MAPPING OF GEOCHEMICAL CONTAMINATION IN URBAN AREAS OF LITHUANIA

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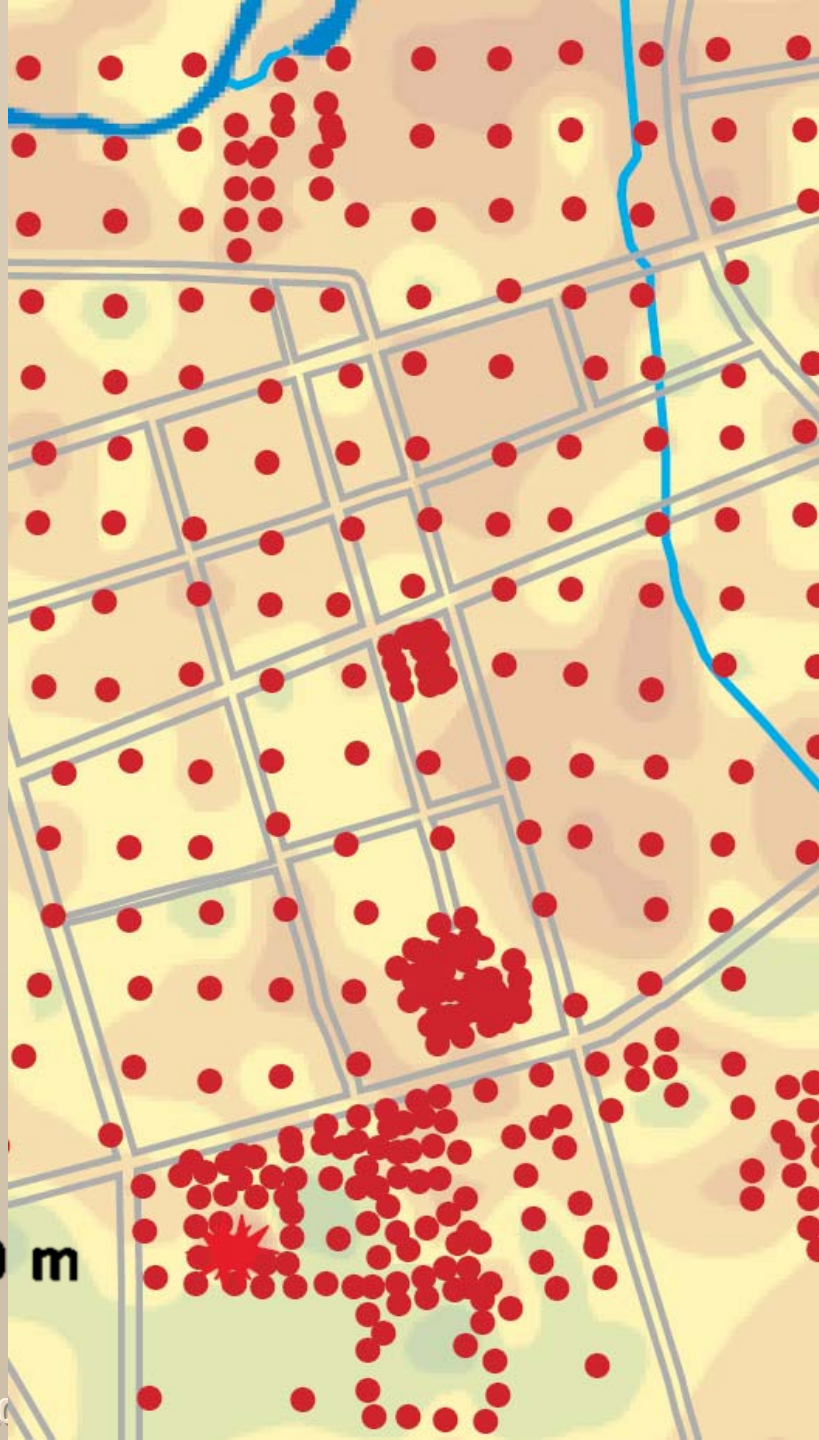
OBJECTIVES

- Revelation of **spatial geochemical properties of urban soil** with regard to distribution of hazardous substances
- Sanitary assessment of **topsoil contamination level**
- Detection of:
  - **contamination sources**
  - its geochemical matrix;
  - its impact areas
  - pathways of contamination spread
  - impact of soil contamination on **ground water quality**

