 was found in dozen samples or so.

V VANADIUM

The vanadium contents in soils of the survey area are low (from <1 to 90 ppm; av. 13 ppm), but in its cartographic representation they are considerably differentiated, in particular within the Vistula R. delta. The average vanadium contents in soils of the postglacial uplands are in the range of <1 to 47 ppm (9 ppm on the average), while within the spits the respective values are usually 8 ppm (and <2 ppm on the average). The anomalies with the maximums over 32 ppm are clearly visible against the differentiated background of the Vistula R. delta. The distribution of fields showing the elevated vanadium contents is similar to those drawn for a series of other elements (Al, Co, Cr, Ni), which may provide evidence that the lithological composition of soils is much more complex than concluded from available geological maps.

The manner of vanadium preservation in water sediments is similar to that in soils; this deals with the image of both the spatial distribution and the level of concentrations . The lowest V contents are observed in lacustrine sediments (av. 9 ppm) and small unnamed reservoirs (av. 10 ppm). The average vanadium contents in alluvia of the Vistula, Martwa Wisła, Radunia, Nogat, and Szkarpawa Rivers are below 10 ppm. Among remaining rivers, the Tina shows the highest average V contents (21 ppm).

Zn ZINC

There is close similarity between spatial images of the zinc distribution in soils and water sediments. A low geochemical background characterises the areas of uplands and both spits, while higher and more differentiated – the Vistula R. delta. The average Zn contents in soils of regions mentioned here are 36, 13, and 54 ppm, respectively (Table III). A close range of Zn contents (7–77 ppm) in soils that developed on morainic sediments within the Mazurian Lake District is cited by B. Bieniek (1997). Observation was made in the town areas that urban soils are markedly polluted with zinc (the average for urban soils is 69 ppm); this pollution is of anthropogenic origin.

Against the differentiated background of water sediments there are conspicuous anthropogenic anomalies within the Gdańsk, Puck, Władysławowo, and Tczew areas. The concentration of 4010 ppm Zn was detected in alluvia of the Martwa Wisła R. in the Gdańsk Port. Numerous point-type anomalies, usually below 1000 ppm, can be connected with the occurrence of peaty muds in the Reda R. valley and in the Vistula R. delta. The maximum Zn concentration (14 700 ppm) was found in sediment of a drying up pond within the new individual housing estate northwards of Pruszcz Gdański. In addition, the sample contained Cu (3483 ppm), Cd (2.9 ppm), Cr (314 ppm), and Pb (5607 ppm).

Surface waters contain small amounts of zinc (<5 μg/dm^3). It is frequent case that the high Zn concentrations occur in acid waters (pH<5) with considerable concentration of sulphates. Such was the case of a sample of strongly acidic waters (pH = 2.58) from a ditch in the Gdańsk Port, which contained zinc in the concentration of 5306 μg/dm^3 and also sulphate – in the concentration of 3599 mg/dm^3.

ASSESSMENT OF THE LEVEL OF POLLUTION OF CULTIVATED SOILS AND SURFACE WATERS

SOILS

The recommendations of the Institute of Soil Science and Cultivation of Plants (IUNG) in Puławy were applied to assess the level of pollution of cultivated soils (A. Kabata-Pendias *et al.*, 1995). Table VIII presents the assessment results for the Vistula R. delta area and Table IX – for the Pobrzeże Kaszubskie and the Wysoczyzna Elbląska (postglaciation uplands).

The actual concentrations of Cd, Cu, Cr, Ni, Pb, and Zn in samples of soils under cultivation classify the majority of these soils as representing the "0" level of pollution. Soils at this level are unpolluted, with natural contents of heavy metals. A fraction of samples contain metals at concentrations indicating the "I" level of pollution. Though they belong to soils containing the elevated contents of heavy metals, the Institute's recommendations suggest their unlimited use in agriculture. Only individual soil samples showed higher levels of pollution. Participation of particular metals in soils, decisive for classifying them to the "I" level of pollution is different and dependent on geographic situation and the way of land use as well. The sequence of metals, expressed by percentage of samples considered to be in the "I" level is as follows:

– for cultivated soils within the Vistula R. delta: Zn>Ni>Cu>Cd>Cr>Pb;
– for soils of pastures (meadows) within the Vistula R. delta: Zn>Cu>Ni>Cd>Cr>Pb;
– for cultivated soils within the Pobrzeże Kaszubskie and the Wysoczyzna Elbląska (uplands): Zn>Cu>Ni>Pb>Cr>Cd;
– for allotment soils: Cu>Pb>Cd>Ni>Zn>Cr;
– for soils of pastures (meadows) within the uplands (Pobrzeże Kaszubskie, Wysoczyzna Elbląska).

It seems very likely that in the case of soils classified to the "I" level of pollution (particularly within the delta area), not the anthropogenic element but the geological nature of parent rocks is that factor which is responsible for the increase of metal contents. The anthropogenic element finds it expression in soils of the upland area being much more urbanised than the Vistula R. delta, by substantially higher participation of lead in the pollution level.

The influence of pollution of anthropogenic origin is best observed in soils of the allotments, where the pollution with copper, lead, and cadmium is most common. However, the level of pollution does not eliminate these soils from the appropriate use.

Assessments of the pollution level of soils under cultivation within the former Elbląg and Gdańsk provinces are convergent with the present survey. They are presented in studies prepared by the Regional Inspectorate of Environmental Protection – WIOŚ – (Raport, 1995a, b).

SURFACE WATERS

Table X contains the assessment of water purity, compiled according to the recommendation of the Ministry of Environmental Protection, Natural Resources and Forestry (Rozporządzenie, 1991). This classification was made for the entire set of analyses and for waters of some more important rivers such as the Vistula, Martwa Wisła, Nogat, and Święta. Waters in small water courses (mostly drainage ditches) in the Vistula R. delta area and the surrounding uplands were also distinguished. The separation of this group of waters was aimed at investigating the influence of local pollution sources, mostly coming from the surface flow from the immediate environs and having their origin in the lithology of drained areas, upon their chemistry. The influence of point-type sources (the discharge of domestic sewage and industrial effluents) upon pollution of these waters plays a smaller part than in the case of larger rivers.

From the point of view of metal contents (Cd, Cr, Cu, Ni and Zn), waters under this survey belong in almost 100% to the I purity class. Marked pollution with iron, manganese, and partly phosphorus are, to some degree, of natural origin connected with geological structure. High percentage of substandard waters polluted with iron (27.97%), manganese (47.91%), and phosphorus (36.42%) in small water courses within the Vistula R. delta results from the presence of organic mud being enriched with these elements. Waters in small water courses within the uplands are mostly polluted with phosphorus (29.08% of substandard waters), the origin of which is most likely connected with uncontrolled sewage disposal and with the agricultural activity.

Such factors as those causing nitrite-related pollution (domestic sewage, discharge of manure) play smaller part in case of waters in small water courses (ditches). As refers to the Vistula R. delta area, the NO_2 contents are decisive for considering these waters in the I purity class – in 81.56% of cases, II class – in 3.23% of cases, and III class – in 6.15% of cases. Substandard waters constitute 9.06%. More polluted with nitrites are waters in small water courses within the Pleistocene uplands, which results from more advanced urbanisation of these areas. The I purity class includes 62.60% of these waters, the II class – 7.35%, the III class – 16.91%, and substandard waters – 13.14%.

In general salinity of waters in these ditches, small streams and canals, expressed in terms of electrical conductivity is considerably high (17.90% and 12.24% of substandard waters within the delta and the uplands, respectively). The potassium compounds are responsible for this type of salinity. In the Vistula R. delta area only 57.07% belong to the I purity class, 6.51% to the II class, 6.41% to the III class, and as much as 30.01% to substandard waters. Less polluted with potassium are waters in small waters courses within the uplands: 72.45% – the I class, 5.10% – the II class, 1.53% – the III class, and 20.92% – substandard waters.

The Święta R., which drains a considerable part of the Vistula R. delta conducts water being heavily polluted with manganese (61.29% of substandard waters), phosphorus (25.81% of substandard waters), iron (22.58% of substandard waters), and nitrites (16.12% of substandard waters). As indicated by the Regional Inspectorate of Environmental Protection in Elbląg, the main factors responsible for this river degradation in 1996 include: dissolved oxygen, total iron, phosphates total phosphorus, nitrite nitrogen, ammonium nitrogen, and *Coli name* (Raport, 1997a).

Nitrite nitrogen is the main factor which indicates that waters in the Nogat R. have been degraded (19.51% of III class waters and 36.59% of substandard waters). Waters of the Motława R. from Tczew to its mouth are heavily polluted with phosphorus and nitrites (17.24% of substandard waters). A group of waters with phosphorus and nitrites as the main pollutant agents includes also the Vistula River (Table X). The strongest pollution with nitrites affects waters of the Martwa Wisła R. (50.00% of substandard waters).

A separate problem exists which deals with the pollution of surface waters with chlorine, sodium, potassium, lithium, magnesium, phosphorus, and strontium due to the influence of seawater from the Gulf of Gdańsk and the Vistula Lagoon as well. This pollution is observed in waters of the Martwa Wisła R. with its drainage basin and in waters within shores of the Vistula Lagoon. Since waters of the Martwa Wisła R. contain substandard amounts of potassium (95.24% of waters), sodium (85.72% of waters), phosphorus (61.90% of waters), and sulphates (80.96% of waters), and their total mineralisation is 95,24%, they have been classified among substandard waters.

RECAPITULATION

The geochemical background of soils covered by this survey has been determined by the three basic lithological groups of rocks in the substratum:

– Pleistocene formation of the North Polish Glaciation, composed of glacial tills and sandy-gravely sediments of different origin,
– Holocene muds, alluvia and peats within the Vistula R. delta,
– eolian sand and marine clays, sands, and gravel within both the Hel and the Mierzeja Wiślana Spits.

The geological structure is that factor which governs the differentiation of soils and waters sediments with respect to the content of the following elements: Al, As, Ba, Be, Ca, Co, Cr, Cu, Fe, Mg, Mn, Ni, P, S, Ti, V, and Zn. The geochemical background of these elements within the Vistula R. delta covers wider limits and is, in general, higher than that within the uplands surrounding the delta. Strikingly differentiated geochemical background of soils and water sediments in the delta area suggests that the geological structure of the delta is more complicated than it might be concluded from the available geological maps. It seems that in this area there is more abundant representation of organic alluvia enriched with iron, manganese, phosphorus, sulphur, and other elements. The geochemical background of soils and water sediments within the upland areas (the Pobrzeże Kaszubskie at the west and a fragment of the Wysoczyzna Elbląska at the east) is relatively low and weakly differentiated. A number of elements such as chromium, cobalt, copper, iron, manganese, and nickel in soils of these areas have similar limits of concentrations as those in soils that developed on similar base in the other regions of northern Poland (K. Czarnowska, B. Gworek, 1987; B. Gworek, 1985).

The low concentrations make it possible to distinguish distinct As, Ca, S, and Sr anomalies of natural origin, all connected with the occurrence of organic alluvia (peats and gyttjas) in the Reda R. and the Płutnica R. valleys.

A spatial distribution of titanium in soils and water sediments of the surveyed area is essentially different from the distribution of other elements. Due to low and weakly differentiated background of titanium, the delta appears as the distinguishable area. In comparison with strikingly differentiated and higher geochemical background of titanium in soils and water sediments in the glacial formations surrounding the delta, the low and weakly differentiated Ti background makes the delta area conspicuous. In part of the delta area distinct abnormal titanium contents have been noted to the east of Pruszcz Gdański and in the Gdańsk area. The smallest contents all of investigated elements occur in strongly acidic sandy soils within both the Hel and the Mierzeja Wiślana Spits.

The Cd, Cr, Cu, Hg, Pb, and Zn anomalies of anthropogenic origin, all occurring in soils and waters sediments, have mostly been noted within urban areas. Their intensity does not differ from those anomalies that occur within other towns of Poland.

The contents of Ba, Ca, Fe, Li, Mg, Mn, P, SiO_2, Sr, and Zn in surface waters are governed by the geological structure, and the representations of their spatial distribution are simulate to those in soils and water sediments. Waters of the Vistula R. contain such concentrations of elements that are similar to the average concentrations on a regional scale. Distinguishable are only iron and manganese due to their smaller concentrations, and nitrites and nitrates – due to the higher concentrations.

The presence of anomalous concentrations of NO_2 and NO_3 in surface waters is the main effect of domestic sewage discharge. A part played by the surface flow on the nitrogen compounds due to the agricultural activity is smaller.

The high concentrations of chlorine, sodium, potassium, sulphates, lithium, magnesium, phosphorus, and strontium in some surface waters result from the influence of seawaters from the Gulf of Gdańsk and the Vistula Lagoon. The most distinct increase in their concentrations is observed in the Martwa Wisła R. and its basin, and in water courses within the Vistula Lagoon shores. Point-type and sometimes areal anomalies of these elements and chemical compounds observed in great numbers in surface waters of the Vistula R. delta may be connected with the presence of relict seawaters in the deltaic sediments.

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7. Al – Glin. Aluminium
8. As – Arsen. Arsenic
9. Ba – Bar. Barium
10. Be – Beryl. Beryllium
11. Ca – Wapń. Calcium
12. Cd – Kadm. Cadmium
13. Co – Kobalt. Cobalt
14. Cr – Chrom. Chromium
15. Cu – Miedź. Copper
16. Fe – Żelazo. Iron
17. Hg – Rtęć. Mercury
18. Mg – Magnez. Magnesium
19. Mn – Mangan. Manganese
20. Ni – Nikiel. Nickel
21. P – Fosfor. Phosphorus
22. Pb – Ołów. Lead
23. S – Siarka. Sulphur
24. Sr – Stront. Strontium
25. Ti – Tytan. Titanium
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32. Ba – Bar. Barium
33. Be – Beryl. Beryllium
34. Ca – Wapń. Calcium
35. Cd – Kadm. Cadmium
36. Co – Kobalt. Cobalt
37. Cr – Chrom. Chromium
38. Cu – Miedź. Copper
39. Fe – Żelazo. Iron
40. Hg – Rtęć. Mercury
41. Mg – Magnez. Magnesium
42. Mn – Mangan. Manganese
43. Ni – Nikiel. Nickel
44. P – Fosfor. Phosphorus
45. Pb – Ołów. Lead
46. S – Siarka. Sulphur
47. Sr – Stront. Strontium
48. Ti – Tytan. Titanium
49. V – Wanad. Vanadium
50. Zn – Cynk. Zinc

WODY POWIERZCHNIOWE. SURFACE WATERS

51. pH – Kwasowość. Acidity
52. Przewodność elektryczna. Conductivity
53. Al - Glin. Aluminium
54. As - Arsen. Arsenic
55. B – Bor. Boron
56. Ba – Bar. Barium
57. Br – Brom. Bromine
58. Ca – Wapń. Calcium
59. Cd – Kadm. Cadmium
60. Cl – Chlor. Chlorine
61. Co – Kobalt. Cobalt
62. Cr – Chrom. Chromium
63. Cu – Miedź. Copper
64. F – Fluor. Fluorine
65. Fe – Żelazo. Iron
66. HCO3 – Węglany. Carbonates
67. K – Potas. Potassium
68. Li – Lit. Lithium
69. Mg – Magnez. Magnesium
70. Mn – Mangan. Manganese
71. Na – Sód. Sodium
72. Ni – Nikiel. Nickel
73. NO2 – Azotyny. Nitrites
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78. Sr – Stront. Strontium
79. Ti – Tytan. Titanium
80. Zn – Cynk. Zinc

TABLES

Tabela I
Table

Metody analityczne oraz granice oznaczalności pierwiastków
stosowane dla próbek gleb i osadów

Analytical methods and detection limits of elements used for soil and sediment samples

Pierwiastek Element	Metoda analityczna Analytical method	Długość fali Wave length (in nm)	Jednostka Unit	Granica oznaczalności Detection limit
pH	potencjometria			
Ag	ICP-AES	328.068	ppm	1
Al		308.215	%	0.01
As		193.695	ppm	5
Ba		455.403	ppm	1
Be		313.042	ppm	0.5
Ca		315.887	%	0.01
Cd		226.502	ppm	0.5
Co		228.616	ppm	1
Cr		267.716	ppm	1
Cu		324.754	ppm	1
Fe		259.940	%	0.01
Hg	CV-AES	253.7	ppm	0.05
Mg	ICP-AES	383.829	%	0.01
Mn		257.610	ppm	1
Ni		231.604	ppm	1
P		178.224	%	0.005
Pb		220.353	ppm	3
S		182.000	%	0.005
Sr		407.771	ppm	1
Ti		337.279	ppm	1
V		290.881	ppm	1
Zn		213.856	ppm	1

ICP-AES – atomowa spektrometria emisyjna ze wzbudzeniem plazmowym
Inductively Coupled Plasma Atomic Emission Spectrometry

CV-AAS – atomowa spektrometria absorpcyjna z techniką zimnych par
Cold Vapour Atomic Absorption Spectrometry

Tabela II
Table

Metody analityczne oraz granice oznaczalności składników stosowane dla próbek wód powierzchniowych

Analytical methods and detection limits of components used for surface water samples

Składnik Component	Metoda analityczna Analytical method	Długość fali (w nm) Wave length (in nm)	Jednostka Unit	Granica oznaczalności Detection limit
Al	ICP-AES	308.215	mg/dm^3	0.05
As		189.042	mg/dm^3	0.05
B		208.893	mg/dm^3	0.03
Ba		455.403	$\mu g/dm^3$	1
Br	HPLC		mg/dm^3	0.1
Ca	ICP-AES	315.887	mg/dm^3	1
Cd		226.502	$\mu g/dm^3$	3
Cl	HPLC		mg/dm^3	1
Co	ICP-AES	228.616	$\mu g/dm^3$	5
Cr		267.716	$\mu g/dm^3$	4
Cu		324.754	$\mu g/dm^3$	5
F	HPLC		mg/dm^3	0.1
Fe	ICP-AES	259.940	mg/dm^3	0.01
HCO_3	HPLC		mg/dm^3	5
K	FAAS	766.491	mg/dm^3	0.5
Li		670.776	$\mu g/dm^3$	1
Mg	ICP-AES	383.829	mg/dm^3	0.1
Mn		257.610	$\mu g/dm^3$	1
Na	FAAS	589.592	mg/dm^3	1
Ni	ICP-AES	231.604	$\mu g/dm^3$	10
NO_2	HPLC		mg/dm^3	0.01
NO_3			mg/dm^3	0.01
P	ICP-AES	178.224	mg/dm^3	0.1
SiO_2		251.611	mg/dm^3	0.1
SO_4	HPLC		mg/dm^3	1
Sr	ICP-AES	407.771	$\mu g/dm^3$	1
Ti		337.279	$\mu g/dm^3$	5
Zn		213.856	$\mu g/dm^3$	5

ICP-AES – atomowa spektrometria emisyjna ze wzbudzeniem plazmowym
Inductively Coupled Plasma Atomic Emission Spectrometry

FAAS – płomieniowa atomowa spektrometria absorpcyjna
Flame Atomic Absorption Spectrometry

HPLC – wysokosprawna chromatografia cieczowa
High Performance Liquid Chromatography

Tabela III
Table

Parametry statystyczne pierwiastków chemicznych i kwasowości gleb Pobrzeża Gdańskiego

Statistical parameters of chemical elements and acidity in soils of Gdańsk Region

Gleby Soils	Parametry Parameters	Ag ppm	Al %	As ppm	Ba ppm	Be ppm	Ca %	Cd ppm	Co ppm	Cr ppm	Cu ppm	Fe %	Hg ppm	Mg %	Mn ppm	Ni ppm	P %	Pb ppm	S %	Sr ppm	Ti ppm	V ppm	Zn ppm	pH
Gleby ogółem All soils n = 2491	a	<1	0.01	<5	<1	<0.5	<0.01	<0.5	<1	<1	<1	<0.01	<0.05	<0.01	<1	<2	<0.005	<3	<0.005	<1	1	<1	<1	1.9
	b	11	2.07	45	981	2.2	22.96	11.8	17	266	2771	5.75	5.50	2.90	2787	47	1.009	9232	1.195	434	657	90	1800	9.4
	c	<1	0.63	<5	66	<0.5	0.67	<0.5	4	13	14	1.45	0.06	0.19	409	13	0.083	20	0.043	25	77	16	57	6.1
	d	<1	0.46	<5	45	<0.5	0.36	<0.5	3	10	8	1.10	<0.05	0.14	272	9	0.066	12	0.028	16	66	13	44	6.0
	e	<1	0.56	<5	58	<0.5	0.47	<0.5	4	12	11	1.31	0.05	0.18	376	12	0.074	12	0.028	20	62	14	49	6.4
Gleby z delty Wisły Soils of Vistula river delta n = 1576	a	<1	0.01	<5	<1	<0.5	<0.01	<0.5	<1	<1	<1	<0.01	<0.05	<0.01	<1	<2	<0.005	<3	<0.005	<1	1	<1	<1	3.5
	b	11	2.07	42	981	2.2	10.16	11.8	13	48	2771	5.75	1.10	2.90	2787	47	0.825	634	0.815	286	657	90	1800	9.4
	c	<1	0.82	<5	87	0.5	0.75	<0.5	5	16	17	1.90	0.06	0.24	535	19	0.101	15	0.047	30	66	20	61	6.5
	d	<1	0.72	<5	74	<0.5	0.55	<0.5	5	15	13	1.70	0.05	0.22	473	17	0.090	13	0.037	24	59	18	54	6.4
	e	<1	0.78	<5	82	0.5	0.54	<0.5	5	16	14	1.87	0.06	0.24	509	18	0.093	13	0.033	24	56	19	57	6.6
Gleby z wysoczyzn (Pobrzeże Kaszubskie, Wysoczyzna Elbląska) Soils of uplands (Pobrzeże Kaszubskie, Wysoczyzna Elbląska) n = 774	a	<1	0.02	<5	1	<0.5	<0.01	<0.5	<1	<1	<1	0.03	<0.05	<0.01	3	<2	<0.005	<3	<0.005	1	15	<1	5	2.2
	b	8	1.72	45	624	2.1	22.96	9.0	17	266	261	4.62	5.50	1.43	2211	29	1.009	9232	1.195	434	504	47	1156	8.1
	c	<1	0.32	<5	35	<0.5	0.61	<0.5	2	9	9	0.76	0.07	0.10	221	5	0.058	32	0.038	18	107	10	55	5.8
	d	<1	0.27	<5	24	<0.5	0.23	<0.5	2	7	5	0.63	<0.05	0.08	156	4	0.047	12	0.021	10	93	9	36	5.6
	e	<1	0.28	<5	24	<0.5	0.26	<0.5	2	7	5	0.67	<0.05	0.09	181	4	0.052	11	0.018	11	95	9	33	6.1
Gleby z mierzei (Hel, Mierzeja Wiślana) Soils of spits (Hel, Mierzeja Wiślana) n = 141	a	<1	0.02	<5	1	<0.5	<0.01	<0.5	<1	<1	<1	0.03	<0.05	<0.01	<1	<2	<0.005	<3	<0.005	<1	11	<1	4	1.9
	b	<1	1.64	9.0	120	0.9	4.97	0.6	9	31	39	3.03	0.18	0.43	886	31	0.120	46	0.161	59	225	36	229	7.6
	c	<1	0.09	<5	9	<0.5	0.12	<0.5	<1	2	2	0.23	<0.05	0.03	38	<2	0.017	7	0.015	5	41	3	19	4.4
	d	<1	0.06	<5	5	<0.5	0.03	<0.5	<1	2	1	0.17	<0.05	0.02	12	<2	0.012	5	0.009	2	33	2	13	4.3
	e	<1	0.05	<5	4	<0.5	0.02	<0.5	<1	2	1	0.16	<0.05	0.02	9	<2	0.011	5	0.008	2	29	2	11	4.2
Gleby terenów bez zabudowy i z zabudową wiejską Soils of undevelopment areas and village development n = 2178	a	<1	0.01	<5	<1	<0.5	<0.01	<0.5	<1	<1	<1	<0.01	<0.05	<0.01	<1	<2	<0.005	<3	<0.005	<1	1	<1	<1	1.9
	b	1	2.07	42	351	2.2	22.96	7.6	17	48	2771	5.75	0.35	2.90	2655	47	0.648	294	1.195	434	657	50	1800	9.4
	c	<1	0.67	<5	68	<0.5	0.66	<0.5	4	14	13	1.54	0.06	0.20	439	14	0.085	13	0.044	25	73	17	51	6.1
	d	<1	0.50	<5	47	<0.5	0.35	<0.5	3	11	8	1.18	<0.05	0.14	297	10	0.068	11	0.029	16	63	13	42	6.0
	e	<1	0.63	<5	62	<0.5	0.46	<0.5	4	13	11	1.47	0.05	0.20	420	15	0.078	12	0.028	20	59	16	48	6.4
Gleby pól uprawnych Cultivated soils n = 1409	a	<1	0.01	<5	<1	<0.5	<0.01	<0.5	<1	<1	<1	<0.01	<0.05	<0.01	<1	<2	<0.005	<3	<0.005	<1	1	<1	<1	3.4
	b	1	2.07	41	268	1.6	17.90	6.1	12	48	2771	5.48	0.35	2.90	2655	47	0.365	294	0.815	434	459	50	1800	9.4
	c	<1	0.81	<5	82	0.5	0.66	<0.5	5	16	16	1.83	0.06	0.23	514	18	0.097	13	0.040	26	69	19	57	6.4
	d	<1	0.72	<5	68	<0.5	0.47	<0.5	5	15	12	1.63	<0.05	0.21	455	15	0.088	12	0.032	21	62	18	51	6.4
	e	<1	0.77	<5	77	0.5	0.50	<0.5	5	16	13	1.80	0.05	0.23	490	18	0.089	12	0.029	22	57	18	54	6.5
Gleby terenów podmiejskich Soils in suburban areas n = 133	a	<1	0.03	<5	<1	<0.5	0.01	<0.5	<1	<1	<1	0.03	<0.05	<0.01	4	<2	<0.005	<3	<0.005	1	17	1	7	2.2
	b	11	1.22	12	981	1.7	3.57	11.8	9	41	155	4.56	3.85	0.71	2787	29	0.242	1098	0.094	242	504	31	969	7.9
	c	<1	0.34	<5	51	<0.5	0.66	<0.5	2	9	12	0.81	0.11	0.19	214	7	0.058	34	0.025	22	97	10	76	6.3
	d	<1	0.26	<5	30	<0.5	0.35	<0.5	2	7	7	0.63	0.05	0.09	138	5	0.047	15	0.019	14	84	8	48	6.1
	e	<1	0.27	<5	27	<0.5	0.41	<0.5	2	7	7	0.68	<0.05	0.09	158	5	0.055	13	0.018	14	88	9	48	6.7
Gleby terenów o zabudowie miejskiej zwartej Soils in urban areas with compact development n = 146	a	<1	0.06	<5	3	<0.5	0.01	<0.5	<1	1	<1	0.07	<0.05	<0.01	10	<2	0.006	<3	<0.005	1	24	<1	13	3.0
	b	5	0.83	11	183	0.8	8.11	8.1	6	153	119	2.18	0.99	0.29	2005	15	0.263	214	0.113	65	330	22	541	8.1
	c	<1	0.29	<5	46	<0.5	0.82	<0.5	2	11	14	0.71	0.11	0.10	187	5	0.065	32	0.026	22	111	9	91	6.5
	d	<1	0.26	<5	36	<0.5	0.51	<0.5	2	8	10	0.63	0.07	0.08	147	5	0.056	23	0.022	17	102	8	69	6.5
	e	<1	0.27	<5	37	<0.5	0.66	<0.5	2	8	10	0.65	0.05	0.09	159	5	0.060	23	0.022	18	103	8	73	6.8
Gleby terenów o zabudowie przemysłowej Soils in industrial areas n = 34	a	<1	0.15	<5	10	<0.5	0.06	<0.5	<1	3	2	0.41	<0.05	0.04	63	2	0.022	7	0.009	3	31	4	18	4.5
	b	8	1.01	45	624	1.0	6.54	9.0	10	266	261	4.62	5.50	0.47	878	31	1.009	9232	0.494	378	381	90	1156	7.7
	c	<1	0.35	7	95	<0.5	1.25	0.9	4	21	43	1.25	0.30	0.14	261	11	0.122	356	0.065	54	124	17	215	6.6
	d	<1	0.32	<5	64	<0.5	0.81	<0.5	3	12	22	1.06	0.10	0.12	224	9	0.072	45	0.041	31	104	13	118	6.6
	e	<1	0.32	<5	61	<0.5	1.15	<0.5	3	10	18	1.01	0.09	0.13	203	9	0.064	25	0.038	32	113	11	98	6.9
Gleby lasów Forest soils n = 288	a	<1	0.02	<5	1	<0.5	<0.01	<0.5	<1	<1	<1	0.03	<0.05	<0.01	<1	<2	<0.005	<3	<0.005	<1	11	<1	4	1.9
	b	<1	1.26	11	115	0.9	4.97	3.1	10	25	43	2.67	0.35	0.43	1240	32	0.117	85	0.477	66	442	27	275	7.8
	c	<1	0.15	<5	11	<0.5	0.10	<0.5	<1	4	3	0.35	<0.05	0.04	81	2	0.023	9	0.015	4	71	5	20	4.2
	d	<1	0.11	<5	7	<0.5	0.03	<0.5	<1	3	1	0.26	<0.05	0.02	29	<2	0.017	7	0.010	3	53	4	14	4.1
	e	<1	0.11	<5	7	<0.5	0.03	<0.5	<1	3	1	0.28	<0.05	0.02	25	<2	0.016	8	0.010	2	61	4	13	4.0
Gleby łąk Meadow soils n = 361	a	<1	0.03	<5	1	<0.5	0.01	<0.5	<1	<1	<1	0.06	<0.05	<0.01	5	<2	0.008	<3	0.005	1	15	<1	7	3.0
	b	3	1.93	42	222	1.3	10.16	3.8	10	36	105	5.75	0.55	0.63	2211	43	0.648	50	1.195	286	657	49	367	7.8
	c	<1	0.59	<5	62	<0.5	0.87	<0.5	4	12	12	1.46	0.07	0.18	439	13	0.089	13	0.083	32	80	15	50	6.1
	d	<1	0.45	<5	47	<0.5	0.52	<0.5	3	10	9	1.16	0.05	0.14	334	9	0.074	11	0.048	21	69	13	43	6.0
	e	<1	0.48	<5	55	<0.5	0.54	<0.5	4	11	10	1.29	0.06	0.16	365	11	0.073	12	0.042	21	67	14	45	6.2
Gleby ugorów i nieużytków Fallow and barren land soils n = 252	a	<1	0.03	<5	2	<0.5	0.01	<0.5	<1	<1	<1	0.07	<0.05	<0.01	4	<2	0.006	<3	<0.005	1	15	<1	8	2.2
	b	11	1.44	45	981	2.1	22.96	11.8	17	98	261	4.80	3.85	0.63	2787	40	0.825	1098	0.494	378	413	84	156	8.1
	c	<1	0.39	<5	54	<0.5	0.94	0.5	3	10	15	1.03	0.09	0.14	294	9	0.073	31	0.034	28	95	12	72	6.5
	d	<1	0.32	<5	34	<0.5	0.46	<0.5	2	8	8	0.79	0.05	0.11	212	6	0.056	13	0.022	17	82	10	47	6.4
	e	<1	0.32	<5	32	<0.5	0.52	<0.5	2	8	8	0.78	<0.05	0.12	206	6	0.058	12	0.023	17	81	10	46	6.7
Gleby trawników i parków miejskich Lawn and city park soils n = 167	a	<1	0.05	<5	7	<0.5	0.03	<0.5	<1	1	<1	0.13	<0.05	0.01	6	<2	0.011	5	0.005	3	21	<1	13	2.4
	b	8	1.96	28	624	2.2	8.11	8.1	13	266	119	3.98	5.50	1.43	2005	41	1.009	9232	0.202	223	504	90	749	7.8
	c	<1	0.33	<5	59	<0.5	0.91	<0.5	2	12	16	0.82	0.14	0.12	218	7	0.078	90	0.033	27	118	11	105	6.6
	d	<1	0.29	<5	44	<0.5	0.61	<0.5	2	8	11	0.72	0.07	0.10	167	6	0.061	26	0.026	21	104	9	77	6.5
	e	<1	0.28	<5	45	<0.5	0.71	<0.5	2	8	12	0.74	0.06	0.10	170	6	0.061	23	0.025	22	107	9	76	6.8
Gleby ogródków działkowych Allotment soils n = 14	a	<1	0.16	<5	16	<0.5	0.12	<0.5	<1	5	3	0.54	<0.05	0.05	104	3	0.019	6	0.007	7	54	6	22	5.2
	b	<1	0.74	10	177	0.8	3.04	0.8	5	41	31	1.28	0.31	0.30	385	15	0.252	41	0.244	123	319	23	508	7.8
	c	<1	0.32	<5	66	<0.5	1.04	<0.5	2	10	13	0.78	0.07	0.12	200	7	0.078	20	0.061	39	112	11	117	6.6
	d	<1	0.30	<5	49	<0.5	0.73	<0.5	2	8	11	0.75	0.05	0.10	185	6	0.067	17	0.039	29	100	10	74	6.5
	e	<1	0.29	<5	48	<0.5	0.73	<0.5	3	8	13	0.73	<0.05	0.10	163	6	0.073	17	0.032	26	90	10	52	6.7
Gleby piaszczyste Sandy soils n = 1017	a	<1	0.02	<5	1	<0.5	<0.01	<0.5	<1	<1	<1	0.03	<0.05	<0.01	<1	<2	<0.005	<3	<0.005	<1	11	<1	4	2.1
	b	11	1.96	45	981	2.2	8.11	11.8	17	266	257	4.62	5.50	0.71	2110	41	1.009	9232	0.440	242	657	90	969	8.1
	c	<1	0.30	<5	35	<0.5	0.46	<0.5	2	8	8	0.72	0.07	0.10	211	6	0.053	27	0.025	15	84	9	49	5.7
	d	<1	0.23	<5	21	<0.5	0.18	<0.5	1	5	4	0.55	<0.05	0.07	119	4	0.040	10	0.018	9	68	7	31	5.6
	e	<1	0.27	<5	24	<0.5	0.22	<0.5	2	6	5	0.63	<0.05	0.08	175	4	0.048	9	0.018	10	71	8	31	6.2
Gleby gliniaste, gliny, mułki Loamy soils n = 1363	a	<1	0.01	<5	<1	<0.5	<0.01	<0.5	<1	<1	<1	<0.05	<0.05	<0.01	<1	<2	<0.005	<3	<0.005	<1	1	<1	<1	3.5
	b	1	2.07	25	268	1.4	22.96	6.1	12	48	2771	5.48	0.99	2.90	2787	47	0.825	294	0.815	286	413	84	1800	9.4
	c	<1	0.87	<5	89	0.5	0.74	<0.5	6	18	17	1.96	0.06	0.25	548	19	0.103	15	0.042	28	70	21	63	6.4
	d	<1	0.80	<5	77	<0.5	0.55	<0.5	5	16	13	1.80	0.05	0.24	494	17	0.093	13	0.035	24	63	19	57	6.4
	e	<1	0.83	5	86	0.6	0.54	<0.5	6	17	14	1.94	0.06	0.25	523	19	0.095	13	0.032	24	59	19	59	6.5
Gleby torfiaste Peaty soils n = 111	a	<1	0.07	<5	5	<0.5	0.03	<0.5	<1	1	<1	0.07	<0.05	<0.01	3	<2	0.013	<3	0.030	2	24	<1	7	1.9
	b	<1	1.73	42	351	2.1	17.90	9.0	10	87	261	5.75	0.71	0.41	2211	33	0.648	570	1.195	434	281	47	1156	7.4
	c	<1	0.59	8	79	<0.5	1.76	<0.5	3	13	15	1.82	0.09	0.17	525	12	0.117	21	0.214	66	96	18	56	5.8
	d	<1	0.41	6	55	<0.5	1.17	<0.5	2	9	10	1.37	0.07	0.12	349	7	0.095	15	0.170	45	83	14	40	5.7
	e	<1	0.46	6	62	<0.5	1.33	<0.5	3	11	12	1.62	0.08	0.17	444	10	0.101	15	0.161	52	88	16	42	5.9
Gleby Polski[1)] Soils of Poland n = 10 840	a	<1		<5	<1		<0.01	<0.5	<1	<1	<1	<0.01	<0.05	<0.01	<1	<1	<0.005	<3	<0.005	<1	1	<1	<1	2.1
	b	41		3444	1777		25.45	253.3	46	1873	6401	9.57	7.55	4.90	24 270	146	1.613	16 972	3.263	1298	1542	266	91 110	9.7
	c	<1		<5	48		0.47	0.8	3	6	10	0.67	0.06	0.10	267	6	0.042	35	0.017	17	34	8	88	6.0
	d	<1		<5	32		0.17	<0.5	2	4	5	0.50	<0.05	0.06	173	4	0.033	16	0.012	8	26	6	40	5.9
	e	<1		<5	32		0.18	<0.5	2	4	5	0.51	<0.05	0.06	217	4	0.034	13	0.012	8	26	7	35	6.1

a – minimum; b – maksimum; c – średnia arytmetyczna; d – średnia geometryczna; e – mediana; n – liczba próbek;
minimum; maximum; arithmetic mean; geometric mean; median; number of samples

[1)] rozkład w HCl 1:4 (J. Lis, A. Pasieczna, 1995)

Tabela IV
Table

Parametry statystyczne pierwiastków chemicznych w osadach wodnych Pobrzeża Gdańskiego
Statistical parameters of chemical elements in water sediments of Gdańsk Region

Osady wodne Water sediments	Parametry Parameters	Ag ppm	Al %	As ppm	Ba ppm	Be ppm	Ca %	Cd ppm	Co ppm	Cr ppm	Cu ppm	Fe %	Hg ppm	Mg %	Mn ppm	Ni ppm	P %	Pb ppm	S %	Sr ppm	Ti ppm	V ppm	Zn ppm
Osady wodne ogółem	a	<1	<0.01	<5	4	<0.5	0.02	<0,5	<1	<1	<1	0.05	<0.05	<0.01	5	1	0.007	<5	<0.005	2	6	<1	6
All water sediments	b	16	3.33	105	1228	11.1	20.49	24,9	278	314	3483	27.50	8.60	2.23	16 406	99	4.318	5607	8.617	935	1907	563	14 700
n = 2090	c	<1	0.65	<5	97	<0.5	0.95	<0,5	4	14	16	2.07	0.09	0.20	477	14	0.156	19	0.284	37	98	16	82
	d	<1	0.51	<5	66	<0.5	0.62	<0,5	3	11	10	1.46	0.06	0.17	291	10	0.095	11	0.118	26	88	13	55
	e	<1	0.59	<5	75	<0.5	0.60	<0,5	4	12	11	1.56	0.05	0.19	307	13	0.090	11	0.108	27	85	14	56
Małe cieki bez nazwy	a	<1	<0.01	<5	4	<0.5	0.02	<0.5	<1	<1	<1	0.06	<0.05	0.01	5	1	0.009	<5	0.006	2	6	<1	6
Small streams	b	16	3.19	105	1228	11.1	20.49	24.9	32	121	245	27.50	8.60	0.70	16 406	99	4.318	276	8.617	935	718	60	1327
(unnamed)	c	<1	0.72	<5	110	<0.5	0.94	<0.5	5	15	15	2.39	0.09	0.21	488	16	0.183	15	0.336	40	92	17	75
n = 1392	d	<1	0.59	<5	80	<0.5	0.63	<0.5	4	12	11	1.76	0.06	0.18	321	12	0.113	11	0.141	29	84	15	58
	e	<1	0.68	<5	91	<0.5	0.59	<0.5	5	14	12	1.90	0.06	0.21	340	15	0.107	12	0.132	29	81	16	58
Małe jeziora i sadzawki	a	<1	0.04	<5	4	<0.5	0.03	<0.5	<1	<1	<1	0.05	<0.05	<0.01	10	1	0.007	<5	<0.005	2	29	<1	8
bez nazwy	b	3	1.82	57	507	1.5	9.61	4.2	37	33	207	6.43	0.91	1.02	1641	55	1.500	139	1.977	290	534	53	14 700
Small lakes and pools	c	<1	0.45	<5	48	<0.5	0.75	<0.5	3	10	12	0.99	0.07	0.14	189	8	0.071	17	0.143	25	123	12	147
(unnamed)	d	<1	0.35	<5	33	<0.5	0.36	<0.5	2	8	7	0.72	<0.05	0.10	112	6	0.048	11	0.068	15	108	10	46
n = 181	e	<1	0.36	<5	33	<0.5	0.35	<0.5	2	10	7	0.76	<0.05	0.11	121	6	0.049	10	0.060	14	108	10	42
	a	<1	0.07	<5	4	<0.5	0.10	<0.5	<1	1	<1	0.17	<0.05	0.03	38	1	0.010	<5	0.013	4	23	1	9
Kanały	b	2	1.79	14	351	1.1	7.86	3.2	14	84	54	5.93	1.34	0.68	5898	38	0.533	463	1.699	220	475	40	505
Canals	c	<1	0.63	<5	94	<0.5	1.14	<0.5	5	14	12	1.90	0.08	0.21	623	15	0.131	18	0.236	40	96	15	69
n = 104	d	<1	0.51	<5	69	<0.5	0.80	<0.5	4	12	9	1.51	0.05	0.18	372	11	0.104	11	0.131	31	87	13	57
	e	<1	0.61	<5	79	<05	0.85	<0.5	5	14	11	1.71	0.05	0.22	405	14	0.107	12	0.102	31	84	14	60
	a	<1	0.09	<5	6	<0.5	0.06	<0.5	<1	3	<1	0.21	<0.05	0.03	25	11	0.015	<5	0.013	3	70	3	11
Jeziora	b	<1	0.68	6	88	0.9	6.20	0.7	7	16	63	1.43	0.27	0.34	470	19	0.203	76	1.435	136	255	19	141
Lakes	c	<1	0.31	<5	32	<0.5	1.22	<0.5	2	8	10	0.72	0.07	0.14	147	6	0.059	18	0.204	35	147	11	52
n = 20	d	<1	0.25	<5	24	<0.5	0.60	<0.5	1	7	5	0.62	<0.05	0.11	102	4	0.046	11	0.071	19	136	9	41
	e	<1	0.27	<5	25	<0.5	0.65	<0.5	2	7	4	0.67	<0.05	0.12	93	4	0.046	10	0.064	25	129	10	41
Fiszewka	a	<1	0.16	<5	15	<0.5	0.30	<0.5	<1	4	2	0.42	<0.05	0.06	126	2	0.022	<5	<0.020	8	58	5	16
The Fiszewka river	b	<1	0.96	7	223	0.6	2.98	0.7	8	17	280	3.24	0.23	0.34	3107	22	0.236	132	0.527	90	162	23	480
n = 11	c	<1	0.46	<5	85	<0.5	1.17	<0.5	4	10	35	1.38	0.05	0.18	755	11	0.083	22	0.213	33	99	11	82
	d	<1	0.40	<5	62	<0.5	0.87	<0.5	2	9	11	1.16	<0.05	0.16	486	8	0.068	12	0.150	25	95	10	48
	e	<1	0.38	<5	56	<0.5	0.69	<0.5	4	9	9	1.15	<0.05	0.18	401	10	0.052	12	0.212	19	96	10	38
	a	<1	0.21	<5	54	<0.5	0.28	<0.5	2	5	4	1.04	<0.05	0.11	273	6	0.039	6	0.037	12	50	7	32
Kanał Panieński	b	<1	1.21	14	167	0.7	2.26	3.2	9	24	26	4.89	0.15	0.35	1742	32	0.259	30	0.731	67	122	28	217
The Panieński Canal	c	<1	0.70	<5	96	<0.5	0.81	0.6	6	14	13	2.19	0.07	0.24	643	18	0.134	13	0.140	31	80	16	75
n = 14	d	<1	0.63	<5	89	<0.5	0.72	<0.5	5	13	12	1.99	0.05	0.22	557	16	0.117	11	0.096	29	78	15	65
	e	<1	0.69	<5	85	<0.5	0.75	<0.5	5	14	12	2.03	0.06	0.24	519	16	0.111	11	0.079	29	79	15	59
	a	<1	0.24	<5	20	<0.5	0.19	<0.5	1	5	3	0.63	<0.05	0.08	161	5	0.032	<5	0.023	8	49	6	17
Linawa	b	<1	1.75	10	286	1.0	2.48	0.7	9	31	29	6.16	0.13	0.85	1091	33	0.335	48	0.477	64	379	37	107
The Linawa river	c	<1	0.84	<5	130	0.5	0.79	<0.5	6	16	14	2.57	0.05	0.29	544	20	0.148	12	0.155	32	98	20	57
n = 18	d	<1	0.71	<5	98	<0.5	0.62	<0.5	5	14	11	2.04	<0.05	0.25	447	17	0.118	9	0.119	28	82	17	51
	e	<1	0.86	<5	125	0.6	0.66	<0.5	8	17	16	2.70	0.05	0.26	480	24	0.142	11	0.153	33	73	21	60
	a	<1	0.15	<5	21	<0.5	0.43	<0.5	1	4	5	0.49	<0.05	0.07	110	3	0.036	6	0.025	12	58	6	26
Motława	b	<1	1.30	9	142	0.8	4.29	1.2	8	24	119	3.26	0.65	0.40	1092	26	0.334	177	0.964	20	224	30	298
The Motława river	c	<1	0.58	<5	74	<0.5	1.57	<0.5	4	12	18	1.52	0.11	0.22	485	12	0.117	35	0.207	48	125	15	91
n = 29	d	<1	0.50	<5	65	<0.5	1.30	<0.5	4	11	14	1.33	0.08	0.20	397	10	0.100	21	0.119	41	118	14	73
	e	<1	0.51	<5	68	<0.5	1.23	<0.5	5	11	13	1.29	0.08	0.20	350	12	0.083	18	0.081	43	107	14	61
	a	<1	0.11	<5	13	<0.5	0.18	<0.5	<1	4	2	0.21	<0.05	0.05	30	2	0.013	<5	0.016	5	34	3	19
Nogat	b	<1	0.84	12	212	1.5	4.91	1.1	6	36	132	2.14	0.57	0.33	1319	33	0.250	565	1.042	115	171	23	403
The Nogat river	c	<1	0.35	<5	51	<0.5	0.96	<0.5	3	12	14	0.84	0.13	0.14	226	10	0.056	26	0.150	26	87	9	69
n = 41	d	<1	0.30	<5	37	<0.5	0.74	<0.5	3	10	9	0.72	0.09	0.13	150	8	0.045	10	0.090	21	81	8	52
	e	<1	0.30	<5	35	<0.5	0.75	<0.5	2	10	7	0.67	0.09	0.11	135	7	0.045	9	0.073	21	86	8	45
	a	<1	0.15	<5	20	<0.5	0.61	<0.5	<1	4	3	0.54	<0.05	0.08	92	2	0.036	5	0.014	10	77	4	24
Radunia	b	3	0.99	10	95	<0.5	2.21	1.1	4	14	28	1.56	1.28	0.24	4631	8	0.196	128	1.079	39	223	14	301
The Radunia river	c	<1	0.40	<5	40	<0.5	1.11	<0.5	2	8	9	0.85	0.13	0.15	560	5	0.081	22	0.130	23	141	10	73
n = 23	d	<1	0.36	<5	37	<0.5	1.06	<0.5	2	8	7	0.82	0.06	0.14	362	5	0.073	15	0.064	22	138	9	57
	e	<1	0.39	<5	38	<0.5	0.99	<0.5	2	7	7	0.88	<0.05	0.14	337	5	0.076	11	0.052	22	140	10	45
	a	<1	0.22	<5	21	<0.5	0.39	<0.5	1	5	2	0.39	<0.05	0.08	97	5	0.023	<5	0.026	12	62	5	19
Stary Nogat	b	<1	1.20	8	147	0.7	4.46	<0.5	11	23	56	3.90	1.10	0.45	1124	30	0.476	28	1.757	70	150	26	105
The Stary Nogat river	c	<1	0.53	<5	61	<0.5	1.33	<0.5	4	11	12	1.46	0.13	0.20	450	12	0.088	11	0.357	30	86	12	47
n = 17	d	<1	0.45	<5	53	<0.5	1.05	<0.5	3	9	8	1.22	0.06	0.17	364	10	0.064	9	0.210	27	84	10	43
	e	<1	0.33	<5	61	<0.5	1.13	<0.5	3	7	8	1.38	0.05	0.16	405	9	0.057	9	0.180	28	83	7	43
	a	<1	0.09	<5	19	<0.5	0.12	<0.5	<1	2	<1	0.38	<0.05	0.03	104	3	0.019	<5	0.013	5	40	4	21
Szkarpawa	b	<1	0.78	21	307	0.5	3.98	0.6	8	16	20	5.64	0.16	0.29	8838	20	0.195	35	1.033	78	107	24	83
The Szkarpawa river	c	<1	0.35	5	64	<0.5	0.83	<0.5	3	8	7	1.29	<0.05	0.13	1089	9	0.049	11	0.222	22	75	9	42
n = 15	d	<1	0.29	<5	45	<0.5	0.51	<0.5	3	7	5	0.95	<0.05	0.11	408	8	0.040	8	0.116	17	71	8	38
	e	<1	0.27	<5	40	<0.5	0.51	<0.5	3	7	5	0.86	<0.05	0.11	372	8	0.037	9	0.098	14	74	9	40
	a	<1	0.17	<5	14	<0.5	0.25	<0.5	1	3	4	0.69	<0.05	0.05	159	4	0.056	<5	0.022	19	42	5	20
Święta	b	<1	1.32	8	464	1.1	2.97	2.9	8	23	192	12.17	0.84	0.33	5964	34	0.687	89	4.886	149	287	27	577
The Święta river	c	<1	0.77	5	180	0.5	1.00	0.5	5	15	20	3.41	0.12	0.22	1287	17	0.242	17	0.355	59	83	18	95
n = 30	d	<1	0.71	<5	149	<0.5	0.79	<0.5	5	13	14	2.72	0.08	0.20	797	16	0.189	12	0.143	50	75	17	69
	e	<1	0.74	<5	150	0.5	0.71	<0.5	5	14	14	2.68	0.07	0.20	706	17	0.153	12	0.147	44	71	17	60
	a	<1	0.32	<5	22	<0.5	0.57	<0.5	2	8	4	0.74	<0.05	0.21	151	5	0.051	6	0.030	26	72	9	23
Tina	b	<1	1.59	9	309	1.1	2.75	0.6	11	28	72	4.68	0.43	0.45	2255	32	0.676	55	0.826	115	218	39	157
The Tina river	c	<1	0.91	<5	144	0.6	1.44	<0.5	6	18	21	2.46	0.15	0.29	906	20	0.195	18	0.254	60	112	22	72
n = 13	d	<1	0.85	<5	122	<0.5	1.32	<0.5	6	17	17	2.27	0.11	0.29	676	18	0.155	16	0.173	55	107	21	66
	e	<1	0.84	<5	127	0.6	1.45	<0.5	6	17	16	2.23	0.12	0.26	739	19	0.135	15	0.206	53	101	21	69
	a	<1	0.16	<5	18	<0.5	0.19	<0.5	<1	3	3	0.33	<0.05	0.06	57	4	0.017	<5	0.024	10	45	3	16
Tuga	b	<1	0.97	6	178	0.9	4.24	2.7	6	24	47	4.56	0.29	0.37	4828	21	0.379	54	1.045	127	118	50	487
The Tuga river	c	<1	0.46	<5	73	<0.5	1.10	0.5	4	9	11	1.43	0.07	0.16	789	11	0.089	15	0.262	34	70	13	95
n = 14	d	<1	0.42	<5	57	<0.5	0.79	<0.5	3	8	8	1.14	0.05	0.14	399	10	0.058	11	0.154	26	68	10	51
	e	<1	0.43	<5	60	<0.5	0.87	<0.5	4	9	7	1.13	<0.05	0.14	305	11	0.048	8	0.148	26	68	10	36
	a	<1	0.10	<5	6	<0.5	0.11	<0.5	<1	3	<1	0.27	<0.05	0.05	46	2	0.015	<5	0.006	4	27	<1	19
Wisła	b	<1	0.88	8	92	0.5	1.15	1.8	8	26	23	1.92	0.42	0.31	1098	22	1.116	208	0.093	31	105	19	367
The Vistula river	c	<1	0.35	<5	35	<0.5	0.47	<0.5	3	10	8	0.81	0.09	0.15	344	10	0.049	18	0.033	14	68	8	88
n= 36	d	<1	0.30	<5	29	<0.5	0.41	<0.5	3	9	6	0.73	0.07	0.13	266	8	0.043	11	0.028	13	65	7	76
	e	<1	0.29	<5	31	<0.5	0.41	<0.5	3	10	8	0.74	0.06	0.14	267	9	0.042	10	0.028	14	65	7	75
Martwa Wisła +	a	<1	0.07	<5	5	<0.5	0.05	<0.5	<1	2	<1	0.20	<0.05	0.03	39	1	0.017	<5	0.006	4	39	2	12
Wisła Śmiała	b	4	3.33	73	373	2.1	7.59	2.9	278	314	3483	7.24	0.61	2.23	1679	66	0.873	5607	0.340	251	1907	563	4010
The Martwa Wisła +	c	<1	0.38	7	75	<0.5	0.77	0.5	17	24	209	1.26	0.11	0.22	241	9	0.096	343	0.079	38	188	39	292
Wisła Śmiała river	d	<1	0.20	<5	32	<0.5	0.30	<0.5	2	7	9	0.71	0.06	0.11	134	5	0.046	19	0.039	17	97	8	59
n = 18	e	<1	0.19	<5	30	<0.5	0.28	<0.5	2	7	11	0.65	<0.05	0.10	113	5	0.034	14	0.036	13	86	7	40
Osady wodne Polski[1]	a	<1		<5	<1	<0.5	<0.01	<0.5	<1	<1	<1	<0.01	<0.05	<0.01	<1	<1	<0.005	<5	<0.005	<1	<1	<1	<1
Water sediments	b	117		6215	1794	21.0	43.15	8736.0	357	12 251	15 460	31.14	11.00	10.62	63 719	1298	5.886	43 878	8.610	7628	5354	427	407 501
of Poland[1]	c	<1		7	80	<0.5	1.67	2.8	4	18	21	1.18	0.12	0.17	506	11	0.102	68	0.113	40	42	9	247
n = 12 778	d	<1		<5	52	<0.5	0.84	0.6	3	6	8	0.75	<0.05	0.11	255	6	0.064	15	0.047	21	31	7	73
	e	<1		<5	54	<0.5	0.86	<0.5	3	5	7	0.80	0.05	0.11	274	6	0.059	13	0.040	20	30	7	62

a – minimum; minimum b – maksimum; maximum c – średnia arytmetyczna; arithmetic mean d – średnia geometryczna; geometric mean e – mediana; median n – liczba próbek; number of samples

[1] rozkład w HCl 1:4 (J. Lis, A. Pasieczna, 1995)

Tabela V
Table

Parametry statystyczne pierwiastków chemicznych, kwasowości i przewodności elektrycznej wód powierzchniowych Pobrzeża Gdańskiego
Statistical parameters of chemical elements, acidity and conductivity in surface waters of Gdańsk Region

Wody powierzchniowe Surface waters	Parametry Parameters	Al mg/dm³	As mg/dm³	B mg/dm³	Ba μg/dm³	Ca mg/dm³	Cd μg/dm³	Co μg/dm³	Cr μg/dm³	Cu μg/dm³	Fe mg/dm³	K mg/dm³	Li μg/dm³	Mg mg/dm³	Mn μg/dm³	Na mg/dm³	Ni μg/dm³	P mg/dm³	SiO_2 mg/dm³	Sr μg/dm³	Ti μg/dm³	Zn μg/dm³	pH	Przewodność Conductivity mS/m
Wody powierzchniowe ogółem	a	<0.05	<0.05	<0.03	3	1.3	<3	<5	<4	<5	<0.01	<0.5	<1	0.4	<1	1.2	<10	<0.1	<0.1	5	<5	<5	2.6	0.02
All surface waters	b	61.30	0.29	2.80	1006	642.1	18	365	230	275	408.67	1370.0	284	236.0	46 635	1893.0	940	35.8	84.0	3929	1310	5306	9.8	7.98
n = 1805	c	0.11	<0.05	0.20	73	96.1	<3	<5	<4	<5	3.15	16.8	13	19.8	1077	80.5	<10	1.0	16.3	421	<5	19	7.4	0.93
	d	<0.05	<0.05	0.13	54	83.8	<3	<5	<4	<5	0.29	8.0	10	14.6	291	35.2	<10	0.2	12.5	349	<5	<5	7.4	0.72
	e	<0.05	<0.05	0.14	56	86.7	<3	<5	<4	<5	0.19	7.1	11	14.5	282	32.4	<10	0.2	15.1	382	<5	<5	7.5	0.69
Małe cieki bez nazwy	a	<0.05	<0.05	<0.03	3	2.1	<3	<5	<4	<5	<0.01	<0.5	<1	0.4	2	1.3	<10	<0.1	0.3	9	<5	<5	2.6	0.06
Small streams (unnamed)	b	61.30	0.29	2.80	1006	642.1	18	365	230	275	408.67	1370.0	284	156.5	46 635	1339.0	940	35.8	84.0	3929	1310	5306	9.8	6.66
n = 1110	c	0.16	<0.05	0.22	84	107.2	<3	<5	<4	<5	4.49	19.9	15	20.2	1417	77.5	<10	1.3	18.6	462	<5	23	7.3	0.96
	d	<0.05	<0.05	0.15	64	94.4	<3	<5	<4	<5	0.53	8.8	12	16.2	477	38.5	<10	0.3	15.3	396	<5	5	7.3	0.80
	e	<0.05	<0.05	0.15	65	94.1	<3	<5	<4	<5	0.36	7.7	12	15.9	614	34.5	<10	0.2	17.6	407	<5	<5	7.4	0.74
Małe jeziora i sadzawki bez nazwy	a	<0.05	<0.05	<0.03	3	1.3	<3	<5	<4	<5	<0.01	<0.5	<1	0.4	5	1.2	<10	<0.1	<0.1	5	<5	<5	4.6	0.02
Small lakes and pools (unnamed)	b	1.30	0.06	0.92	378	230.8	4	12	5	13	72.98	155.0	43	106.5	7963	905.0	34	7.9	57.9	816	13	1334	9.7	4.95
n = 179	c	0.06	<0.05	0.12	52	56.1	<3	<5	<4	<5	1.43	16.0	7	10.9	354	34.9	<10	0.6	8.2	208	<5	31	7.4	0.51
	d	<0.05	<0.05	0.06	37	42.5	<3	<5	<4	<5	0.19	7.4	4	7.2	93	15.8	<10	0.2	4.1	152	<5	8	7.4	0.38
	e	<0.05	<0.05	0.07	40	53.1	<3	<5	<4	<5	0.16	7.5	5	8.4	85	16.9	<10	0.1	4.9	188	<5	6	7.5	0.43
Kanały	a	<0.05	<0.05	<0.03	3	28.9	<3	<5	<4	<5	<0.01	1.0	3	4.1	<1	6.5	<10	<0.1	1.3	77	<5	<5	6.5	0.27
Canals	b	0.26	<0.05	1.81	258	176.2	<3	14	12	6	73.64	190.0	62	236.0	8113	1893.0	<10	7.6	49.9	1388	<5	36	8.2	7.44
n = 102	c	<0.05	<0.05	0.27	67	90.6	<3	<5	<4	<5	1.19	14.2	15	26.2	971	153.6	<10	1.2	17.9	462	<5	5	7.5	1.22
	d	<0.05	<0.05	0.19	52	87.4	<3	<5	<4	<5	0.15	9.3	13	18.0	274	63.8	<10	0.4	15.8	417	<5	<5	7.5	0.91
	e	<0.05	<0.05	0.23	57	86.9	<3	<5	<4	<5	0.12	8.4	14	14.8	226	59.8	<10	0.3	15.8	404	<5	<5	7.5	0.77
Jeziora	a	<0.05	<0.05	<0.03	13	14.1	<3	<5	<4	<5	0.01	0.7	<1	2.2	8	5.2	<10	<0.1	0.1	44	<5	<5	6.7	0.13
Lakes	b	<0.05	<0.05	0.57	83	155.1	<3	<5	<4	<5	13.60	31.9	26	79.6	1825	639.0	<10	0.6	35.9	665	<5	22	8.9	3.86
n = 20	c	<0.05	<0.05	0.12	36	60.8	<3	<5	<4	<5	0.79	5.5	6	14.1	165	69.5	<10	0.2	8.2	249	<5	7	7.7	0.69
	d	<0.05	<0.05	0.08	30	54.2	<3	<5	<4	<5	0.06	4.1	4	9.5	47	27.2	<10	0.1	4.3	196	<5	<5	7.7	0.51
	e	<0.05	<0.05	0.07	27	58.2	<3	<5	<4	<5	0.04	3.8	5	7.5	40	31.2	<10	0.1	6.0	187	<5	<5	7.8	0.51
Fiszewka	a	<.05	<0.05	0.14	38	85.3	<3	<5	<4	<5	0.02	6.4	8	15.0	48	26.5	<10	<0.1	1.8	371	<5	<5	7.6	0.62
The Fiszewka river	b	007	<0.05	0.21	83	111.1	<3	<5	<4	<5	0.18	10.7	16	19.6	448	39.8	<10	0.2	7.8	467	<5	16	8.2	0.83
n = 11	c	<.05	<0.05	0.16	58	98.4	<3	<5	<4	<5	0.08	8.6	13	17.8	182	32.6	<10	<0.1	4.8	432	<5	<5	7.9	0.72
	d	<0.05	<0.05	0.16	57	97.8	<3	<5	<4	<5	0.07	8.5	12	17.7	157	32.2	<10	<0.1	4.4	431	<5	<5	7.9	0.72
	e	<0.05	<0.05	0.16	56	106.2	<3	<5	<4	<5	0.08	8.5	12	19.0	166	35.2	<10	<0.1	4.5	446	<5	<5	7.9	0.77
Kanał Panieński	a	<0.05	<0.05	0.10	30	61.0	<3	<5	<4	<5	0.03	3.5	10	9.7	47	33.8	<10	<0.1	9.9	298	<5	<5	7.2	0.52
The Panieński canal	b	<0.05	<0.05	0.43	94	85.0	<3	<5	<4	<5	0.58	16.3	18	16.7	1842	82.1	<10	0.9	22.6	399	<5	36	7.7	0.93
n = 14	c	<0.05	<0.05	0.26	63	74.0	<3	<5	<4	<5	0.23	7.3	14	14.1	416	63.3	<10	0.4	13.9	362	<5	6	7.4	0.71
	d	<0.05	<0.05	0.25	59	73.7	<3	<5	<4	<5	0.19	6.8	13	13.9	241	61.7	<10	0.2	13.5	360	<5	<5	7.4	0.70
	e	<0.05	<0.05	0.26	74	74.8	<3	<5	<4	<5	0.23	7.7	14	14.7	230	66.1	<10	0.4	13.5	365	<5	<5	7.4	0.71
Linawa	a	<0.05	<0.05	0.10	60	59.1	<3	<5	<4	<5	0.02	1.0	11	12.6	40	16.5	<10	<0.1	12.0	325	<5	<5	6.7	0.59
The Linawa river	b	<0.08	<0.05	0.34	183	111.4	<3	<5	<4	<5	13.59	8.9	21	21.8	2845	71.7	<10	1.4	29.5	550	<5	14	7.8	0.91
n = 18	c	<0.05	<0.05	0.27	96	96.7	<3	<5	<4	<5	3.01	4.9	16	16.7	1118	54.8	<10	0.3	20.1	470	<5	<5	7.3	0.77
	d	<0.05	<0.05	0.25	90	95.8	<3	<5	<4	<5	0.38	4.1	16	16.5	585	52.7	<10	0.1	19.2	465	<5	<5	7.3	0.77
	e	<0.05	<0.05	0.29	83	99.9	<3	<5	<4	<5	0.19	5.2	17	16.0	626	56.1	<10	0.1	20.8	476	<5	<5	7.3	0.78
Motława	a	<0.05	<0.05	0.04	10	30.8	<3	<5	<4	<5	<0.01	4.4	7	3.5	28	7.1	<10	<0.1	5.6	103	<5	<5	6.7	0.26
The Motława river	b	<0.18	<0.05	0.38	270	162.3	4	10	<4	17	3.94	58.3	21	35.6	4122	191.0	<10	3.0	34.4	626	<5	23	8.0	1.43
n = 29	c	<0.05	<0.05	0.20	49	100.7	<3	<5	<4	<5	0.32	10.5	14	15.1	390	41.4	<10	0.5	14.8	415	<5	5	7.6	0.69
	d	<0.05	<0.05	0.17	39	95.0	<3	<5	<4	<5	0.10	8.7	13	14.0	146	33.8	<10	0.2	13.5	384	<5	<5	7.6	0.65
	e	<0.05	<0.05	0.18	42	96.3	<3	<5	<4	<5	0.11	7.7	13	14.0	124	31.7	<10	0.2	14.9	388	<5	<5	7.7	0.62
Nogat	a	<0.05	<0.05	<0.03	32	39.2	<3	<5	<4	<5	0.02	3.7	7	9.6	17	12.8	<10	<0.1	0.3	285	<5	<5	7.0	0.29
The Nogat river	b	<0.06	<0.05	0.21	84	90.0	<3	<5	<4	<5	1.85	11.8	15	34.9	328	235.0	<10	0.5	20.5	475	<5	18	8.3	1.66
n = 41	c	<0.05	<0.05	0.12	44	72.1	<3	<5	<4	<5	0.14	5.2	9	12.7	131	40.7	<10	0.2	11.1	337	<5	<5	7.5	0.58
	d	<0.05	<0.05	0.11	43	71.6	<3	<5	<4	<5	0.08	5.0	9	12.1	103	32.3	<10	0.1	9.9	335	<5	<5	7.5	0.55
	e	<0.05	<0.05	0.12	42	73.7	<3	<5	<4	<5	0.07	4.7	9	11.4	109	27.4	<10	0.1	11.5	323	<5	<5	7.5	0.53
Radunia	a	<0.05	<0.05	<0.03	15	55.1	<3	<5	<4	<5	0.01	2.7	3	7.3	25	7.3	<10	<0.1	5.9	130	<5	<5	7.4	0.30
The Radunia river	b	<0.12	<0.05	0.12	54	131.2	<3	6	<4	<5	0.20	11.8	6	12.1	201	36.0	<10	0.3	15.3	304	<5	17	7.9	0.71
n = 23	c	<0.05	<0.05	0.04	21	62.0	<3	<5	<4	<5	0.05	3.4	4	7.9	77	9.1	<10	0.1	7.4	149	<5	5	7.7	0.36
	d	<0.05	<0.05	0.03	20	60.9	<3	<5	<4	<5	0.04	3.2	4	7.9	66	8.4	<10	0.1	7.3	146	<5	<5	7.7	0.36
	e	<0.05	<0.05	0.04	18	58.5	<3	<5	<4	<5	0.03	3.0	4	7.8	66	7.6	<10	0.1	7.5	140	<5	<5	7.6	0.37
Stary Nogat	a	<0.05	<0.05	<0.03	28	64.2	<3	<5	<4	<5	<0.01	2.3	5	8.7	9	6.3	<10	<0.1	0.1	202	<5	<5	6.8	0.24
The Stary Nogat river	b	<0.29	<0.05	0.30	381	188.4	<3	<5	<4	<5	42.78	29.0	13	25.7	10158	74.0	<10	5.9	39.2	662	<5	16	8.3	1.02
n = 17	c	<0.05	<0.05	0.09	99	108.4	<3	<5	<4	<5	5.52	10.0	8	19.7	1393	26.2	<10	0.7	14.9	446	<5	5	7.6	0.71
	d	<0.05	<0.05	0.07	75	104.5	<3	<5	<4	<5	0.13	7.3	7	18.9	233	22.8	<10	0.2	7.4	429	<5	<5	7.6	0.68
	e	<0.05	<0.05	0.08	69	103.6	<3	<5	<4	<5	0.05	8.3	7	21.3	183	25.9	<10	<0.1	14.4	501	<5	<5	7.6	0.76
Szkarpawa	a	<0.05	<0.05	0.07	51	57.2	<3	<5	<4	<5	0.03	4.3	7	10.7	90	29.9	<10	<0.1	8.3	278	<5	<5	7.2	0.51
The Szkarpawa river	b	<0.05	<0.05	0.21	84	87.0	<3	<5	<4	<5	0.11	10.5	14	27.9	484	175.0	<10	0.7	14.4	412	<5	6	7.8	1.36
n = 15	c	<0.05	<0.05	0.12	63	65.7	<3	<5	<4	<5	0.06	6.0	10	14.1	289	59.6	<10	0.2	12.1	331	<5	<5	7.4	0.69
	d	<0.05	<0.05	0.11	62	65.2	<3	<5	<4	<5	0.06	5.8	10	13.5	260	50.8	<10	0.1	12.0	328	<5	<5	7.4	0.66
	e	<0.05	<0.05	0.09	59	61.7	<3	<5	<4	<5	0.05	5.3	9	11.6	323	40.7	<10	0.1	12.1	330	<5	<5	7.4	0.63
Święta	a	<0.05	<0.05	0.06	41	32.7	<3	<5	<4	<5	0.03	1.1	3	4.9	12	10.8	<10	<0.1	13.2	119	<5	<5	6.4	0.30
The Święta river	b	0.05	<0.05	0.40	263	126.4	<3	<5	<4	<5	12.56	126.0	36	15.6	6811	97.9	<10	2.1	29.6	755	<5	15	7.9	0.94
n = 31	c	<0.05	<0.05	0.26	113	75.9	<3	<5	<4	<5	1.74	14.6	19	12.4	1877	54.8	<10	0.3	21.3	520	<5	<5	7.5	0.69
	d	<0.05	<0.05	0.23	102	74.0	<3	<5	<4	<5	0.41	9.7	17	12.3	910	47.3	<10	0.2	20.7	495	<5	<5	7.5	0.67
	e	<0.05	<0.05	0.30	89	74.4	<3	<5	<4	<5	0.35	10.1	20	12.6	1322	59.7	<10	0.1	21.4	536	<5	<5	7.4	0.72

C.d. Tabeli V na str. 8
Continued Table V on the page 8

C.d. Tabeli V
Continued Table V

Wody powierzchniowe Surface waters	Parametry Parameters	Al mg/dm³	As mg/dm³	B mg/dm³	Ba µg/dm³	Ca mg/dm³	Cd µg/dm³	Co µg/dm³	Cr µg/dm³	Cu µg/dm³	Fe mg/dm³	K mg/dm³	Li µg/dm³	Mg mg/dm³	Mn µg/dm³	Na mg/dm³	Ni µg/dm³	P mg/dm³	SiO_2 mg/dm³	Sr µg/dm³	Ti µg/dm³	Zn µg/dm³	pH	Przewodność Conductivity mS/m
Tina The Tina river n = 13	a	<0.05	<0.05	0.04	26	45.7	<3	<5	<4	<5	0.04	2.5	8	15.0	53	16.3	<10	<0.1	4.3	377	<5	<5	7.0	0.51
	b	0.11	<0.05	0.30	202	100.7	<3	<5	<4	<5	20.91	19.2	18	26.7	6116	107.0	<10	4.0	24.5	690	805	47	8.0	1.15
	c	<0.05	<0.05	0.17	64	88.2	<3	<5	<4	<5	2.30	7.4	13	17.8	767	39.2	<10	0.6	13.1	500	64	8	7.6	0.67
	d	<0.05	<0.05	0.16	52	86.3	<3	<5	<4	<5	0.31	6.6	12	17.6	257	31.4	<10	0.3	11.7	493	<5	<5	7.6	0.64
	e	<0.05	<0.05	0.14	40	92.9	<3	<5	<4	<5	0.14	6.1	12	17.1	159	25.7	<10	0.2	11.1	492	<5	<5	7.6	0.62
Tuga The Tuga river n = 14	a	<0.05	<0.05	0.08	52	58.2	<3	<5	<4	<5	0.02	5.8	11	12.5	91	48.3	<10	<0.1	8.2	332	<5	<5	7.1	0.61
	b	<0.05	<0.05	0.34	110	106.0	<3	<5	<4	<5	1.55	12.2	22	28.8	1002	78.5	<10	0.5	23.5	579	<5	7	7.5	1.06
	c	<0.05	<0.05	0.25	81	73.5	<3	<5	<4	<5	0.17	9.1	18	14.9	389	65.7	<10	0.2	14.6	481	<5	<5	7.3	0.75
	d	<0.05	<0.05	0.24	78	72.6	<3	<5	<4	<5	0.06	8.9	18	14.6	290	65.3	<10	0.1	13.9	475	<5	<5	7.3	0.74
	e	<0.05	<0.05	0.30	80	73.0	<3	<5	<4	<5	0.04	9.4	19	14.0	279	65.6	<10	0.2	13.4	508	<5	<5	7.3	0.73
Wisła The Vistula river n = 36	a	<0.05	<0.05	0.06	34	57.0	<3	<5	<4	<5	<0.01	4.2	6	8.8	8	17.9	<10	<0.1	3.4	247	<5	<5	7.0	0.41
	b	0.69	<0.05	0.13	68	95.8	<3	<5	<4	<5	0.44	11.2	15	15.2	954	86.2	<10	0.4	13.5	438	33	21	8.0	0.86
	c	<0.05	<0.05	0.08	46	75.8	<3	<5	<4	<5	0.06	5.0	8	10.8	106	37.0	<10	0.1	8.5	317	<5	<5	7.6	0.61
	d	<0.05	<0.05	0.08	45	74.9	<3	<5	<4	<5	0.03	4.9	8	10.6	43	33.9	<10	<0.1	8.0	311	<5	<5	7.6	0.60
	e	<0.05	<0.05	0.08	44	71.9	<3	<5	<4	<5	0.03	4.5	8	10.5	41	28.9	<10	0.1	9.6	292	<5	<5	7.6	0.56
Martwa Wisła + Wisła Śmiała The Martwa Wisła river + Wisła Śmiała river n = 21	a	<0.05	<0.05	0.09	19	76.0	<3	<5	<4	<5	<0.01	6.7	8	11.1	6	32.4	<10	<0.1	1.7	329	<5	<5	7.4	0.56
	b	<0.05	<0.05	0.80	76	101.5	<3	<5	<4	<5	2.43	65.2	38	224.4	1387	1810.0	<10	5.1	12.4	1345	<5	43	8.7	7.98
	c	<0.05	<0.05	0.55	38	90.7	<3	<5	<4	<5	0.14	48.6	28	148.1	110	878.4	<10	1.5	5.0	989	<5	7	7.8	5.98
	d	<0.05	<0.05	0.50	35	90.5	<3	<5	<4	<5	0.01	44.0	26	130.4	35	579.3	<10	0.7	4.6	942	<5	<5	7.8	5.38
	e	<0.05	<0.05	0.61	41	90.7	<3	<5	<4	<5	<0.01	54.2	33	161.7	39	1050.0	<10	0.6	4.6	1095	<5	<5	7.8	6.63
Wody powierzchniowe Polski[1)] Surface waters of Poland[1)] n = 12 955	a	<0.1		<0.02	<1	3	<3	<5	<5	<5	<0.02	<1	<20	0.2	<1	<1	<8	<0.04	<0.3	4	<5	<5		
	b	1.2		12.87	3470	6400	238	136	4445	3732	438.72	473	2780	833.8	34 500	5723	1326	45.12	83.1	26 078	350	16 414		
	c	0.2		0.08	66	92	<3	<5	<5	<5	1.00	9	<20	14.8	247	40	<8	0.59	13.1	374	<5	67		
	d	0.1		0.04	55	79	<3	<5	<5	<5	0.52	5	<20	11.5	107	16	<8	0.19	10.2	263	<5	36		
	e	0.1		0.04	54	83	<3	<5	<5	<5	0.52	5	<20	11.6	102	14	<8	0.16	12.5	243	<5	33		

a – minimum; b – maksimum; c – średnia arytmetyczna; d – średnia geometryczna; e – mediana; n – liczba próbek;
minimum; maximum; arithmetic mean; geometric mean; median; number of samples

[1)] J. Lis, A. Pasieczna (1995)

Tabela VI
Table VI

Parametry statystyczne anionów w wodach powierzchniowych Pobrzeża Gdańskiego
Statistical parameters of anions in surface waters of Gdańsk Region

Wody powierzchniowe Surface waters	Parametry Parameters	Br	Cl	F	HCO_3	NO_2	NO_3	SO_4
		mg/dm³						
Wody powierzchniowe ogółem All surface waters	a	<0.1	<1	<0.1	<5	<0.01	<0.01	<1
	b	177.0	3470	11.7	4208	4.64	58.10	3973
	c	0.4	146	0.2	275	0.08	1.65	93
	d	<0.1	55	0.1	211	0.02	0.11	33
	e	<0.1	52	<0.1	252	<0.01	0.09	39
	n	1778	1803	1803	1780	1746	1755	1797
Małe cieki bez nazwy Small streams (unnamed)	a	<0.1	2	<0.1	<5	<0.01	<0.01	<1
	b	177.0	2639	11.7	4208	4.64	58.10	3973
	c	0.5	130	0.2	300	0.08	1.70	111
	d	<0.1	60	0.1	227	0.02	0.09	34
	e	<0.1	55	<0.1	286	<0.01	0.07	41
	n	1096	1110	1110	1106	1082	1087	1104
Jeziora i sadzawki bez nazwy Lakes and pools (unnamed)	a	<0.1	1	<0.1	<5	<0.01	<0.01	<1
	b	2.6	1736	1.5	621	2.68	26.10	340
	c	0.1	62	0.1	171	0.05	0.56	33
	d	<0.1	27	0.1	108	8.55	0.02	15
	e	<0.1	30	<0.1	163	<0.01	<0.01	19
	n	178	179	179	179	178	178	179
Jeziora Lakes	a	<0.1	9	<0.1	42	<0.01	<0.01	<1
	b	4.5	1240	0.6	380	0.19	1.17	201
	c	0.4	125	0.2	191	0.02	0.11	34
	d	0.1	43	0.1	165	7.63	0.02	19
	e	<0.1	50	0.1	178	<0.01	0.01	27
	n	20	20	20	19	19	19	20
Kanały Canals	a	<0.1	11	<0.1	<5	<0.01	<0.01	<1
	b	13.0	2886	2.1	1113	3.67	14.60	551
	c	0.7	256	0.2	303	0.12	0.99	67
	d	0.1	87	0.1	259	0.02	0.10	33
	e	<0.1	79	0.1	305	0.01	0.10	36
	n	99	101	101	98	93	94	101
Fiszewka The Fiszewka river n = 11	a	<0.1	35	<0.1	239	0.06	0.03	30
	b	0.2	72	0.3	288	0.18	0.67	117
	c	<0.1	53	0.2	274	0.10	0.21	71
	d	<0.1	51	0.2	273	0.09	0.16	64
	e	<0.1	63	0.2	281	0.09	0.18	91
Kanał Panieński The Panieński Canal n = 14	a	<0.1	42	<0.1	211	<0.01	<0.01	13
	b	0.5	104	0.5	347	3.67	4.18	36
	c	0.2	75	0.2	287	0.34	0.58	22
	d	0.1	73	0.2	284	0.03	0.17	21
	e	0.2	78	0.2	309	0.02	0.13	21
Linawa The Linawa river n = 18	a	<0.1	41	<0.1	173	<0.01	<0.01	<1
	b	0.5	110	0.2	389	0.44	0.59	114
	c	0.2	86	<0.1	306	0.04	0.11	44
	d	0.1	83	<0.1	299	0.01	0.04	23
	e	0.1	90	<0.1	322	<0.01	0.05	30
Motława The Motława river n = 29	a	<0.1	10	<0.1	96	<0.01	<0.01	3
	b	0.8	351	1.0	500	0.82	8.32	203
	c	0.1	54	0.3	294	0.14	2.98	85
	d	<0.1	39	0.3	280	0.03	0.99	67
	e	<0.1	37	0.3	294	<0.01	2.46	73
Nogat The Nogat river n = 41	a	<0.1	21	<0.1	170	<0.01	<0.01	1
	b	1.3	463	0.3	277	0.56	4.39	121
	c	0.1	71	0.1	206	0.15	1.74	46
	d	<0.1	52	<0.1	205	0.06	0.83	41
	e	<0.1	43	0.1	207	0.12	1.41	44
Radunia The Radunia river n = 22	a	<0.1	9	<0.1	7	<0.01	<0.01	24
	b	<0.1	66	0.2	335	0.20	21.40	1238
	c	<0.1	14	0.1	194	0.03	2.49	85
	d	<0.1	12	0.1	172	0.01	1.05	35
	e	<0.1	10	0.1	196	<0.01	1.09	29
Stary Nogat The Stary Nogat river n = 17	a	<0.1	12	<0.1	114	<0.01	<0.01	<1
	b	0.2	100	0.3	484	0.10	0.90	180
	c	<0.1	52	<0.1	312	0.02	0.13	55
	d	<0.1	46	<0.1	290	<0.01	0.04	22
	e	<0.1	56	<0.1	312	<0.01	0.04	41
Święta The Święta river n = 31	a	<0.1	20	<0.1	85	<0.01	<0.01	5
	b	0.3	101	0.4	422	3.21	9.21	105
	c	<0.1	66	0.2	307	0.16	0.88	28
	d	<0.1	63	0.1	298	0.02	0.13	23
	e	<0.1	69	0.2	315	<0.01	0.20	21
Szkarpawa The Szkarpawa river n = 15	a	<0.1	56	<0.1	145	<0.01	<0.01	38
	b	1.0	319	0.2	239	0.38	3.50	64
	c	0.3	109	<0.1	167	0.10	1.06	48
	d	0.1	95	<0.1	166	0.05	0.58	47
	e	<0.1	88	<0.1	161	0.08	0.68	47
Tina The Tina river n = 13	a	<0.1	15	<0.1	135	<0.01	<0.01	<1
	b	0.7	171	0.5	464	0.16	0.81	202
	c	0.1	45	0.3	313	0.04	0.18	40
	d	<0.1	35	0.2	301	0.01	0.04	21
	e	<0.1	31	0.3	310	<0.01	0.04	28
Tuga The Tuga river n = 14	a	<0.1	70	<0.1	165	<0.01	<0.01	19
	b	0.3	134	0.5	348	0.11	1.23	170
	c	0.2	86	0.2	259	0.03	0.19	36
	d	0.1	85	0.2	253	0.02	0.04	28
	e	0.2	79	0.2	276	0.03	0.05	22
Wisła The Vistula river	a	<0.1	33	<0.1	141	<0.01	<0.01	35
	b	0.6	165	0.2	216	0.20	6.60	77
	c	0.2	78	<0.1	176	0.06	3.74	54
	d	0.1	70	<0.1	175	0.04	1.97	54
	e	<0.1	56	<0.1	177	0.06	3.60	52
	n	36	36	44	36	36	36	36
Martwa Wisła + Wisła Śmiała The Wisła Martwa river + Wisła Śmiała river	a	0.4	68	<0.1	15	<0.01	0.03	32
	b	13.0	3470	<0.1	228	0.41	1.48	565
	c	9.2	2400	<0.1	100	0.17	0.55	375
	d	7.4	2004	<0.1	72	0.07	0.34	336
	e	10.6	2692	<0.1	82	0.13	0.41	391
	n	14	21	21	6	4	7	21

a – minimum; b – maksimum; c – średnia arytmetyczna; d – średnia geometryczna; e – mediana; n – liczba próbek;
minimum; maximum; arithmetic mean; geometric mean; median; number of samples

Tabela VII
Table

Orientacyjna mineralizacja wód powierzchniowych(n=1805)
obliczona z przewodności elektrycznej
Approximate mineralisation of surface water (n=1805) computed from conductivity

Przewodność Conductivity mS/cm	Podział wód (wg A.S. Kleczkowskiego, A. Różkowskiego,red.,1997) Water classification (after A.S. Kleczkowski, A. Różkowski,Eds.,1997)		Udział próbek Percentage of samples %
	Mineralizacja Mineralisation g/dm^3	Wody Waters	
<1,399 ≥1,39 – <4,17 >1,39 – ≤2,78	<1 ≥1 – <3 ≥3 – <10	słodka fresh półsłodka semifresh słonawa brackish	88,75 8,98 2,27

Tabela VIII
Table

Procentowy udział próbek gleb z delty Wisły w zależności od stopnia
zanieczyszczenia, według zaleceń IUNG w Puławach
(A. Kabata-Pendias i in., 1995)
Percentage of soil samples from Vistula River delta in respect of degree of soil pollution,
according to recommendations of the IUNG at Puławy (A. Kabata-Pendias *et al.,* 1995)

Metal Metal	Stopień zanieczyszczenia Degree of pollution					
	0	I	II	III	IV	V
	Pola uprawne. Cultivated fields n = 1207					
Cd	94,28	4,56	0,99	0,17	-	-
Cu	80,70	18,89	0,25	-	0,08	0,08
Cr	96,77	3,23	-	-	-	-
Ni	77,30	22,70	-	-	-	-
Pb	99,42	0,33	0,17	0,08	-	-
Zn	73,57	25,77	0,41	0,17	0,08	-
	Łąki Meadows n = 246					
Cd	93,09	6,50	0,41	-	-	-
Cu	82,11	17,07	0,41	-	0,41	-
Cr	97,97	2,03	-	-	-	-
Ni	83,74	16,26	-	-	-	-
Pb	98,78	1,22	-	-	-	-
Zn	75,61	23,17	0,41	0,81	-	-

Tabela IX
Table

Procentowy udział próbek gleb z Pobrzeża Kaszubskiego i Wysoczyzny Elbląskiej w zależności od stopnia zanieczyszczenia, według zaleceń IUNG w Puławach (A. Kabata-Pendias i in., 1995)
Percentage of soil samples from Pobrzeże Kaszubskie and Wysoczyzna Elbląska Upplands in respect of degree of soil pollution, according to recommendations of the IUNG at Puławy (A. Kabata-Pendias *et al*., 1995)

Metal Metal	Stopień zanieczyszczenia Degree of pollution					
	0	I	II	III	IV	V
Pola uprawne Cultivated fields n = 200						
Cd	98,00	1,50	-	-	-	0,50
Cu	89,00	11,00	-	-	-	-
Cr	96,50	3,50	-	-	-	-
Ni	90,50	9,50	-	-	-	-
Pb	95,00	5,00	-	-	-	-
Zn	88,00	12,00	-	-	-	-
Łąki Meadows n = 109						
Cd	94,50	1,83	0,92	0,92	1,83	-
Cu	88,99	11,01	-	-	-	-
Cr	98,17	1,83	-	-	-	-
Ni	99,08	0,92	-	-	-	-
Pb	92,66	7,34	-	-	-	-
Zn	87,16	9,17	3,67	-	-	-
Ogródki działkowe Allotments n=13						
Cd	76,92	23,08	-	-	-	-
Cu	46,15	46,15	7,70	-	-	-
Cr	92,31	7,69	-	-	-	-
Ni	76,92	23,08	-	-	-	-
Pb	61,54	38,46	-	-	-	-
Zn	53,86	15,38	15,38	15,38		

Tabela X
Table

Klasyfikacja wód powierzchniowych Pobrzeża Gdańskiego według kryterium klas czystości (%)
Classification of surface waters after of purity classes of Gdańsk Region (%)

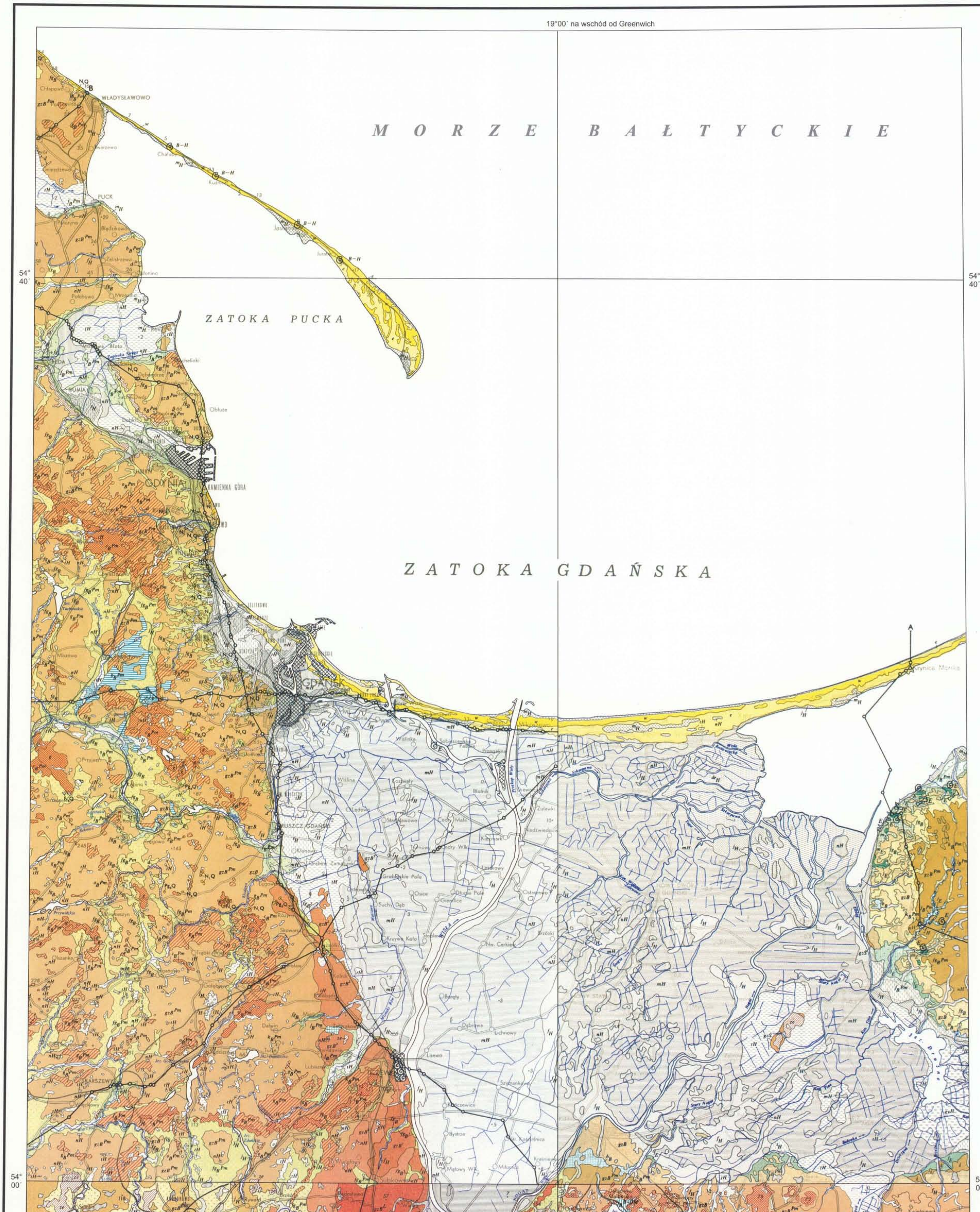
Klasa Class	Wartości graniczne* Limited values*	Wody ogółem All waters n = 1805	Wisła The Vistula river n = 36	Martwa Wisła + Wisła Śmiała The Martwa Wisła river+ Wisła Śmiała river n = 21	Małe cieki z wysoczyzn** Small streams of uplands n = 196	Małe cieki z delty Wisły Small streams of Vistula river delta n = 983	Nogat The Nogat river n = 41	Święta The Święta river n = 31	Motława The Motława river n = 29
				B (mg/dm^3)					
I–III	≤1.0	98.84	100.00	100.00	98.98	98.37	100.00	100.00	100.00
w.p. (s.w.)[1]	>1.0	1.16	–	–	1.02	1.63	–	–	–
				Cd ($\mu g/dm^3$)					
I	≤5	99.67	100.00	100.00	100	99.39	100.00	100.00	100.00
II	>5 – ≤30	0.33	–	–	–	0.61	–	–	–
III	>30 – ≤100		–	–	–	–	–	–	–
w.p. (s.w.)	>100		–	–	–	–	–	–	–
				Cl (mg/dm^3)					
I	≤250	90.24	100.00	4.76	92.35	89.93	95.12	100.00	96.55
II	>250 – ≤300	1.16	–	–	0.51	1.63	–	–	–
III	>300 – ≤400	1.39	–	–	1.53	1.32	2.44	–	3.45
w.p. (s.w.)	>400	7.21	–	95.24	5.61	7.12	2.44	–	–
				Cr ($\mu g/dm^3$)					
I	≤50	99.94	100.00	100.00	99.49	100.00	100.00	100.00	100.00
II–III	>30 – ≤100	–	–	–	–	–	–	–	–
w.p. (s.w.)	>100	0.06	–	–	0.51	–	–	–	–
				Cu ($\mu g/dm^3$)					
I–III	≤50	99.83	100.00	100.00	99.49	99.80	100.00	100.00	100.00
w.p. (s.w.)	<50	0.17	–	–	0.51	0.20	–	–	–
				F (mg/dm^3)					
I–II	≤1.5	98.89	100.00	100.00	98.98	98.47	100.00	100.00	100.00
III	≤1.5 – ≤2.0	0.44	–	–	–	0.71	–	–	–
w.p. (s.w.)	>2.0	0.67	–	–	1.02	0.82	–	–	–
				Fe (mg/dm^3)					
I	≤1.0	74.07	100.00	95.24	80.61	63.89	97.56	67.74	93.10
II	>1.0 – ≤1.5	3.71	–	–	3.57	4.48	2.44	3.23	–
III	>1.5 – ≤2.0	2.66	–	–	1.53	3.66	–	6.45	–
w.p. (s.w.)	>2.0	19.56	–	4.76	14.29	27.97	–	22.58	6.90
				K (mg/dm^3)					
I	≤10	64.05	97.22	4.76	72.45	57.07	97.56	8.39	75.86
II	>10 – ≤12	5.82	2.78	–	5.10	6.51	–	9.67	6.90
III	>12 – ≤15	5.37	–	–	1.53	6.41	–	41.94	10.34
w.p. (s.w.)	>15	24.76	–	95.24	20.92	30.01	2.44	–	6.90
				Mn ($\mu g/dm^3$)					
I	≤100	29.97	80.56	85.72	37.24	18.32	48.78	9.68	41.38
II	>100 – ≤300	20.89	5.56	9.52	29.08	15.56	48.78	9.68	44.83
III	>300 – ≤800	16.34	11.11	–	19.39	18.21	2.44	19.35	3.45
w.p. (s.w.)	>800	32.80	2.77	4.76	14.29	47.91	–	61.29	10.34
				Na (mg/dm^3)					
I	≤100	85.32	100.00	4.76	89.80	83.32	92.68	100.00	96.55
II	>100 – ≤120	2.27	–	–	1.53	2.85	–	–	–
III	>120 – ≤150	2.44	–	9.52	1.53	3.15	–	–	–
w.p. (s.w.)	>150	9.97	–	85.72	7.14	10.68	7.32	–	3.45
				Ni ($\mu g/dm^3$)					
I–III	≤1000	100	100.00	100.00	100.00	100.00	100.00	100.00	100.00
w.p.(s.w.)	>1000		–	–	–	–	–		–
				NO_2 (mg/dm^3)					
I	≤0.02	65.06	58.33	50.00	62.60	81.56	39.02	77.42	62.07
II	>0.02 – ≤0.03	3.09	22.22	–	7.35	3.23	4.88	3.23	–
III	>0.03 – ≤0.06	7.39	16.67	–	16.91	6.15	19.51	3.23	20.69
w.p. (s.w.)	>0.06	24.46	2.78	50.00	13.14	9.06	36.59	16.12	17.24
				NO_3 (mg/dm^3)					
I	≤5.0	90.77	100.00	100.00	94.24	99.18	100.00	100.00	100.00
II	>5.0 – ≤7.0	3.76	–	–	2.62	0.41	–		
III	>7.00 – ≤15.0	3.42	–	–	3.14	0.41	–		
w.p. (s.w.)	>15.0	2.05	–	–	–	–	–		
				P ogólny (mg/dm^3)					
I	≤0.10	42.43	72.23	9.52	40.81	38.76	53.66	51.61	37.93
II	>0.10 – ≤0.25	14.35	19.44	9.52	15.31	13.12	24.40	12.90	24.14
III	>0.25 – ≤0.40	12.69	8.33	19.06	14.80	11.70	19.51	9.68	20.69
w.p. (s.w.)	>0.40	30.53	–	61.90	29.08	36.42	2.43	25.81	17.24
				SO_4 (mg/dm^3)					
I	<150	85.47	100.00	4.76	86.66	83.11	100.00	100.00	86.21
II	>150 – ≤200	3.83	–	4.76	3.09	5.09	–	–	10.34
III	>200 – ≤250	3.16	–	9.52	2.05	3.46	–	–	3.45
w.p. (s.w.)	>250	7.54	–	80.96	8.20	8.34	–	–	–
				Zn ($\mu g/dm^3$)					
I–III	≤200	99.06	100.00	100.00	99.49	98.37	100.00	100.00	100.00
w.p. (s.w.)	>200	0.94	–	–	0.51	1.63	–		–
			Przewodność elektryczna (µS/cm)	Electrical conductivity					
I	≤800	64.65	86.11	4.76	72.46	56.77	92.68	67.74	72.41
II	>800 – ≤900	8.20	13.89	–	6.63	9.26	–	29.03	6.90
III	>900 – ≤1200	12.41	–	–	8.67	16.07	2.44	3.23	17.24
w.p. (s.w.)	>1200	14.74	–	95.24	12.24	17.90	4.88	–	3.45

[1] w.p. (s.w.) – wody pozaklasowe
substandard waters

* – wartości graniczne (Rozporządzenie, 1991)
limited values after standarts (Rozporządzenie, 1991)

** – Pobrzeże Kaszubskie i Wysoczyzna Elbląska
Uplands (Pobrzeże Kaszubskie and Wysoczyzna Elbląska)

MAPA GEOLOGICZNA
GEOLOGICAL MAP



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LEGENDA

CZWARTORZĘD – HOLOCEN	tH	Torfy	
	gyH	Gytie	
	nH	Namuły	
	j_H	Iły, mułki i piaski jeziorne, miejscami głównie kredy jeziorne (kj)	
	de_H	Piaski i żwiry delt rzecznych	
	s_H	Piaski i żwiry stożków napływowych	
	mH	Mady rzeczne	
	f_H	Mułki, piaski i żwiry rzeczne	
	m_H	Iły, piaski i żwiry morskie	
CZWARTORZĘD	e	Piaski eoliczne	
	w	Piaski eoliczne w wydmach	
	ze	Eluwia glin zwałowych	
	d	Piaski i gliny deluwialne	
CZWARTORZĘD – PLEJSTOCEN	j_B^{B-DM}	Iły mułki i piaski jeziorne	Zlodowacenie północnopolskie
	f_B^{DM}	Mady, mułki, piaski i żwiry rzeczne	
	s_B^{Pm}	Piaski i żwiry stożków napływowych	
	j_B^{Pm}	Iły, mułki i piaski jeziorne	
	f_B^{Pm}	Mułki, piaski i żwiry rzeczne, miejscami również wodnolodowcowe ($f+fg$)	
	k_B^{Pm}	Mułki i piaski kemów	
	o_B^{Pm}	Piaski i żwiry ozów	
	c_B^{Pm}	Piaski, żwiry i głazy, miejscami gliny (g) moren czołowych	
	g_B^{Pm}	Piaski, żwiry i głazy lodowcowe	
	gzB^{Pm}	Glina zwałowa	
	fg_B^{Pm}	Piaski i żwiry wodnolodowcowe	
	b_B^{Pm}	Iły, mułki i piaski, miejscami piaski (p) zastoiskowe	
	gzB^{P}	Glina zwałowa	
	fg_B^{P}	Piaski i żwiry wodnolodowcowe	
	gzB^{L}	Glina zwałowa	
	fg_B^{L}	Piaski i żwiry wodnolodowcowe	
	gzB^{3}	Glina zwałowa	
	fg_B^{2}	Piaski i żwiry wodnolodowcowe	
	gzB^{1}	Glina zwałowa	
	fg_B^{1}	Piaski i żwiry wodnolodowcowe	
	gzB	Glina zwałowa, miejscami ilasta	
	fg_B	Piaski i żwiry wodnolodowcowe	
	b_B	Iły, mułki i piaski zastoiskowe	
	j_E	Iły, mułki i piaski jeziorne	Interglacjał eemski
	f_E	Mady, mułki, piaski i żwiry rzeczne, lokalnie torfy	
	m_E	Iły, mułki, piaski i żwiry morskie	
	$gzŚ$	Glina zwałowa, miejscami z warstwami iłów czerwonych	Zlodowacenie środkowopolskie
	N_1Q	Kry utworów miocenu	
	Pg_3Q	Kry utworów oligocenu	
TRZECIORZĘD – NEOGEN	N_1	Piaski, mułki, iły i węgle brunatne	MIOCEN
		Nasypy	

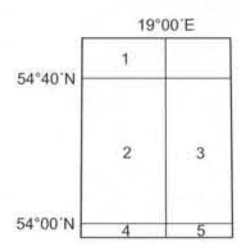
Stanowiska fauny kręgowców (E – interglacjał eemski)

Stanowiska fauny bezkręgowców (B-H – zlodowacenie północnopolskie – holocen, E – interglacjał eemski)

Stanowiska flory (E – interglacjał eemski)

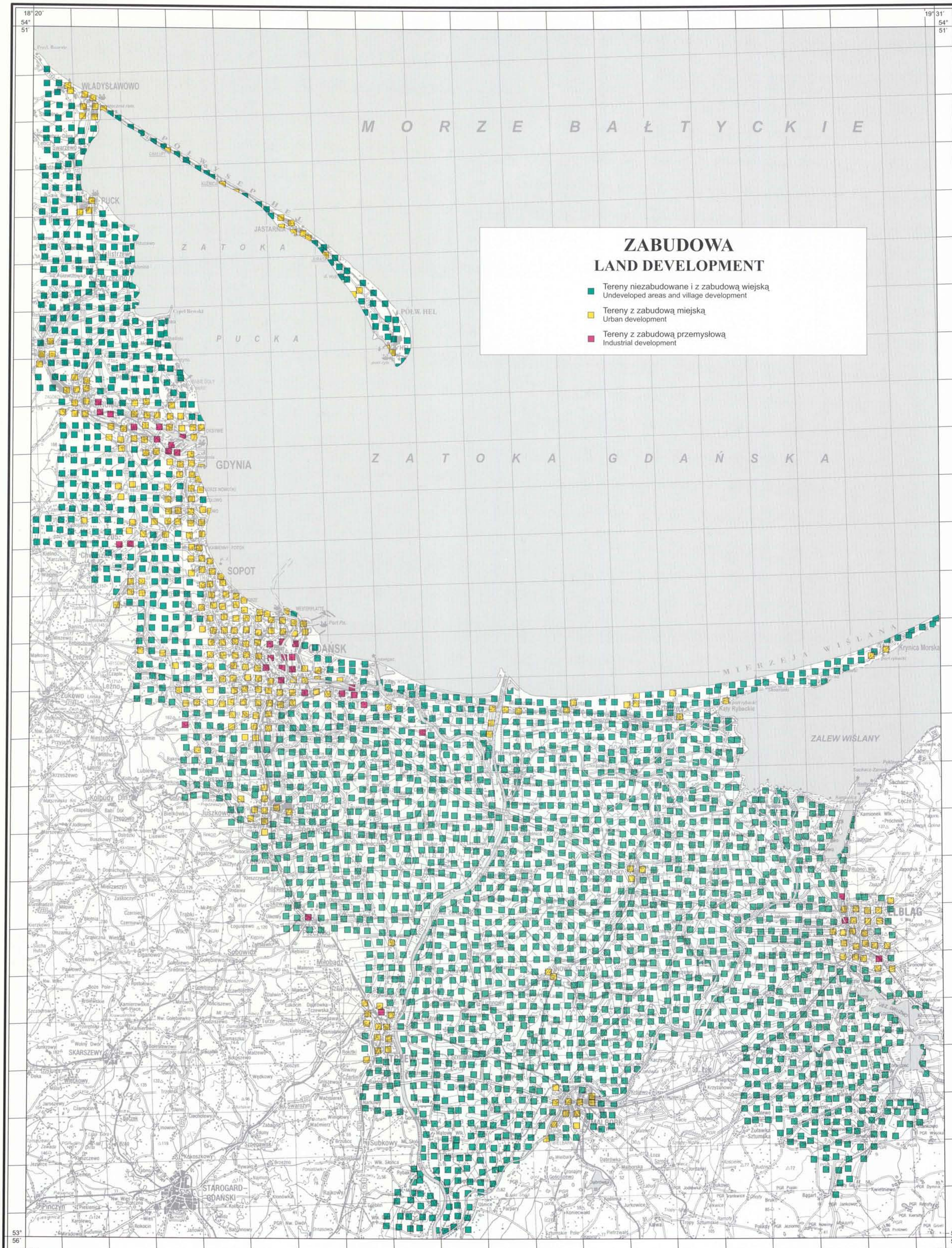
A–B Linie przekrojów geologicznych zamieszczonych na Mapie geologicznej Polski 1:200 000, wyd. A (patrz „Skorowidz arkuszy")

Skorowidz arkuszy
Mapy geologicznej Polski 1:200 000, wyd. A



1. PUCK – L. Bohdziewicz, Z. Pazdro, B. Wróbel; zaktualizował J.E. Mojski, 1980 r.
2. GDAŃSK – J.E. Mojski, J. Sylwestrzak, 1976 r.
3. ELBLĄG – A. Makowska, 1977 r.
4. GRUDZIĄDZ – A. Makowska, 1972 r.
5. IŁAWA – A. Makowska, 1976 r.