SAMPLING DESIGN

- Spatial topsoil sampling **grid** varies:
  - from **100** m to **500** m, in ***residential*** areas with regard to suspected contamination
  - from **20** m to **100** m in ***industrial*** areas with attempt to collect statistically significant sample population
- Sampling **pattern** depends on soil sealing pattern, but always is seeking the regular one



SAMPLING DESIGN (2)

- Observable suspected **hotspots** must be sampled
- Samples of:
  - **industrial dust** from the factory vents and filters (to detect the individual “fingerprints”),
  - **stream & dug well sediments,**
  - **vadose zone** and
  - **snow** (to estimate pathway and area of contamination) are in use if necessary
- Follows the standard: ISO 10381-5: 2005 Soil quality – sampling – Guidance on the procedure for the investigation of urban and industrial sites with regard to soil contamination

ANALYTICAL PROCEDURES

Formal procedures:

- **Total contents** of macro- and trace elements (Al, Ca, Fe, Mg, Ag, B, Ba, Be, Bi, Cd, Ce, Co, Cr, Cu, Ga, Ge, Hf, La, Li, Mn, Mo, Nb, Ni, P, Pb, Sb, Sc, Sn, Sr, Ti, V, W, Y, Yb, Zn, Zr)
- LOI, pH

Extra procedures, subject to suspected type of contamination:

- Hg, As, other **extractable forms** (aqua regia, bioavailable) of toxic heavy metals
- aromatic **hydrocarbons**, PAH, oil products
- PCB, EOX, **pesticides**
- **ions** of sulphate, nitrate, fluoride and potassium chloride

ASSESSMENT OF SOIL CONTAMINATION LEVEL *(according HN 60:2004)*

According to criteria:

- **maximum permissible concentrations** (also, reference values related to the background values for sand & sandy loam soil as well as for loam & clay)

- **risk index K_0**, calculated by formula

$K_0 = C/MPL$, where

C – content of particular element in soil sample (mg/kg)

MPC – maximum permissible concentration of the same element (mg/kg)

- **index of total contamination Z_s**, calculated by formula

$Z_s = \Sigma K_{ki} - (n-1)$, where

$K_{ki} = C_i/C_b$,

C_i – measured content of *i* element-pollutant in soil sample (mg/kg),

C_b – background value of i element-pollutant (mg/kg),

n – number of elements-pollutants,

LINKS between SOIL CONTAMINATION and HUMAN HEALTH *(HN 60:2004)*

In residential areas:

Contamination level	Zs value	Change of population health indices in the contaminated areas
I. Permissible	< 16	The lowest level of sick children rate and minimum frequency of functional divergences
II. Medium dangerous	16 – 32	The increase of total sick rate
III. Dangerous	32 – 128	The increase of total sick rate, number of children that are frequently sick, have chronic diseases or cardiovascular disorders
IV. Extremely dangerous	> 128	The increase of sick children rate, disturbance of reproductive function of women (increase of pregnancy intoxications, premature child birth, number of still-born and hypotrophic newborns)

LINK between SOIL CONTAMINATION and HUMAN HEALTH (2)

Methodology **developed** in 1980-90 in IMGRE, Moskow, Russia by Revich and Saet
(Recomendations concerning eco-geochemical assessment of environment in industrial urban areas, 1982:

Ревич Б.А., Сает Ю.Е., Смирнова Р.С., Е.П. Сорокина. Методические рекомендации по геохимической оценке загрязнения территории городов химическими элементами. М.: ИМГРЭ, 1982

Ревич Б.А., Сает Ю.Е. Эколого-геохимическая оценка окружающей среды промышленных городов. // Урбоэкология. М., "Наука", 1990.

Methodology **certified** in 1990-96 in Vilnius, Lithuania during monitoring of environmental pathology: *(R. Ptašekas, I. Zurlytė, M. Meilūnas, S. Dapkūnas, D. Stoškuvienė, G. Jonauskas, M. Ramanauskaitė, J. Ptašekas, R. Sabaliauskas, N. Šliachtič. Environmental Pathology of city inhabitants in Lithuania (Aplinkos veikiamų Lietuvos miestų gyventojų patologija) //Ekologija 2004, Nr.3, p. 6 – 16.):*

- sick' rate of children neurotoxicosis and alopecia are related to anomalies of heavy metals in urban topsoil
- pregnancy intoxications, premature child birth, children neurotoxicosis, alopecia and tumours are reputed as eco-genic diseases