U w a g a : Oryginał mapy skanowany – różnice w barwach wydzieleń między zbiorczą legendą i mapą oraz na stykach arkuszy



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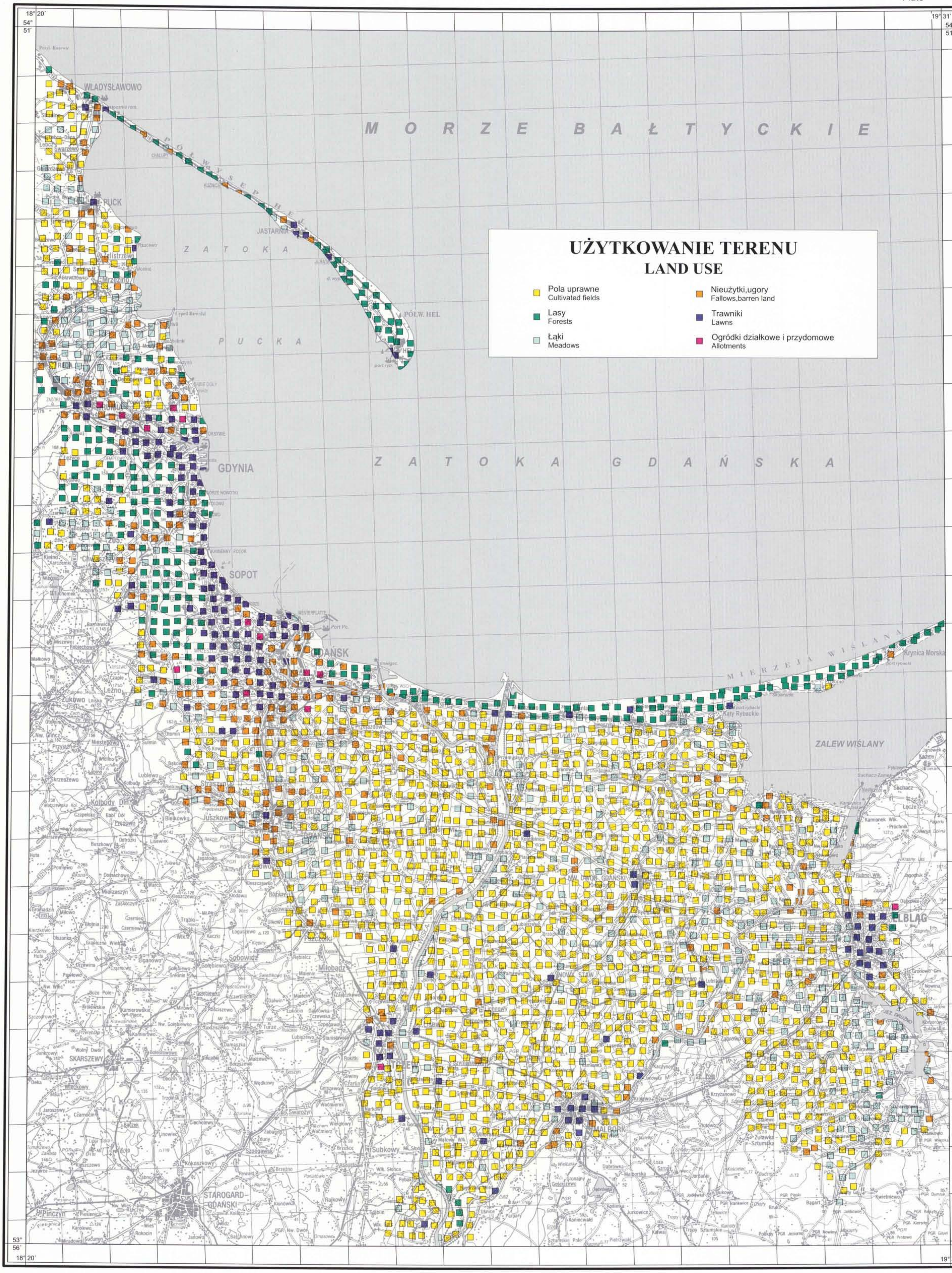

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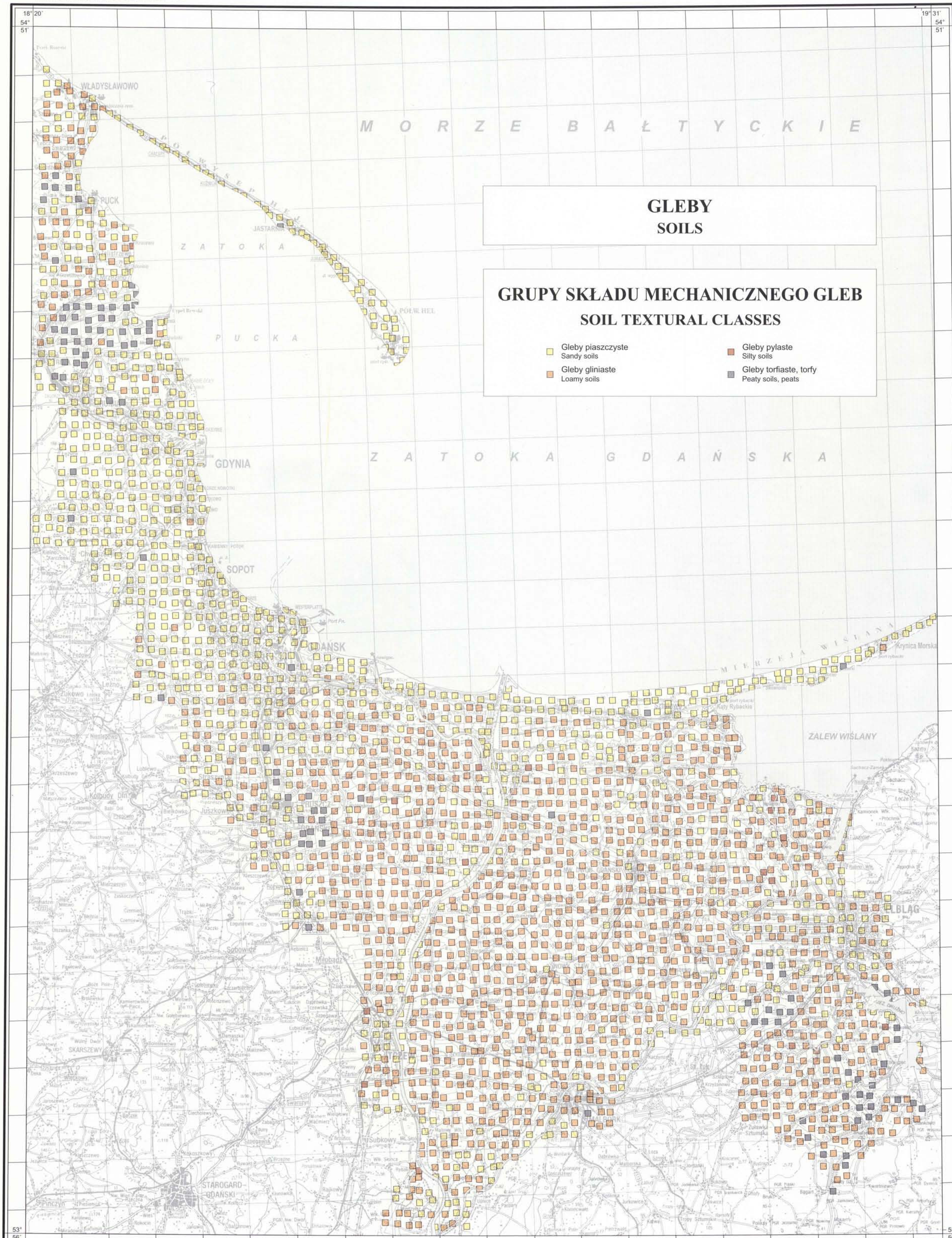

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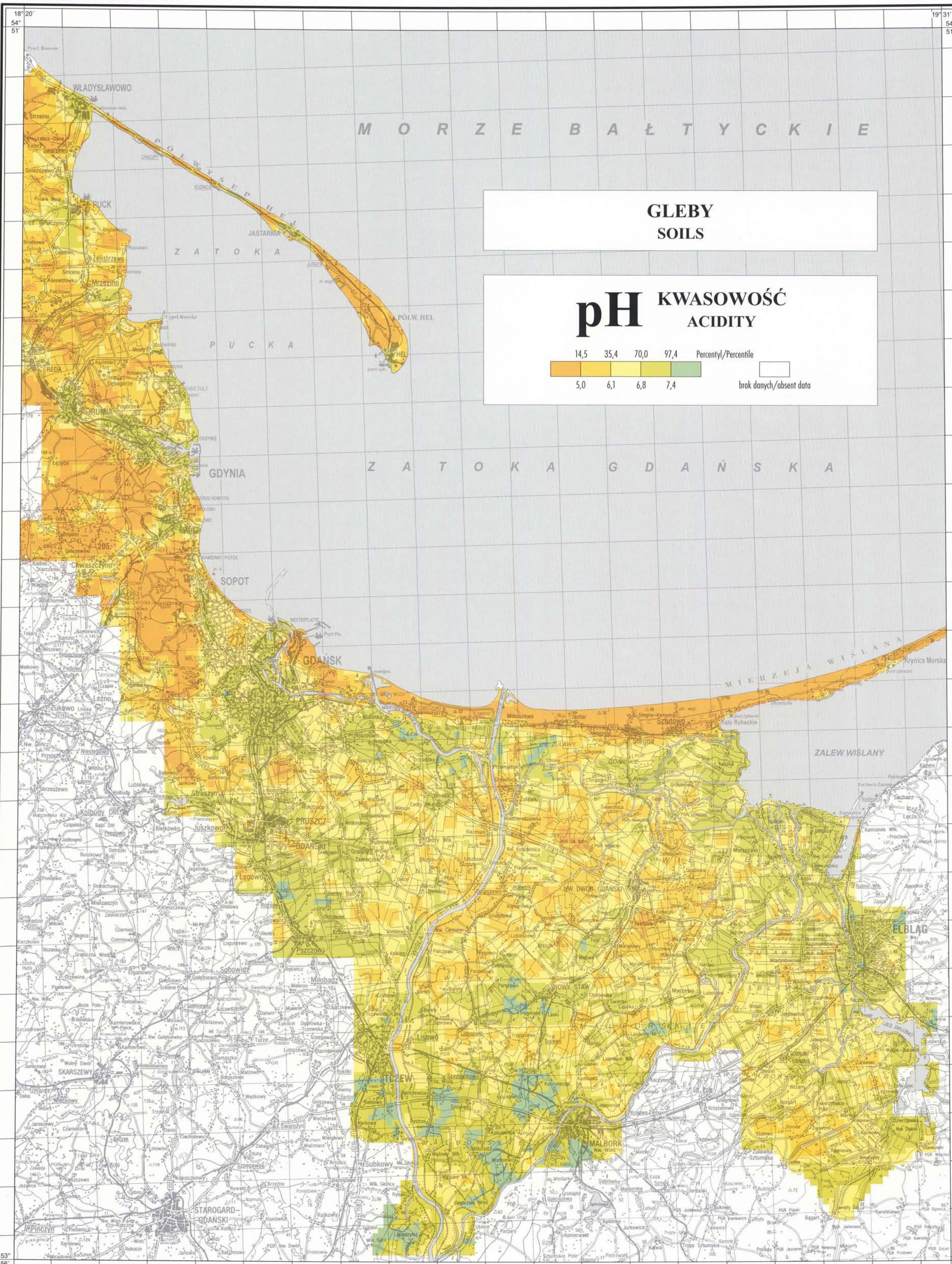
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.

GLEBY
SOILS

pH KWASOWOŚĆ
ACIDITY



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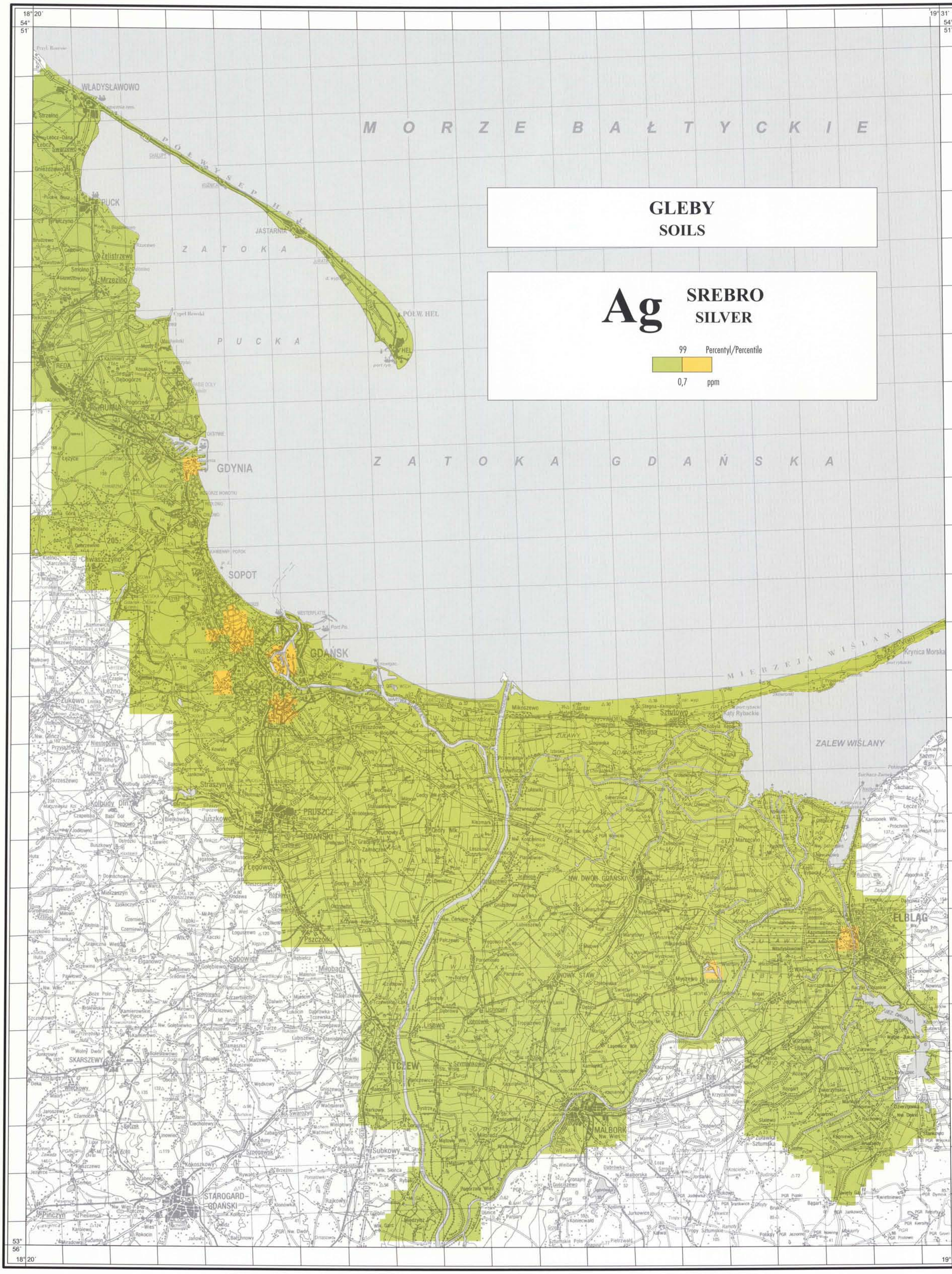
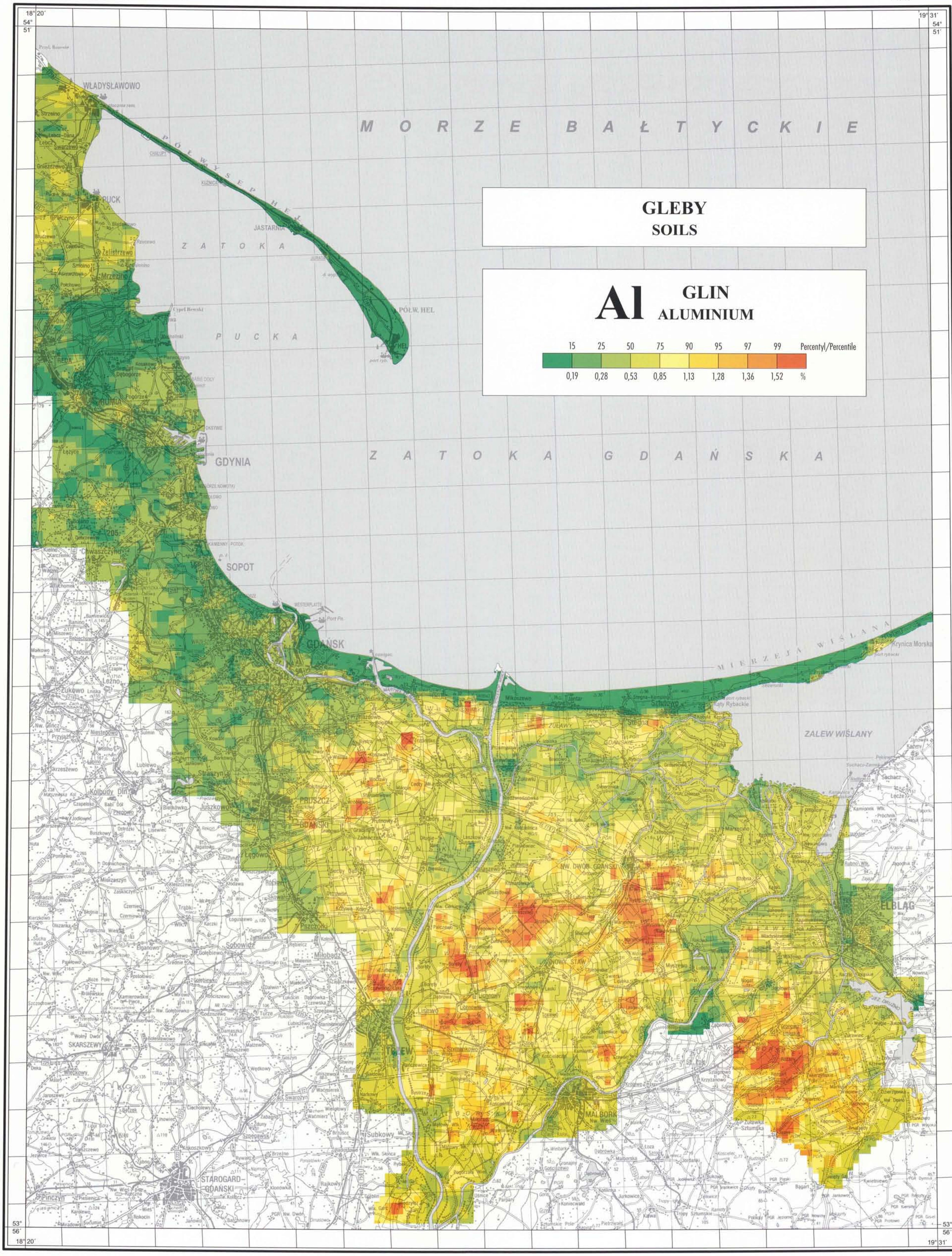

GLEBY
SOILS
Ag
SREBRO
SILVER
99 Percentyl/Percentile
0,7 ppm
M O R Z E B A Ł T Y C K I E
Z A T O K A G D A Ń S K A
Z A T O K A
P U C K A
PÓŁWYSEP HEL
MIERZEJA WIŚLANA
ZALEW WIŚLANY
WŁADYSŁAWOWO
PUCK
JASTARNIA
HEL
GDYNIA
SOPOT
GDAŃSK
PRUSZCZ GDAŃSKI
NW. DWÓR GDAŃSKI
NOWY STAW
ELBLĄG
TCZEW
MALBORK
STAROGARD GDAŃSKI
SKARSZEWY
18° 20'
54° 51'
19° 31'
53° 56'



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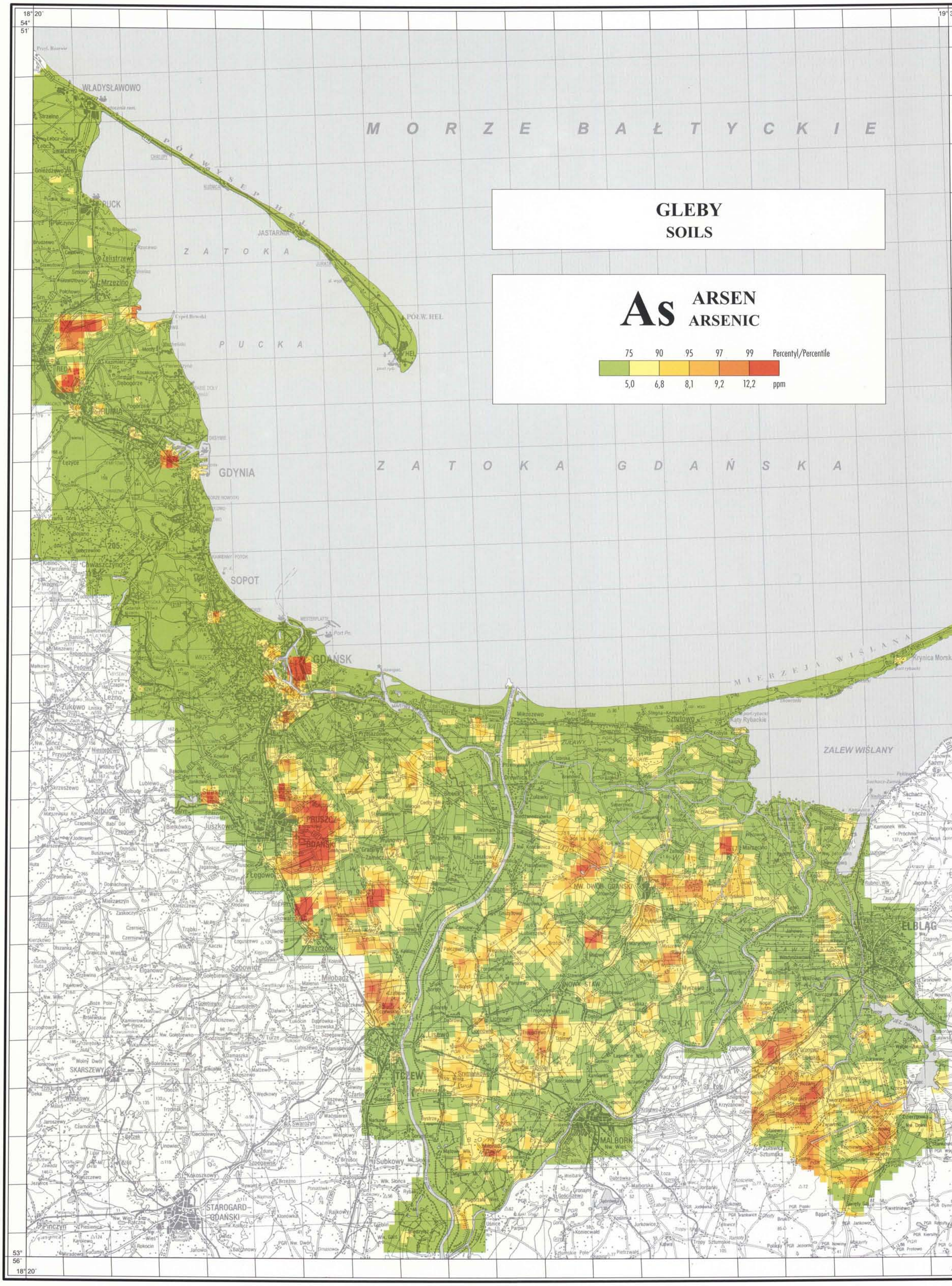

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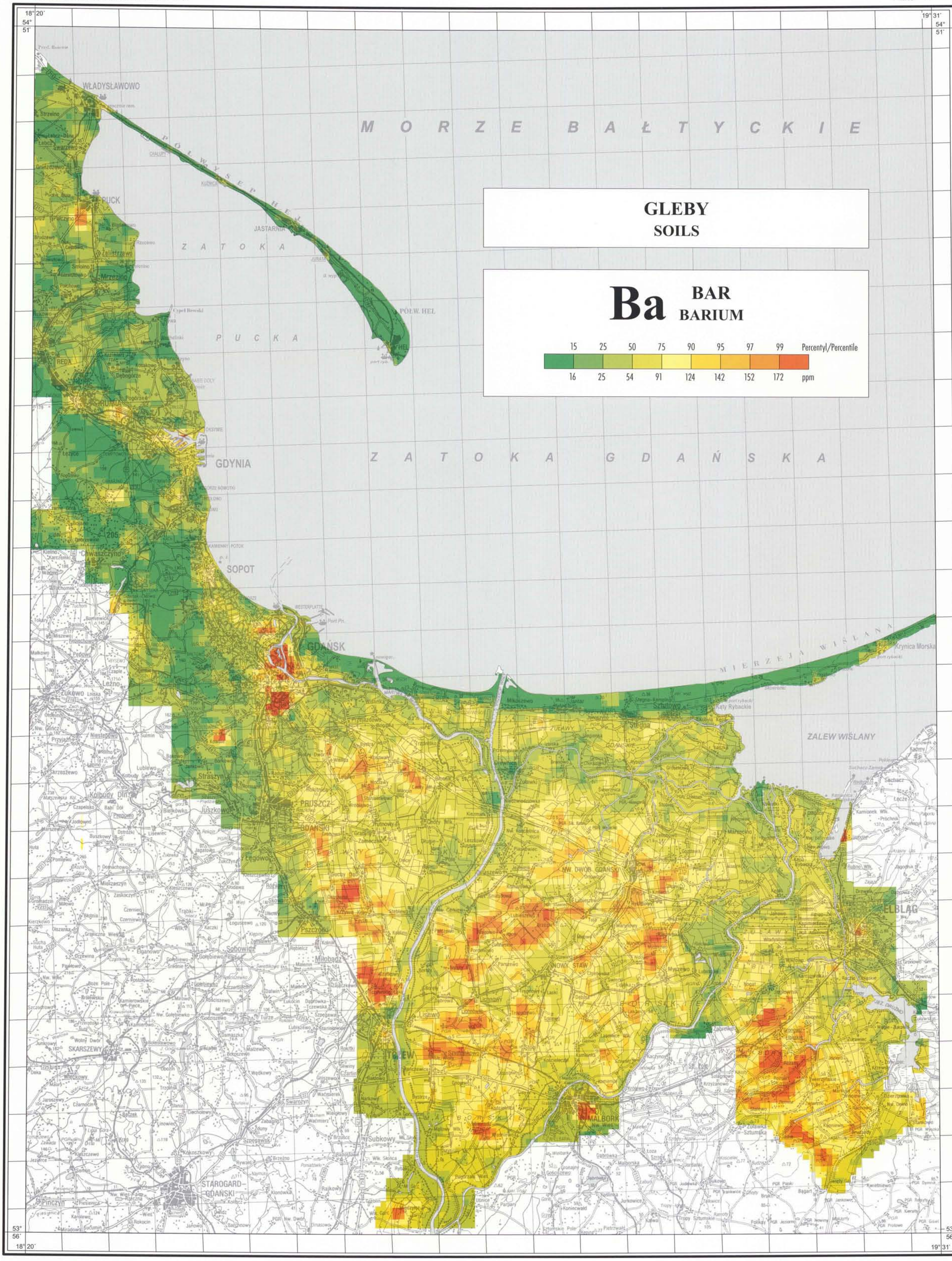

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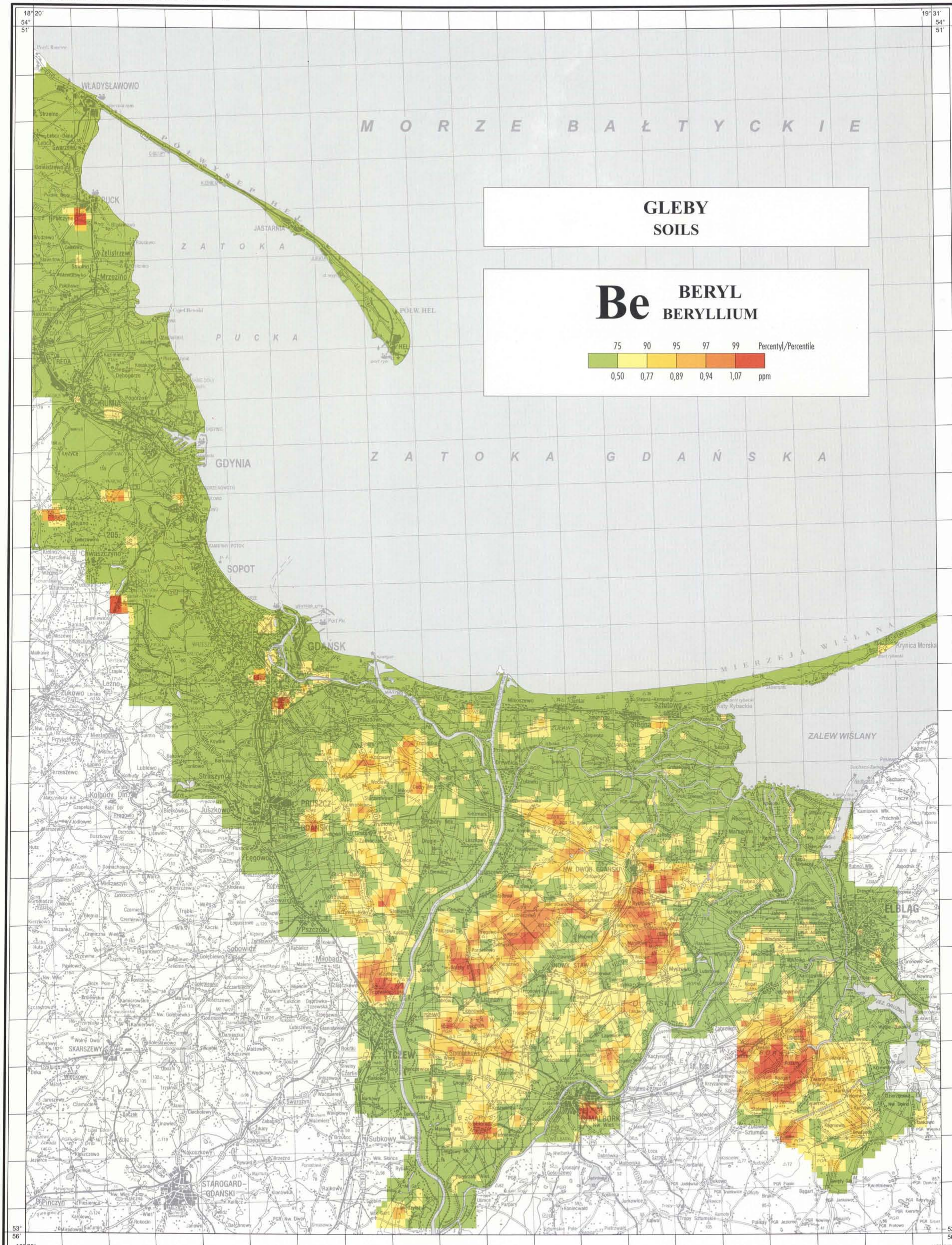

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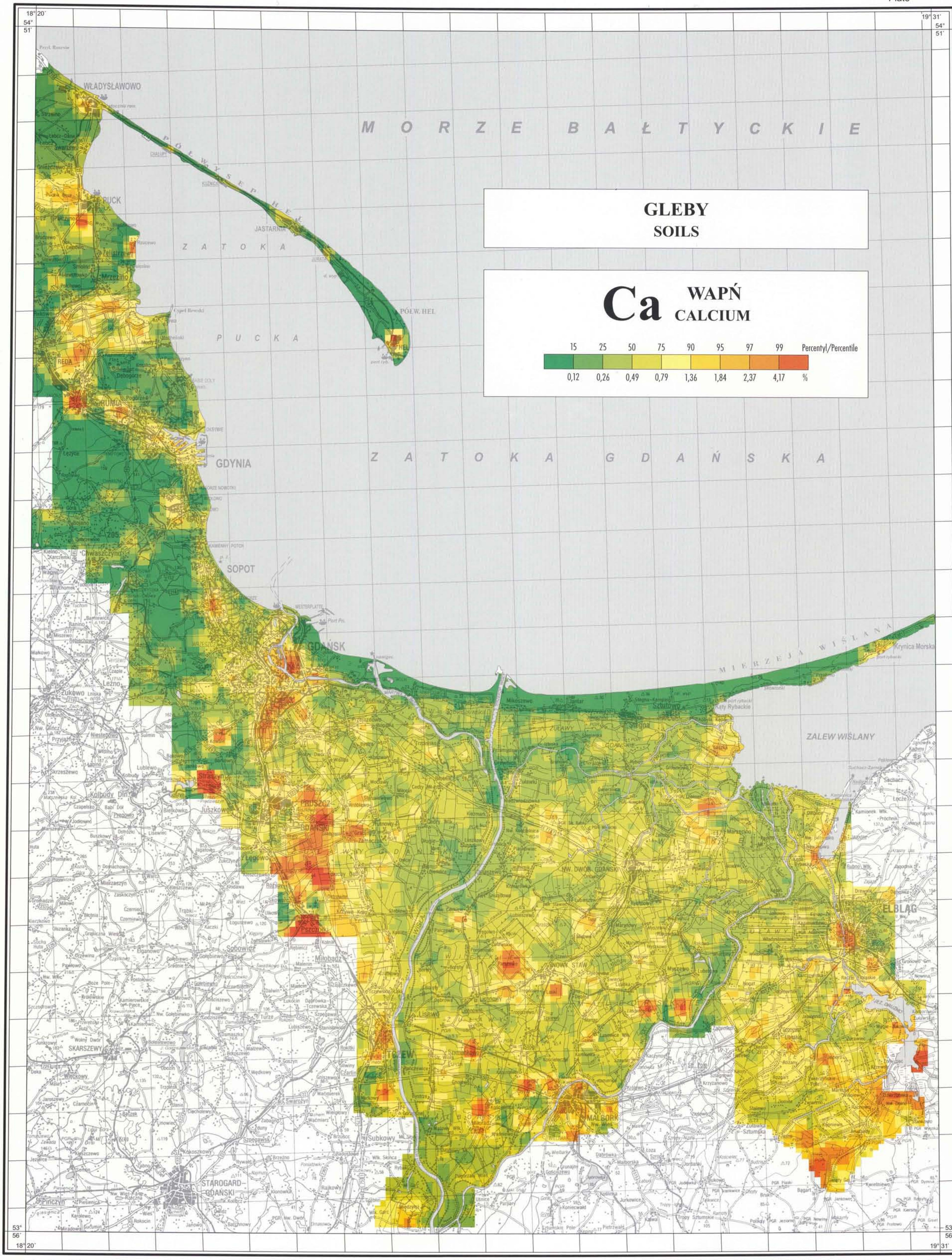

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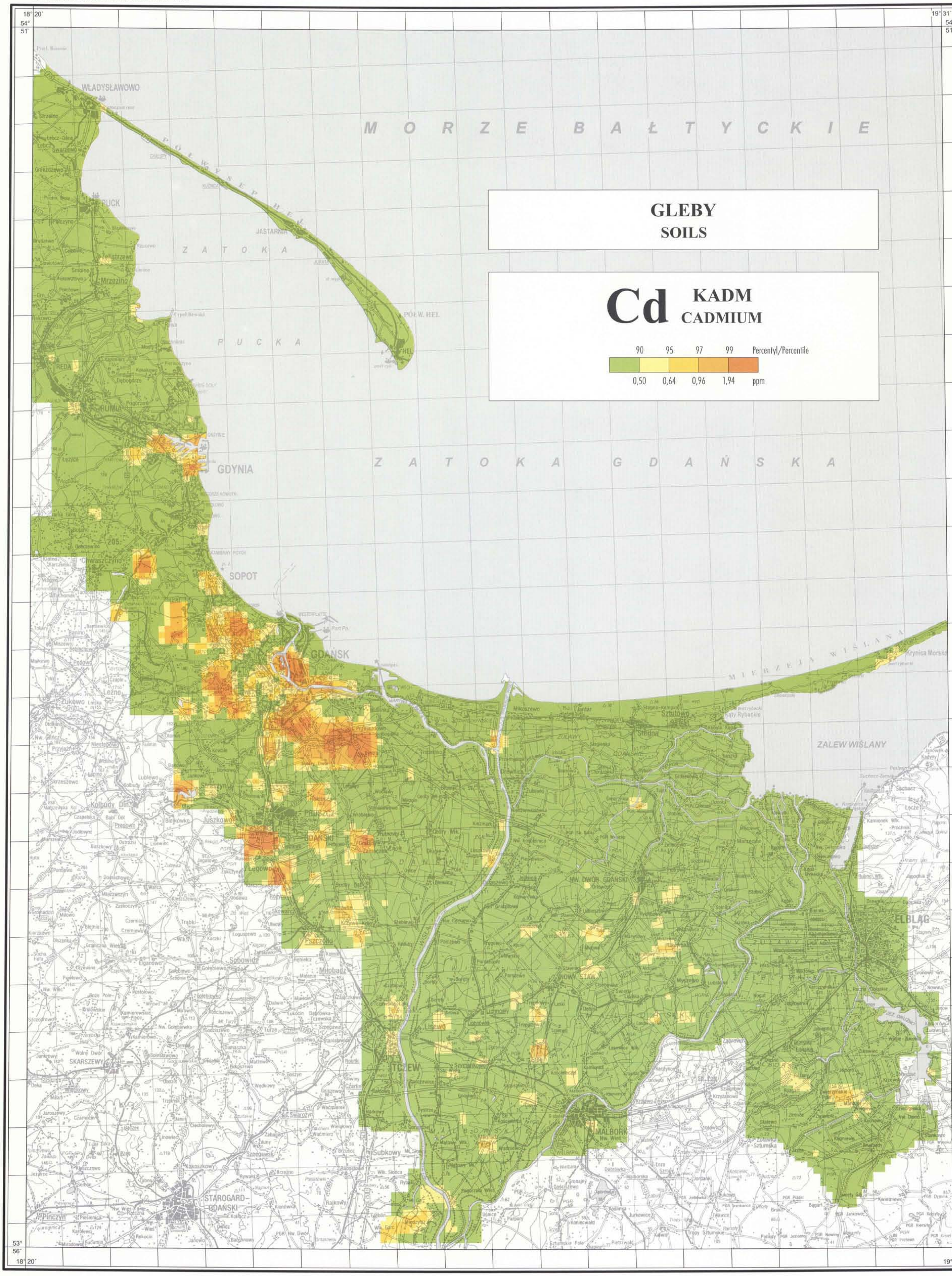
GLEBY
SOILS
Cd
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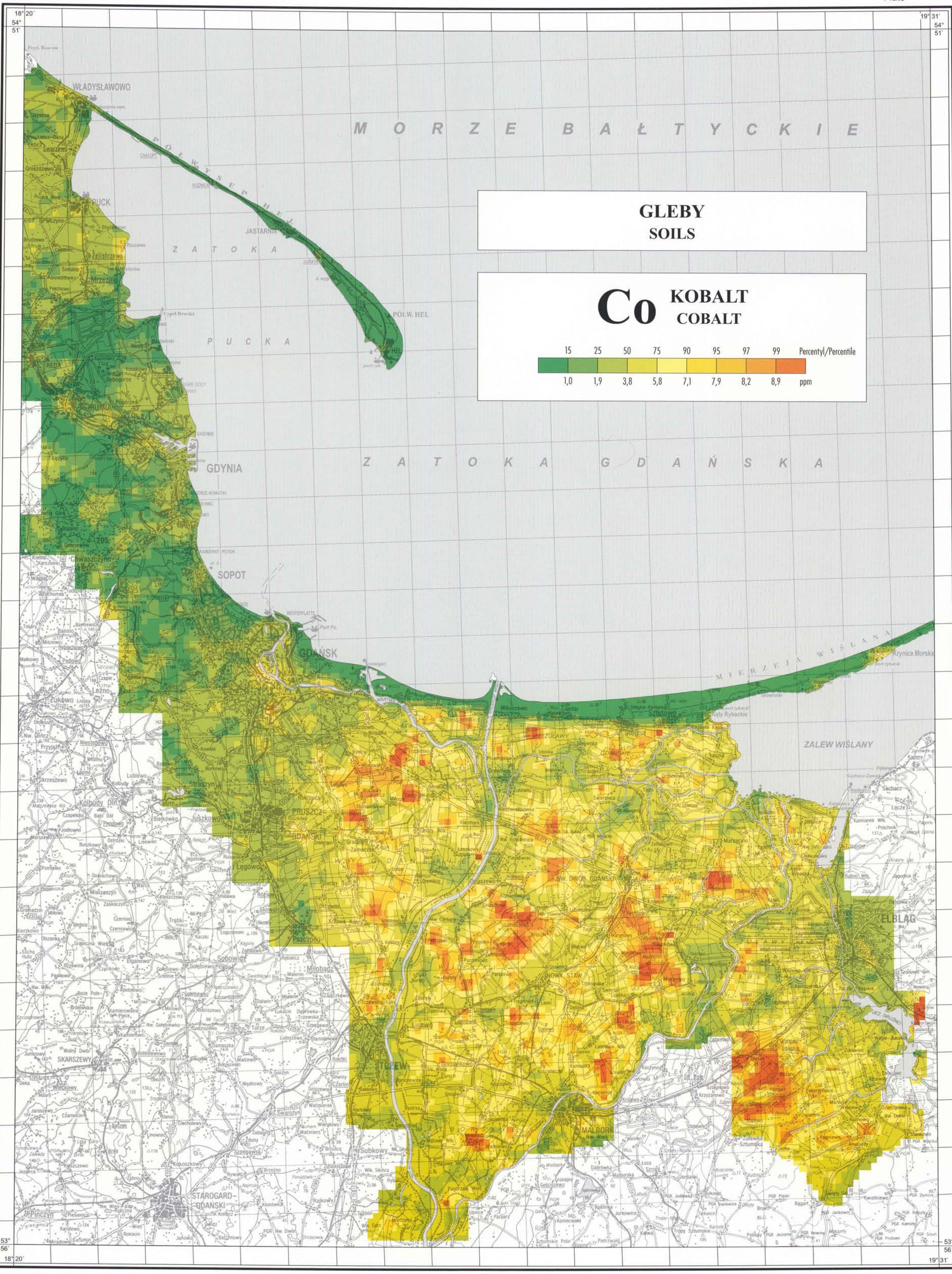
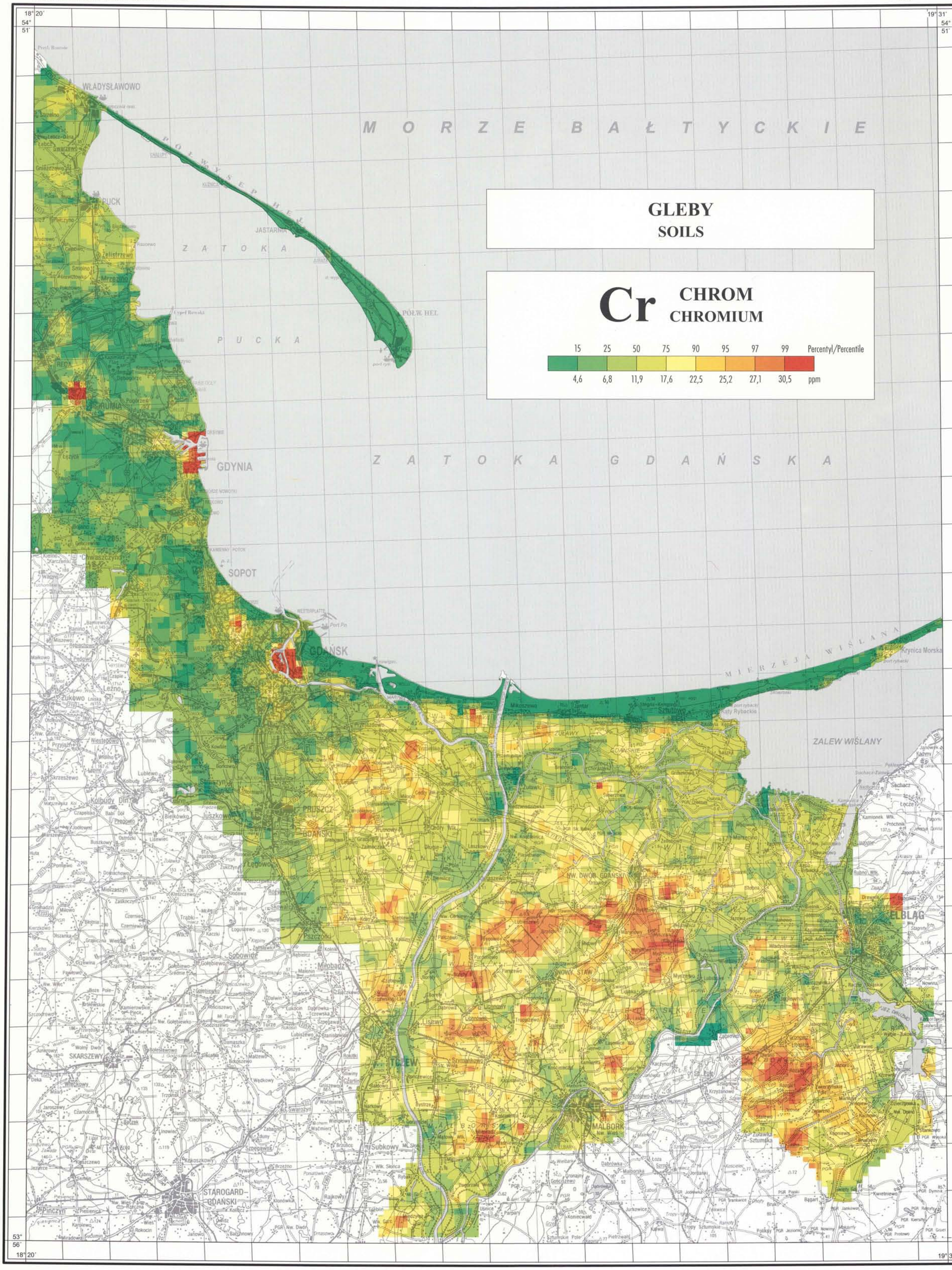
CADMIUM
90 95 97 99 Percentyl/Percentile
0,50 0,64 0,96 1,94 ppm
MORZE BAŁTYCKIE
ZATOKA PUCKA
ZATOKA GDAŃSKA
ZALEW WIŚLANY
MIERZEJA WIŚLANA
WŁADYSŁAWOWO
PUCK
JASTARNIA
HEL
GDYNIA
SOPOT
GDAŃSK
ELBLĄG
TCZEW
MALBORK
STAROGARD GDAŃSKI
SKARSZEWY
NOWY STAW
NW. DWÓR GDAŃSKI
18° 20'
54° 51'
19° 31'
53° 56'


GLEBY
SOILS
Co KOBALT
COBALT
15 25 50 75 90 95 97 99 Percentyl/Percentile
1,0 1,9 3,8 5,8 7,1 7,9 8,2 8,9 ppm
M O R Z E B A Ł T Y C K I E
Z A T O K A P U C K A
Z A T O K A G D A Ń S K A
ZALEW WIŚLANY
M I E R Z E J A W I Ś L A N A
P Ó Ł W Y S E P H E L
WŁADYSŁAWOWO
PUCK
JASTARNIA
HEL
GDYNIA
SOPOT
GDAŃSK
PRUSZCZ GDAŃSKI
NW. DWÓR GDAŃSKI
NOWY STAW
ELBLĄG
TCZEW
MALBORK
SKARSZEWY
STAROGARD GDAŃSKI
18° 20'
54° 51'
19° 31'
53° 56'



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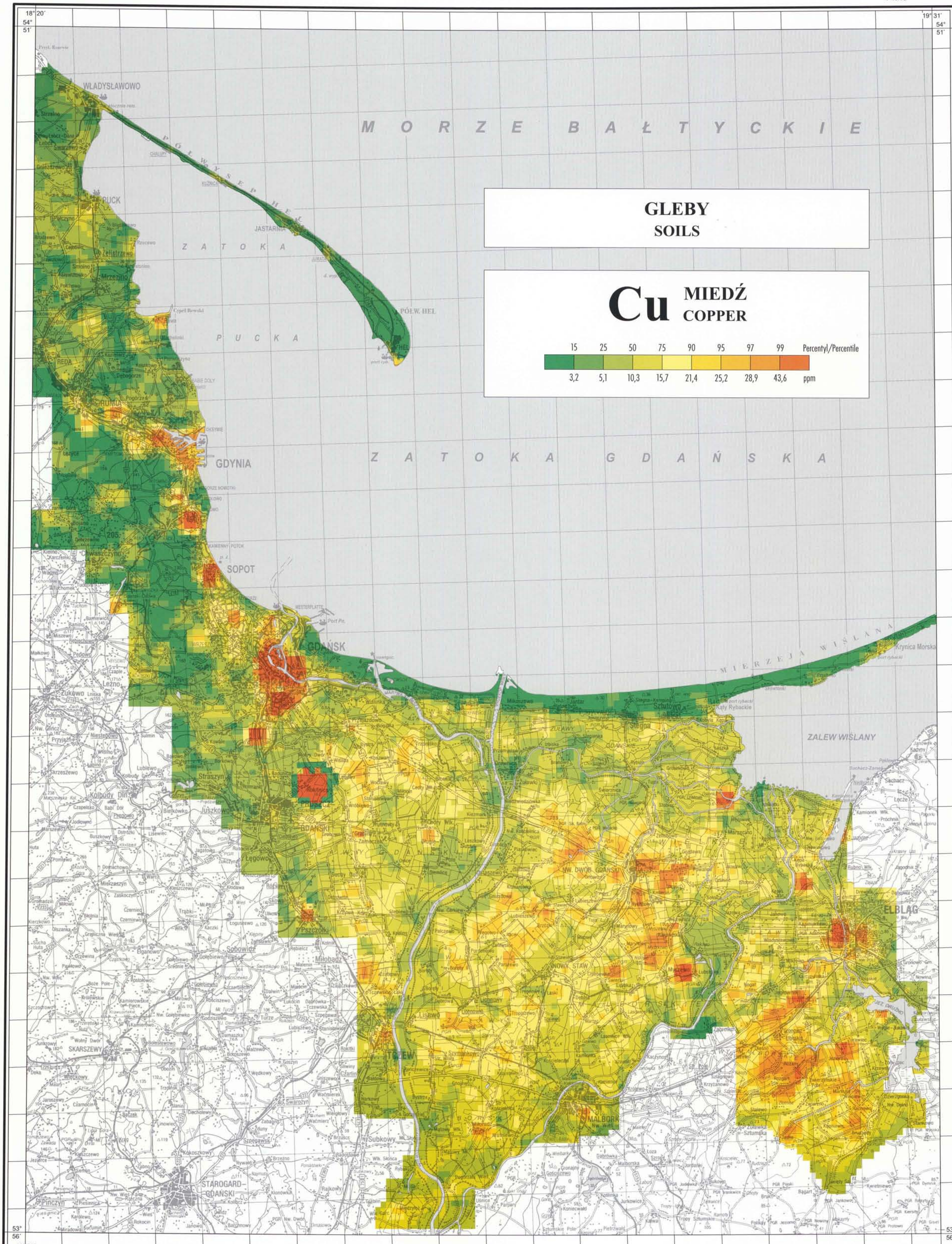

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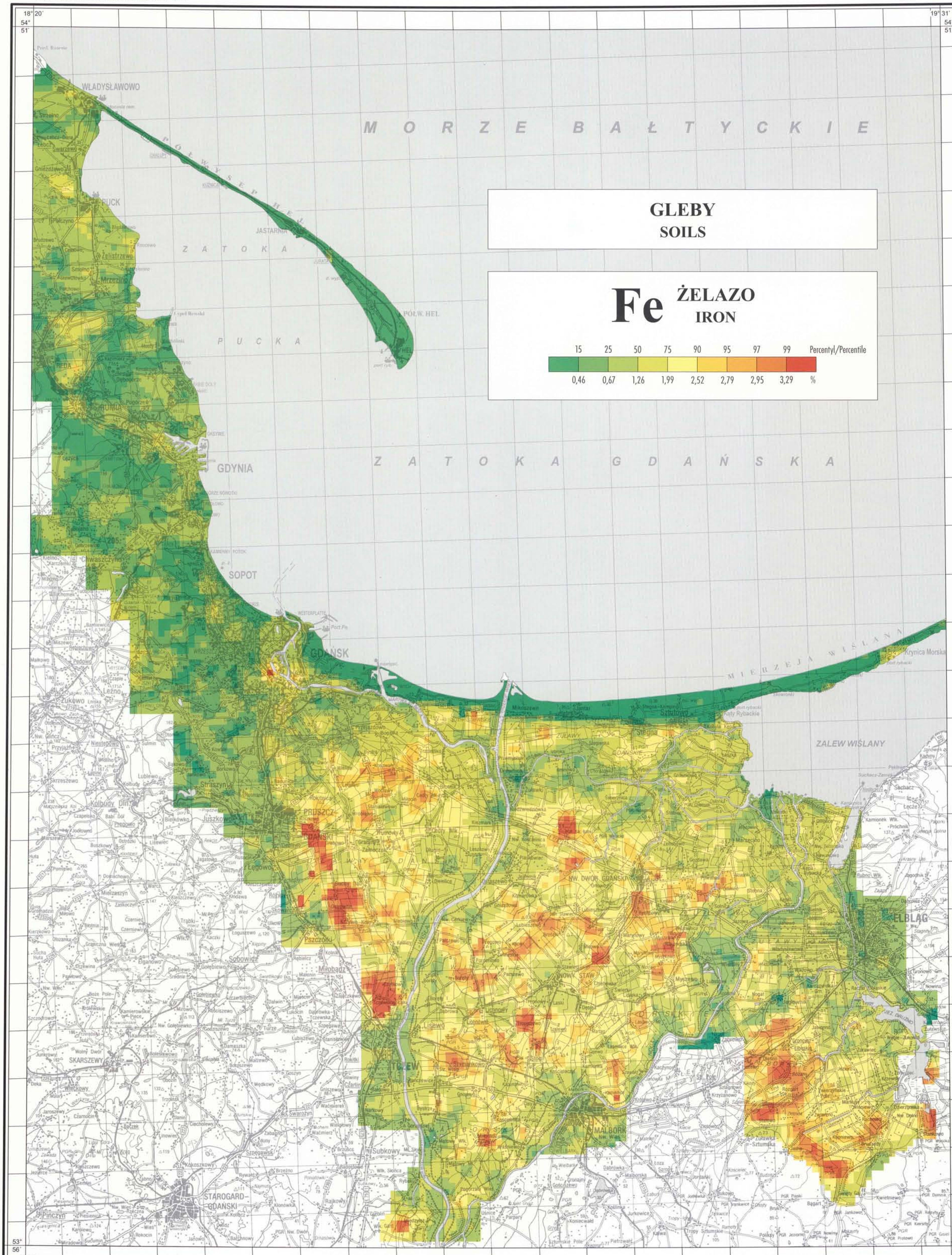
GLEBY
SOILS
Fe ŻELAZO
IRON
15 25 50 75 90 95 97 99 Percentyl/Percentile
0,46 0,67 1,26 1,99 2,52 2,79 2,95 3,29 %
M O R Z E B A Ł T Y C K I E
Z A T O K A G D A Ń S K A
GDYNIA
SOPOT
GDAŃSK
ZALEW WIŚLANY
ELBLĄG
MALBORK
STAROGARD GDAŃSKI
PUCK
WŁADYSŁAWOWO
18° 20′
19° 31′
54° 51′
53° 56′

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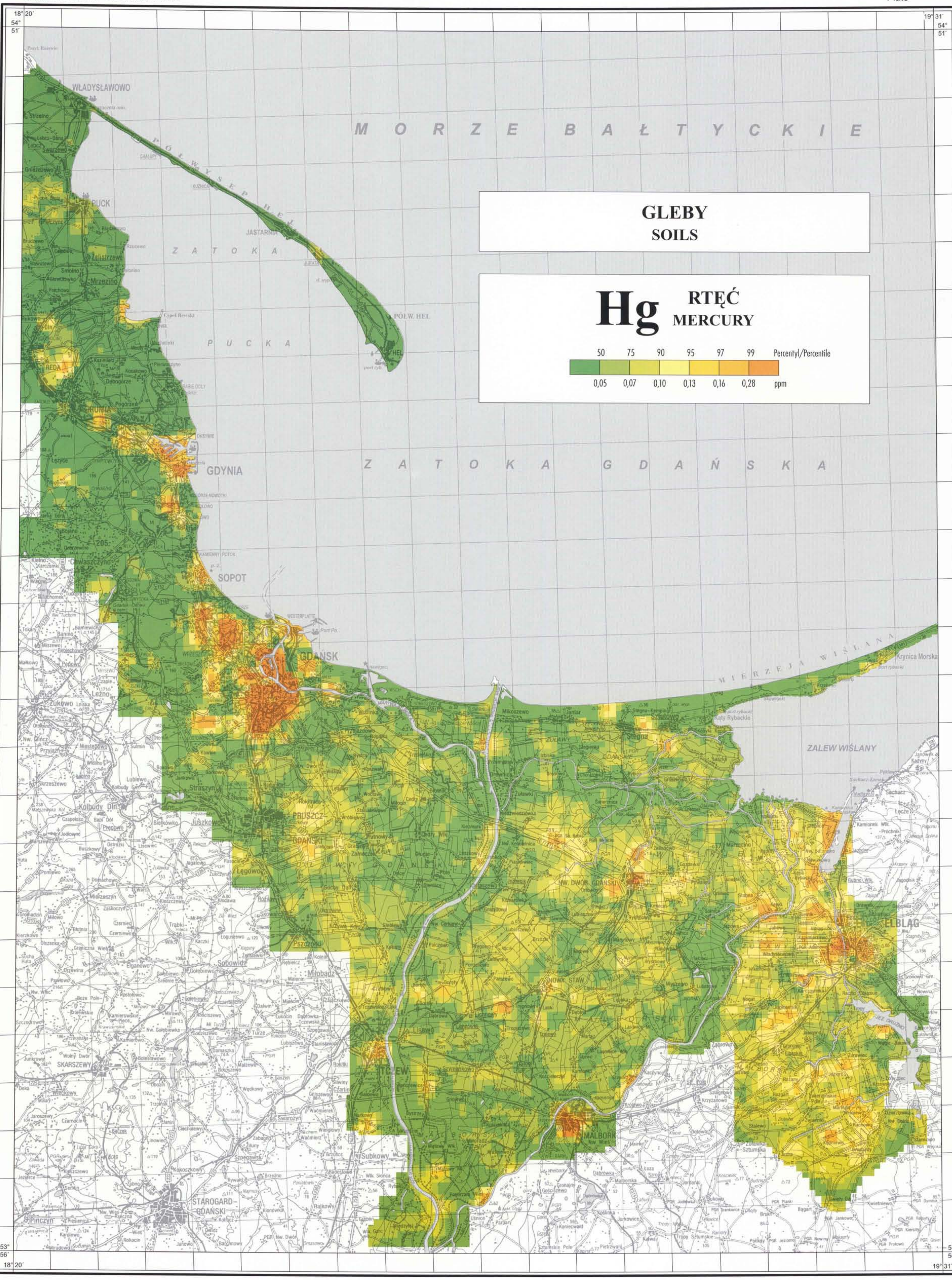

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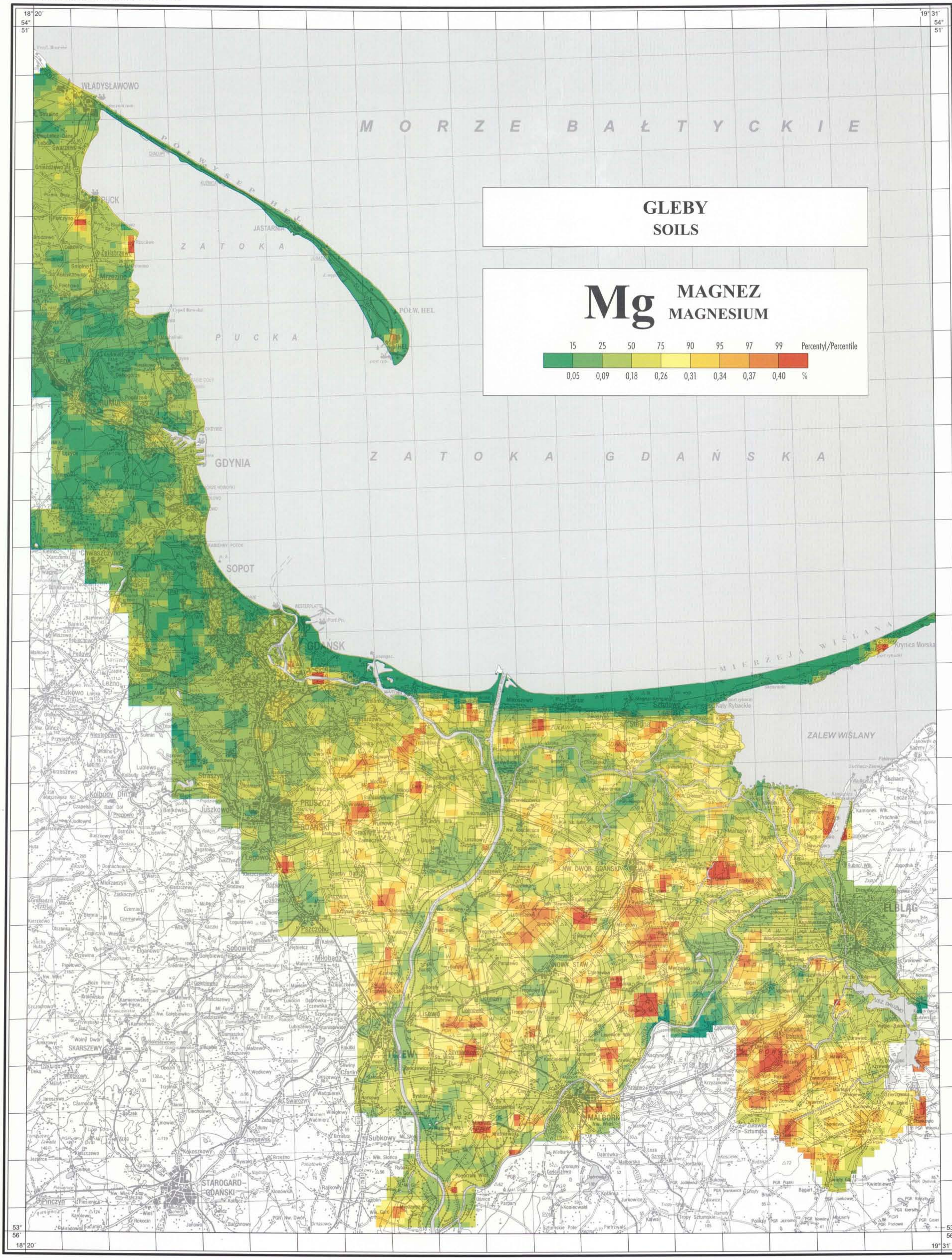
GLEBY
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Mg MAGNEZ
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15 25 50 75 90 95 97 99 Percentyl/Percentile
0,05 0,09 0,18 0,26 0,31 0,34 0,37 0,40 %
M O R Z E B A Ł T Y C K I E
Z A T O K A G D A Ń S K A
Z A T O K A P U C K A
ZALEW WIŚLANY
MIERZEJA WIŚLANA
WŁADYSŁAWOWO
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ELBLĄG
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MALBORK
STAROGARD GDAŃSKI
SKARSZEWY
18° 20′
19° 31′
54° 51′
53° 56′

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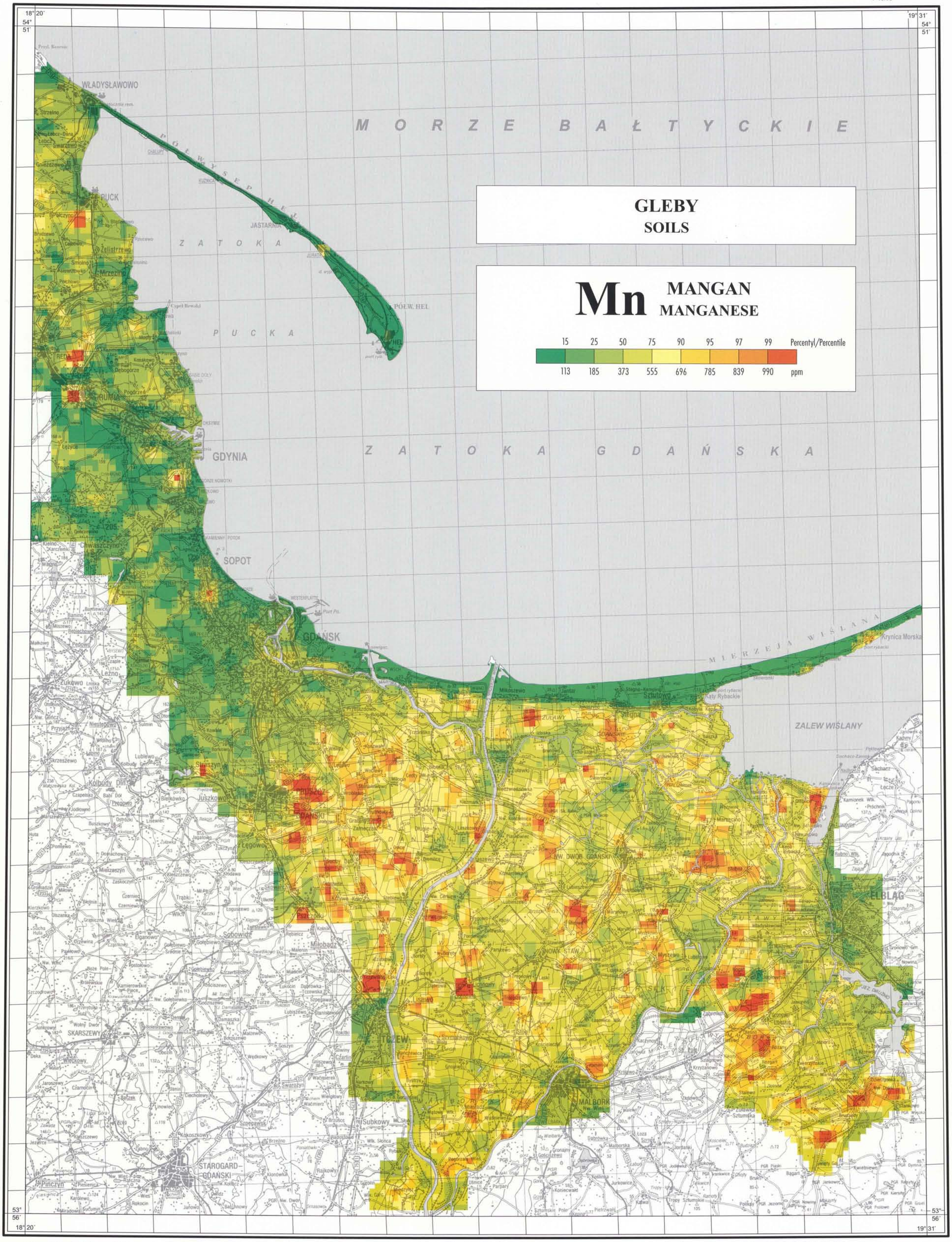

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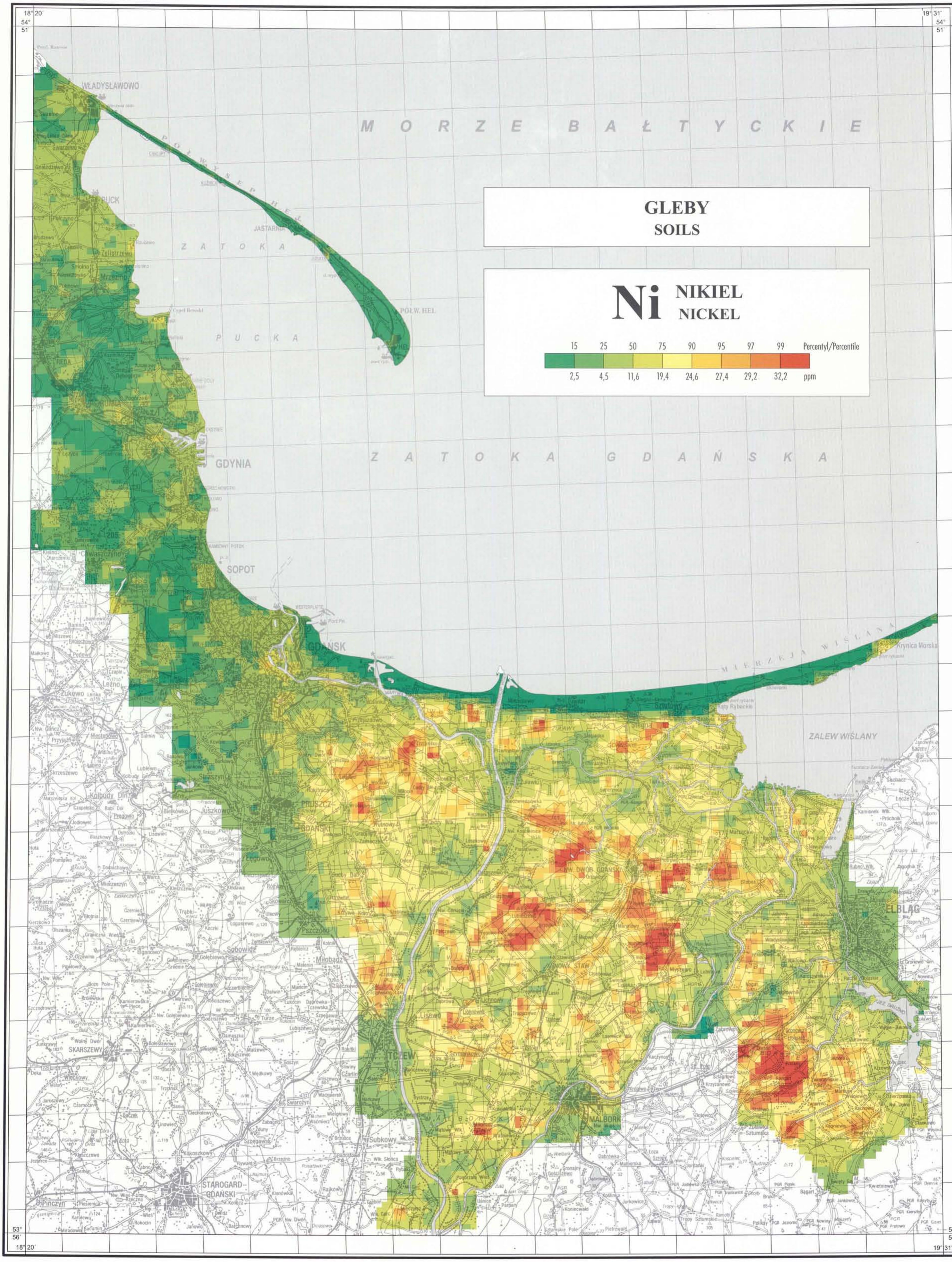

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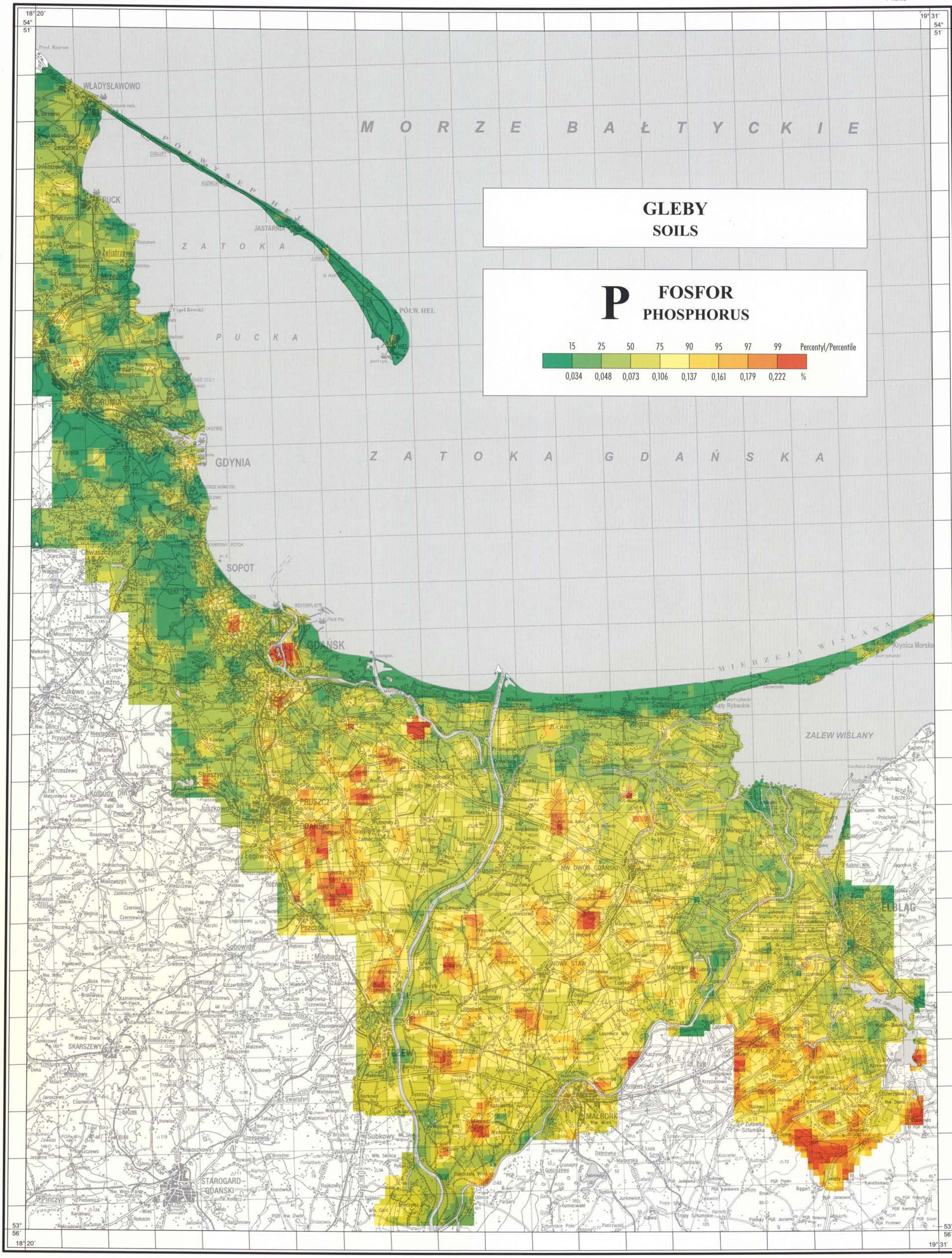

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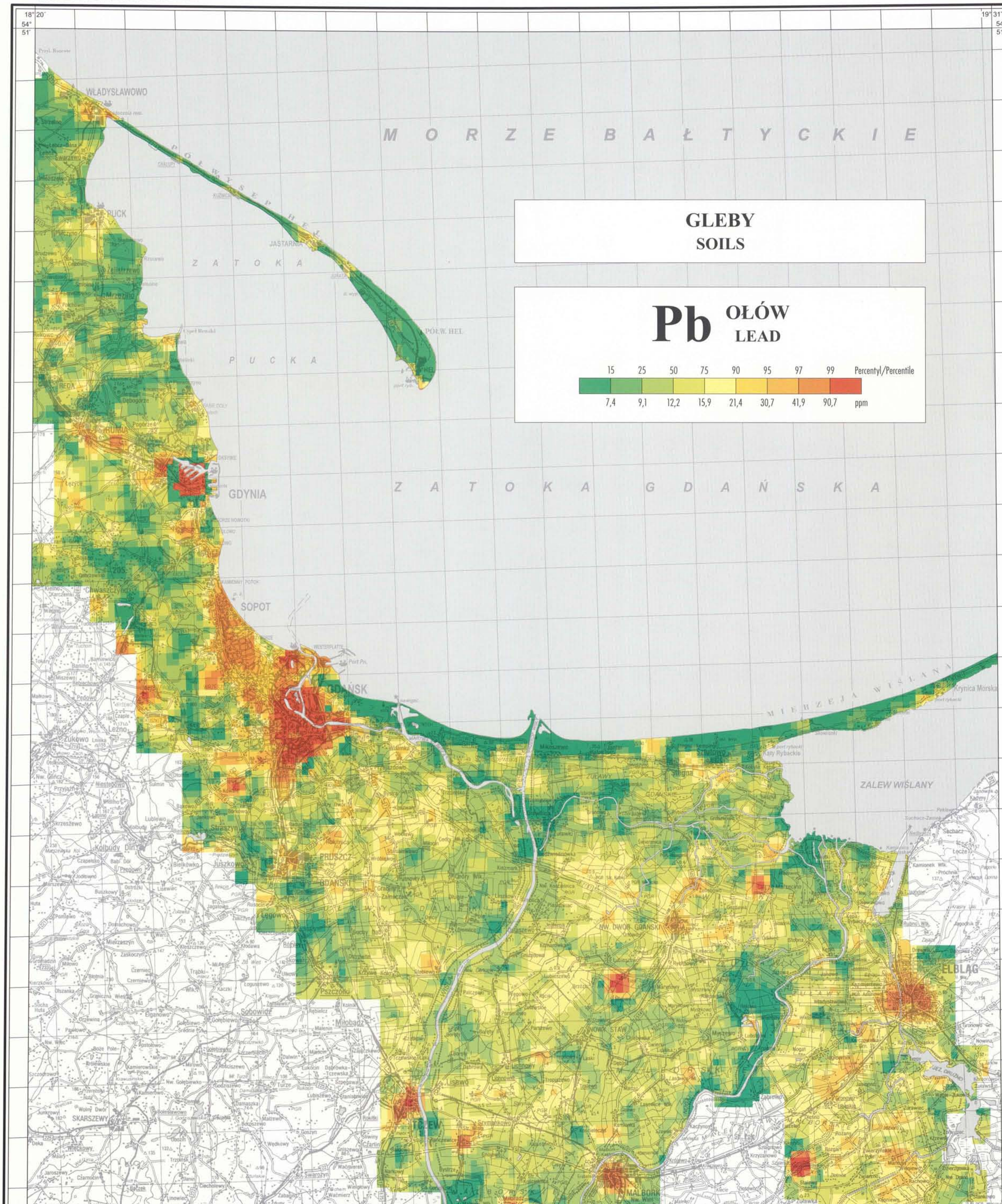

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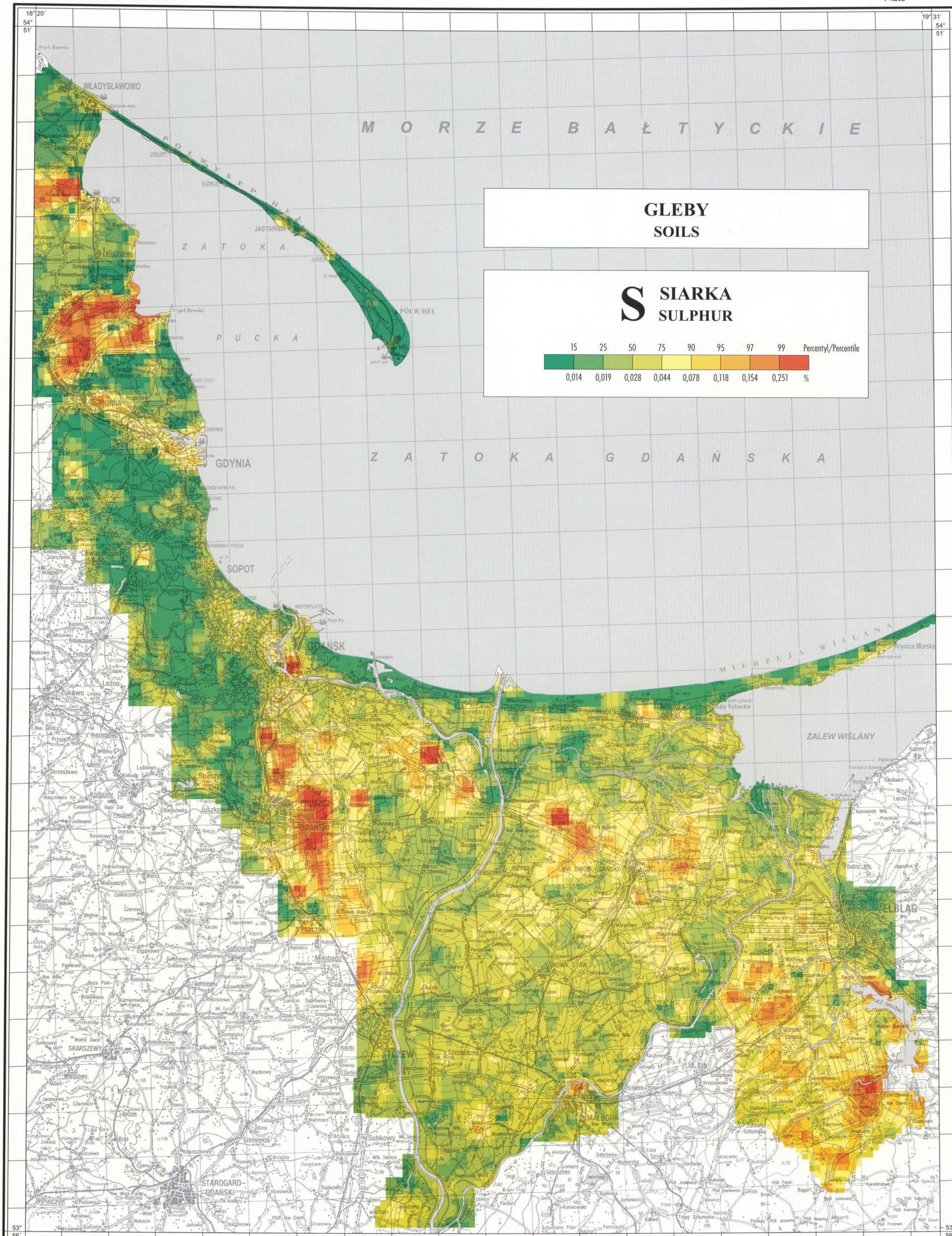

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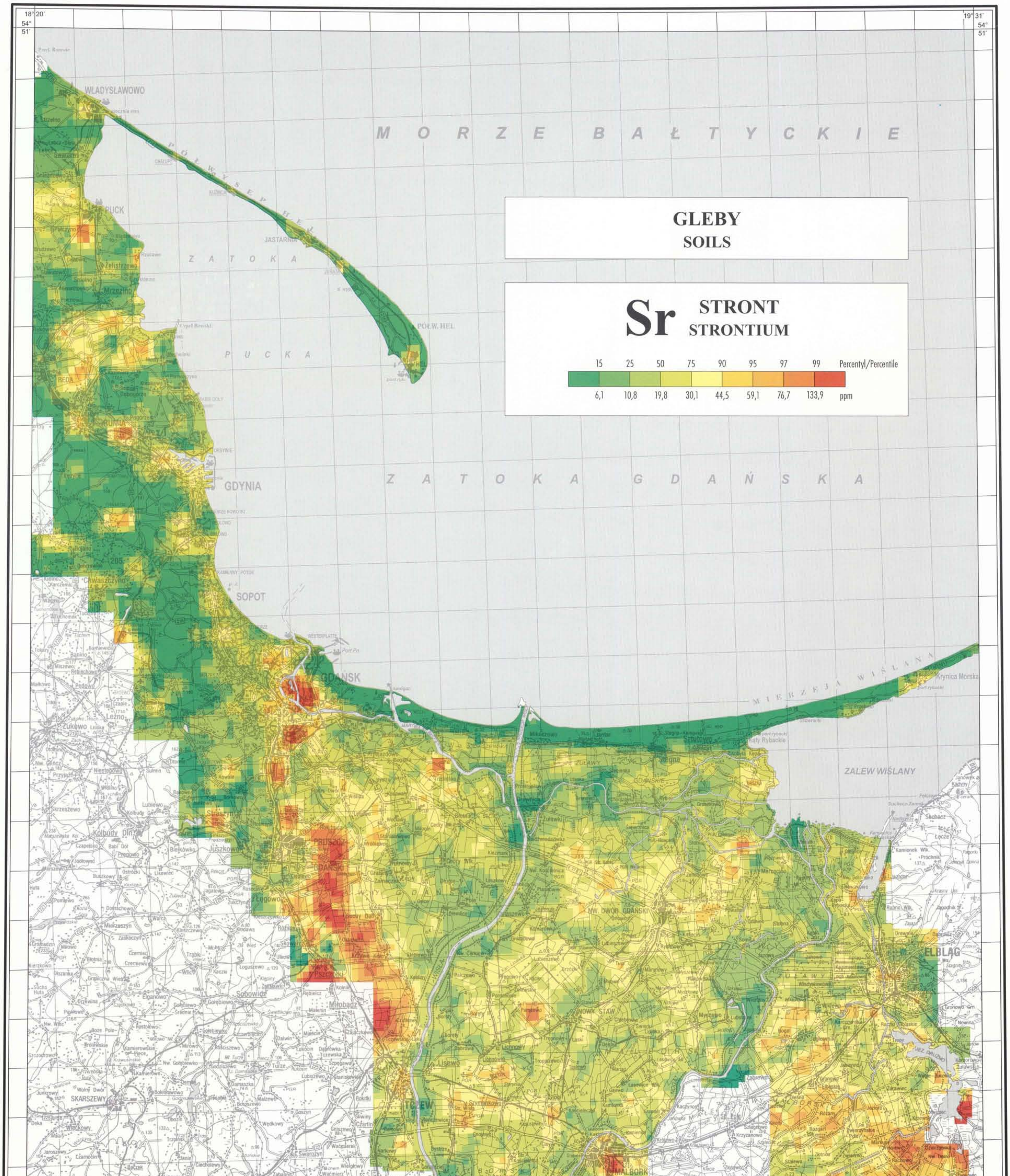

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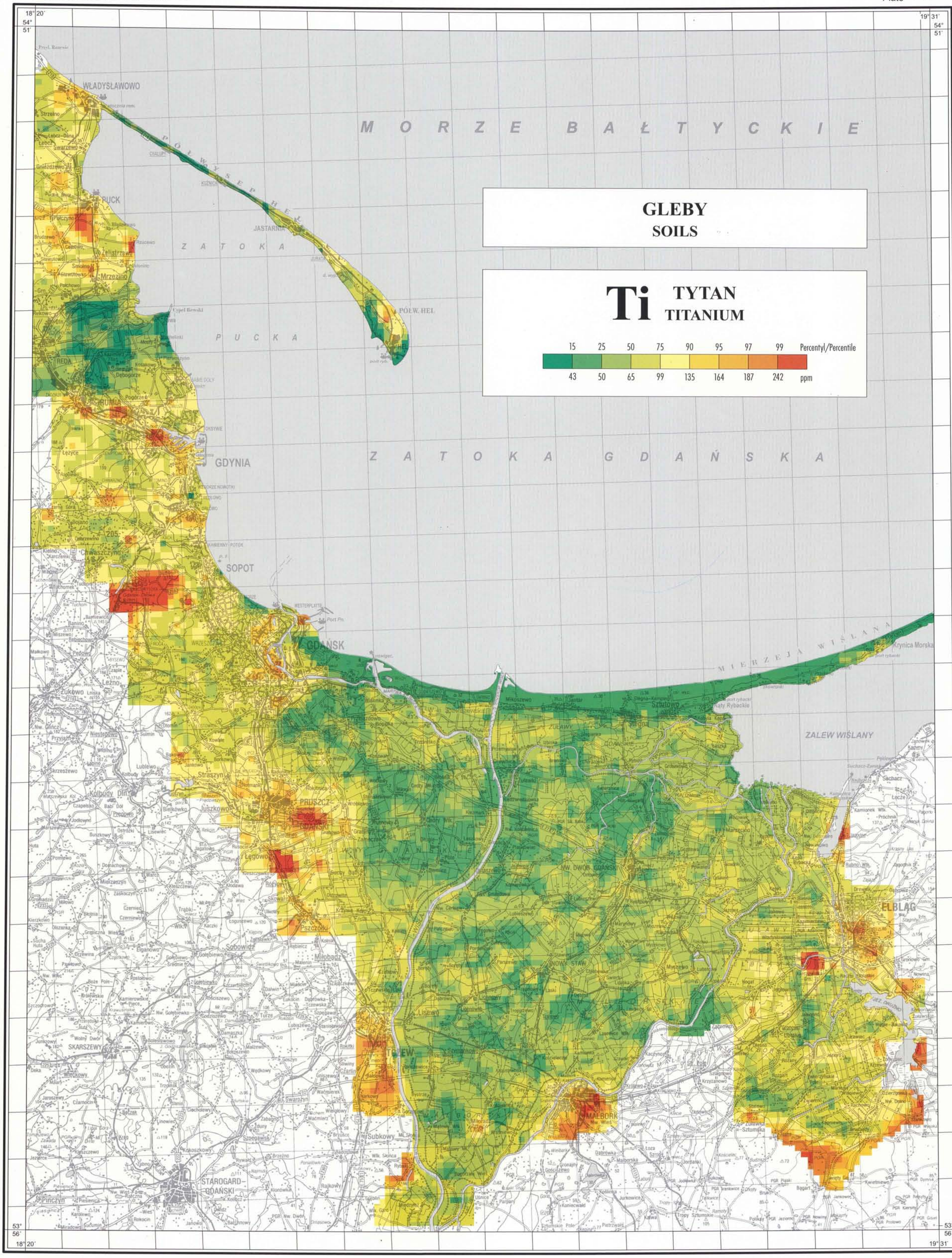

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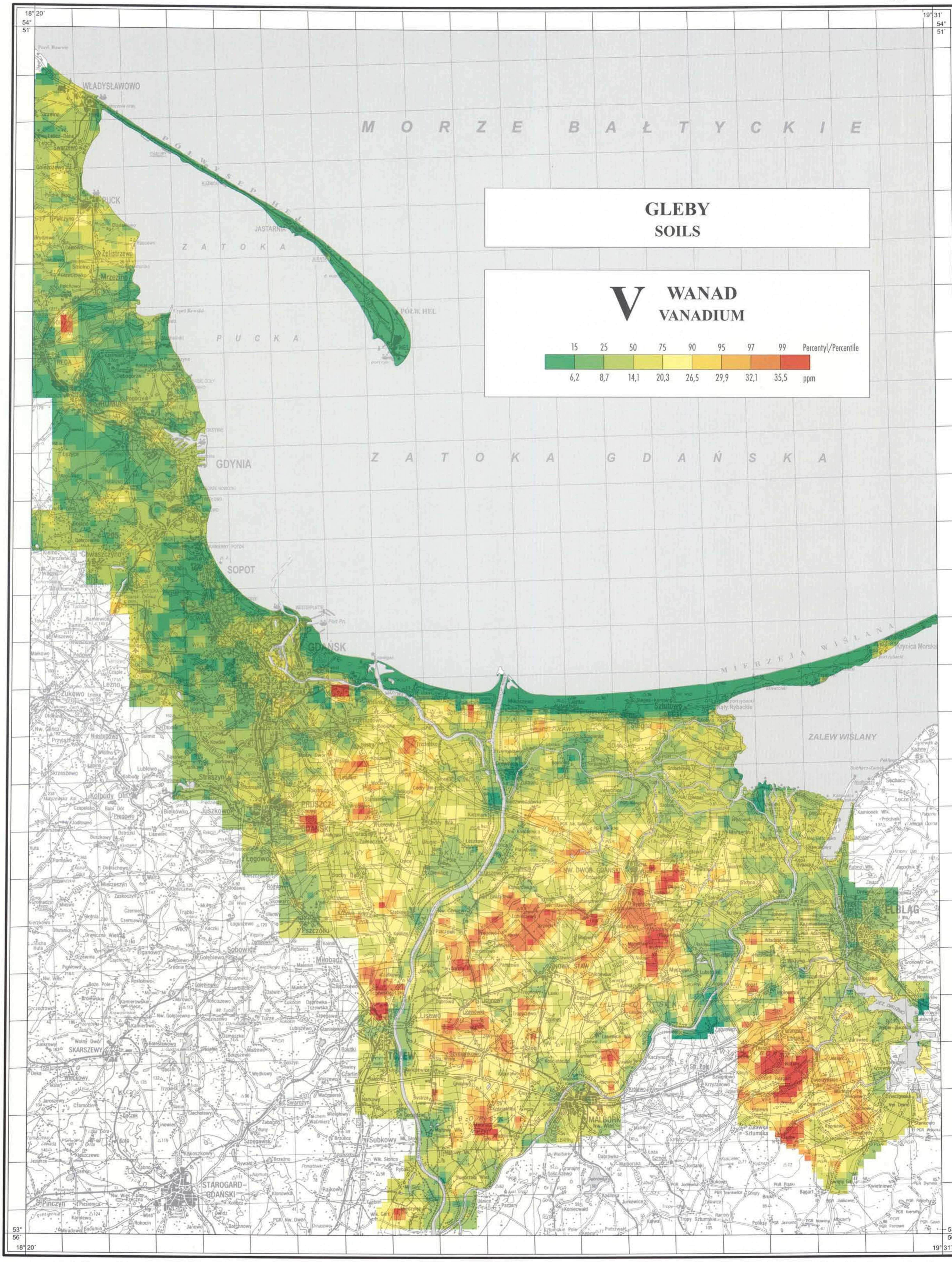
GLEBY
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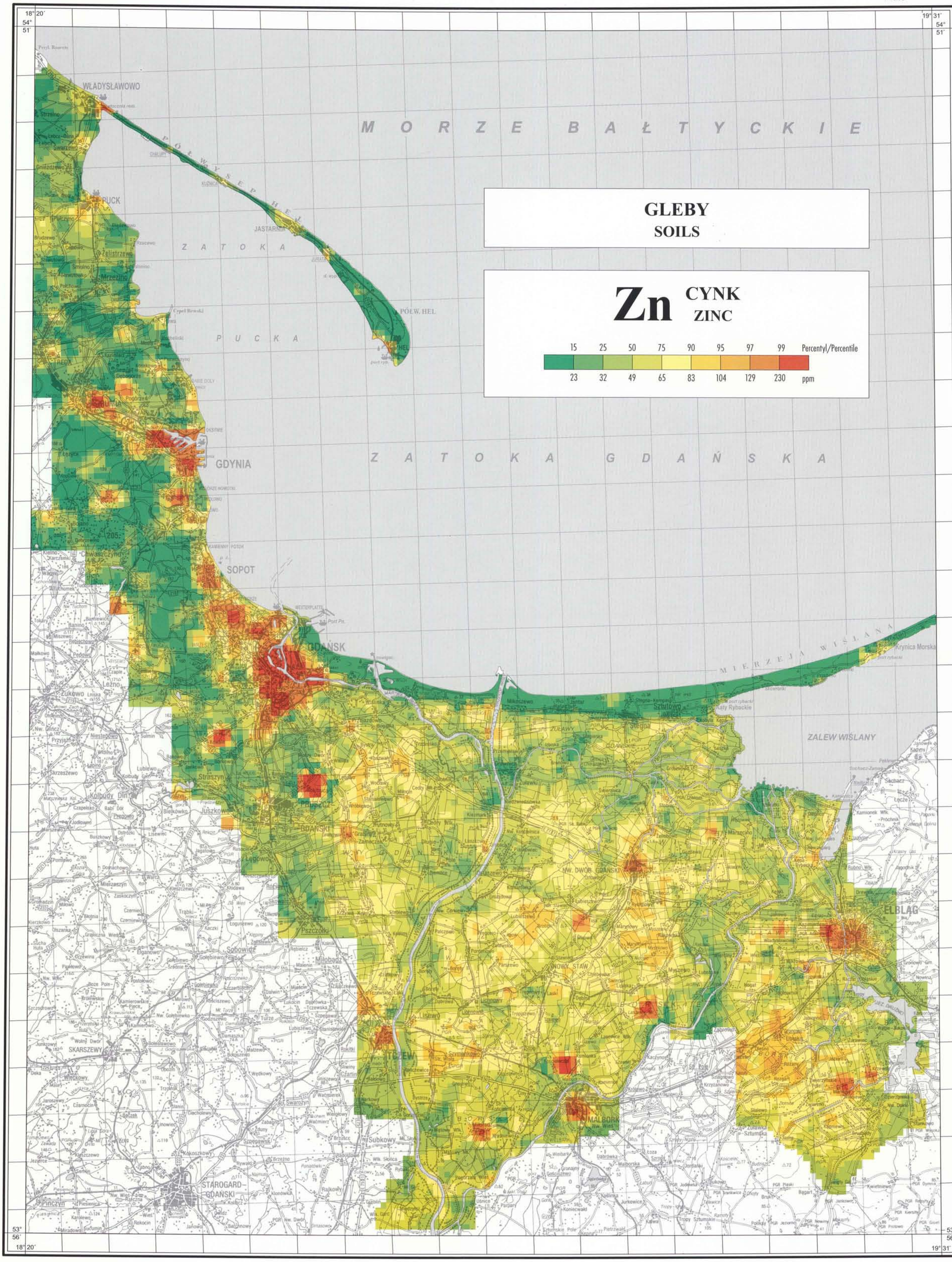
V WANAD
VANADIUM
15 25 50 75 90 95 97 99 Percentyl/Percentile
6,2 8,7 14,1 20,3 26,5 29,9 32,1 35,5 ppm
M O R Z E B A Ł T Y C K I E
Z A T O K A G D A Ń S K A
Z A T O K A P U C K A
ZALEW WIŚLANY
WŁADYSŁAWOWO
PUCK
GDYNIA
SOPOT
GDAŃSK
ELBLĄG
MALBORK
STAROGARD GDAŃSKI
18° 20'
19° 31'
54° 51'
53° 56'

1 : 250 000

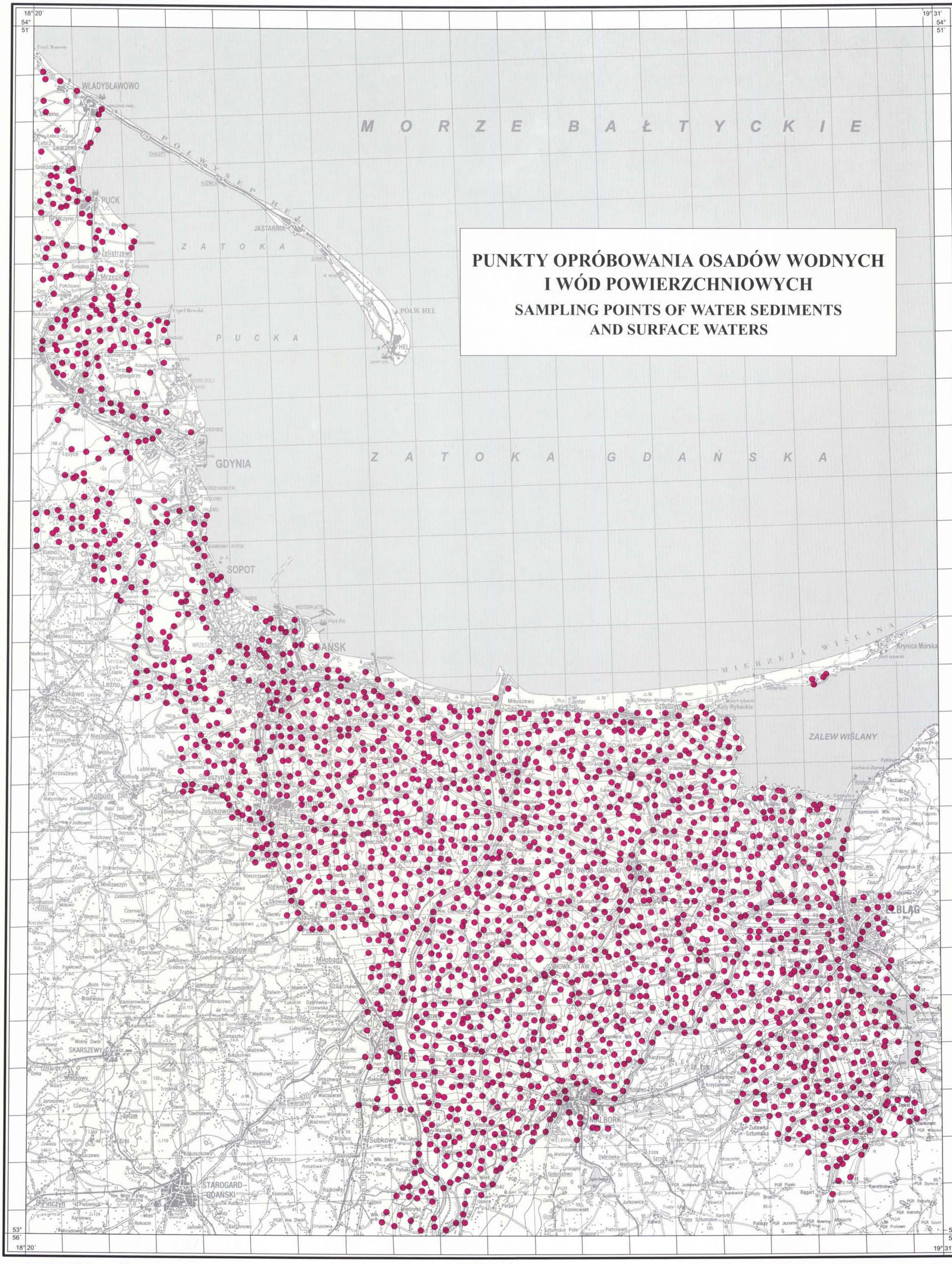


1 : 250 000

Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.