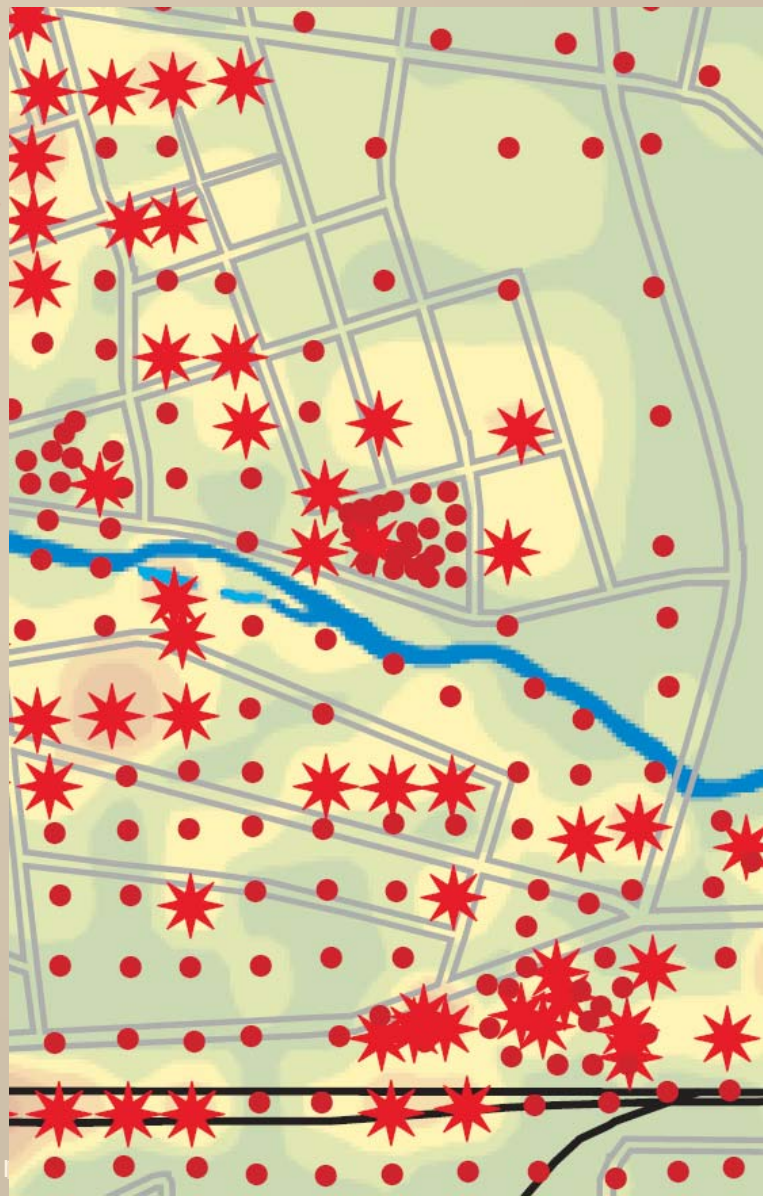
ACTIONS in SITES with CONTAMINATED TOPSOIL

In residential, recreational and agricultural areas:

Contamination level	Z_s value	K_0 value	Required actions
I. Permissible	< 16	$K_0 \leq 1$	Detailed **soil investigation** and monitoring is recomended.
II. Medium dangerous	16 – 32	$1 < K_0 \leq 3$	Reducing of impact from pollution sources. Quality **control** of surface and ground **water.**
III. Dangerous	32 – 128	$3 < K_0 \leq 10$	Obligatory is **soil remediation** (liming, adding of compost, dilution with clean soil) up to permissible level in residential and recreation areas. Agriculture areas must be used for technical crops or afforestation.
IV. Extremely dangerous	> 128	$K_0 > 10$	Polluted **soil** layer must be **removed** to landfill of hazardous substances or remiadiated *in situ* up to superior level of contamination.