PUNKTY OPRÓBOWANIA OSADÓW WODNYCH I WÓD POWIERZCHNIOWYCH

SAMPLING POINTS OF WATER SEDIMENTS AND SURFACE WATERS



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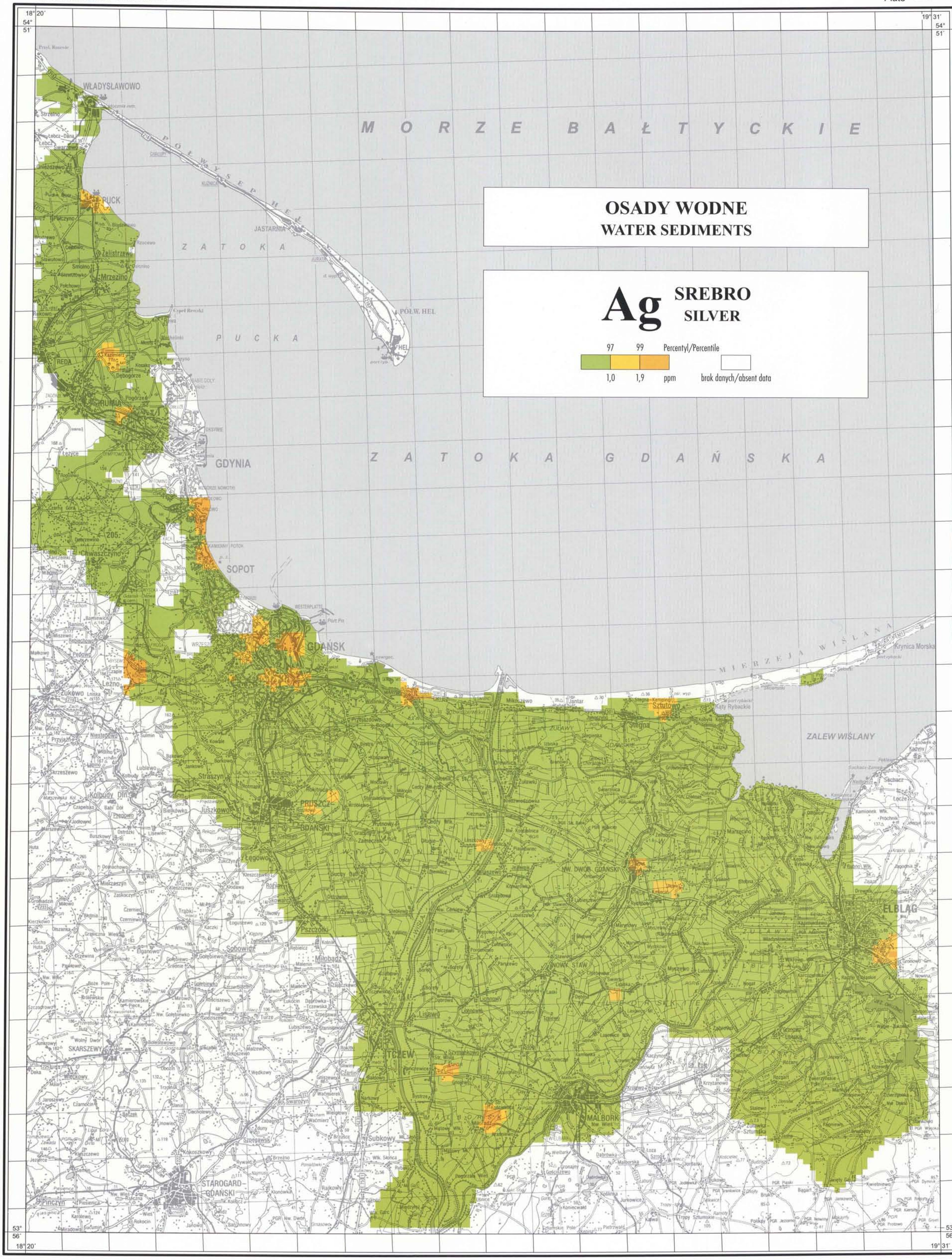

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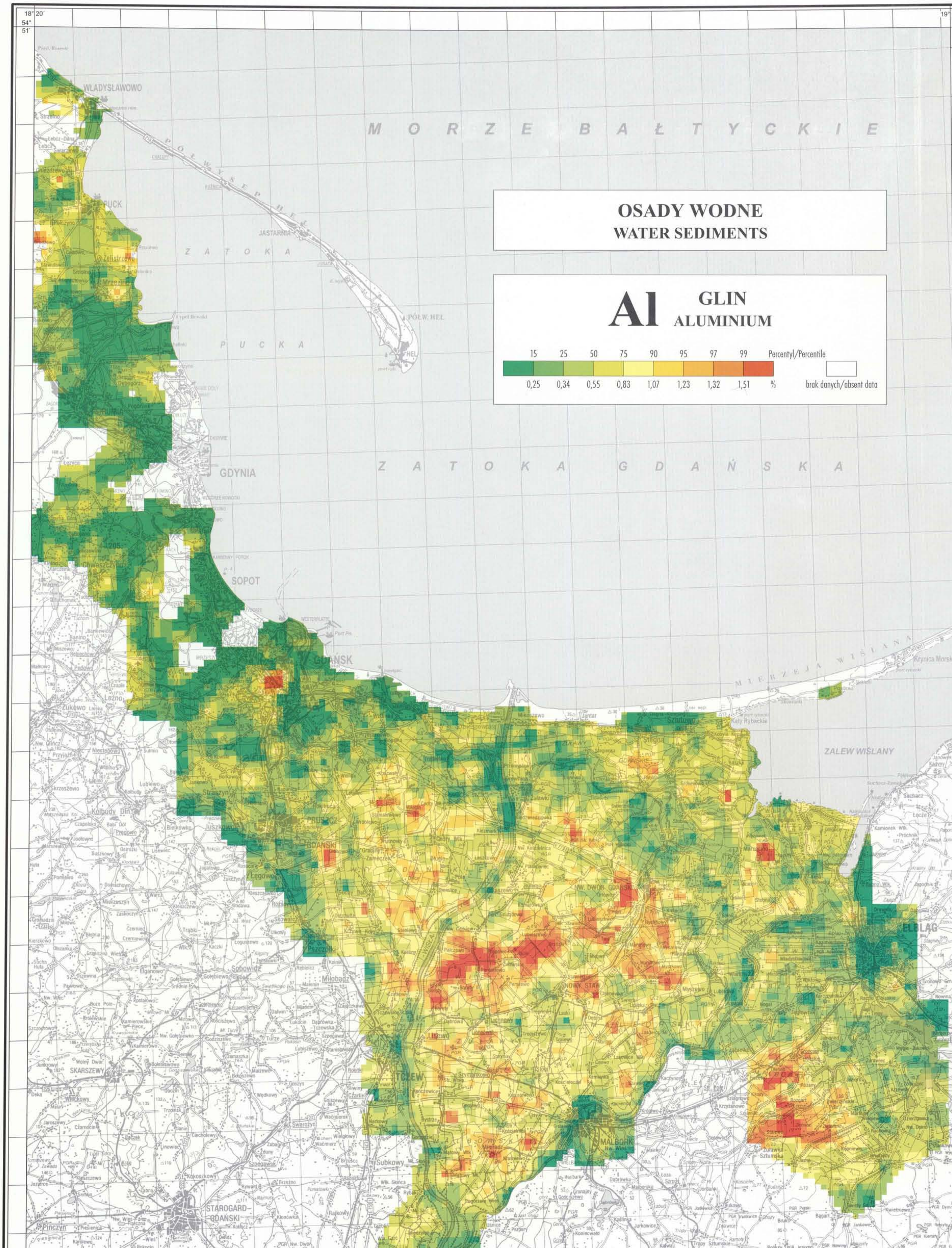
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



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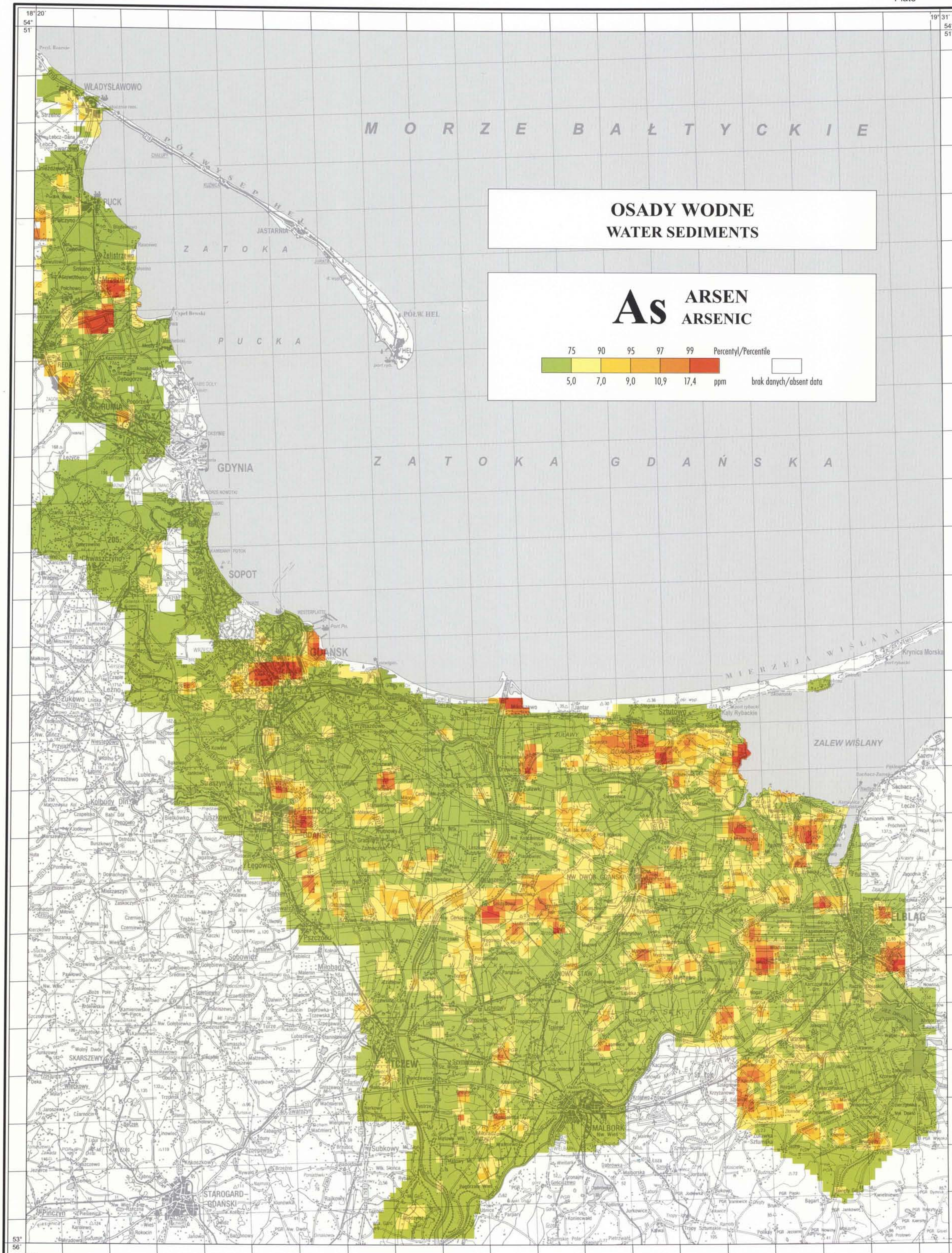
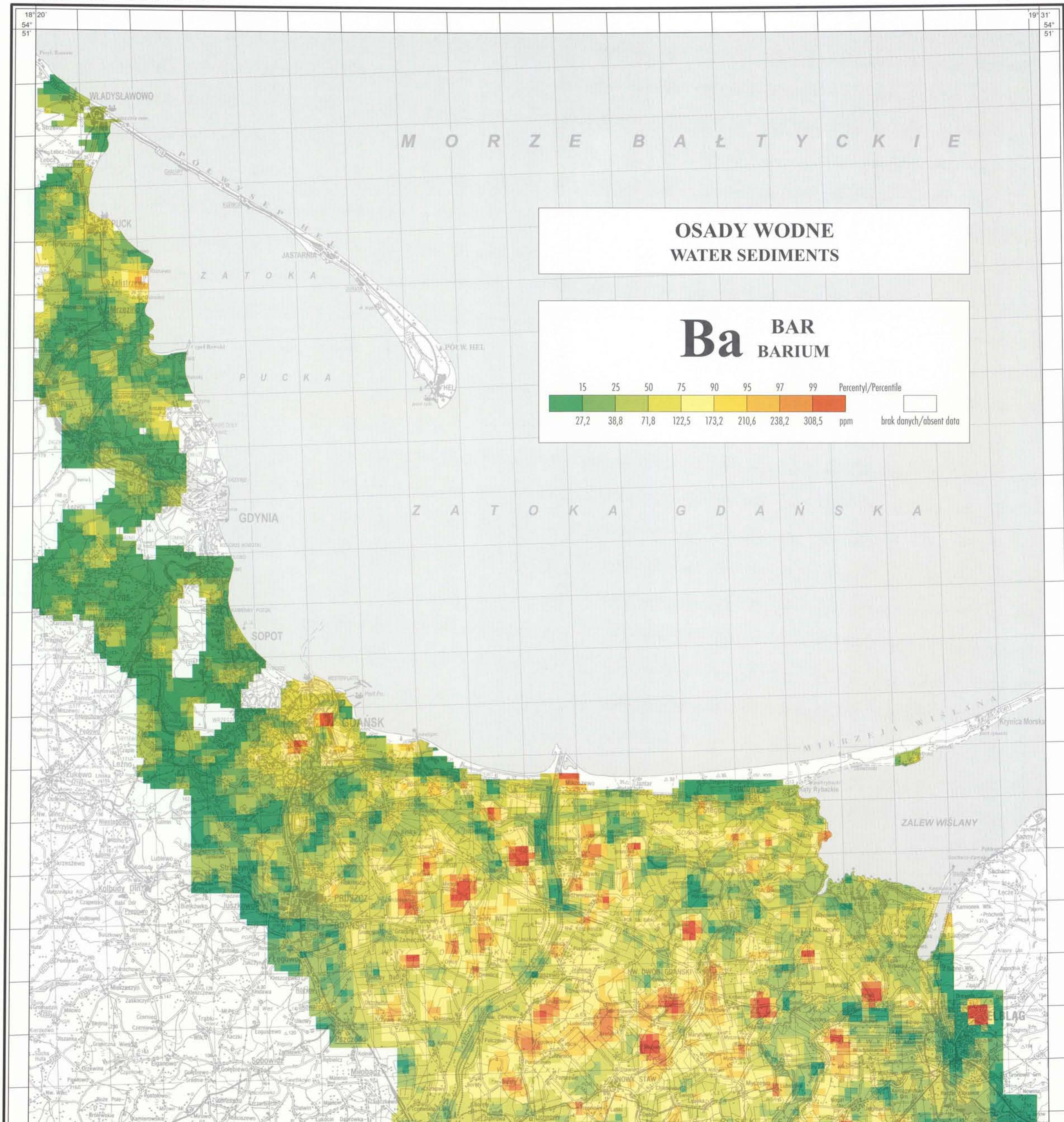
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



1 : 250 000

Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



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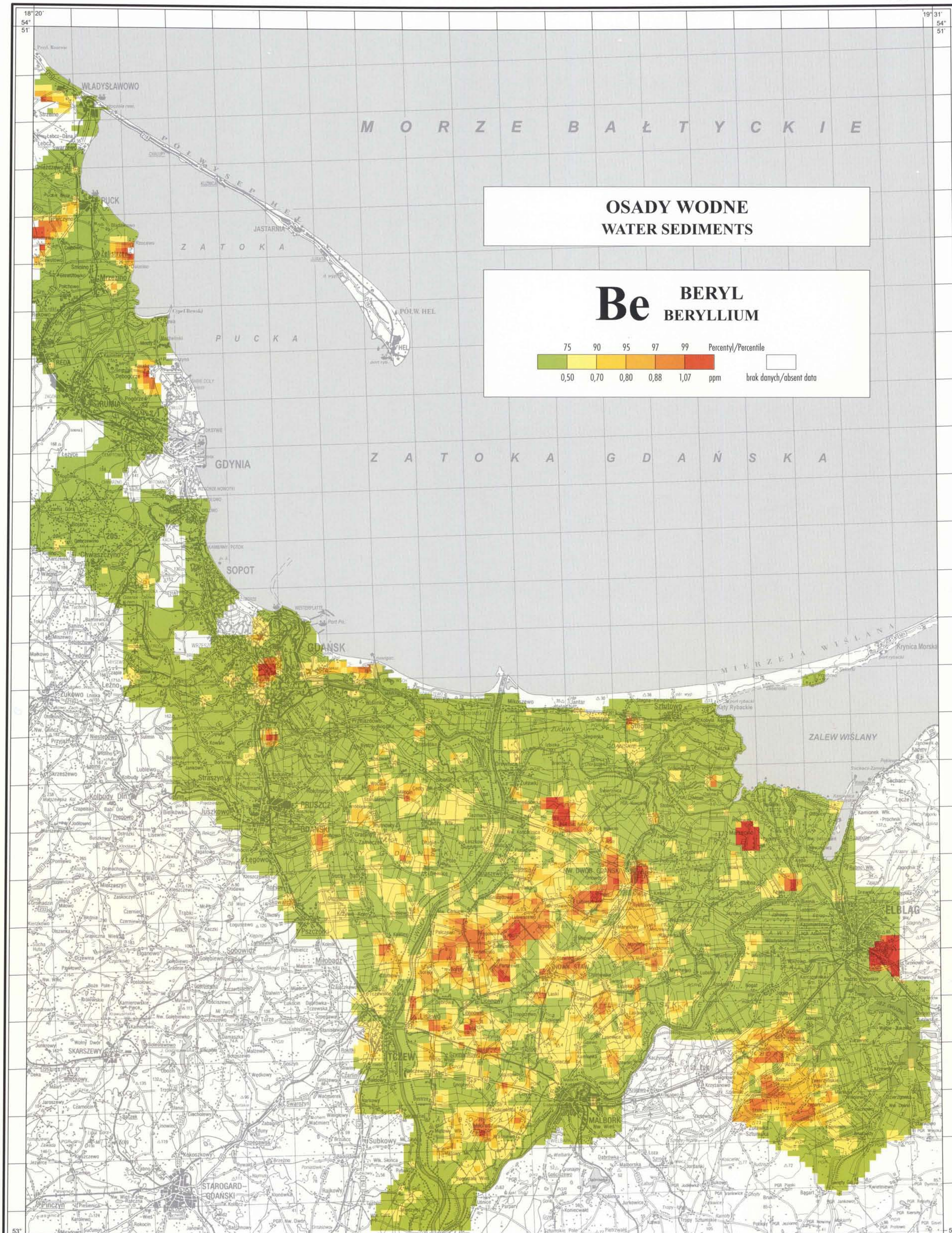
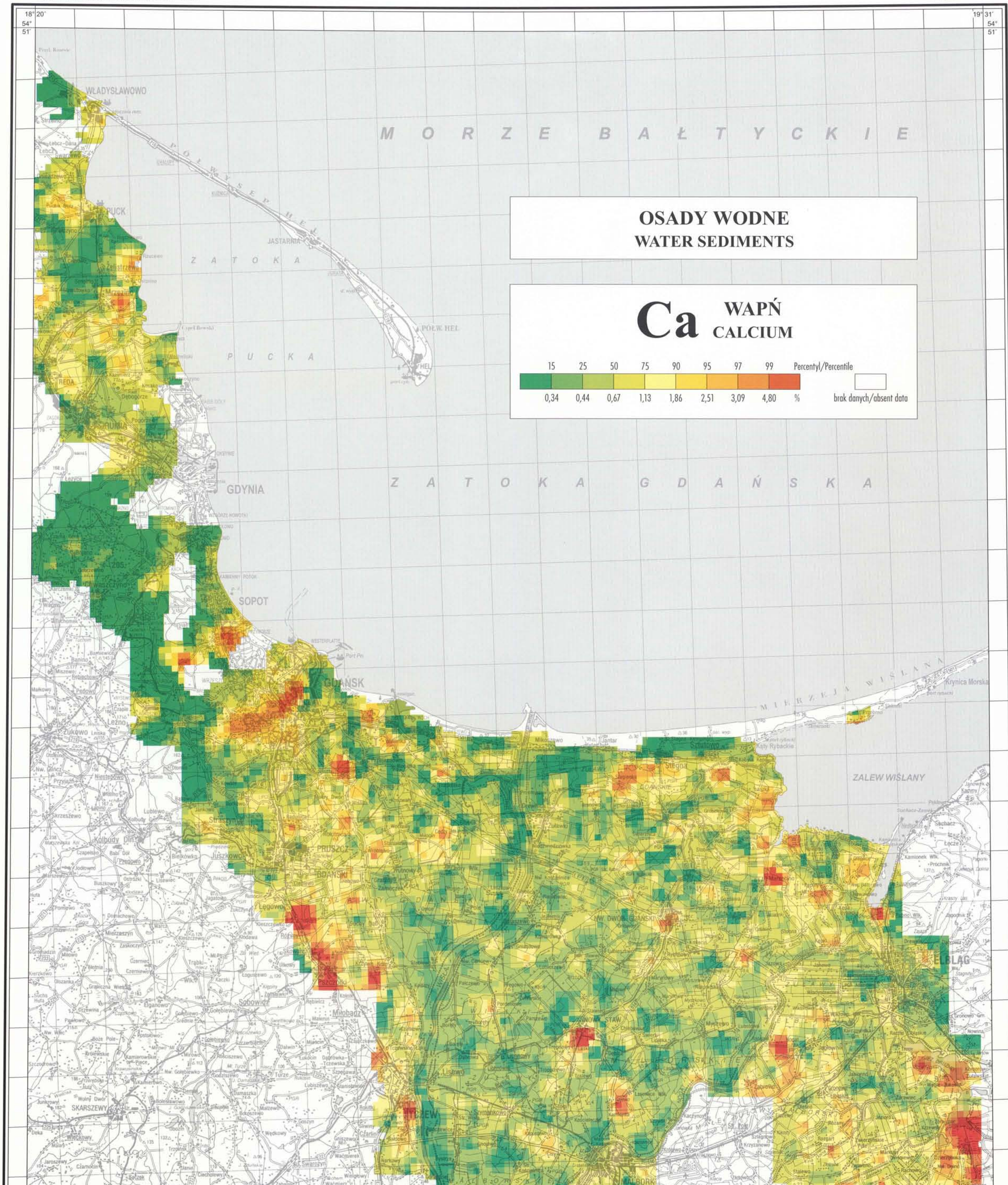


Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



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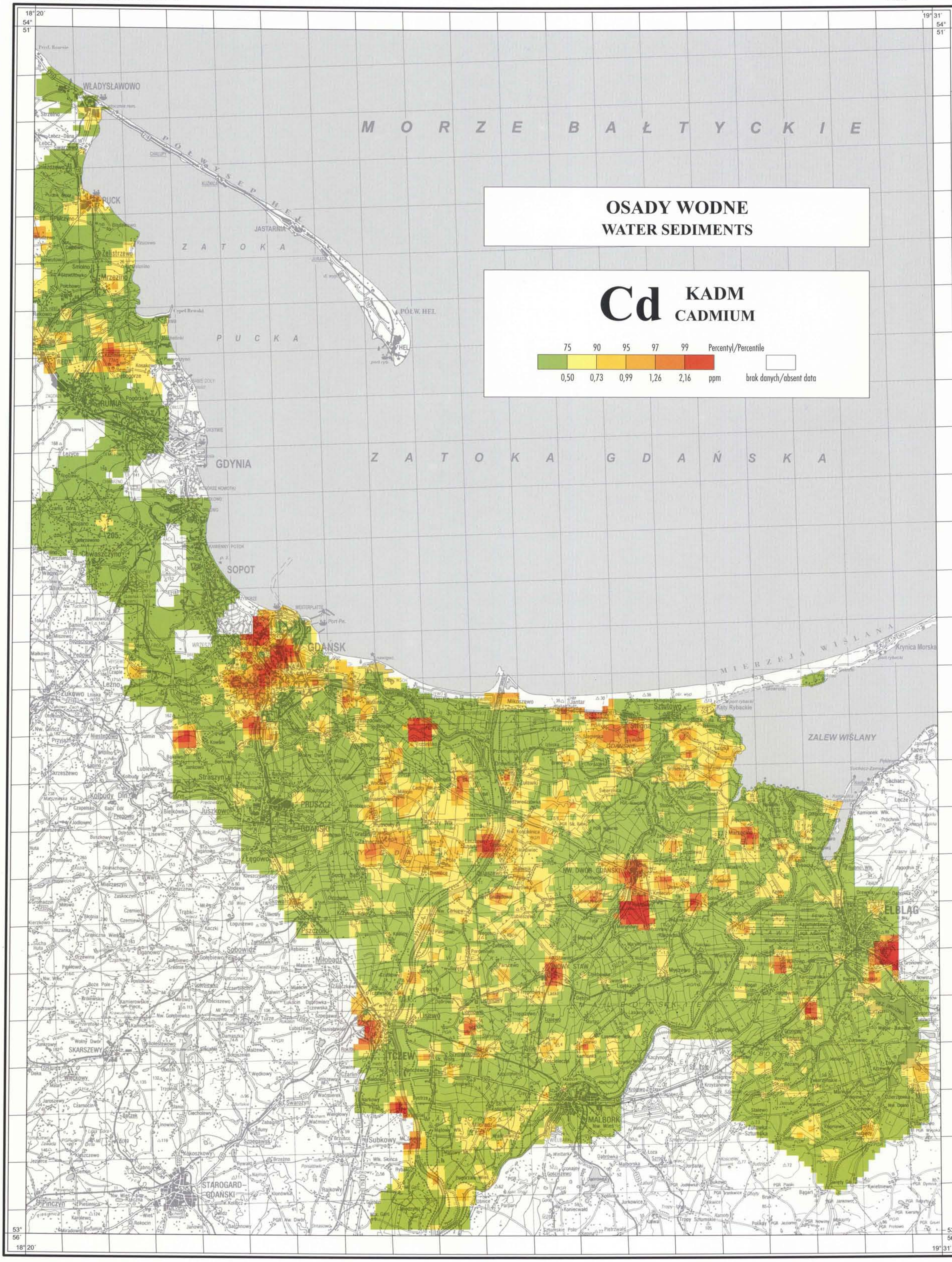

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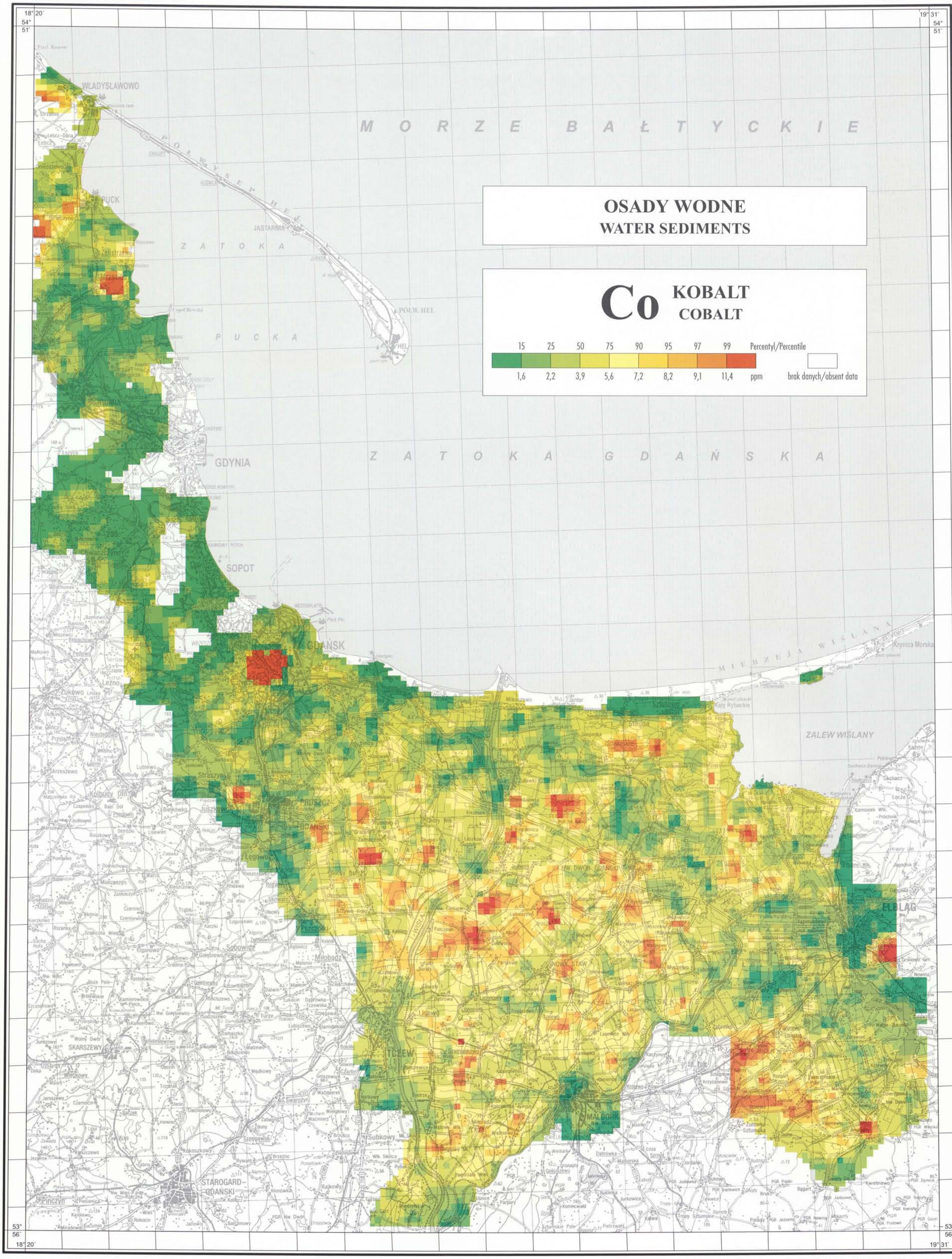

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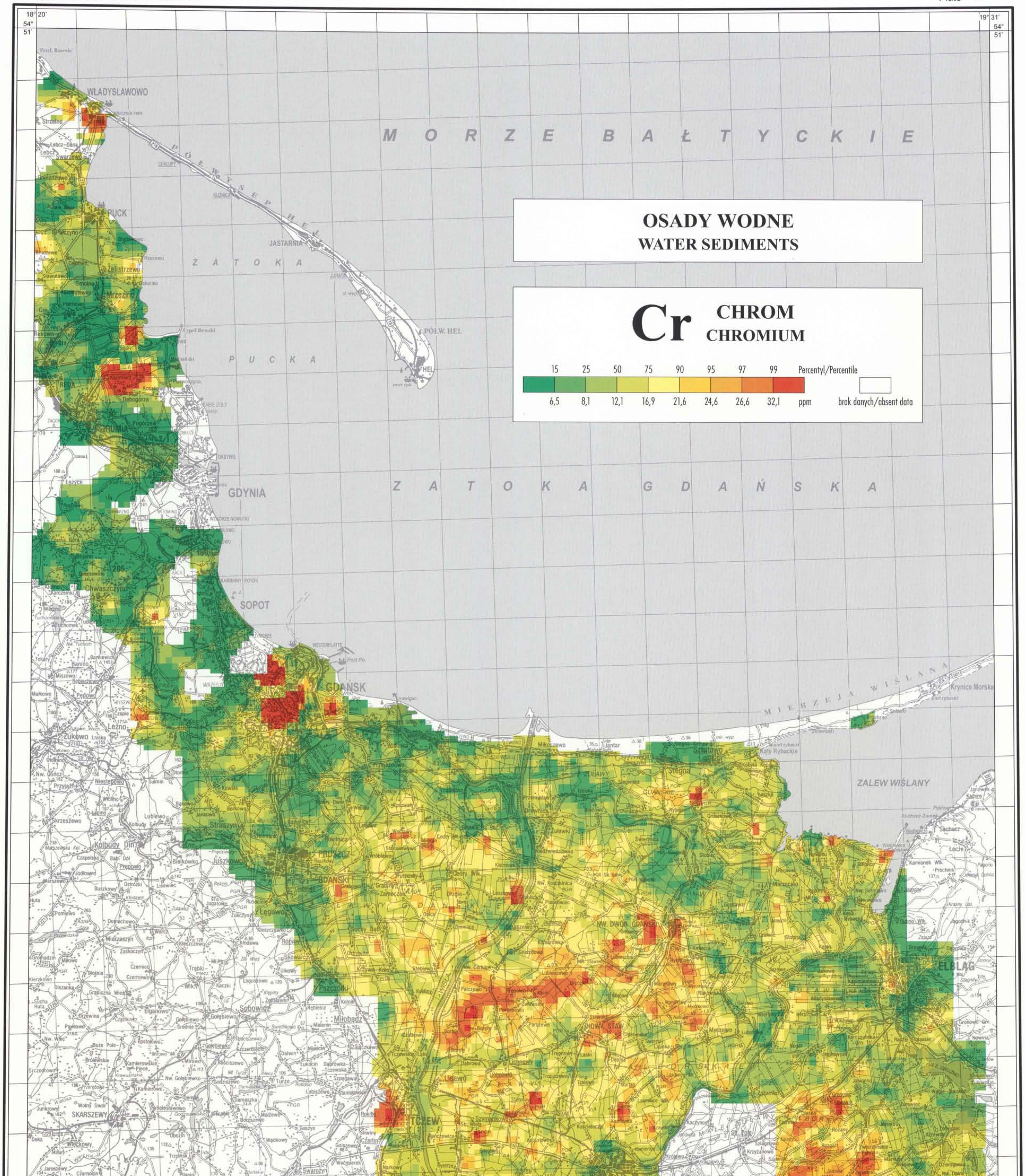
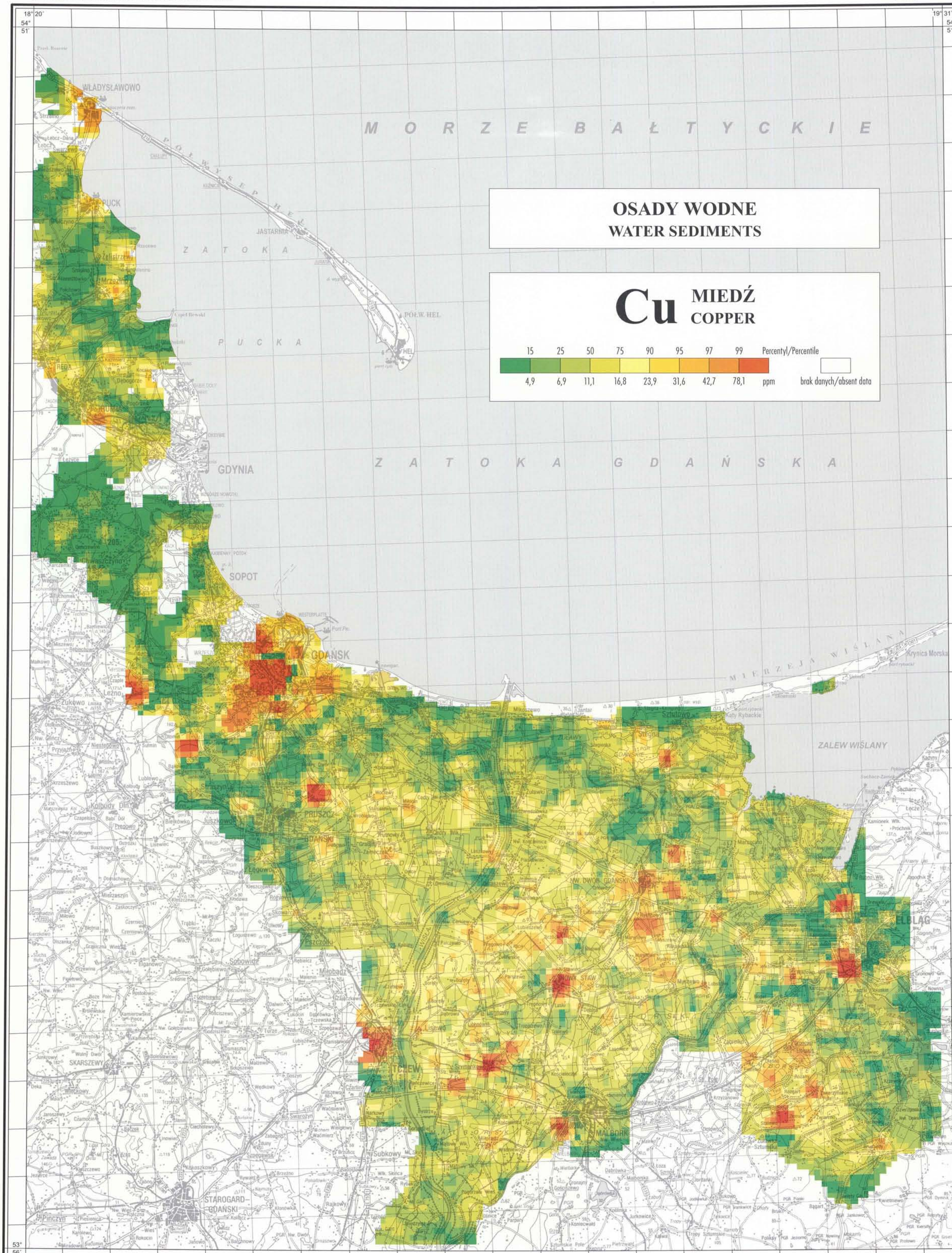
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.


OSADY WODNE
WATER SEDIMENTS
Cr CHROM
CHROMIUM
15 25 50 75 90 95 97 99 Percentyl/Percentile
6,5 8,1 12,1 16,9 21,6 24,6 26,6 32,1 ppm
brak danych/absent data
M O R Z E B A Ł T Y C K I E
Z A T O K A G D A Ń S K A
Z A T O K A
P U C K A
ZALEW WIŚLANY
WŁADYSŁAWOWO
PUCK
JASTARNIA
HEL
GDYNIA
SOPOT
GDAŃSK
ELBLĄG
MALBORK
TCZEW
STAROGARD GDAŃSKI
18° 20'
54° 51'
19° 31'
53° 56'

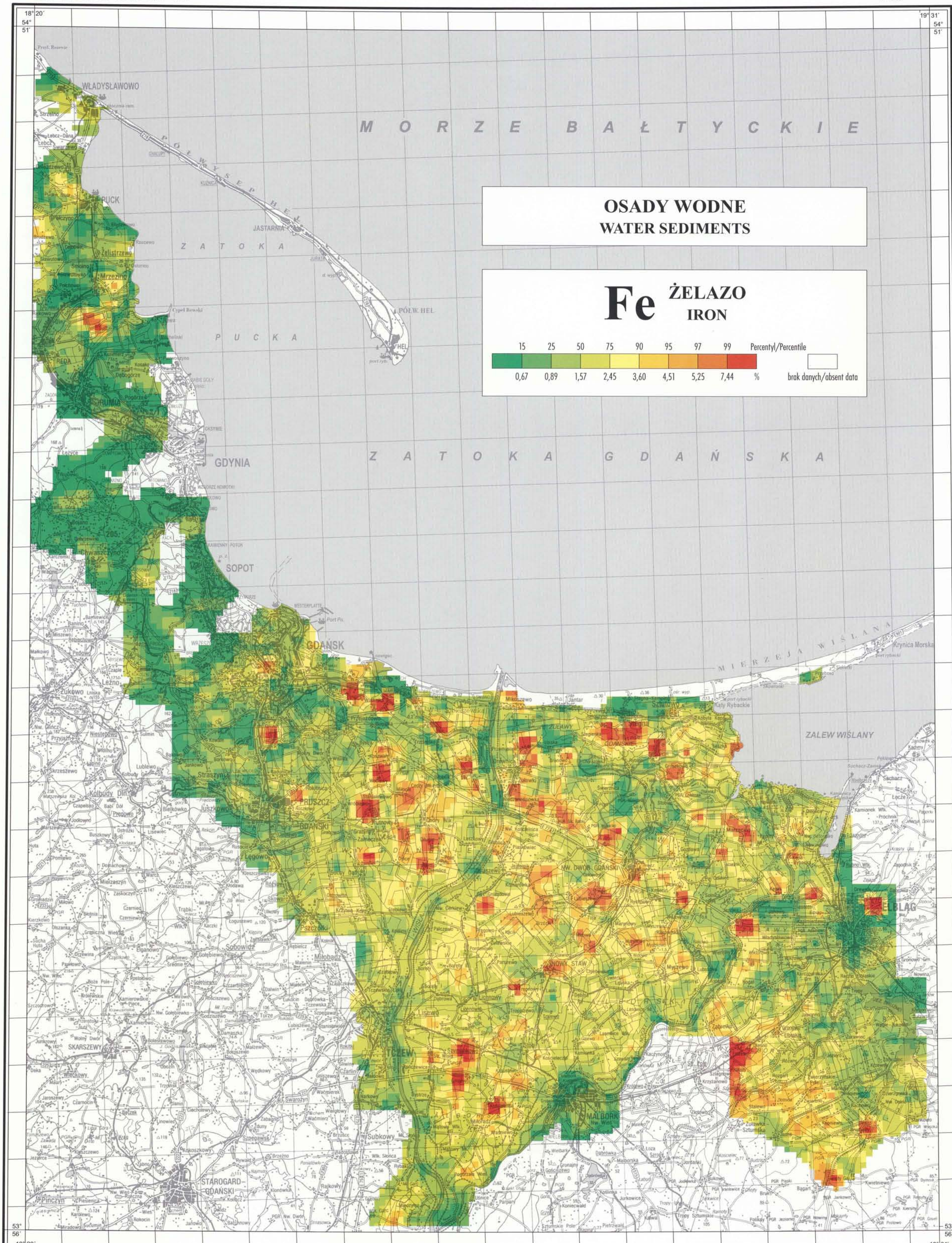

OSADY WODNE
WATER SEDIMENTS
Cu MIEDŹ
COPPER
15 25 50 75 90 95 97 99 Percentyl/Percentile
4,9 6,9 11,1 16,8 23,9 31,6 42,7 78,1 ppm
brak danych/absent data
M O R Z E B A Ł T Y C K I E
Z A T O K A G D A Ń S K A
Z A T O K A P U C K A
ZALEW WIŚLANY
WŁADYSŁAWOWO
PUCK
JASTARNIA
JURATA
PÓŁW. HEL
HEL
GDYNIA
SOPOT
GDAŃSK
PRUSZCZ GDAŃSKI
PSZCZÓŁKI
NOWY STAW
TCZEW
MALBORK
ELBLĄG
SKARSZEWY
STAROGARD GDAŃSKI
Krynica Morska
18° 20′
54° 51′
19° 31′
53° 56′

OSADY WODNE
WATER SEDIMENTS

Fe ŻELAZO
IRON

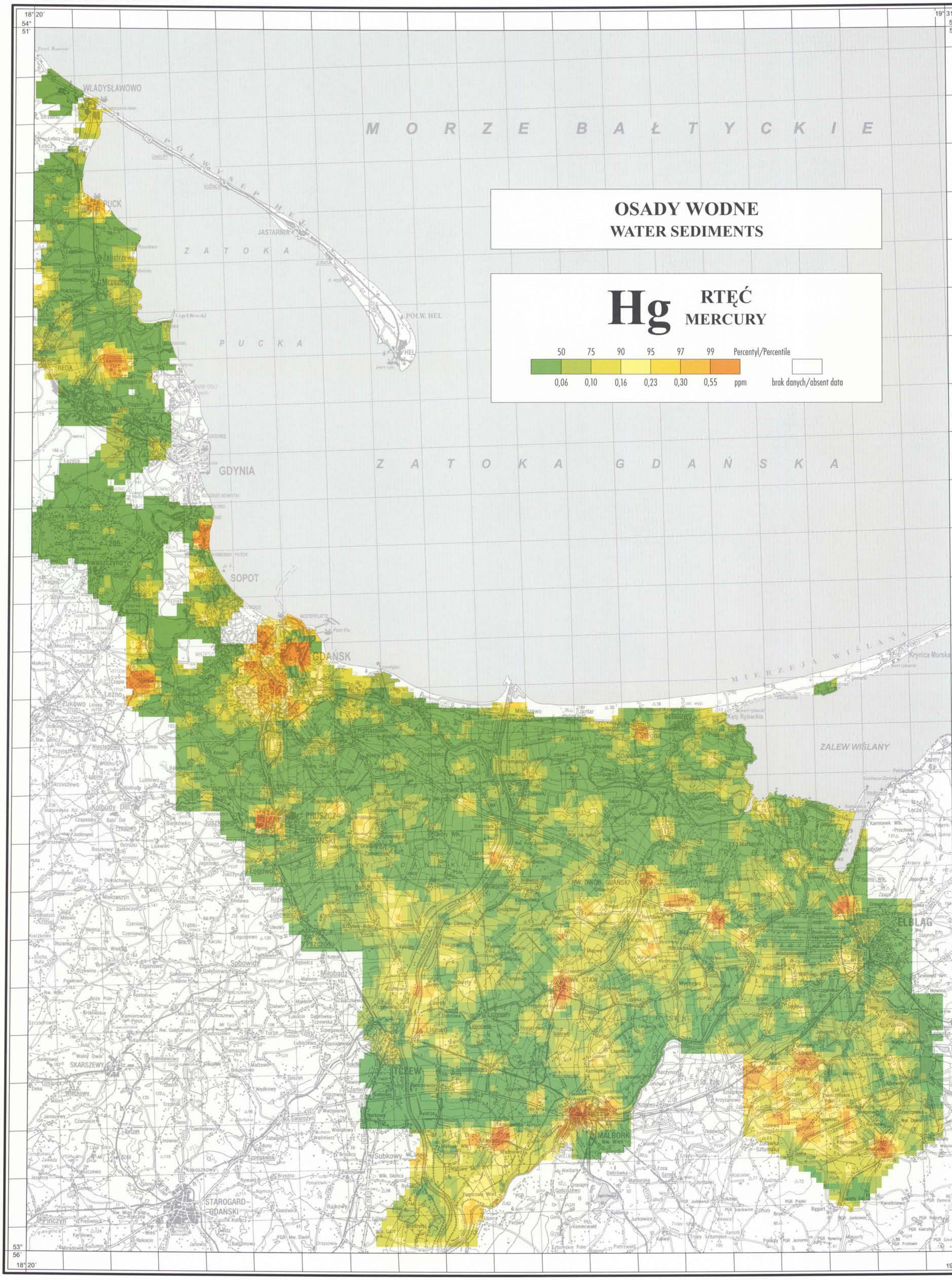
	15	25	50	75	90	95	97	99	Percentyl/Percentile
0,67	0,89	1,57	2,45	3,60	4,51	5,25	7,44	%	

brak danych/absent data



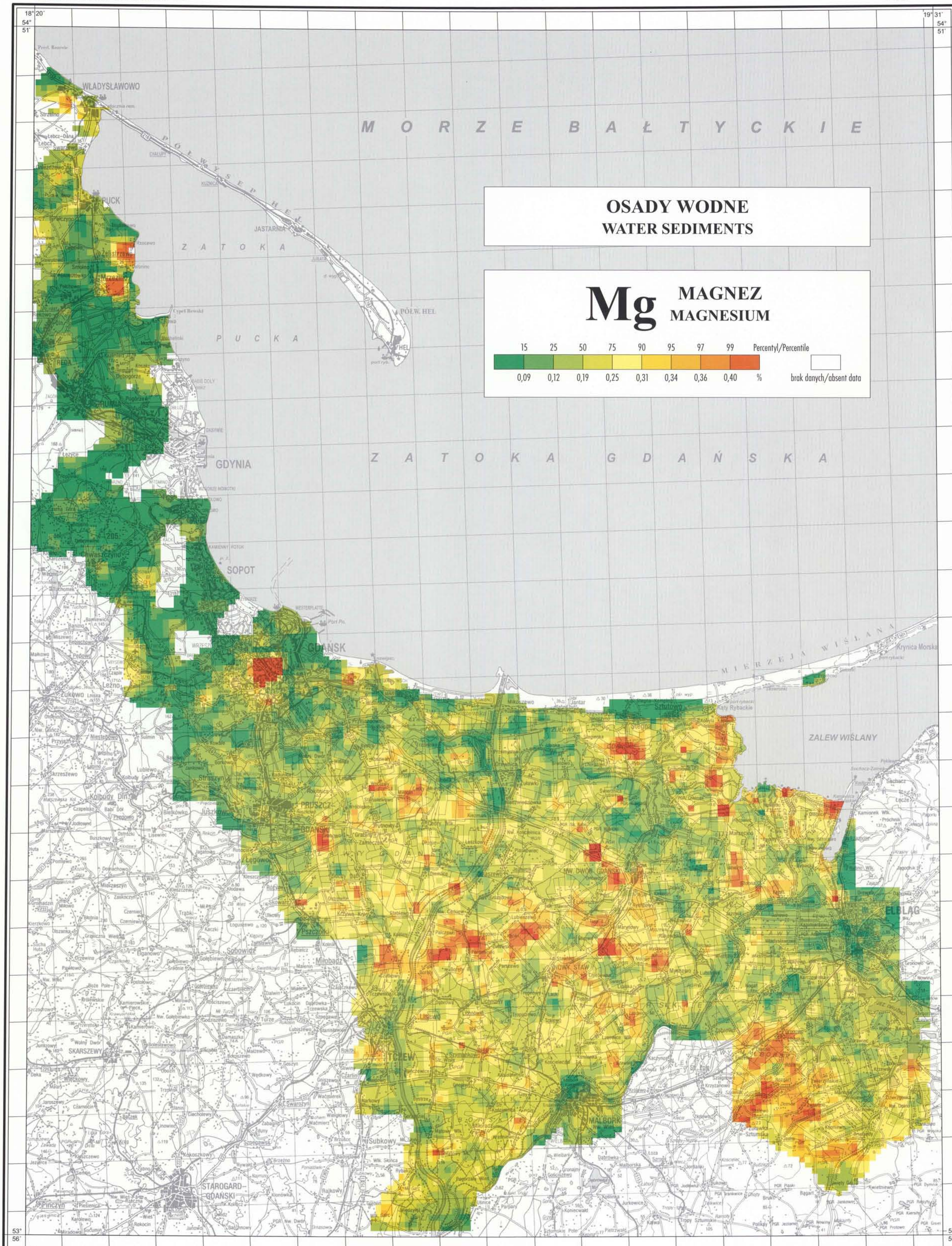
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.

OSADY WODNE
WATER SEDIMENTS



1 : 250 000

Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



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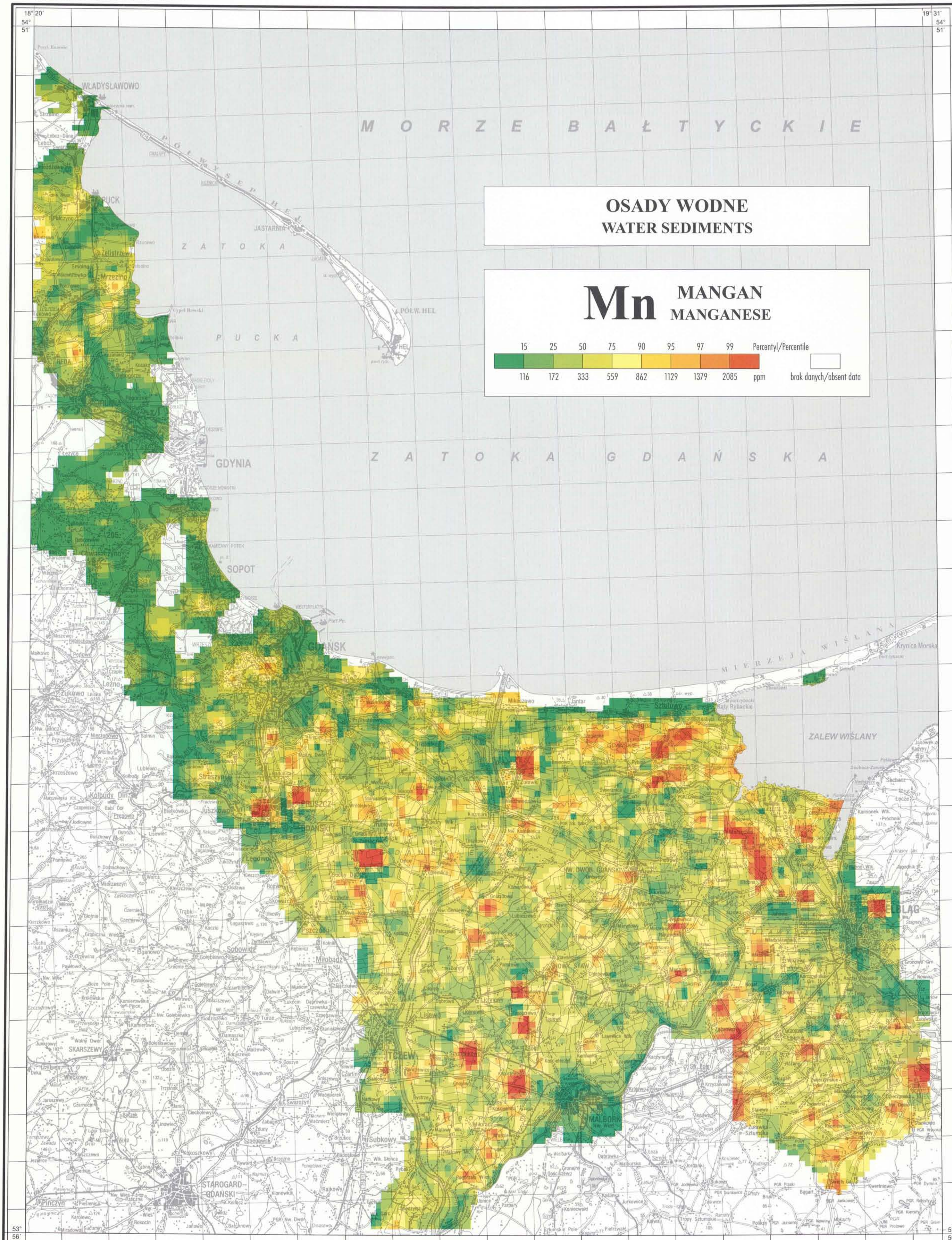
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



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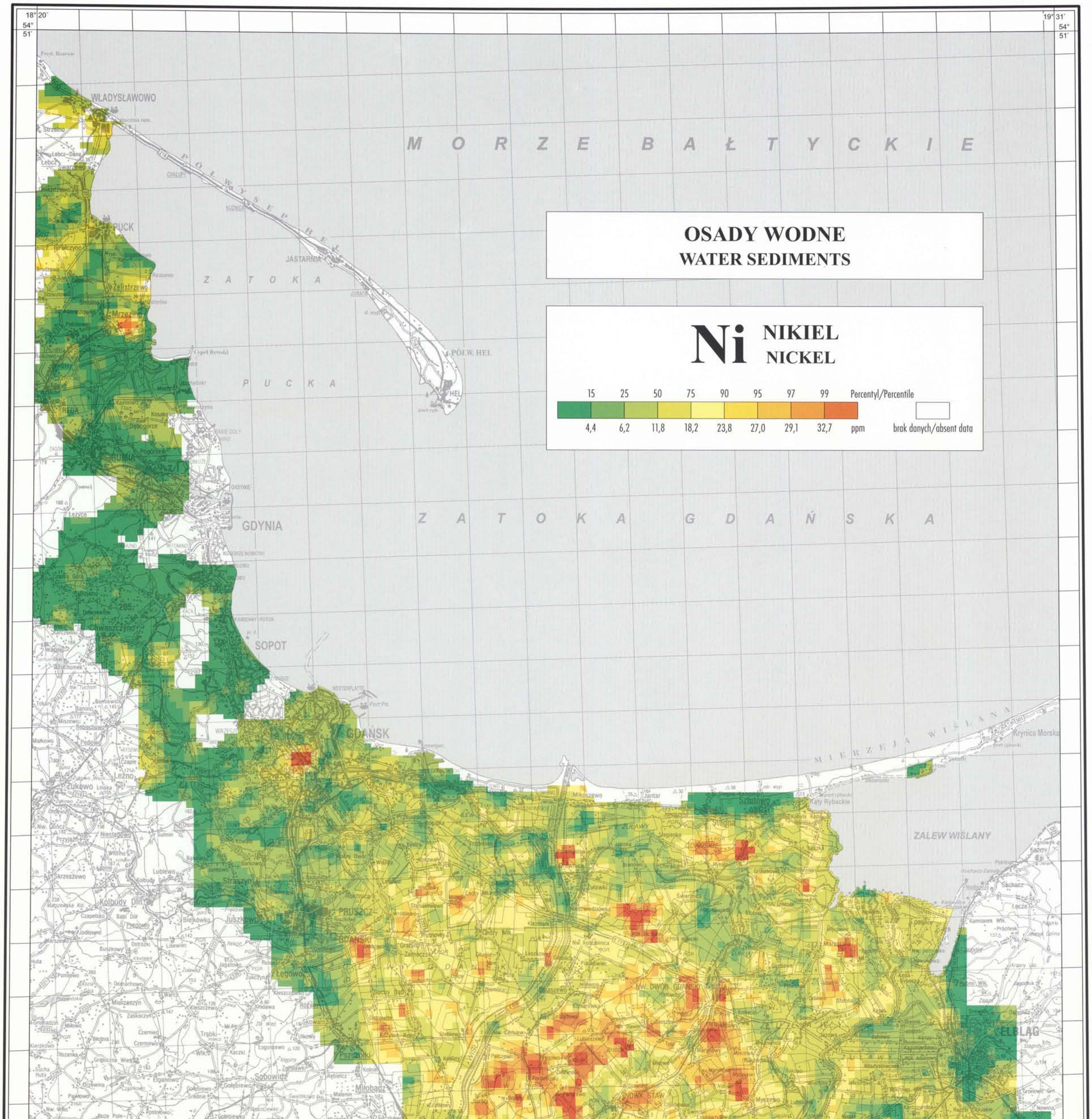
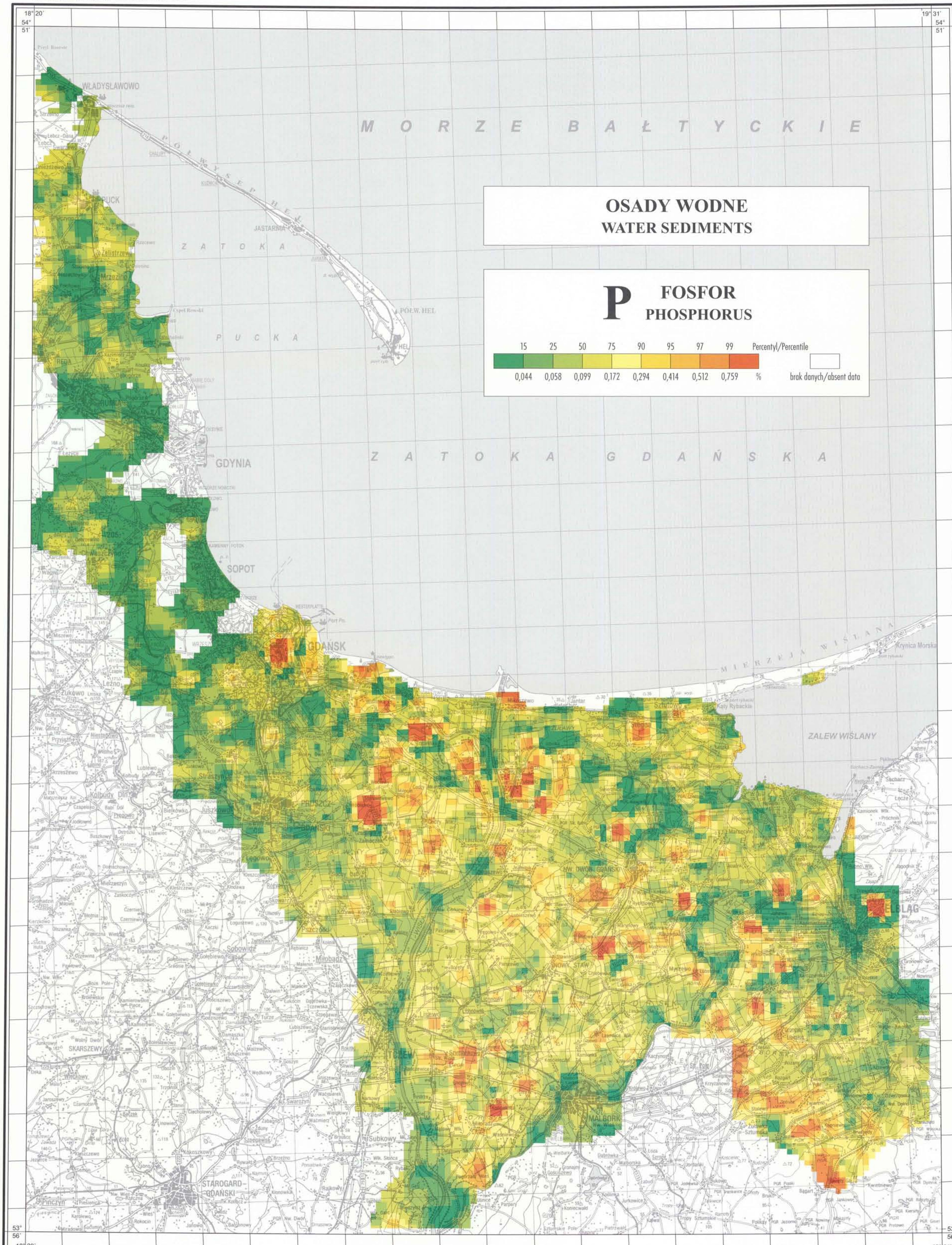
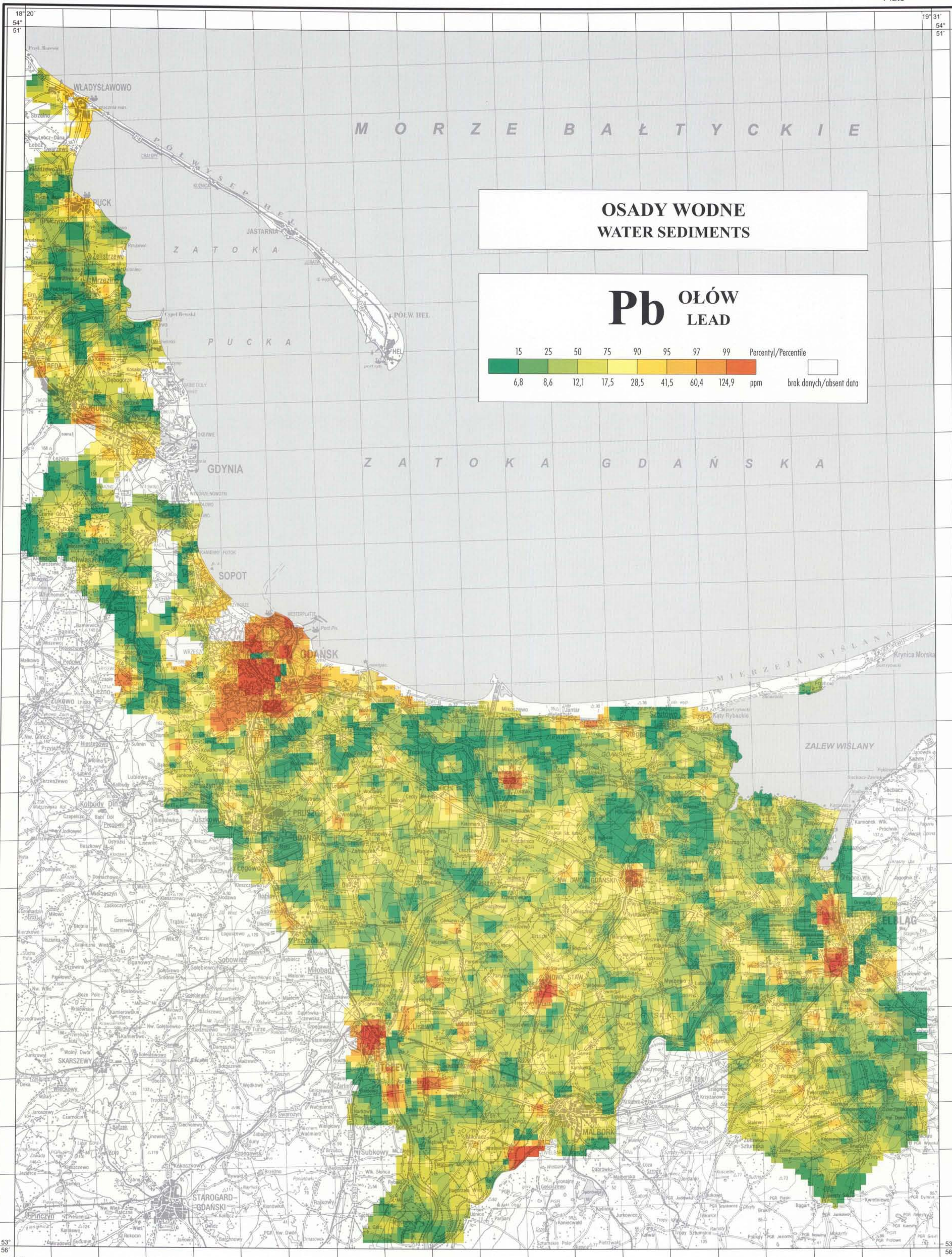
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.


OSADY WODNE
WATER SEDIMENTS
Ni NIKIEL
NICKEL
15 25 50 75 90 95 97 99 Percentyl/Percentile
4,4 6,2 11,8 18,2 23,8 27,0 29,1 32,7 ppm
brak danych/absent data
M O R Z E B A Ł T Y C K I E
Z A T O K A G D A Ń S K A
Z A T O K A P U C K A
ZALEW WIŚLANY
WŁADYSŁAWOWO
PUCK
GDYNIA
SOPOT
GDAŃSK
PRUSZCZ
TCZEW
MALBORK
ELBLĄG
SKARSZEWY
STAROGARD GDAŃSKI
18° 20'
54° 51'
19° 31'
53° 56'

1 : 250 000

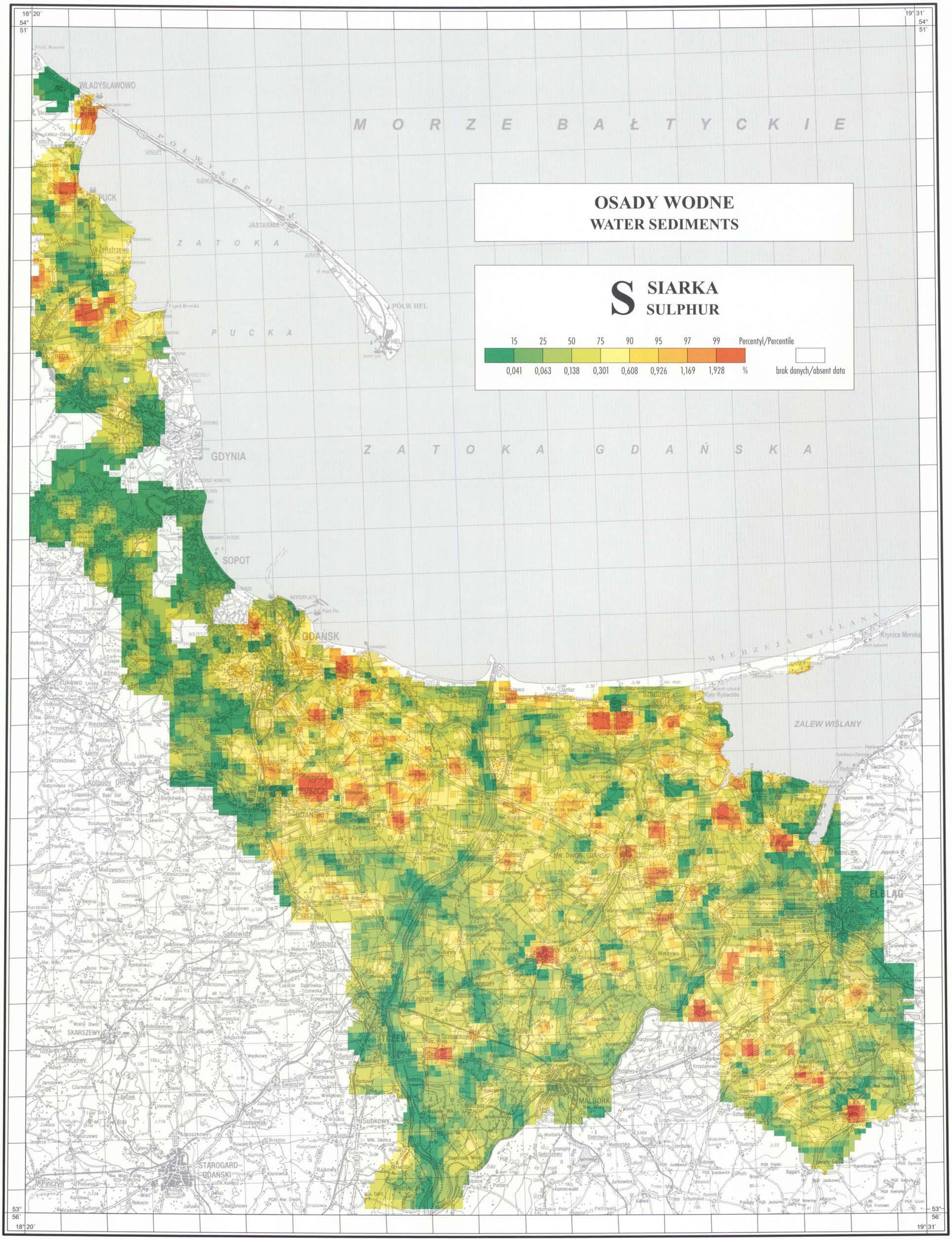


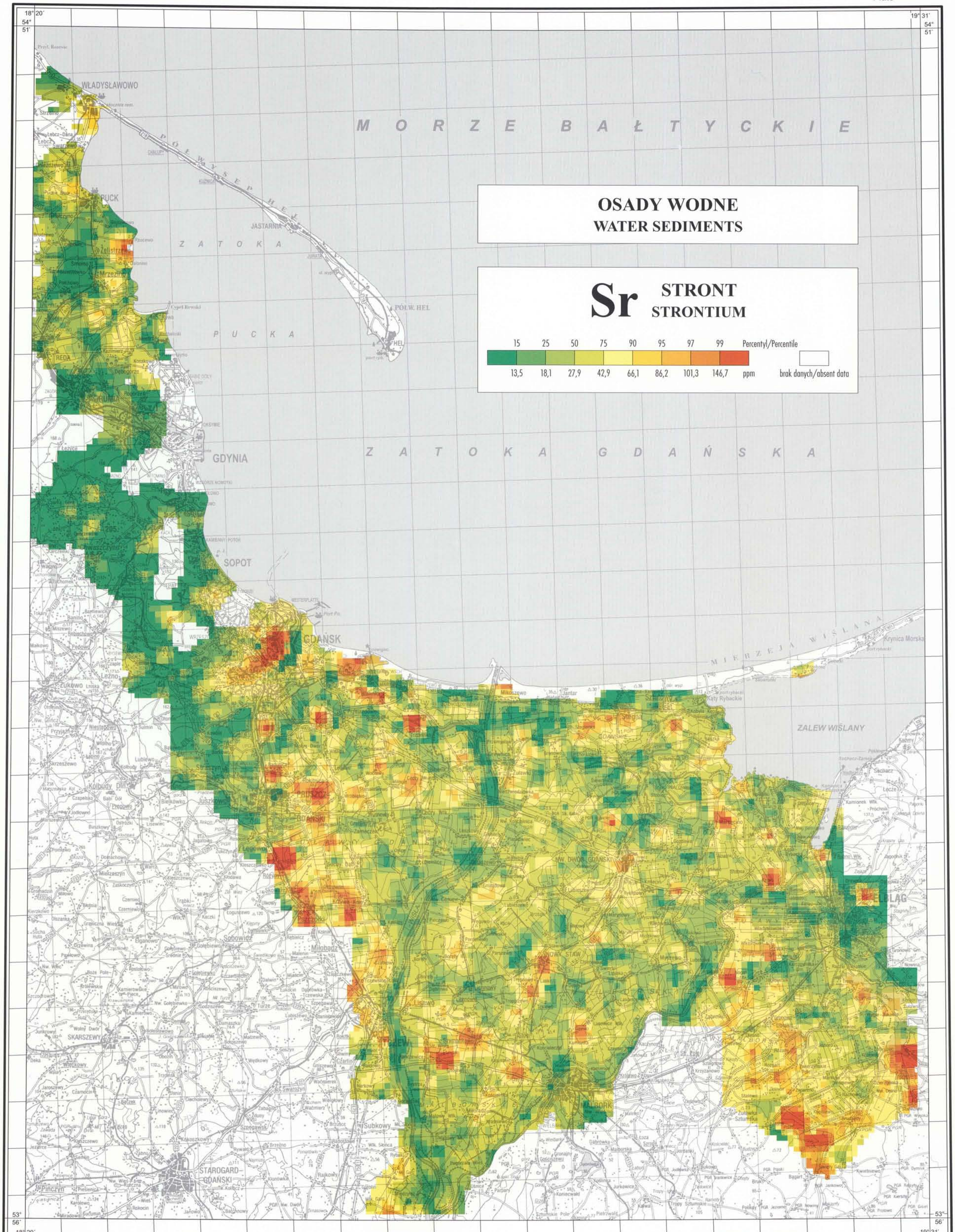
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



1 : 250 000

Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.


OSADY WODNE
WATER SEDIMENTS
S SIARKA
SULPHUR
15 25 50 75 90 95 97 99 Percentyl/Percentile
0,041 0,063 0,138 0,301 0,608 0,926 1,169 1,928 %
brak danych/absent data
M O R Z E B A Ł T Y C K I E
Z A T O K A G D A Ń S K A
Z A T O K A P U C K A
ZALEW WIŚLANY
WŁADYSŁAWOWO
PUCK
GDYNIA
SOPOT
GDAŃSK
ELBLĄG
MALBORK
STAROGARD GDAŃSKI
18° 20'
54° 51'
19° 31'
53° 56'



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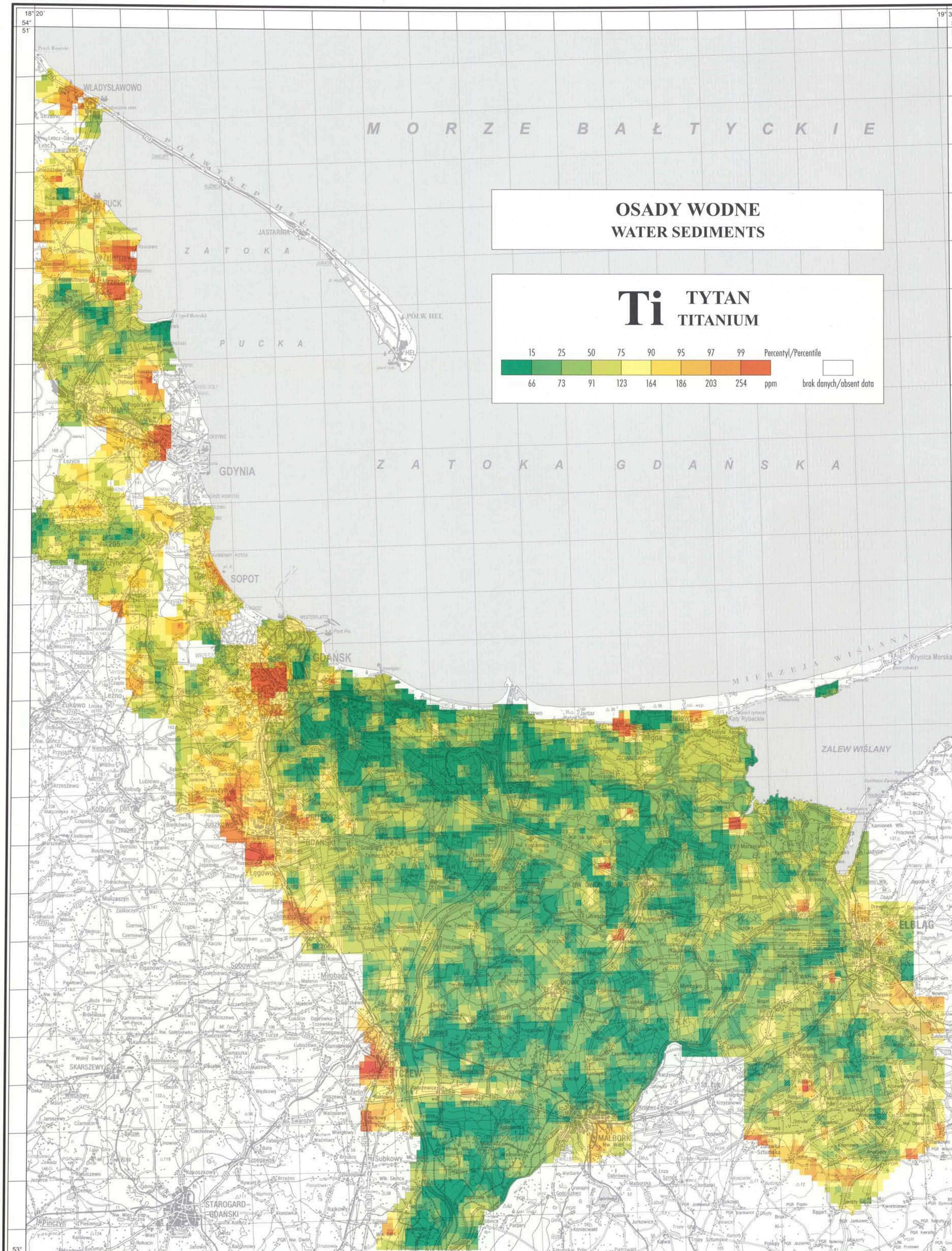
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



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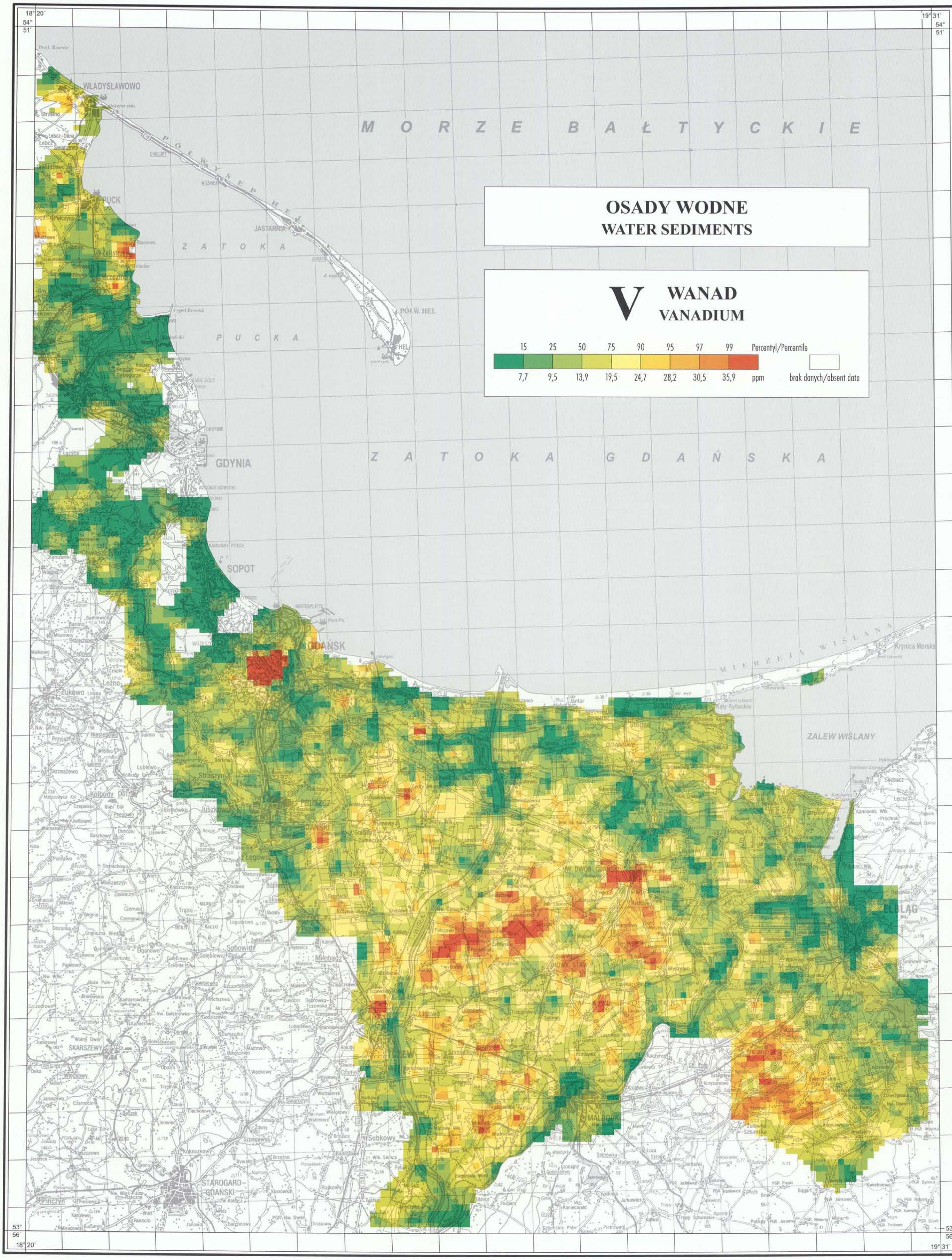
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



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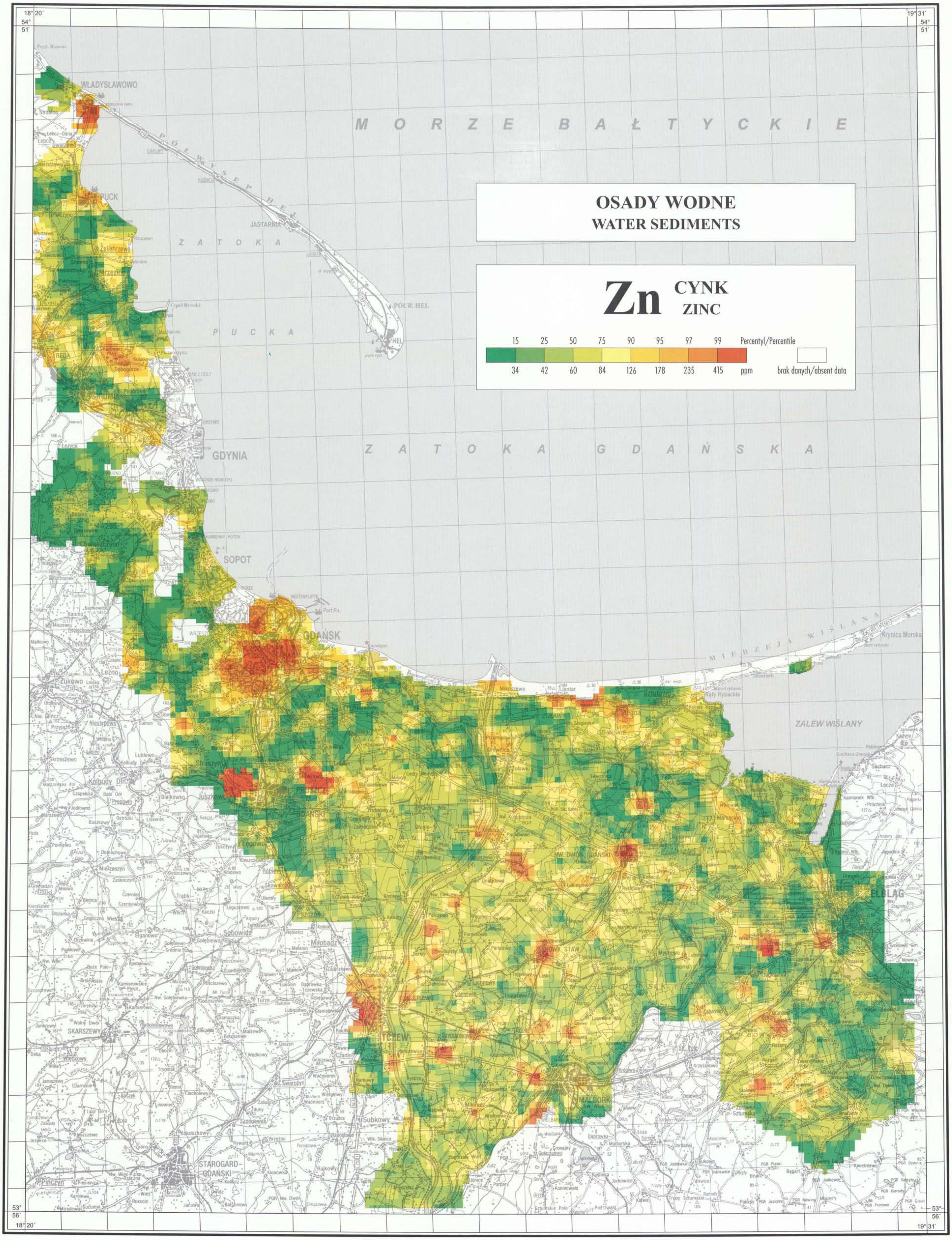
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



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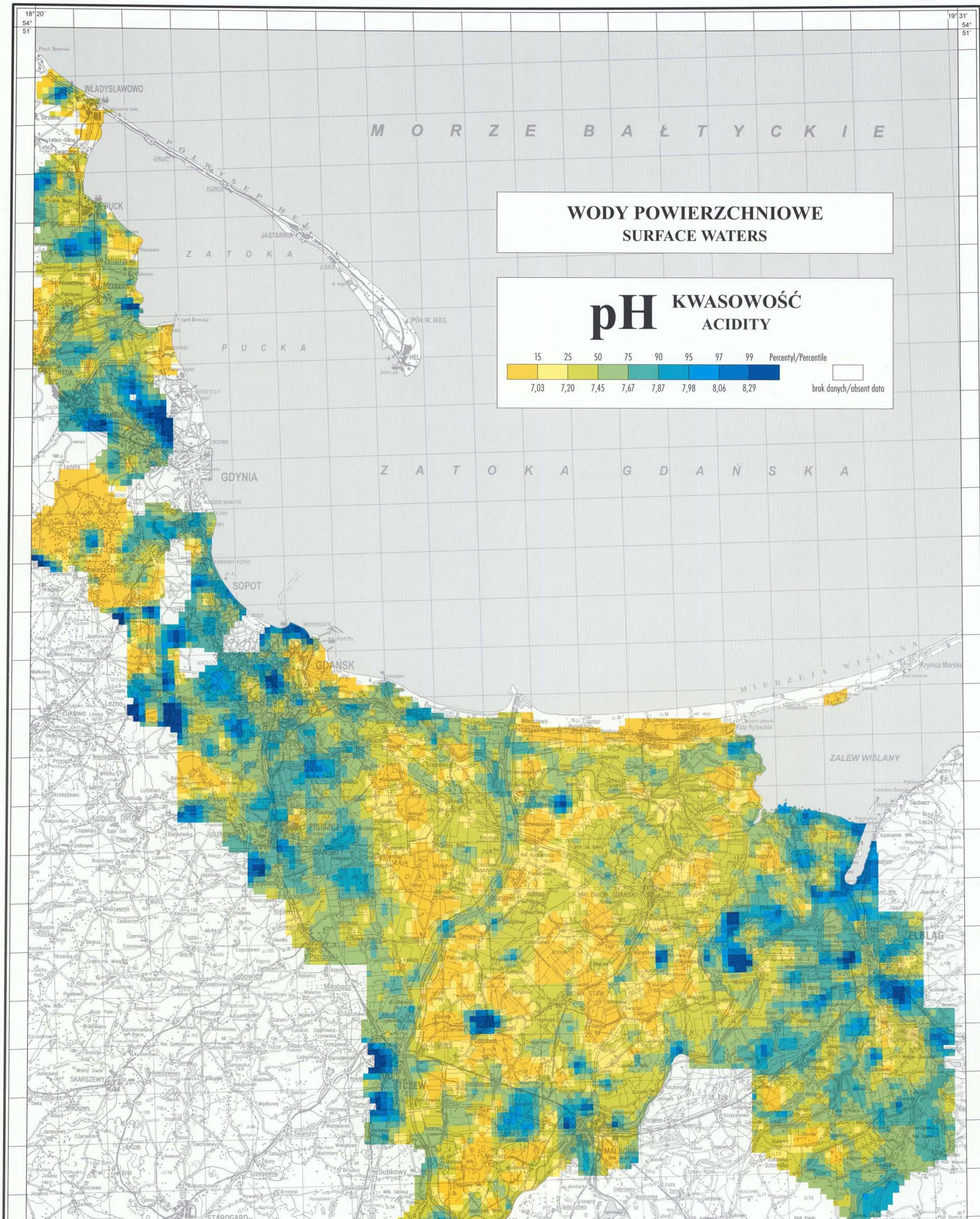
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.

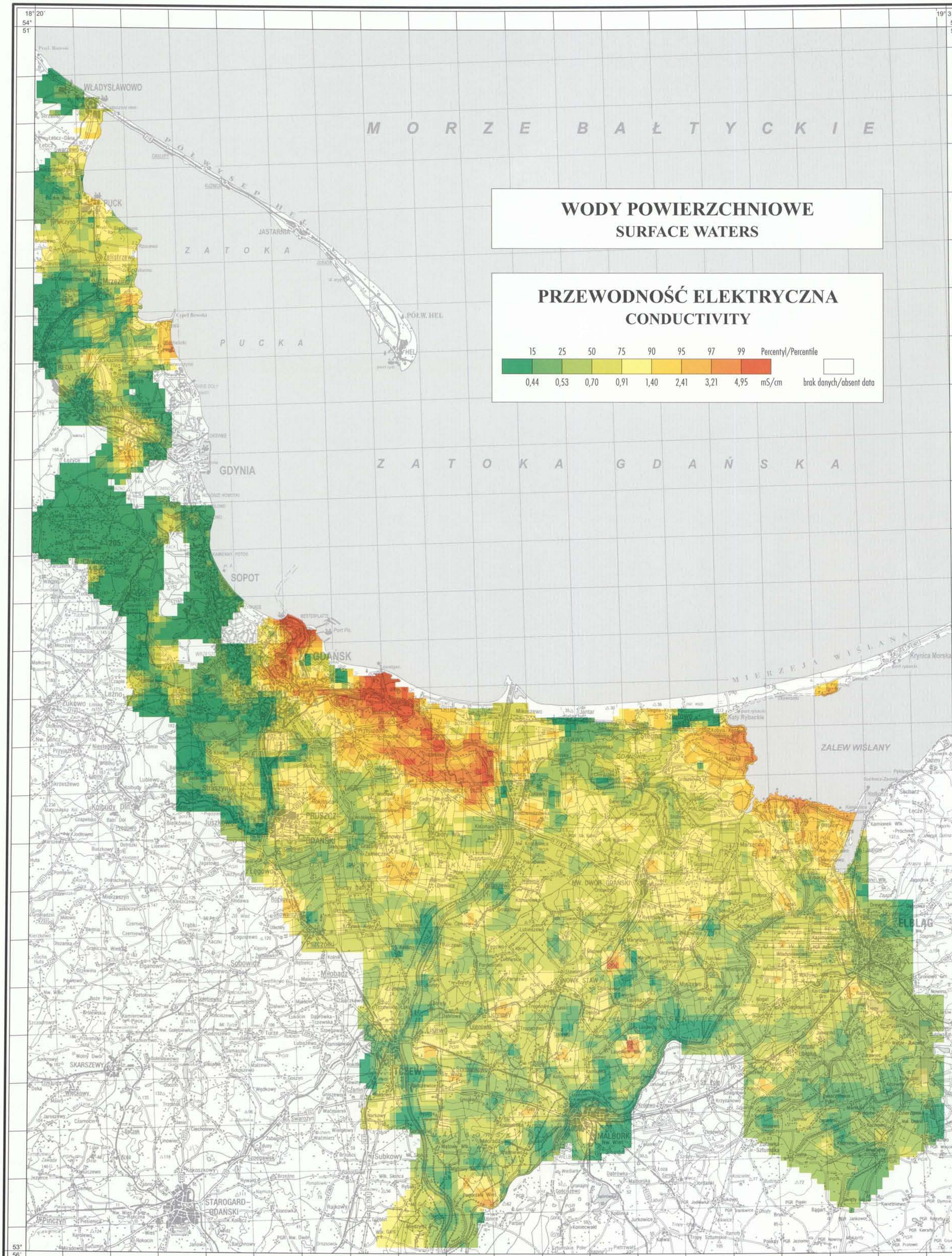

WODY POWIERZCHNIOWE
SURFACE WATERS
pH KWASOWOŚĆ
ACIDITY
15 25 50 75 90 95 97 99 Percentyl/Percentile
7,03 7,20 7,45 7,67 7,87 7,98 8,06 8,29
brak danych/absent data
M O R Z E B A Ł T Y C K I E
Z A T O K A P U C K A
Z A T O K A G D A Ń S K A
ZALEW WIŚLANY
WŁADYSŁAWOWO
PUCK
JASTARNIA
HEL
GDYNIA
SOPOT
GDAŃSK
ELBLĄG
MALBORK
TCZEW
STAROGARD GDAŃSKI
SKARSZEWY
NW. DWÓR GDAŃSKI
NOWY STAW
18°20′
54°51′
19°31′
53°56′

WODY POWIERZCHNIOWE
SURFACE WATERS

PRZEWODNOŚĆ ELEKTRYCZNA
CONDUCTIVITY

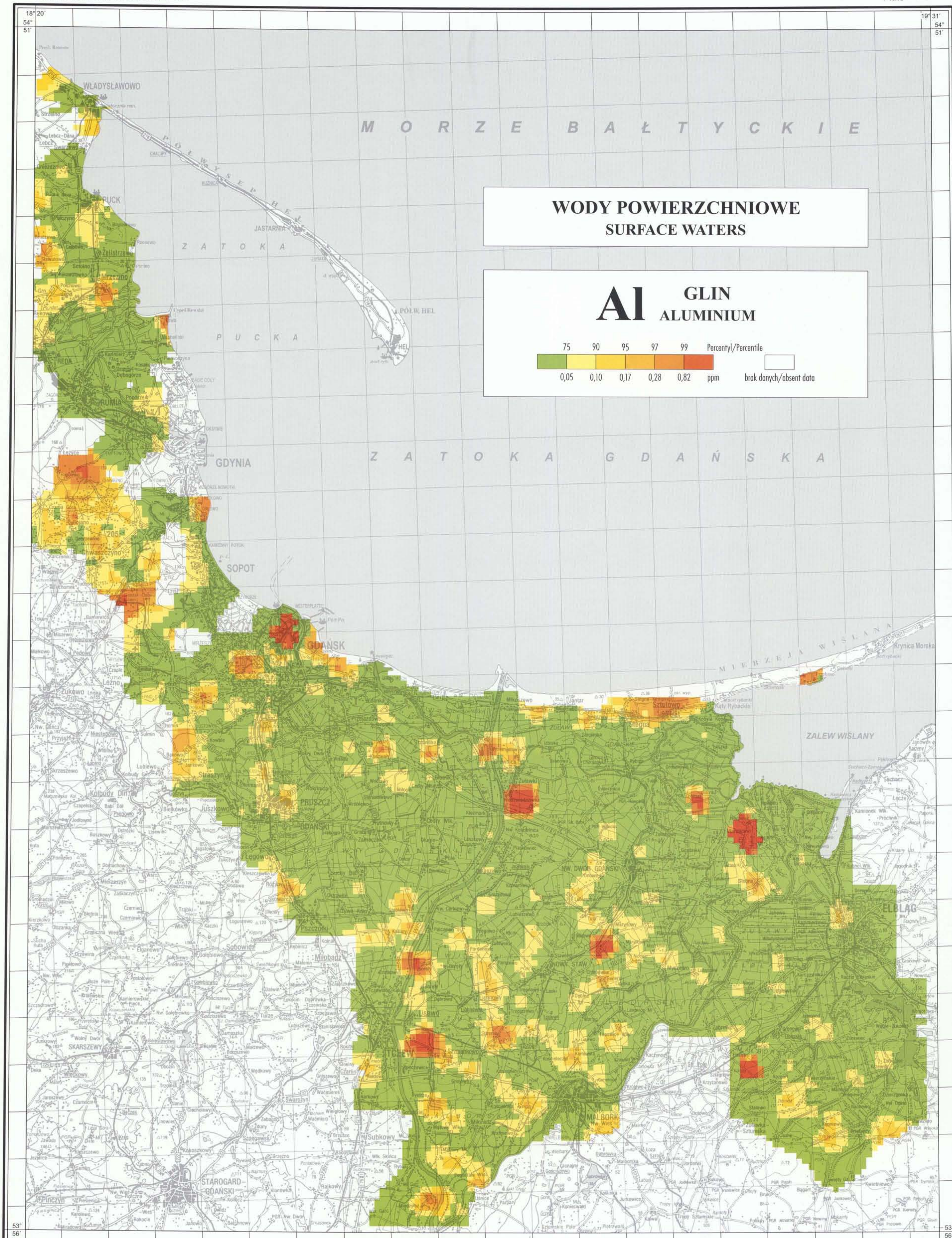
Percentyl/Percentile	15	25	50	75	90	95	97	99
mS/cm	0,44	0,53	0,70	0,91	1,40	2,41	3,21	4,95

brak danych/absent data



1 : 250 000

Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



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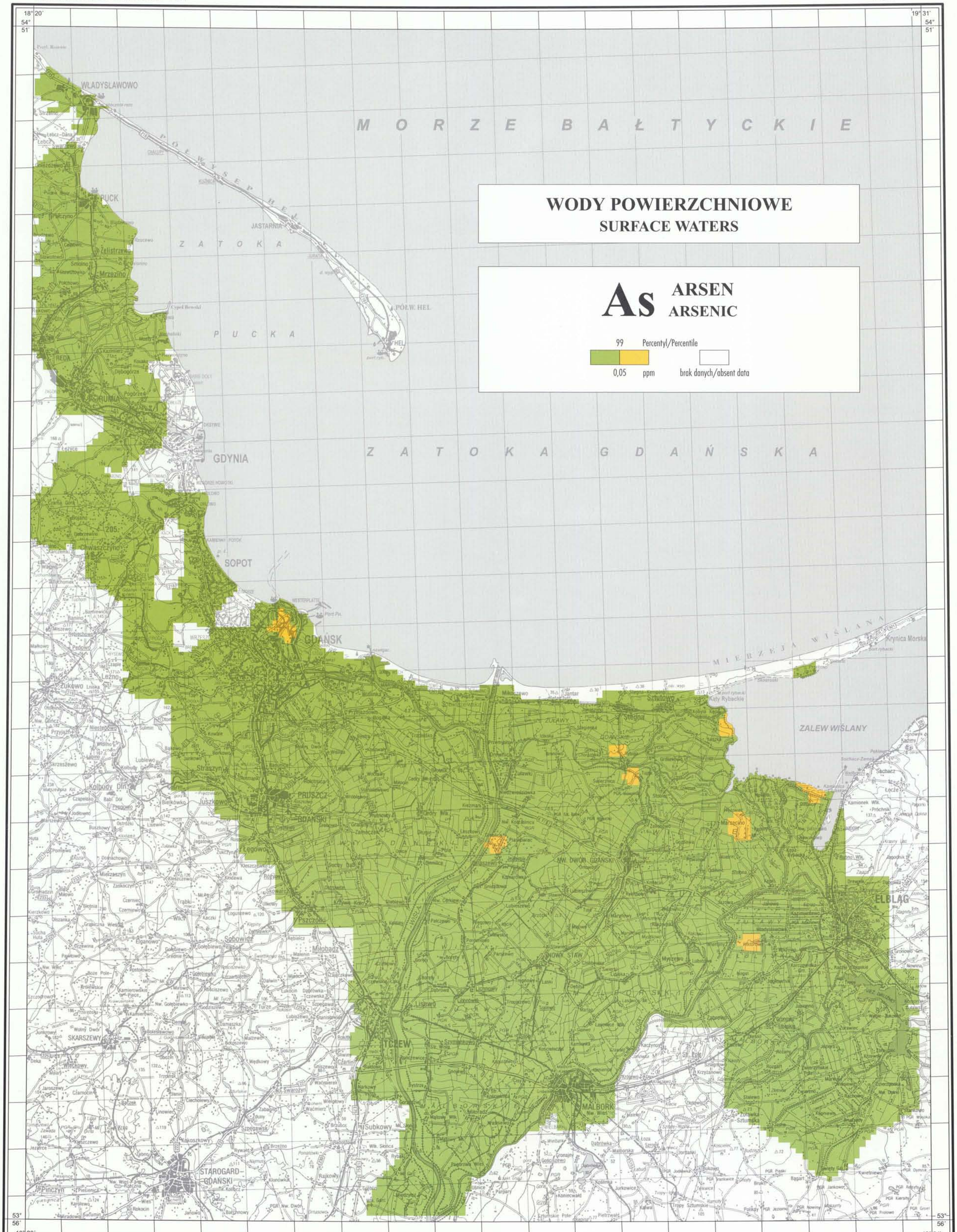