GEOCHEMICALY MAPPED URBAN AREAS

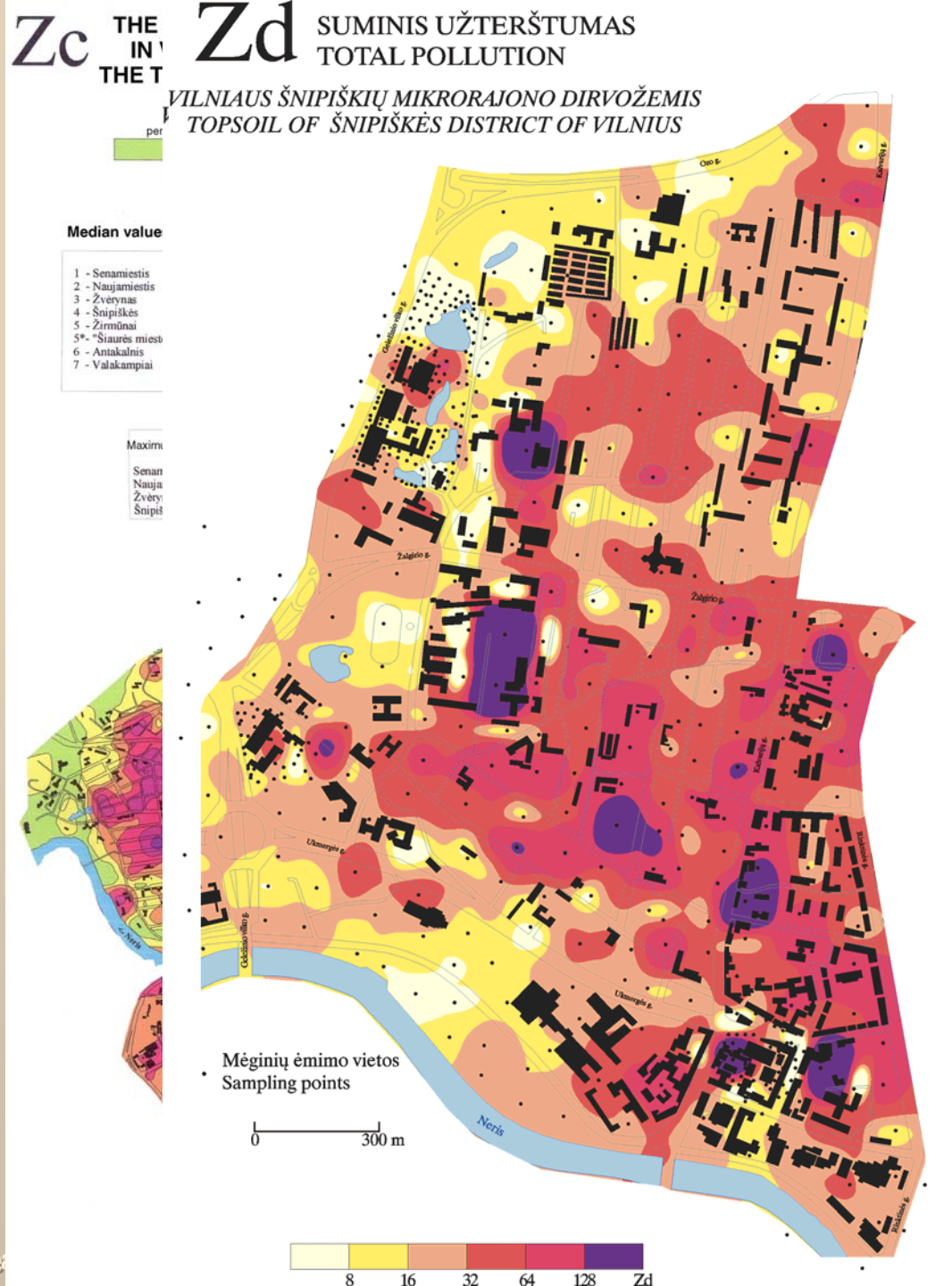
1. **Vilnius**
2. Šiauliai
3. Panevėžys
4. Alytus
5. Klaipėda
6. Mažeikiai
7. Biržai
8. Pasvalys
9. Rokiškis
10. Radviliškis
11. Kėdainiai
12. Kupiškis
13. Jonava
14. Joniškis
15. Trakai
16. Šilutė



LIETUVOS GEOLOGIJOS TARNYBA
GEOLOGICAL SURVEY OF LITHUANIA

Geochemical soil mapping in ***Vilnius*** since 1985:

- elaboration and monitoring of geochemical data in **whole town**
- detailed geochemical mapping in **industrial** Naujamiestis and Žirmūnai districts
- assessment of soil contamination level in Šnipiškės district due to the shift of district' function from **industrial-residential to public-administrative**
- assessment of topsoil sanitary state according the Z_s index in **residential** districts: Old town, Žvėrynas and Antakalnis