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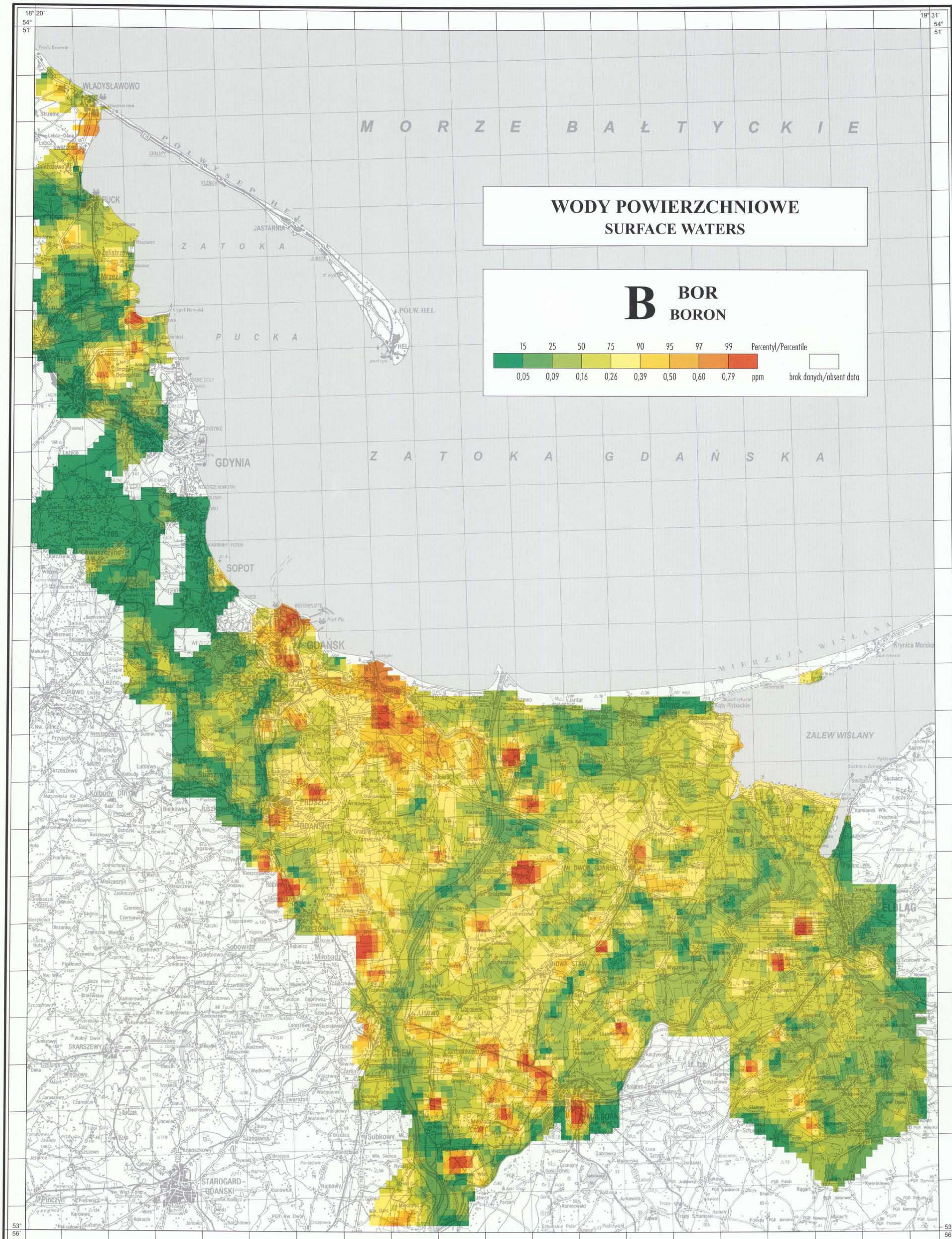
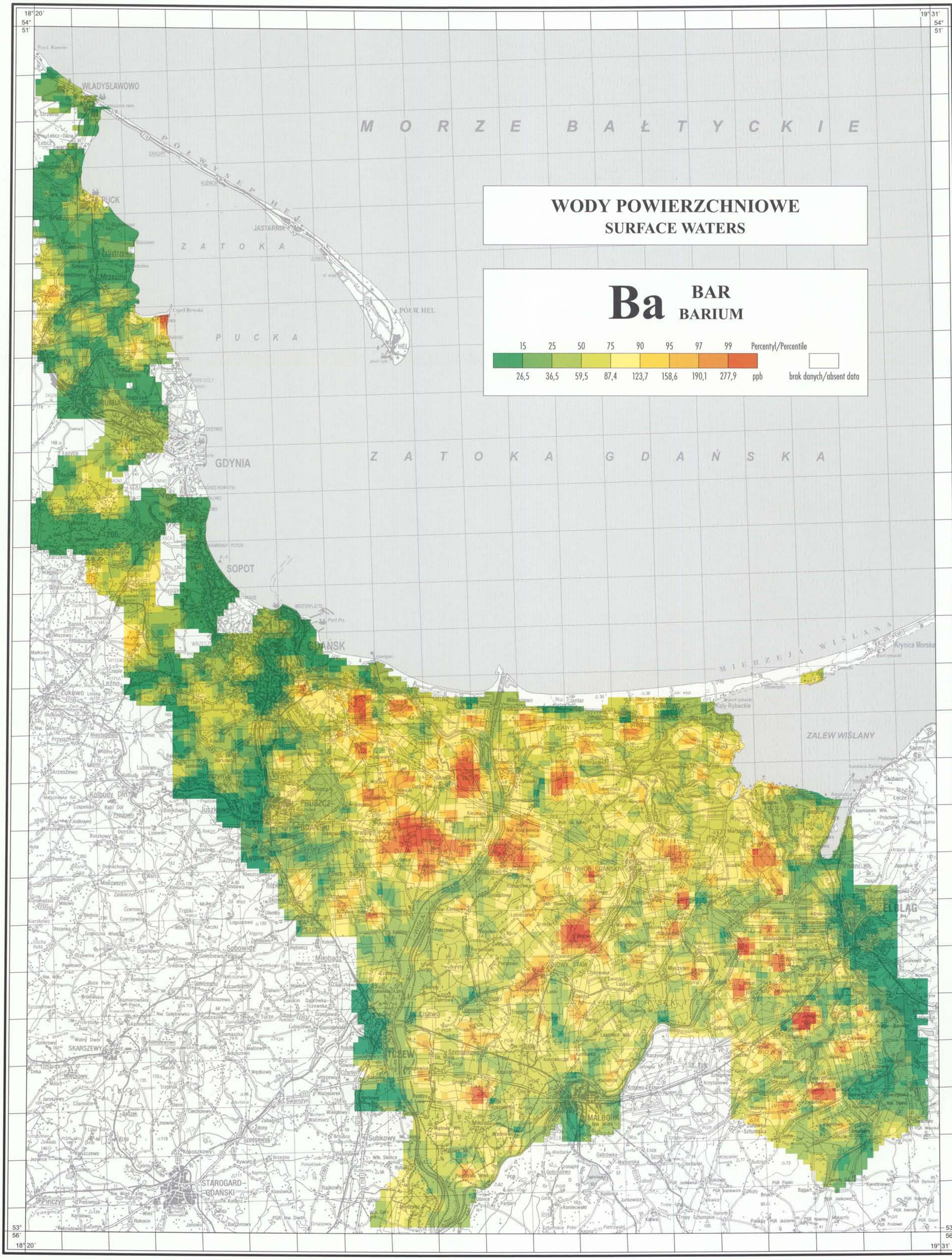
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



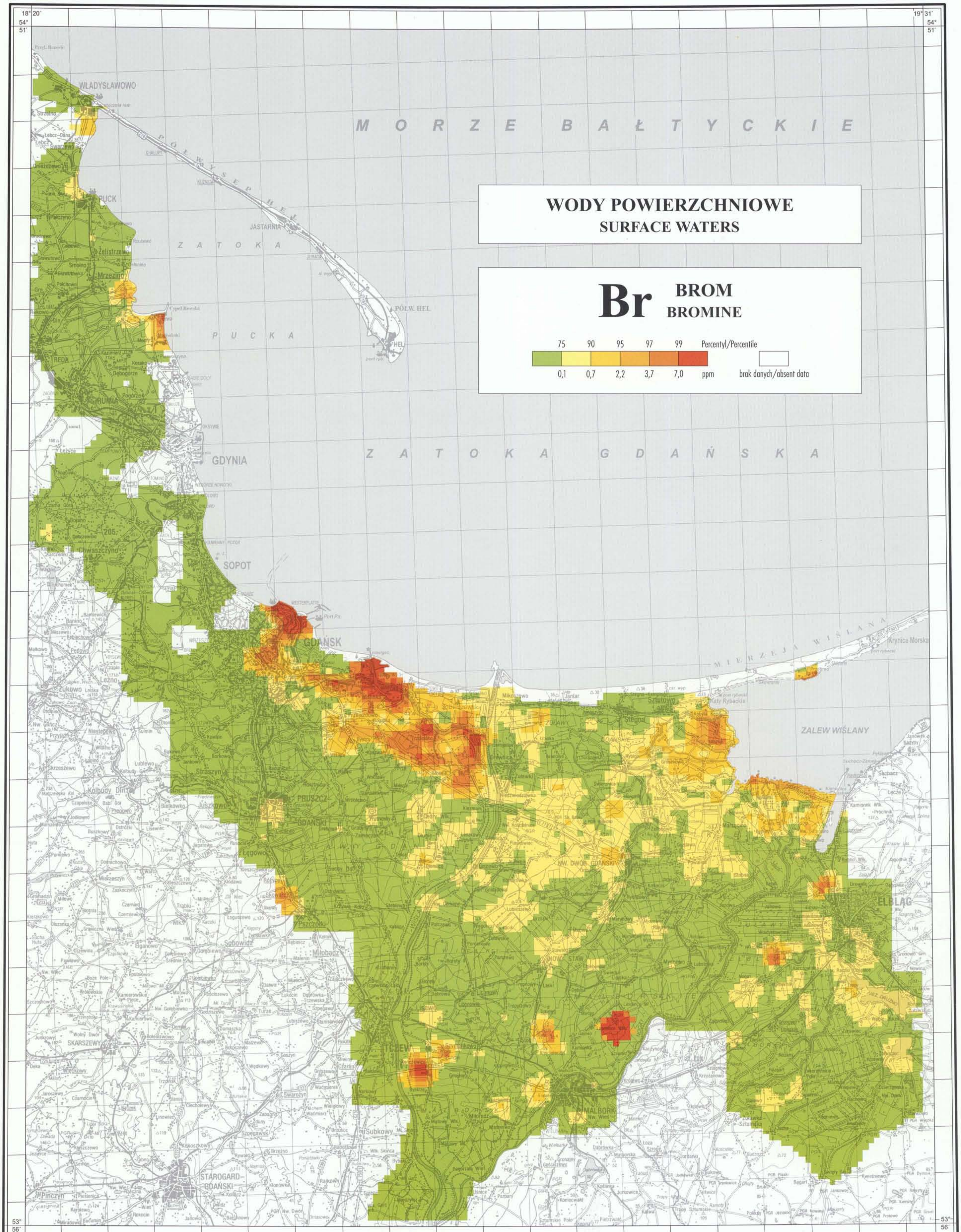
1 : 250 000

Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



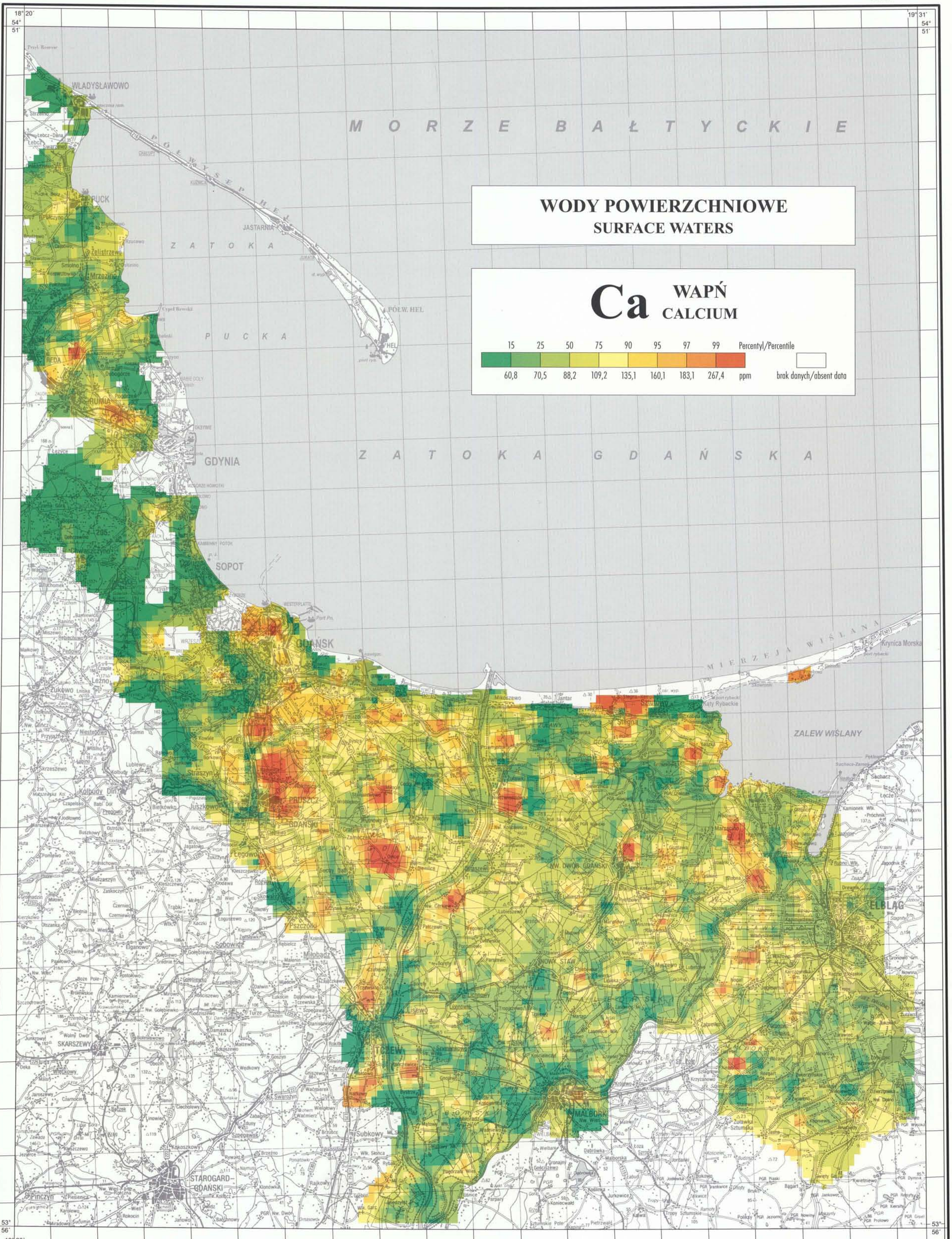
1 : 250 000

Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



1 : 250 000

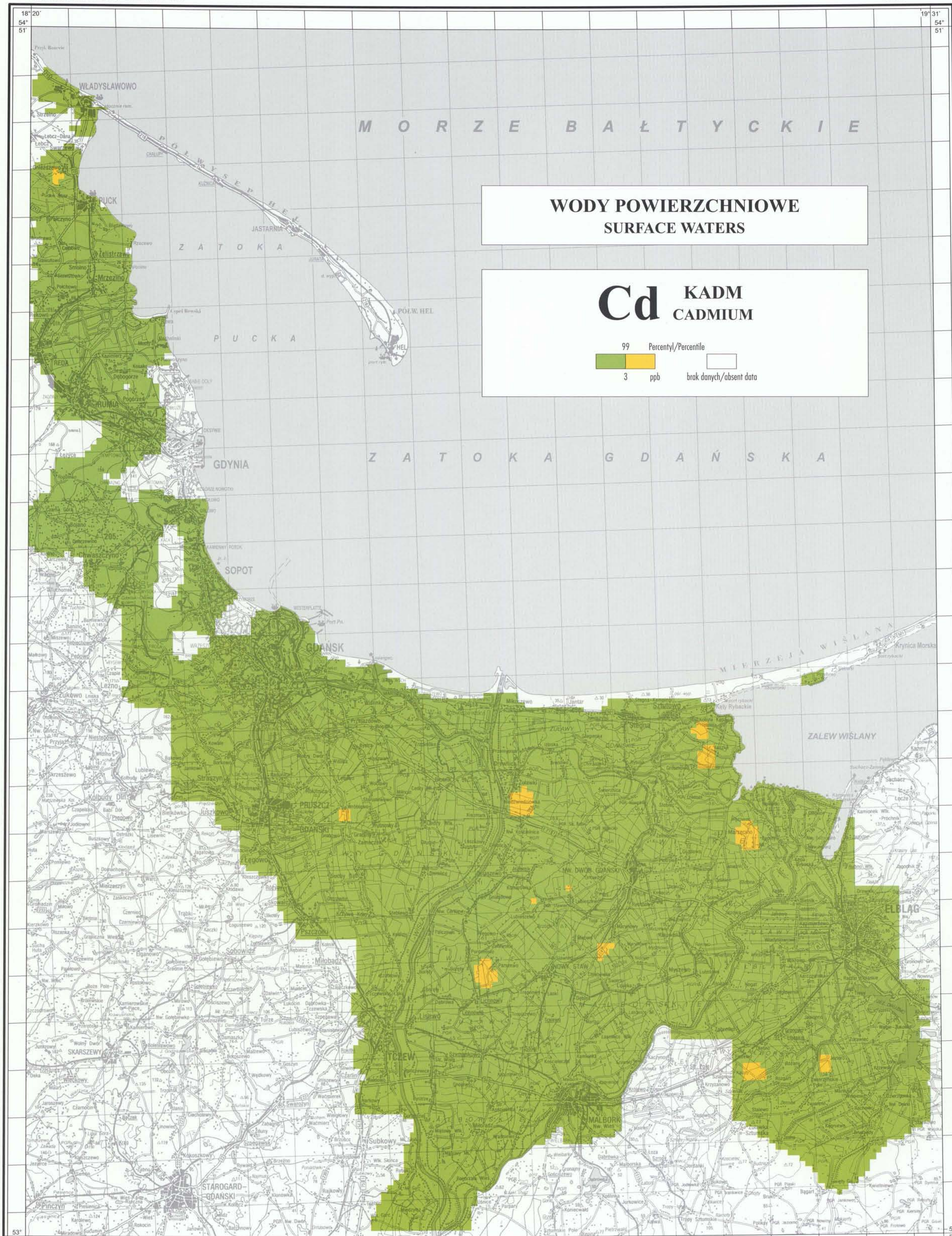
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



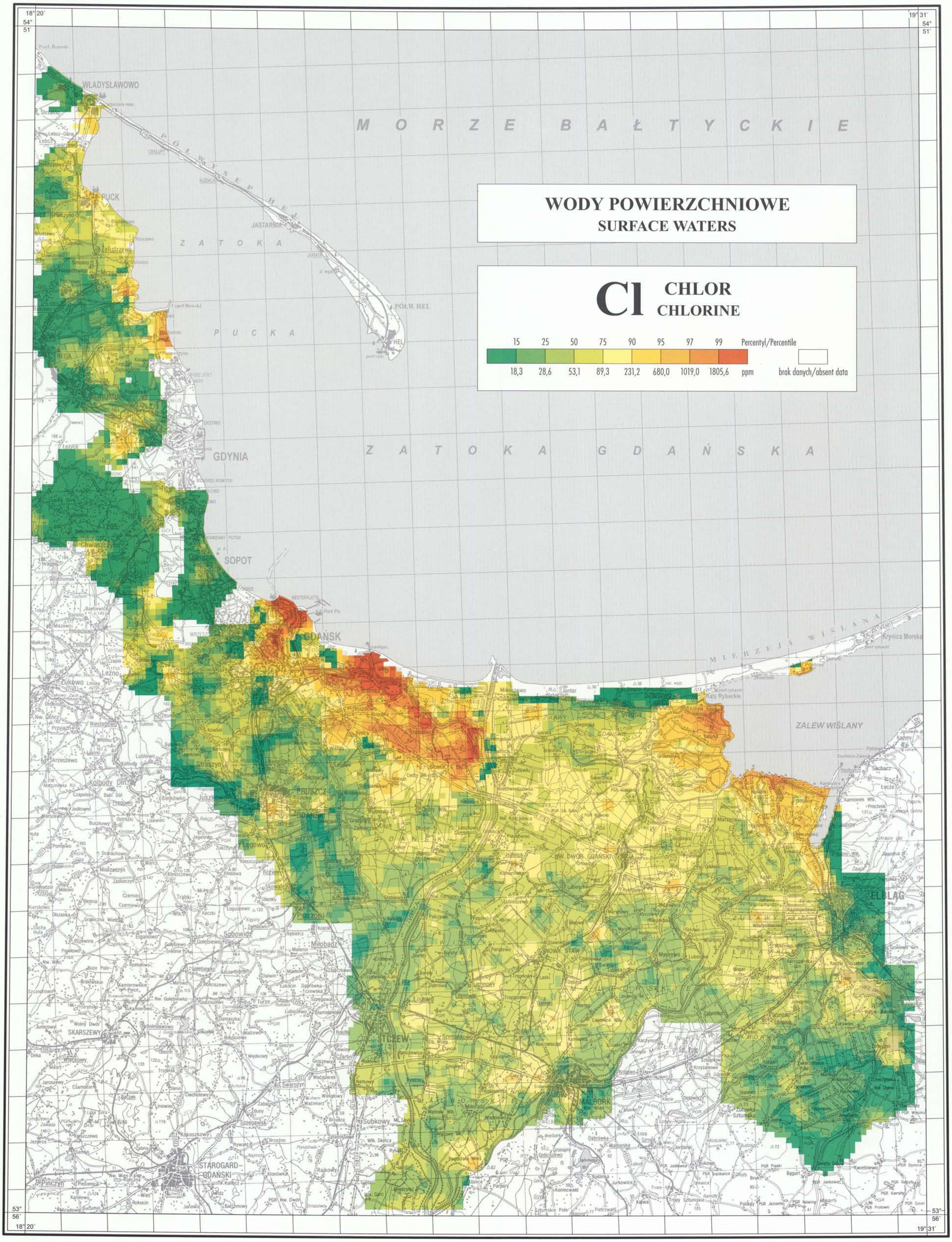
1 : 250 000
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.

WODY POWIERZCHNIOWE
SURFACE WATERS

Cd KADM
CADMIUM



1 : 250 000



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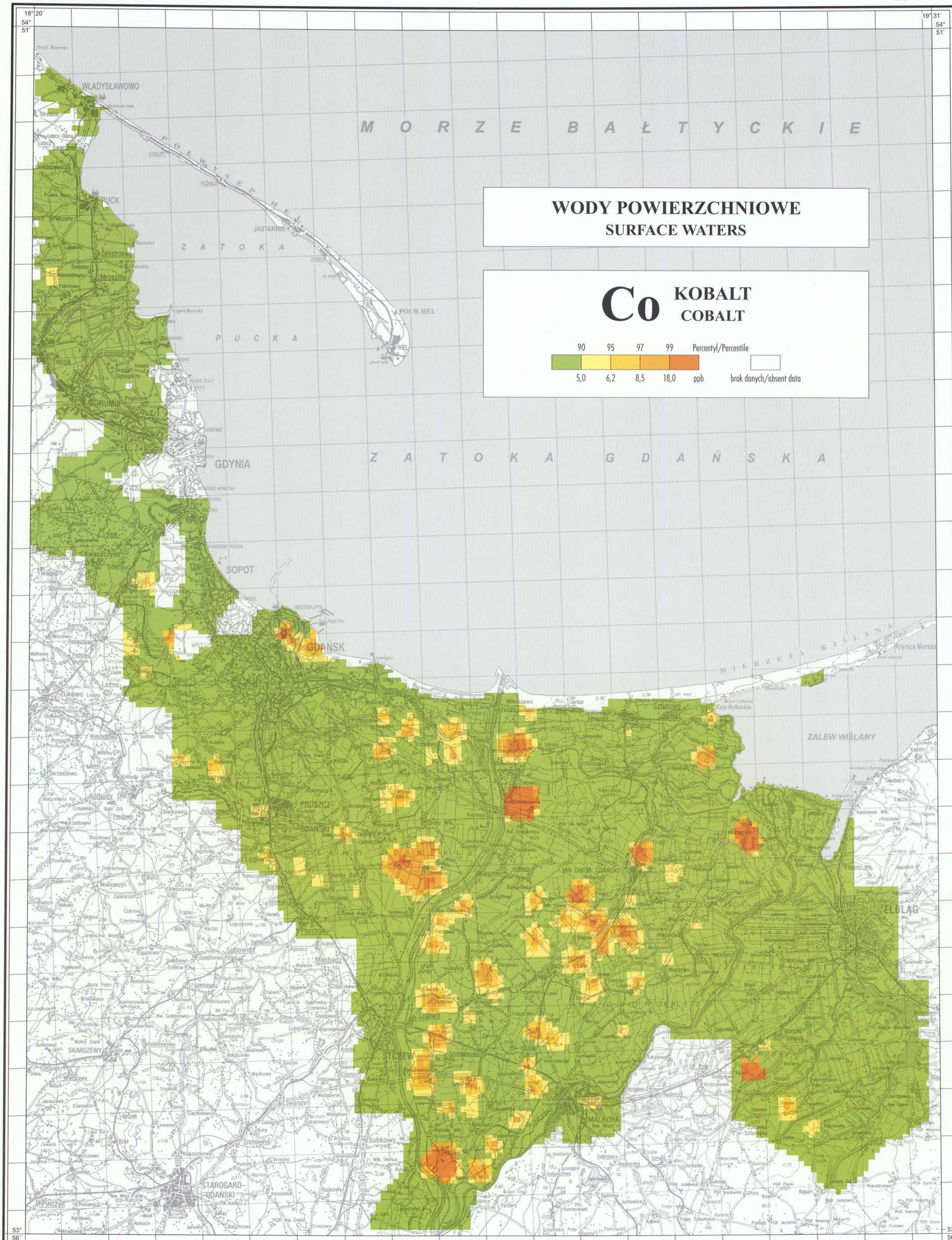

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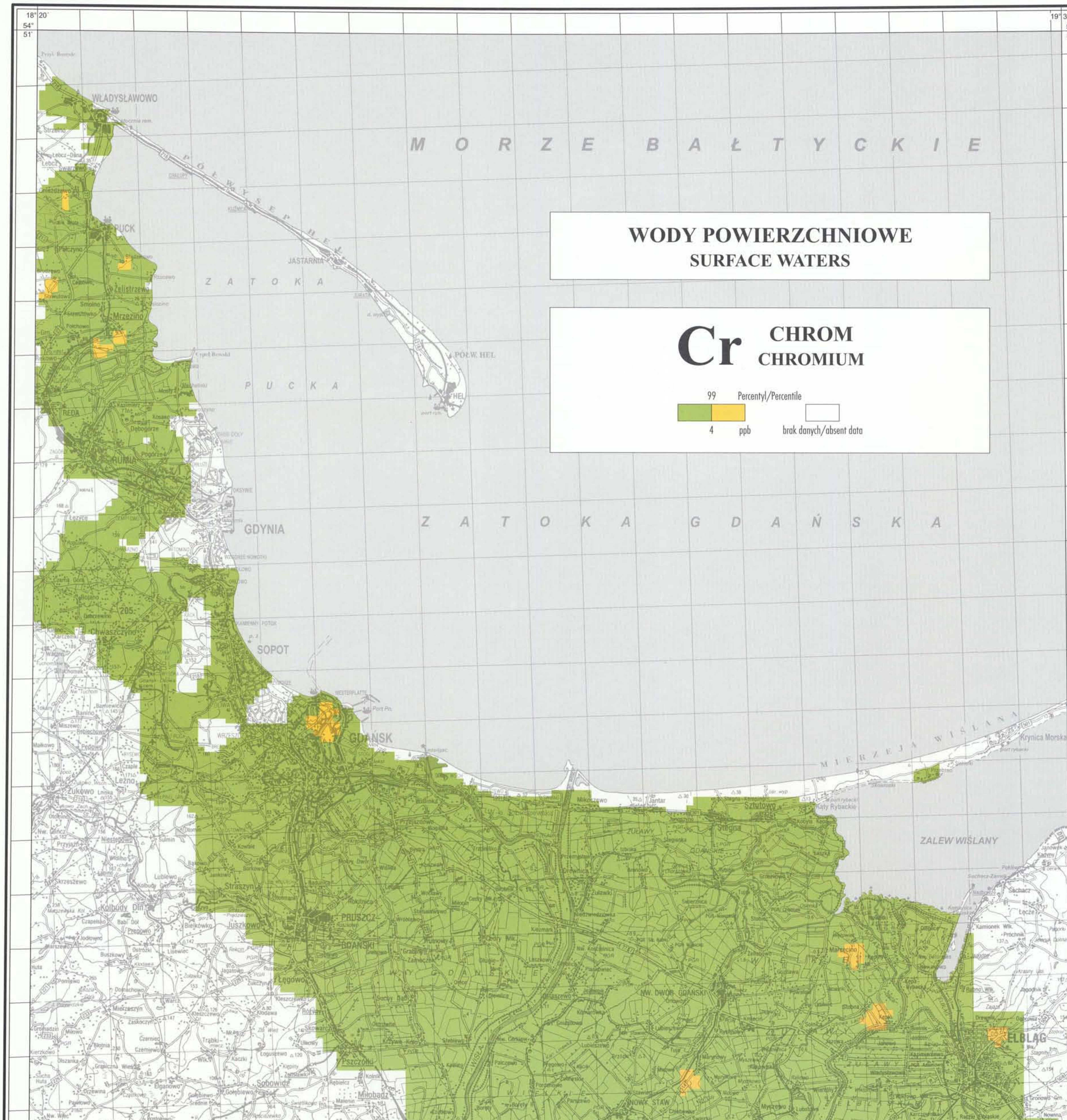
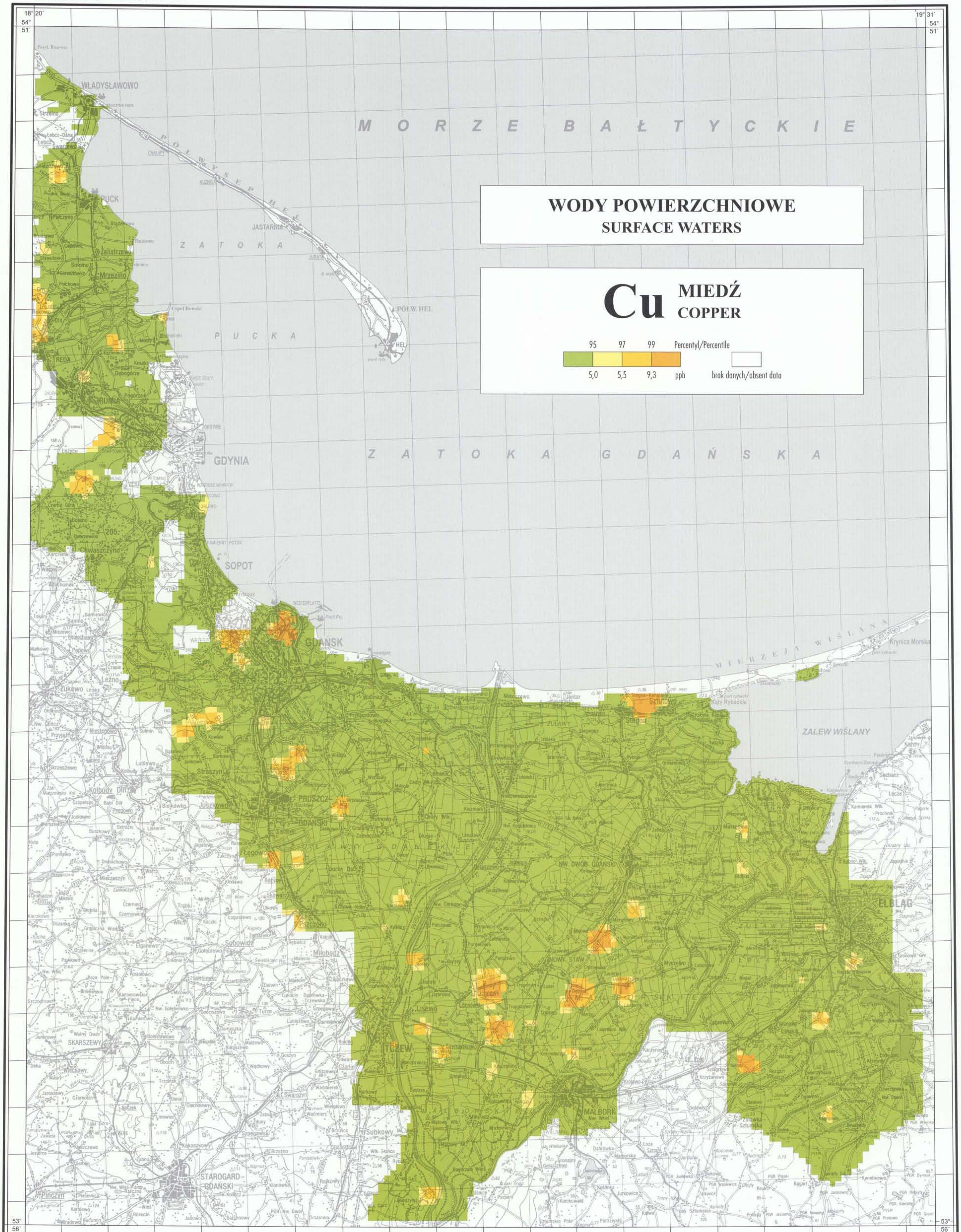
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.

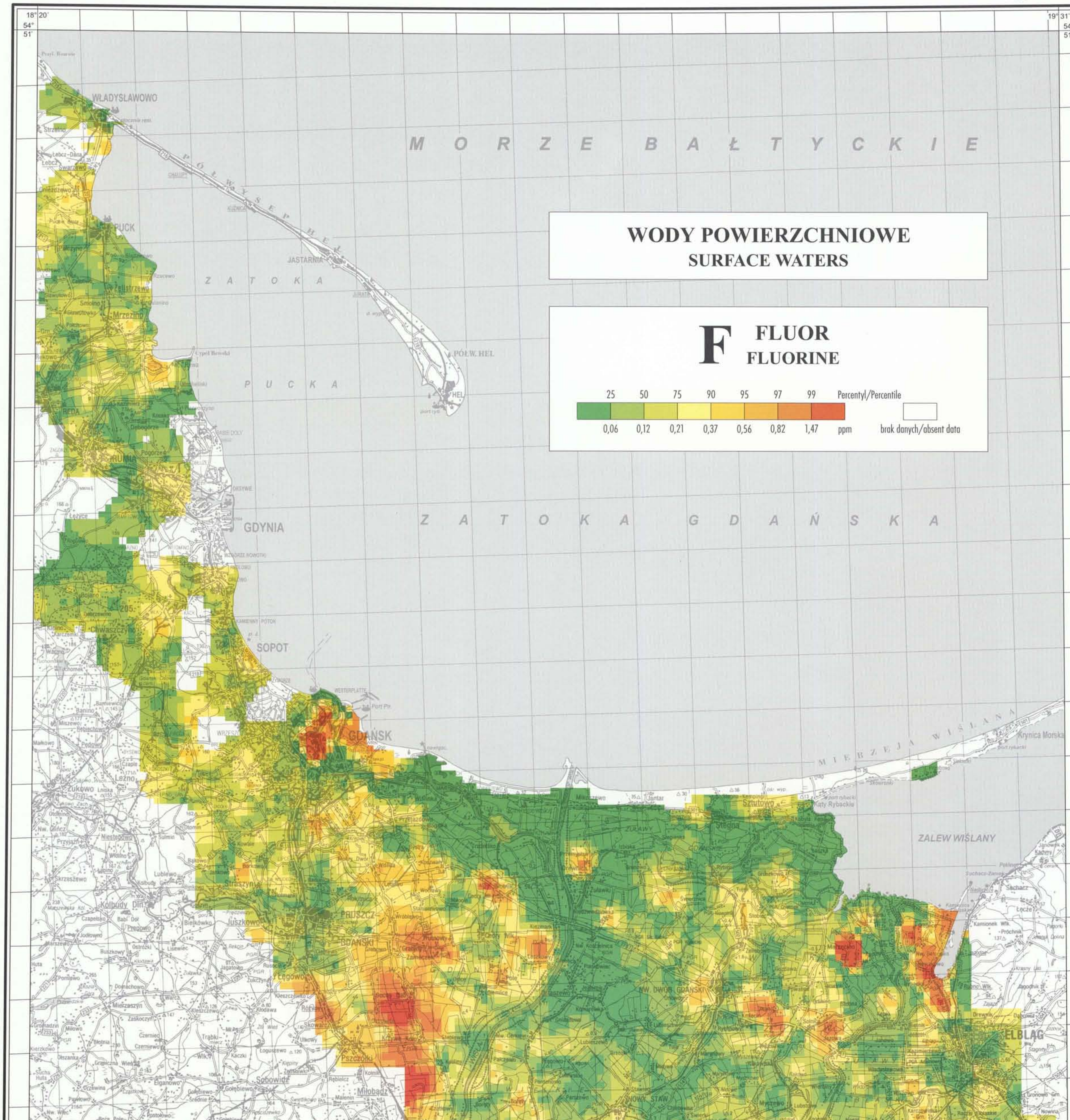


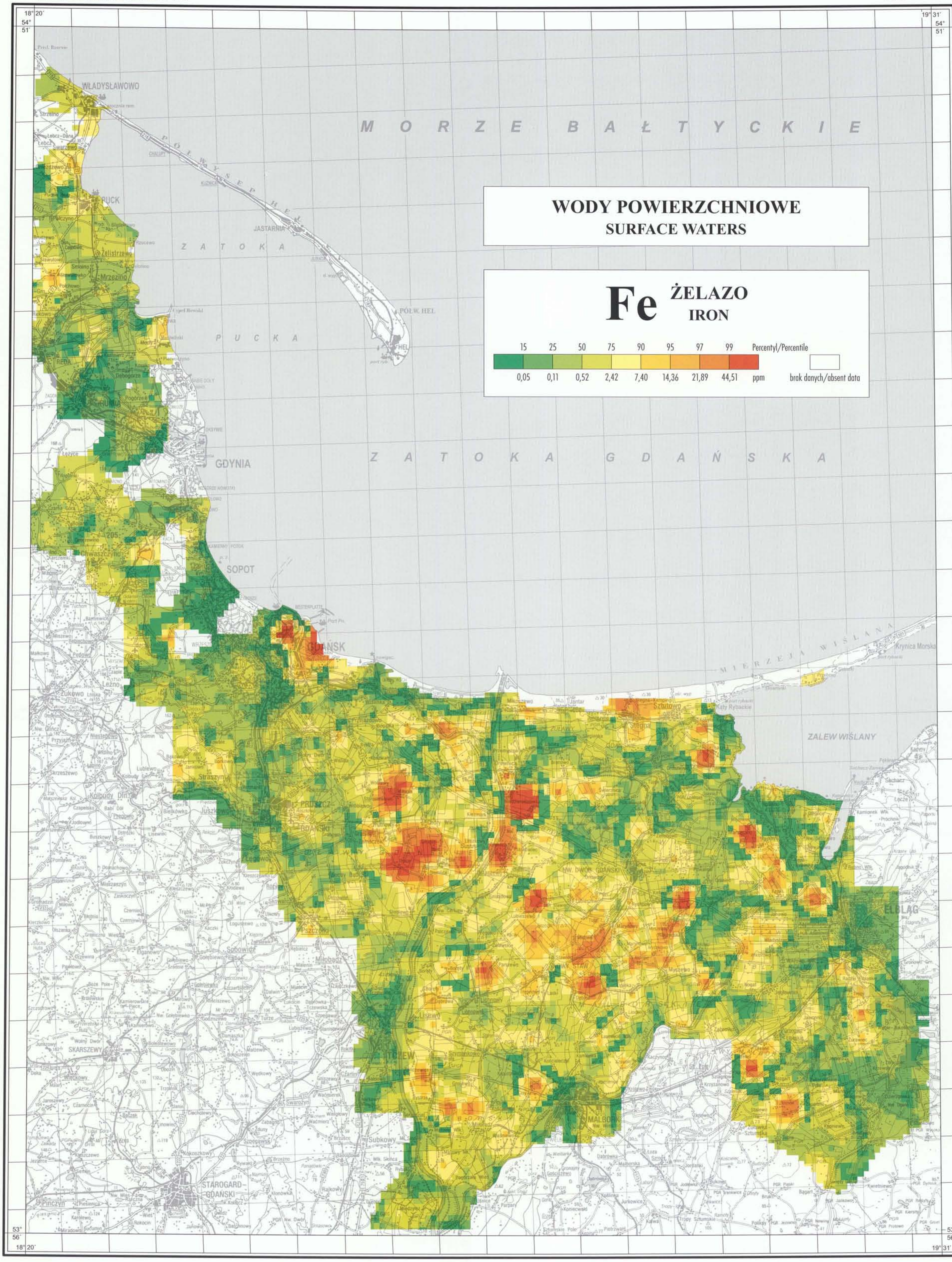
1 : 250 000

Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.

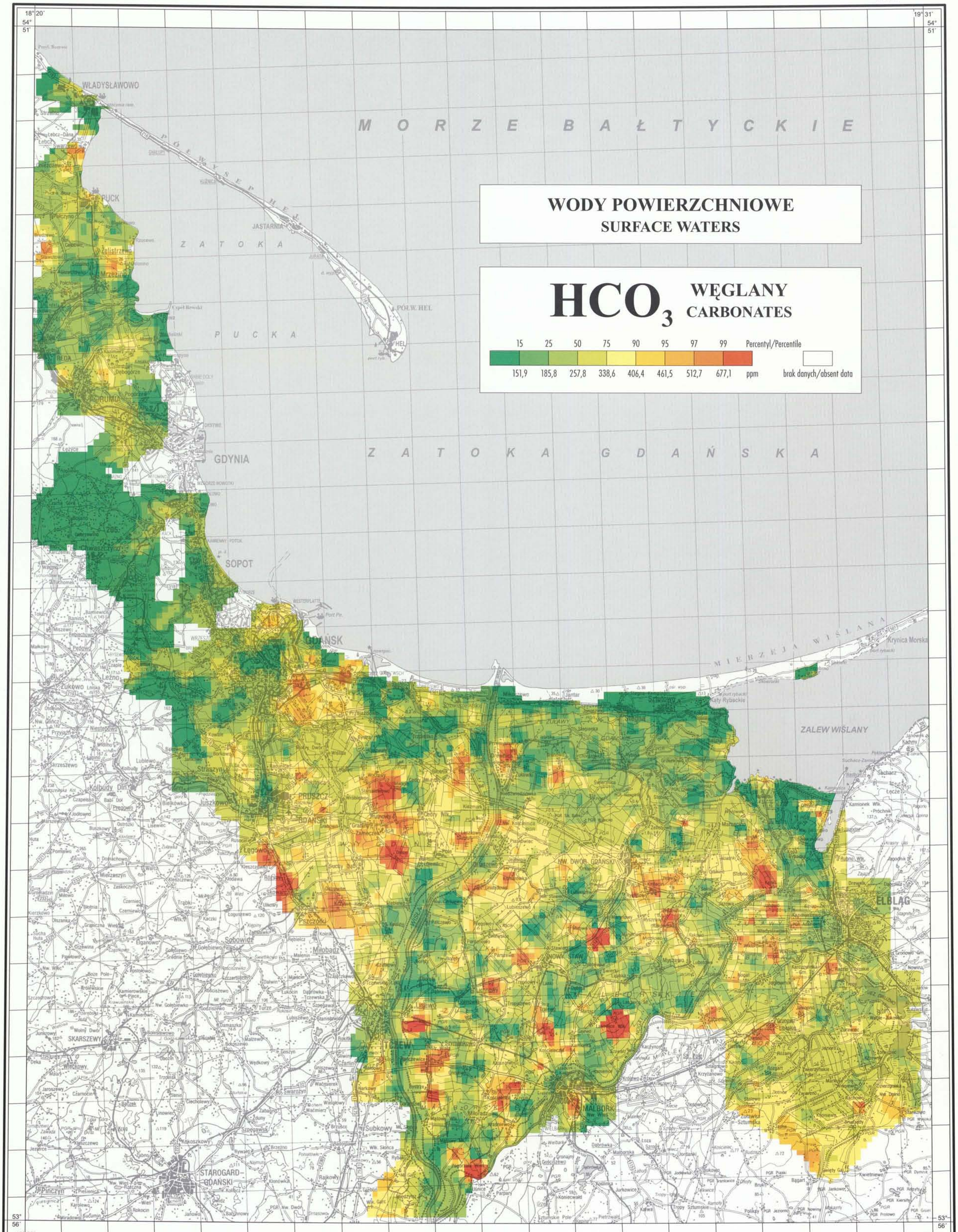

WODY POWIERZCHNIOWE
SURFACE WATERS
Cu MIEDŹ
COPPER
95 97 99 Percentyl/Percentile
5,0 5,5 9,3 ppb
brak danych/absent data
M O R Z E B A Ł T Y C K I E
Z A T O K A G D A Ń S K A
Z A T O K A P U C K A
ZALEW WIŚLANY
WŁADYSŁAWOWO
PUCK
GDYNIA
SOPOT
GDAŃSK
TCZEW
MALBORK
ELBLĄG
STAROGARD GDAŃSKI
18° 20'
19° 31'
54° 51'
53° 56'

1 : 250 000


WODY POWIERZCHNIOWE
SURFACE WATERS
F FLUOR
FLUORINE
25 50 75 90 95 97 99 Percentyl/Percentile
0,06 0,12 0,21 0,37 0,56 0,82 1,47 ppm
brak danych/absent data
M O R Z E B A Ł T Y C K I E
Z A T O K A G D A Ń S K A
Z A T O K A
P U C K A
ZALEW WIŚLANY
WŁADYSŁAWOWO
PUCK
JASTARNIA
HEL
GDYNIA
SOPOT
GDAŃSK
PRUSZCZ GDAŃSKI
TCZEW
MALBORK
ELBLĄG
NOWY STAW
NW. DWÓR GDAŃSKI
STAROGARD GDAŃSKI
SKARSZEWY
Krynica Morska
18° 20´
54° 51´
19° 31´
53° 56´

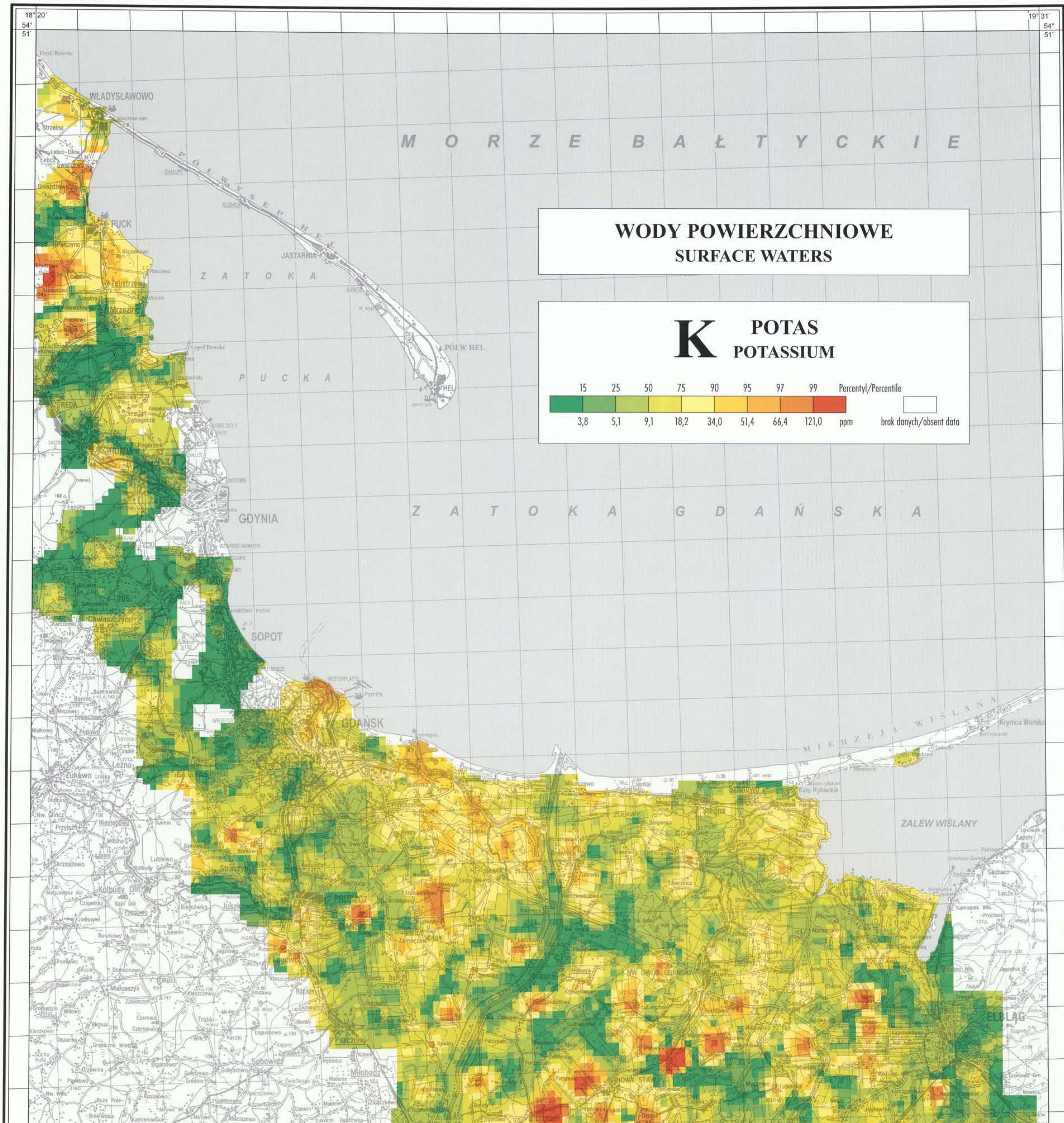

WODY POWIERZCHNIOWE
SURFACE WATERS
Fe ŻELAZO
IRON
15 25 50 75 90 95 97 99 Percentyl/Percentile
0,05 0,11 0,52 2,42 7,40 14,36 21,89 44,51 ppm
brak danych/absent data
M O R Z E B A Ł T Y C K I E
Z A T O K A G D A Ń S K A
Z A T O K A P U C K A
ZALEW WIŚLANY
WŁADYSŁAWOWO
PUCK
JASTARNIA
HEL
GDYNIA
SOPOT
GDAŃSK
ELBLĄG
MALBORK
TCZEW
STAROGARD GDAŃSKI
18°20'
54° 51'
19°31'
53° 56'

1 : 250 000



1 : 250 000

Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



1 : 250 000

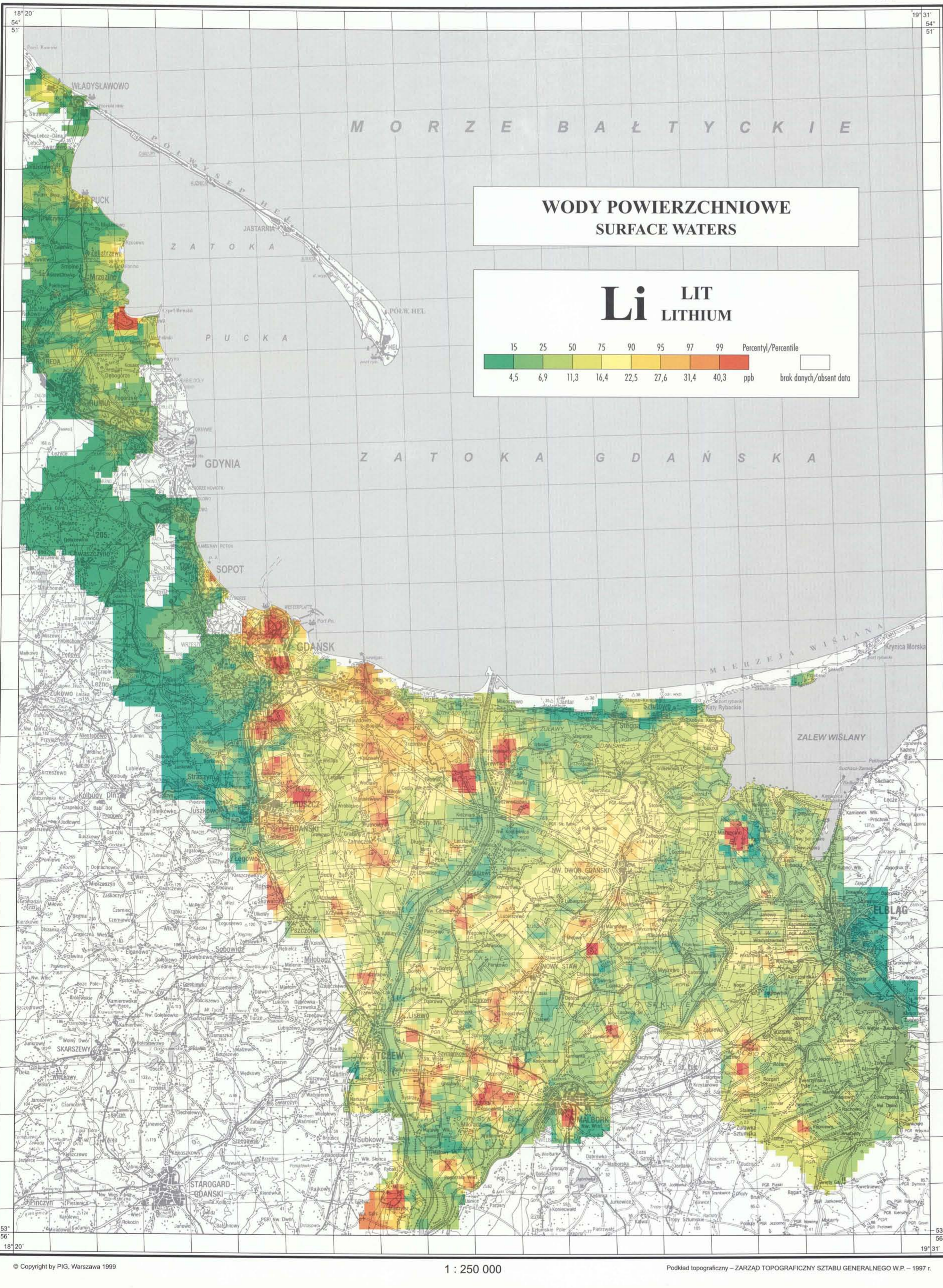
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.

WODY POWIERZCHNIOWE
SURFACE WATERS

Li LIT
LITHIUM

15	25	50	75	90	95	97	99	Percentyl/Percentile
4,5	6,9	11,3	16,4	22,5	27,6	31,4	40,3	ppb

brak danych/absent data



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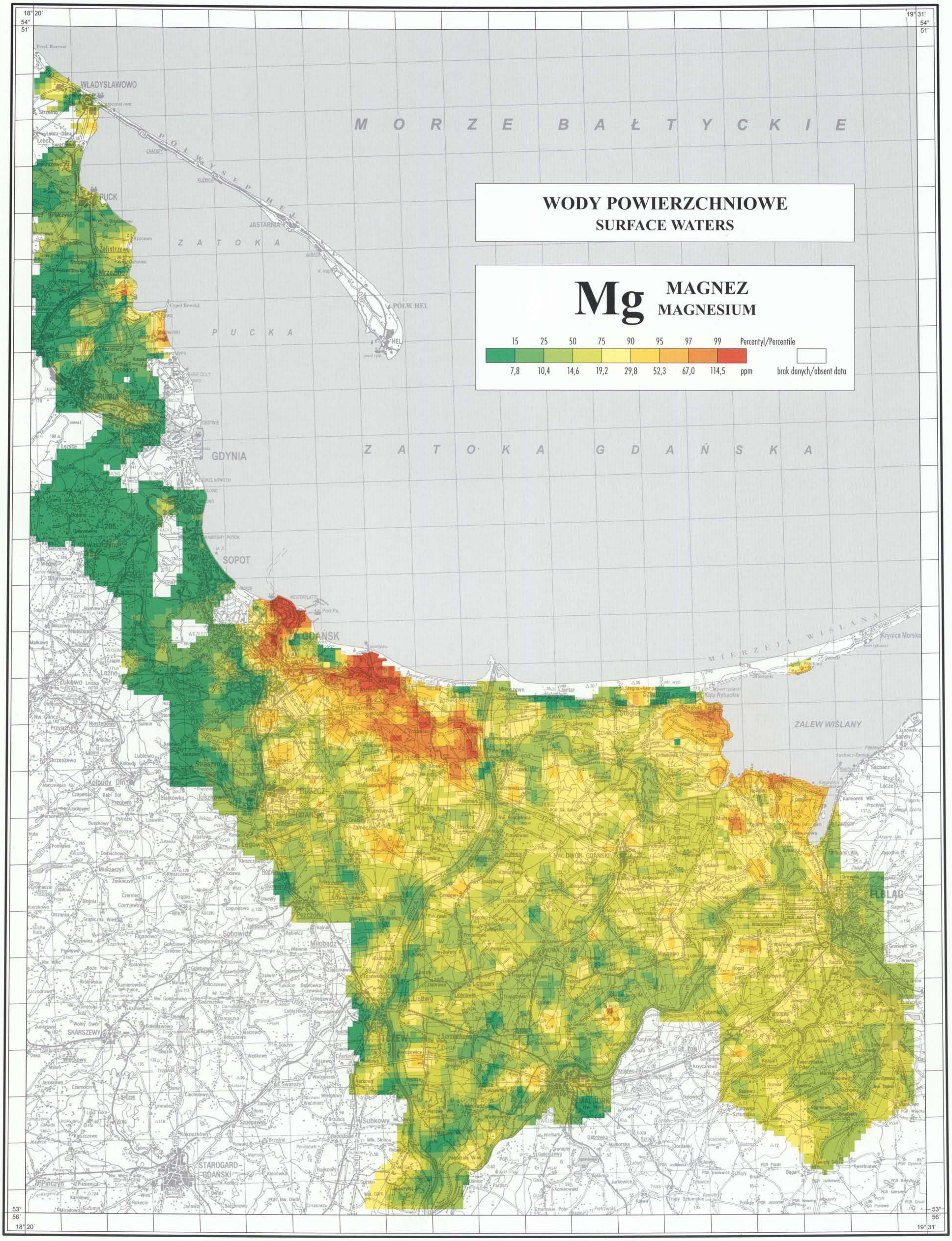
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.



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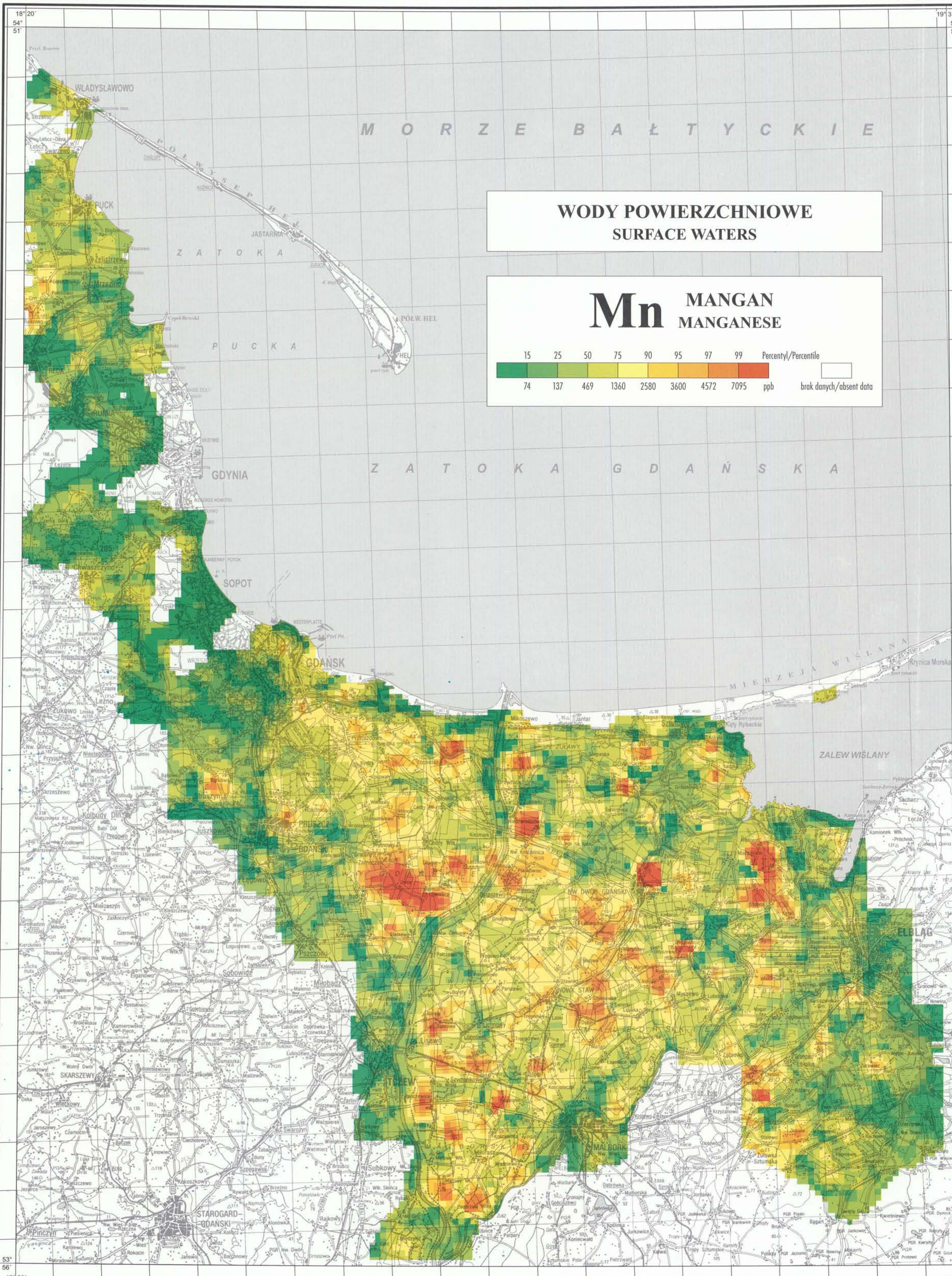

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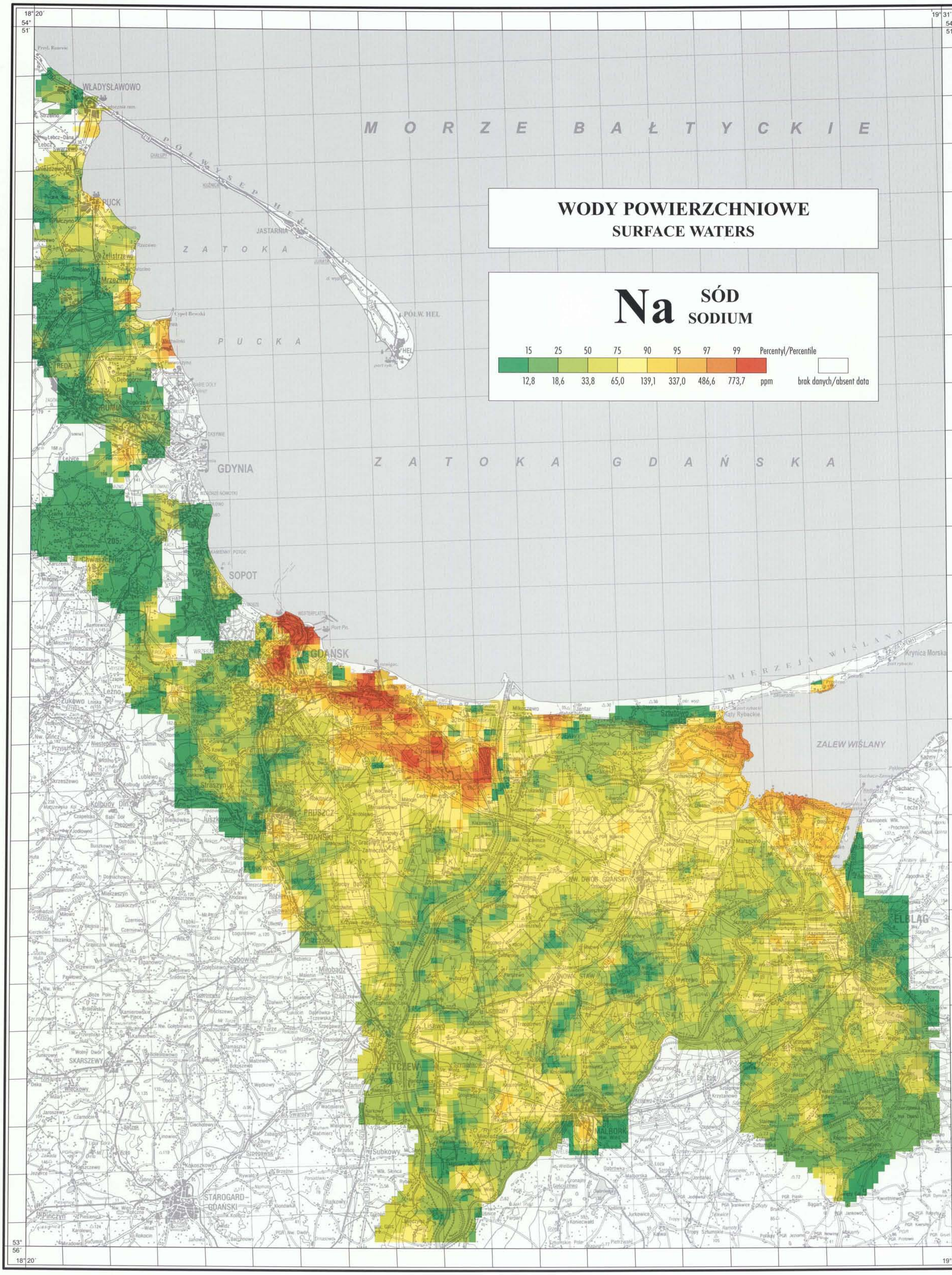

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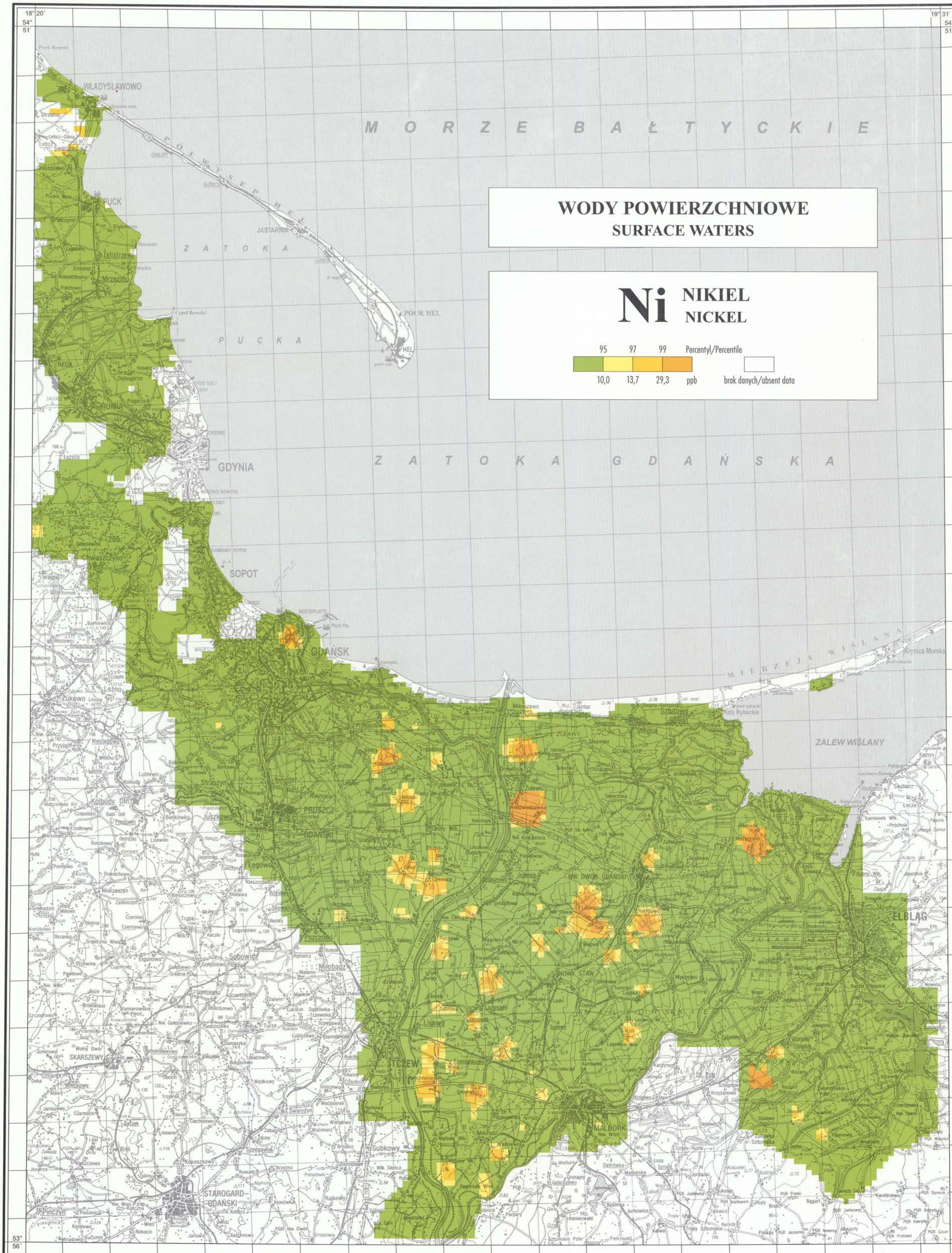

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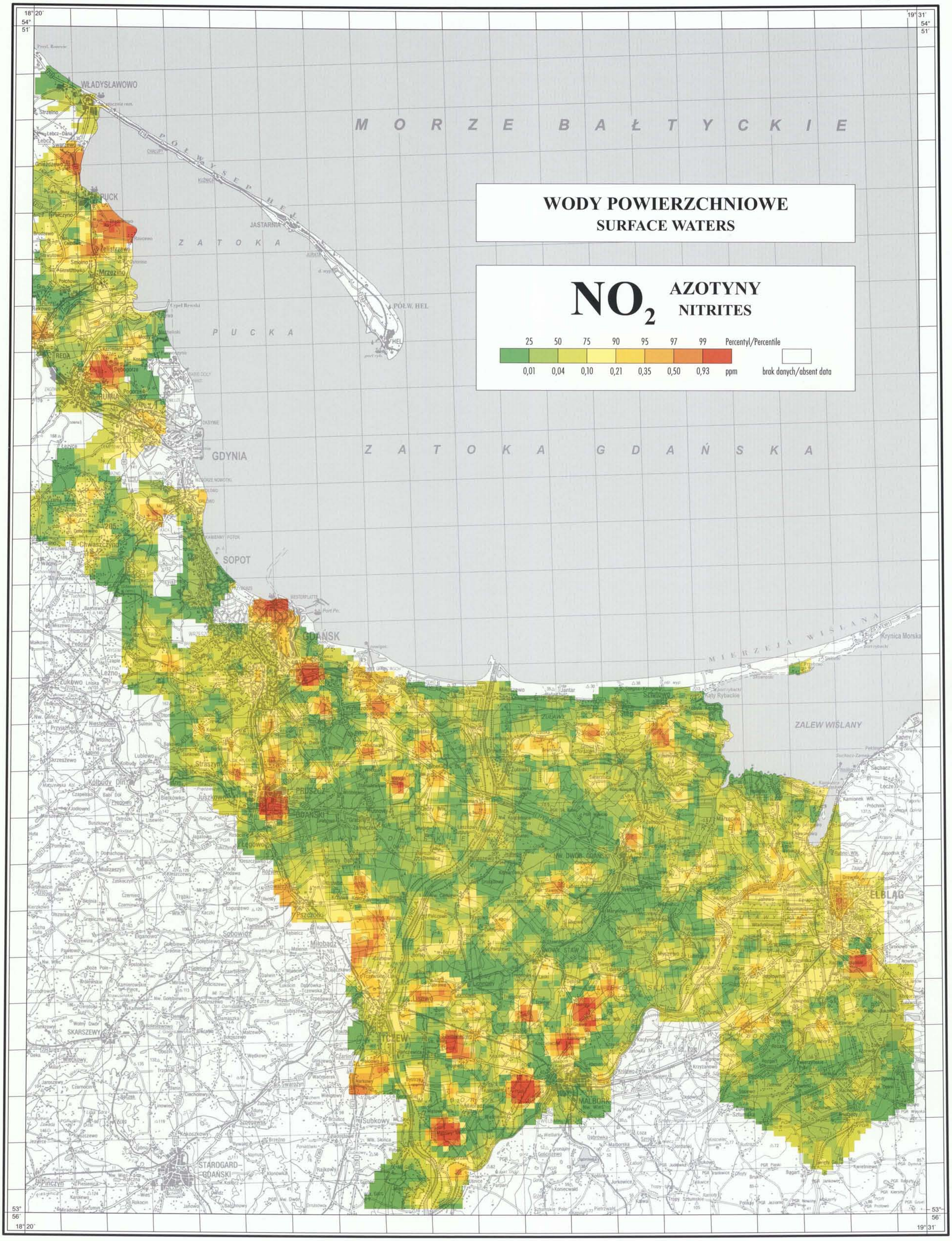

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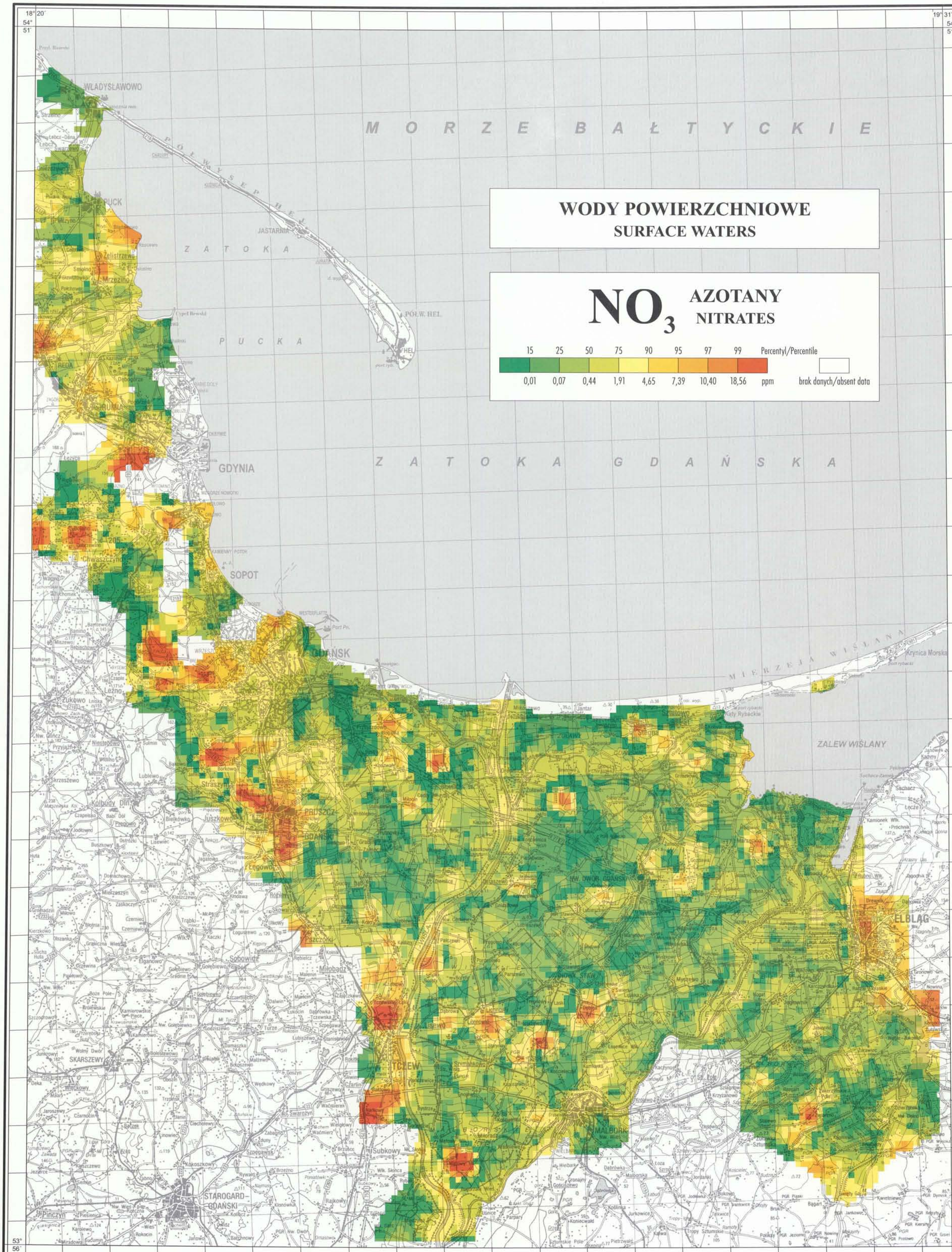

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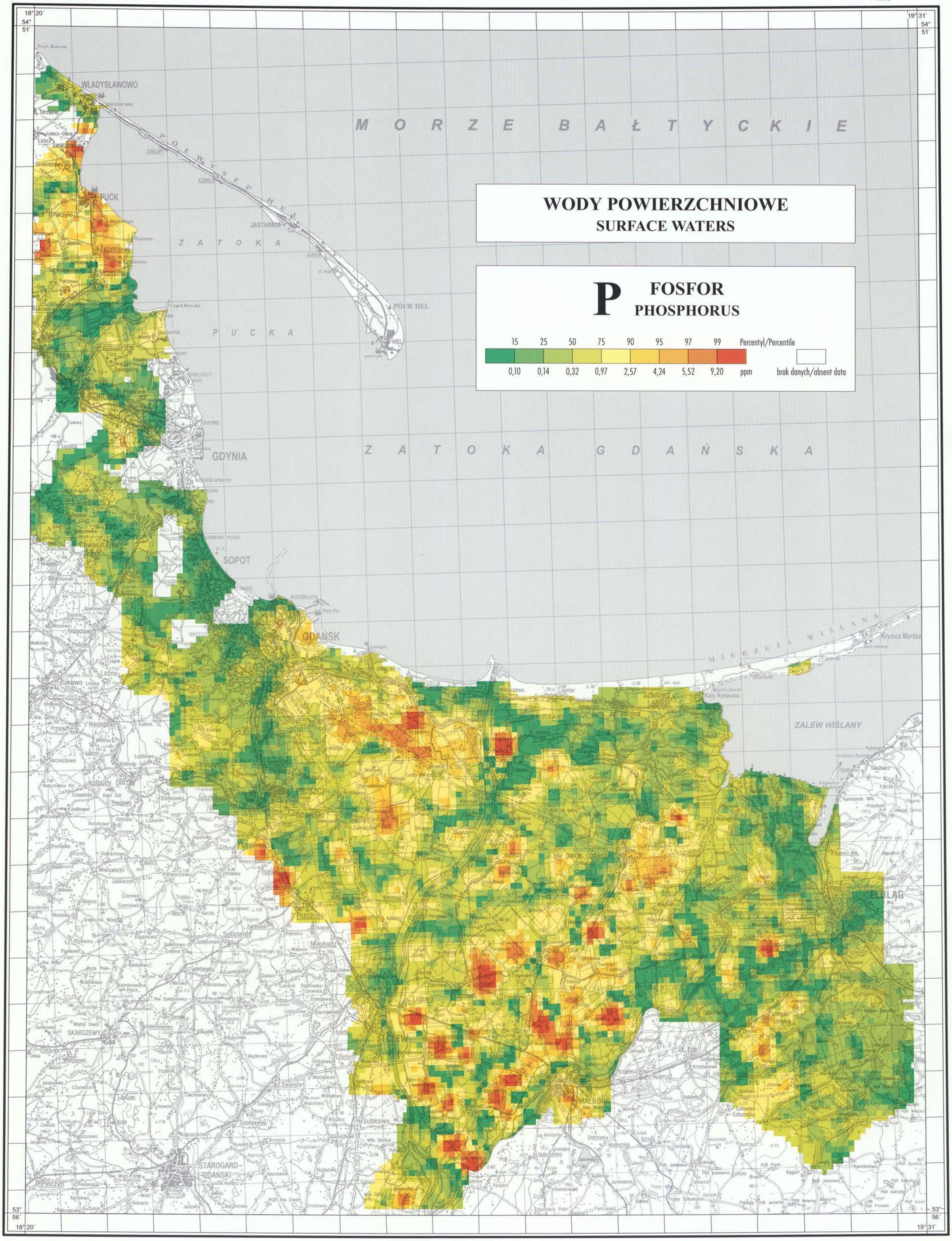

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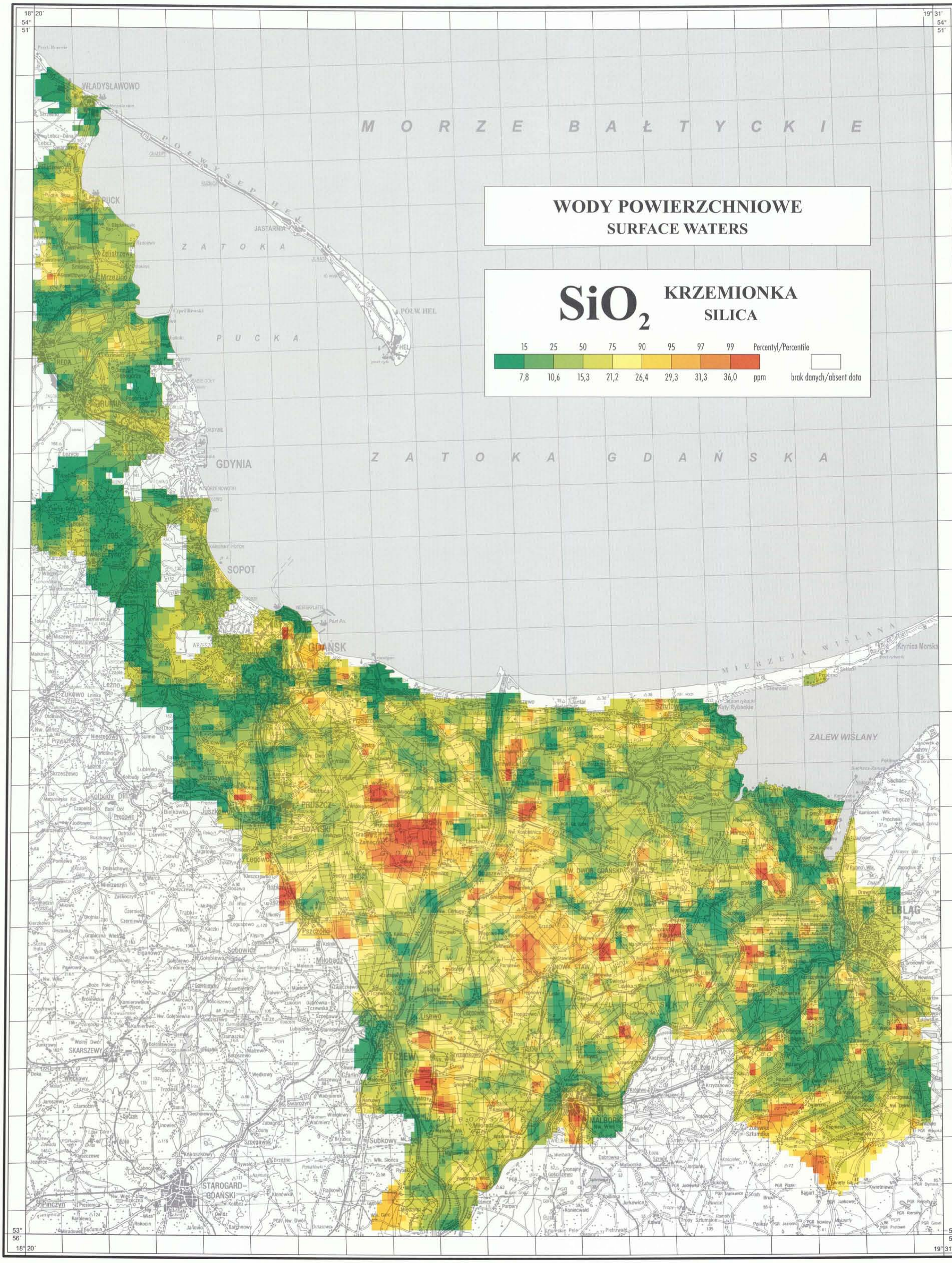
Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.

WODY POWIERZCHNIOWE
SURFACE WATERS

SiO_2 KRZEMIONKA
SILICA

15	25	50	75	90	95	97	99	Percentyl/Percentile
7,8	10,6	15,3	21,2	26,4	29,3	31,3	36,0	ppm

brak danych/absent data



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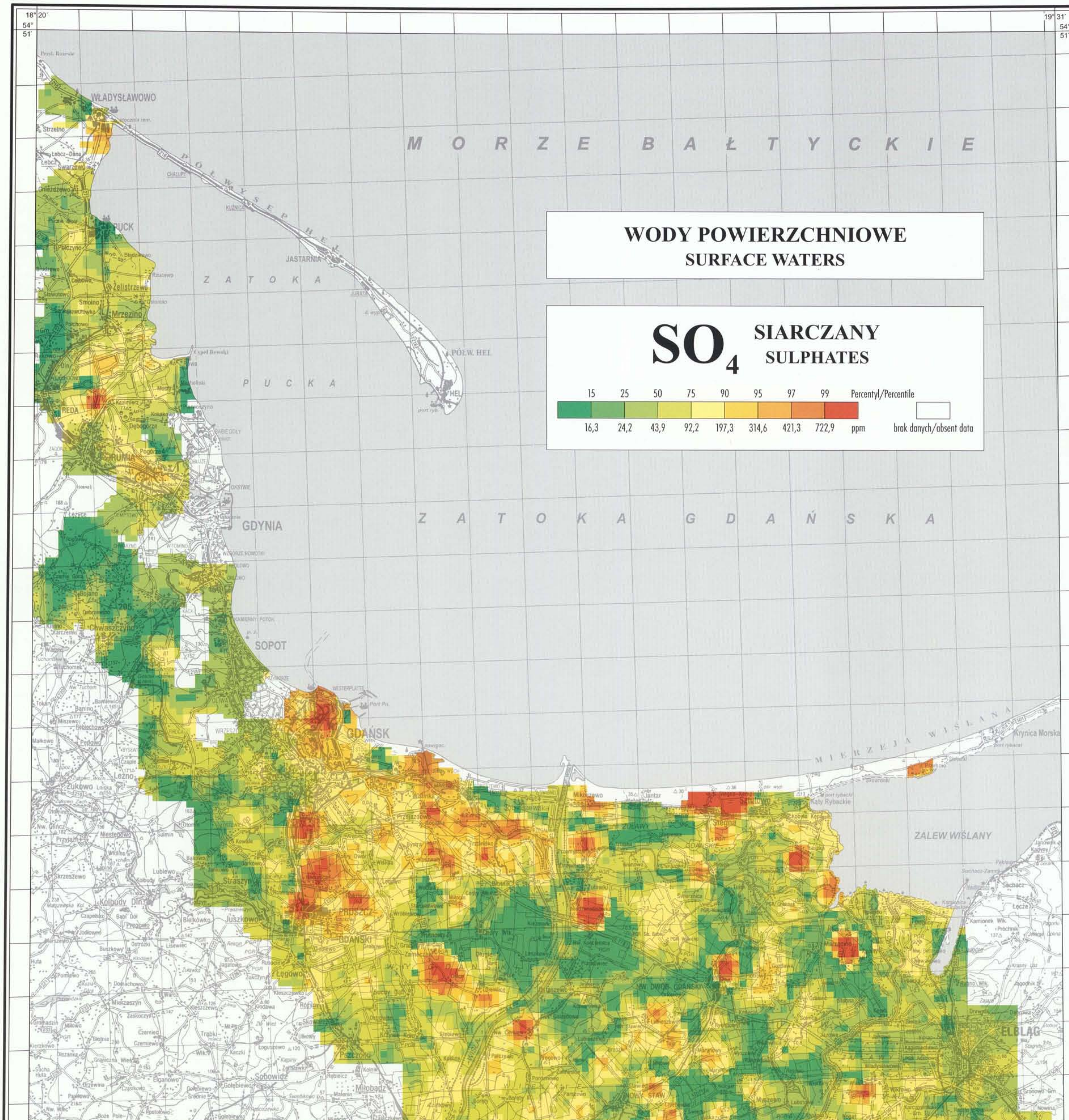

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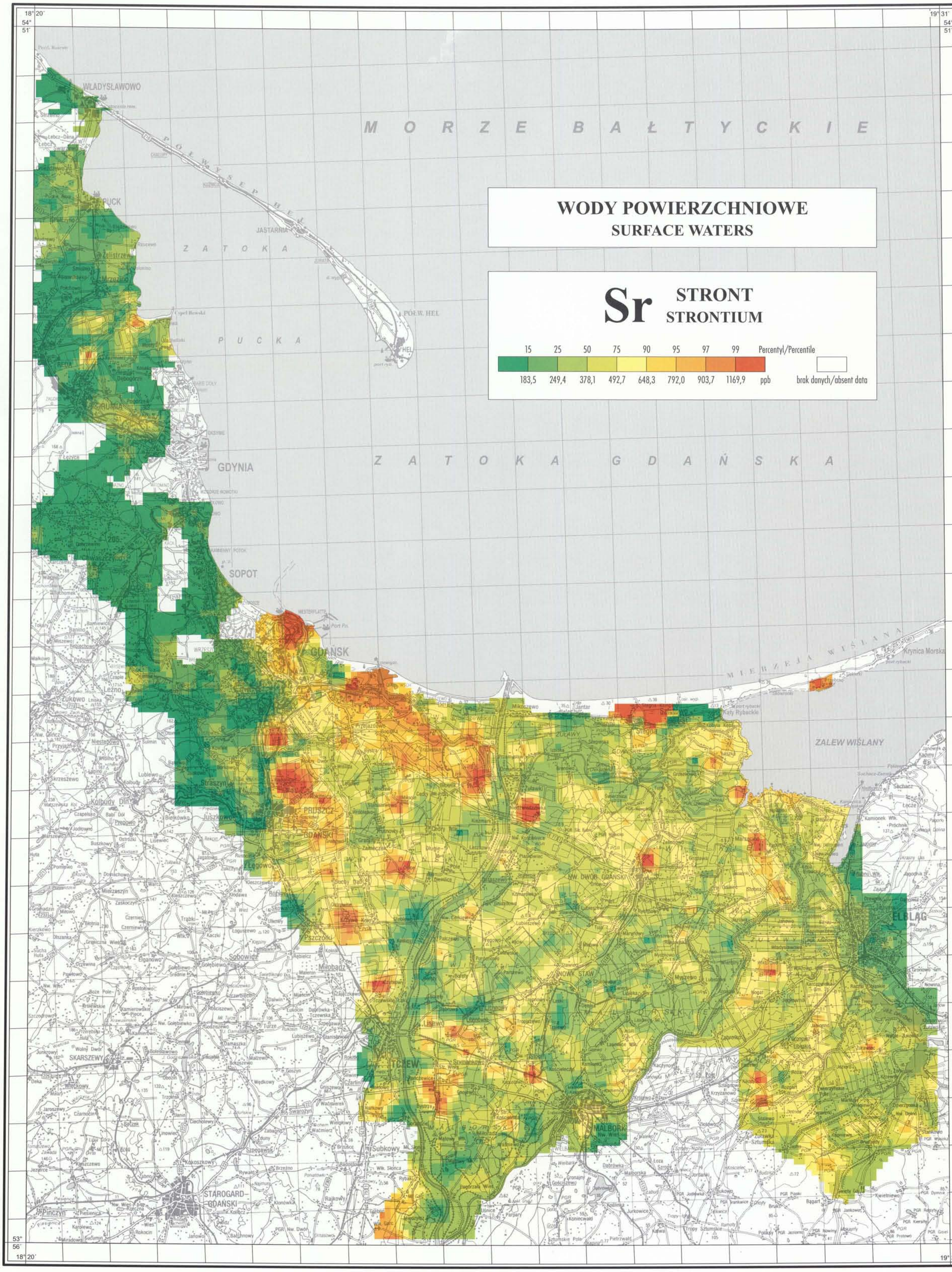
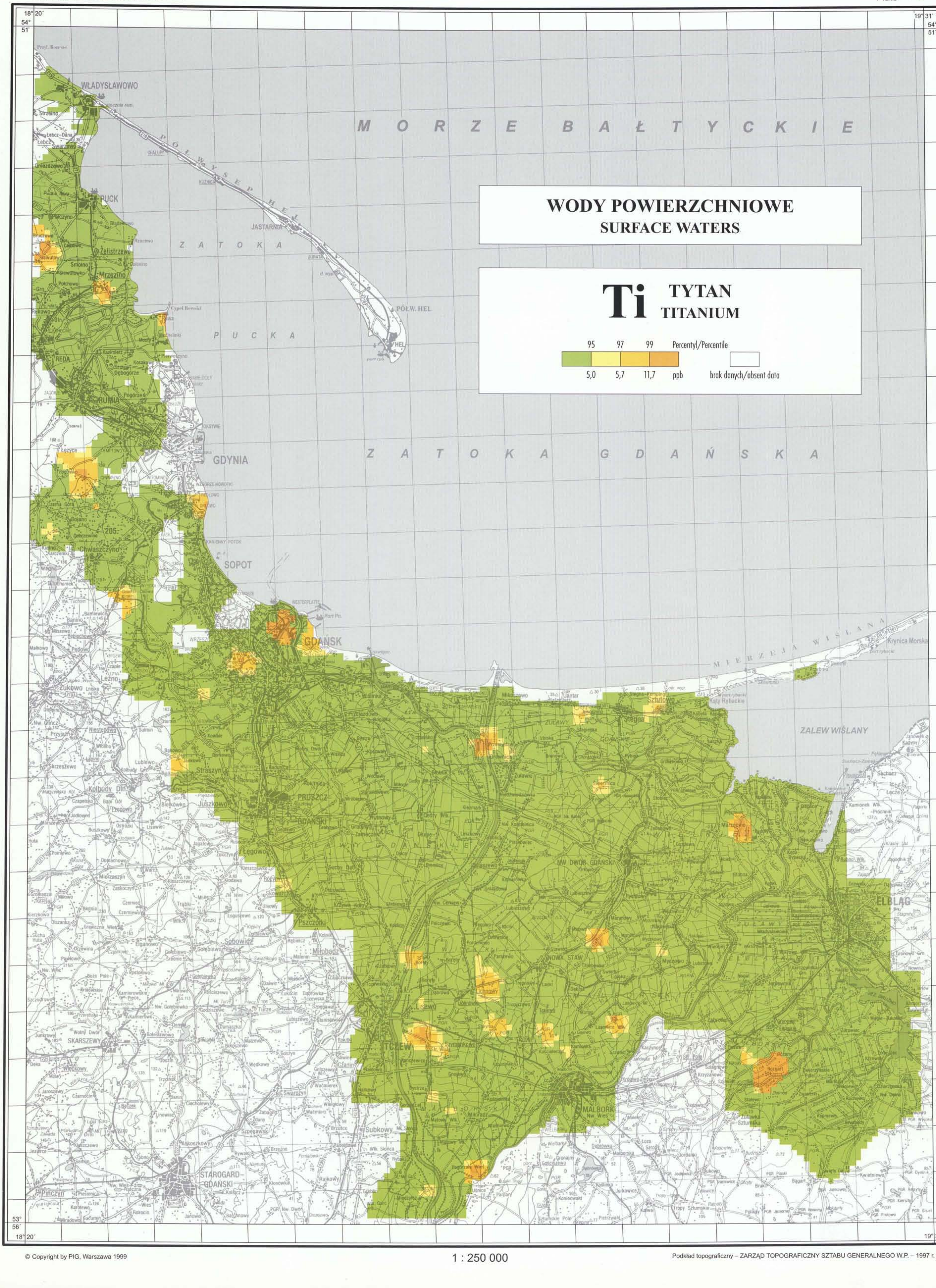
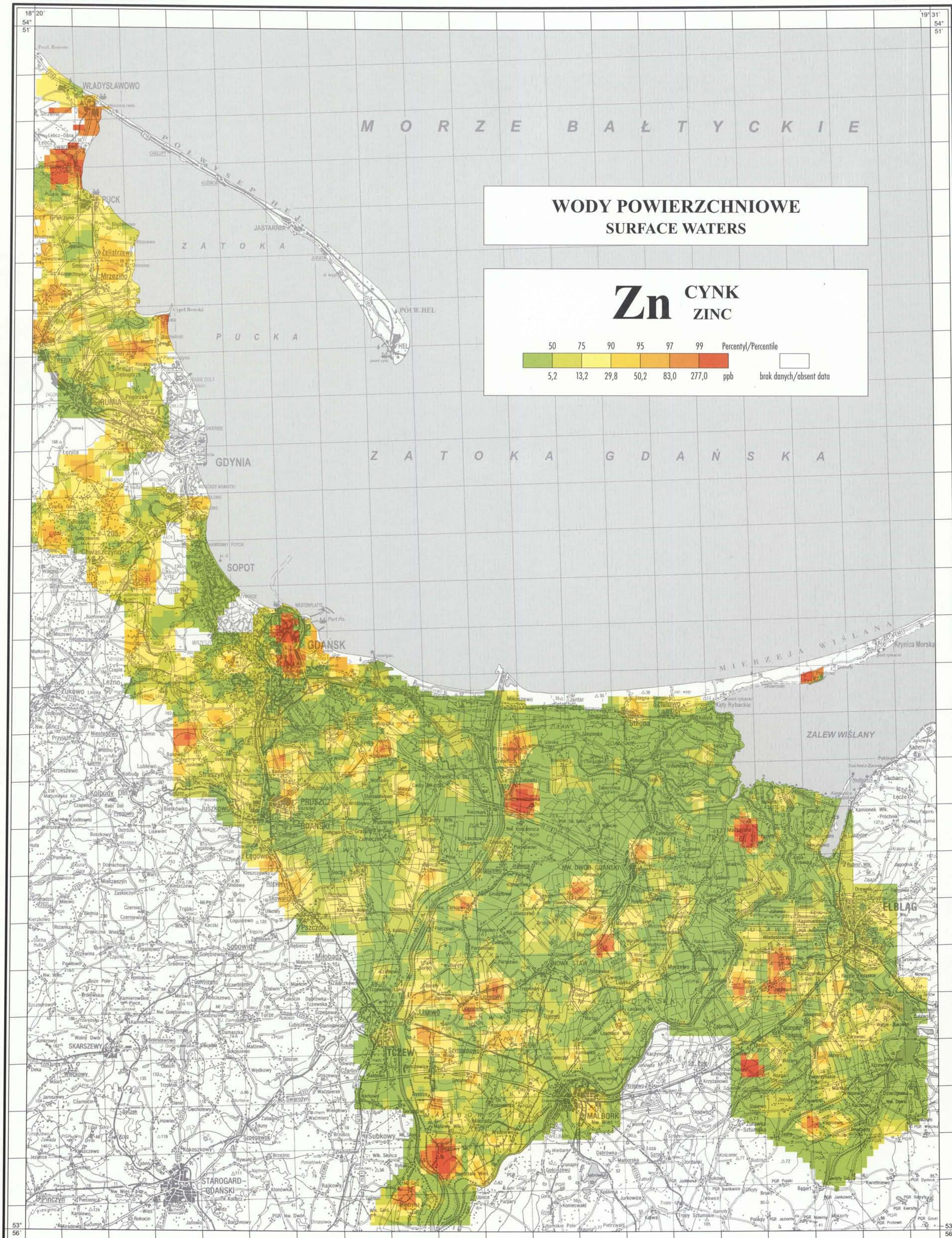

WODY POWIERZCHNIOWE
SURFACE WATERS
Sr
STRONT
STRONTIUM
15 25 50 75 90 95 97 99 Percentyl/Percentile
183,5 249,4 378,1 492,7 648,3 792,0 903,7 1169,9 ppb
brak danych/absent data
M O R Z E B A Ł T Y C K I E
Z A T O K A G D A Ń S K A
Z A T O K A P U C K A
ZALEW WIŚLANY
WŁADYSŁAWOWO
PUCK
JASTARNIA
HEL
GDYNIA
SOPOT
GDAŃSK
PRUSZCZ GDAŃSKI
NW. DWÓR GDAŃSKI
NOWY STAW
ELBLĄG
TCZEW
MALBORK
SKARSZEWY
STAROGARD GDAŃSKI
18° 20'
54° 51'
19° 31'
53° 56'



Podkład topograficzny – ZARZĄD TOPOGRAFICZNY SZTABU GENERALNEGO W.P. – 1997 r.


WODY POWIERZCHNIOWE
SURFACE WATERS
Zn CYNK
ZINC
50 75 90 95 97 99 Percentyl/Percentile
5,2 13,2 29,8 50,2 83,0 277,0 ppb
brak danych/absent data
M O R Z E B A Ł T Y C K I E
Z A T O K A G D A Ń S K A
Z A T O K A P U C K A
ZALEW WIŚLANY
M I E R Z E J A W I Ś L A N A
WŁADYSŁAWOWO
PUCK
JASTARNIA
HEL
REDA
RUMIA
GDYNIA
SOPOT
GDAŃSK
PRUSZCZ GDAŃSKI
ELBLĄG
TCZEW
MALBORK
NOWY STAW
NW. DWÓR GDAŃSKI
SKARSZEWY
STAROGARD GDAŃSKI
18°20'
54° 51'
19°31'
53° 56'