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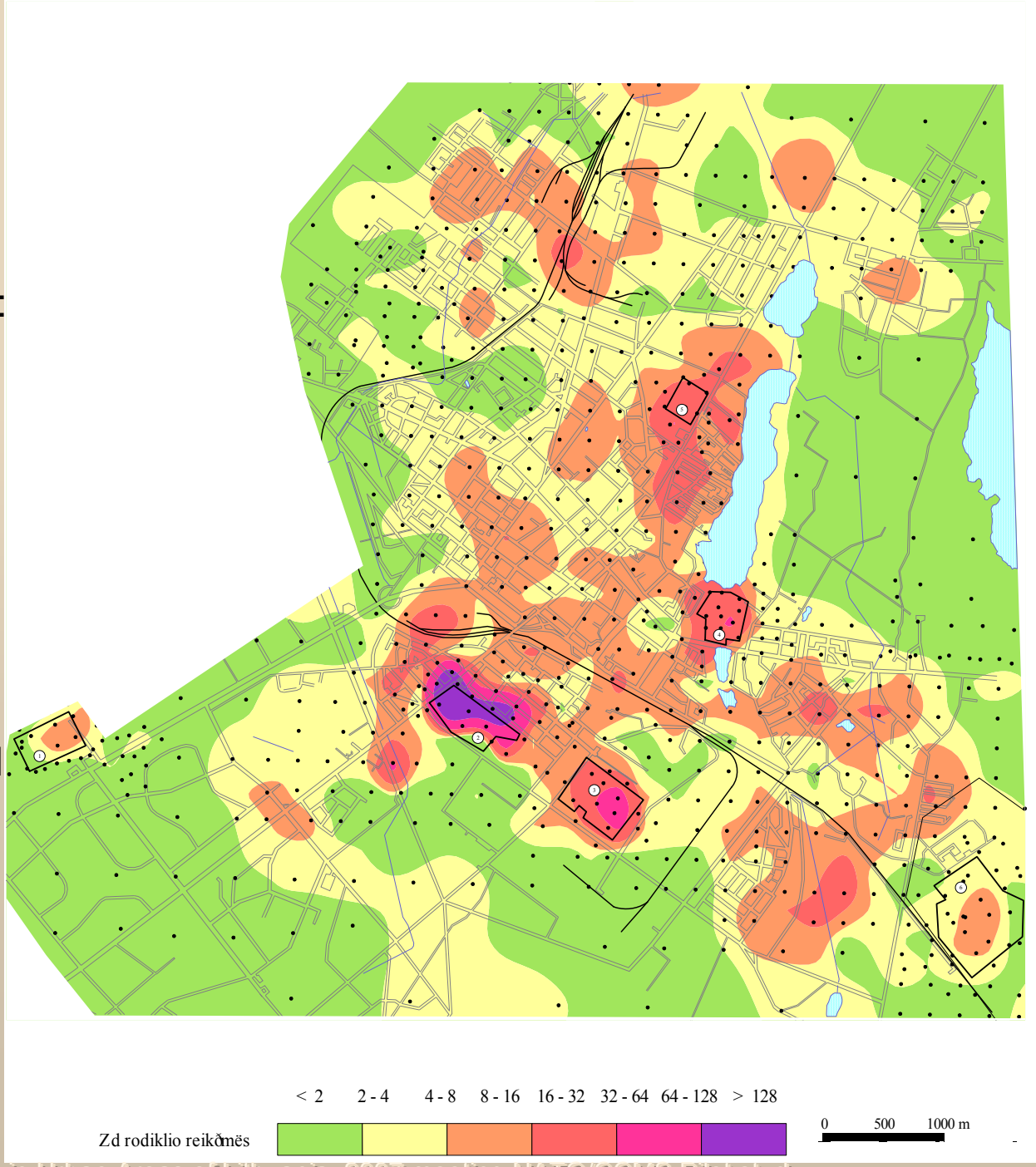
Geochemical mapping of ***Šiauliai*** town in 1989–1992:

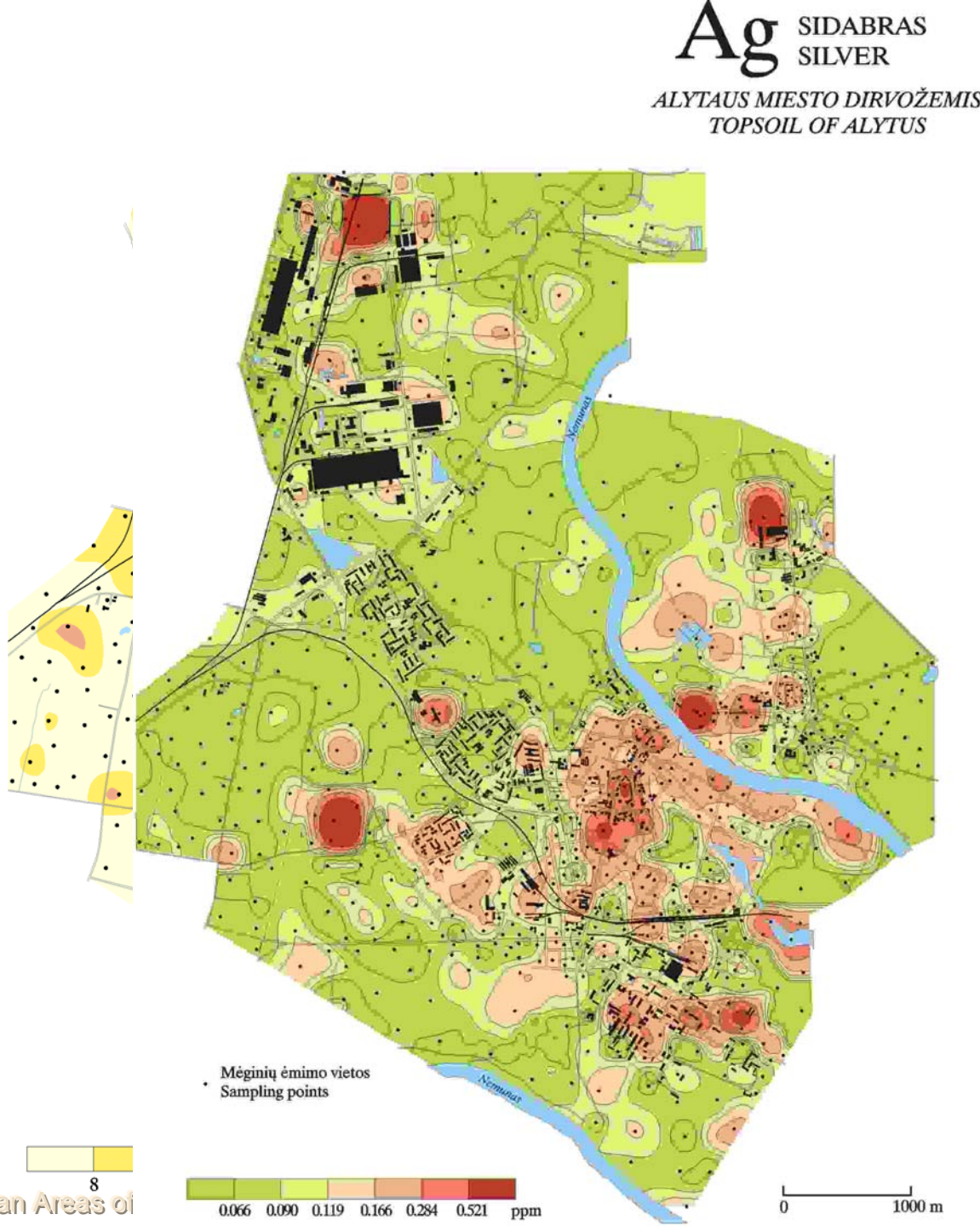
- topsoil, lake and stream sediments
- main elements-pollutants – Zn, Pb, **Cr** (leather&footwear), Cu, Ni, Sn, Mo, Ag
- anomalies of heavy metals in topsoil reflects **historical industrial contamination** and allow to identify impact zones of these enterprises
- **secondary pathways** of contamination were found (usage in gardens of contaminated peat from foot-slope of municipal landfill)



GEOLOGICAL SURVEY OF LITHUANIA

Geochemical mapping of ***Alytus*** town in 1996–1997:

- topsoil & snow
- anomalies of heavy metals in topsoil reflects distribution of **factories and uncontrolled sanitary landfills**
- topsoil contamination was observed also in the modern residential suburbs, where sludge from Dalidė lake (former sewage reservoir) was used for soil recultivation
- main elements-pollutants – Pb, Ag, Zn, Cu, Sn



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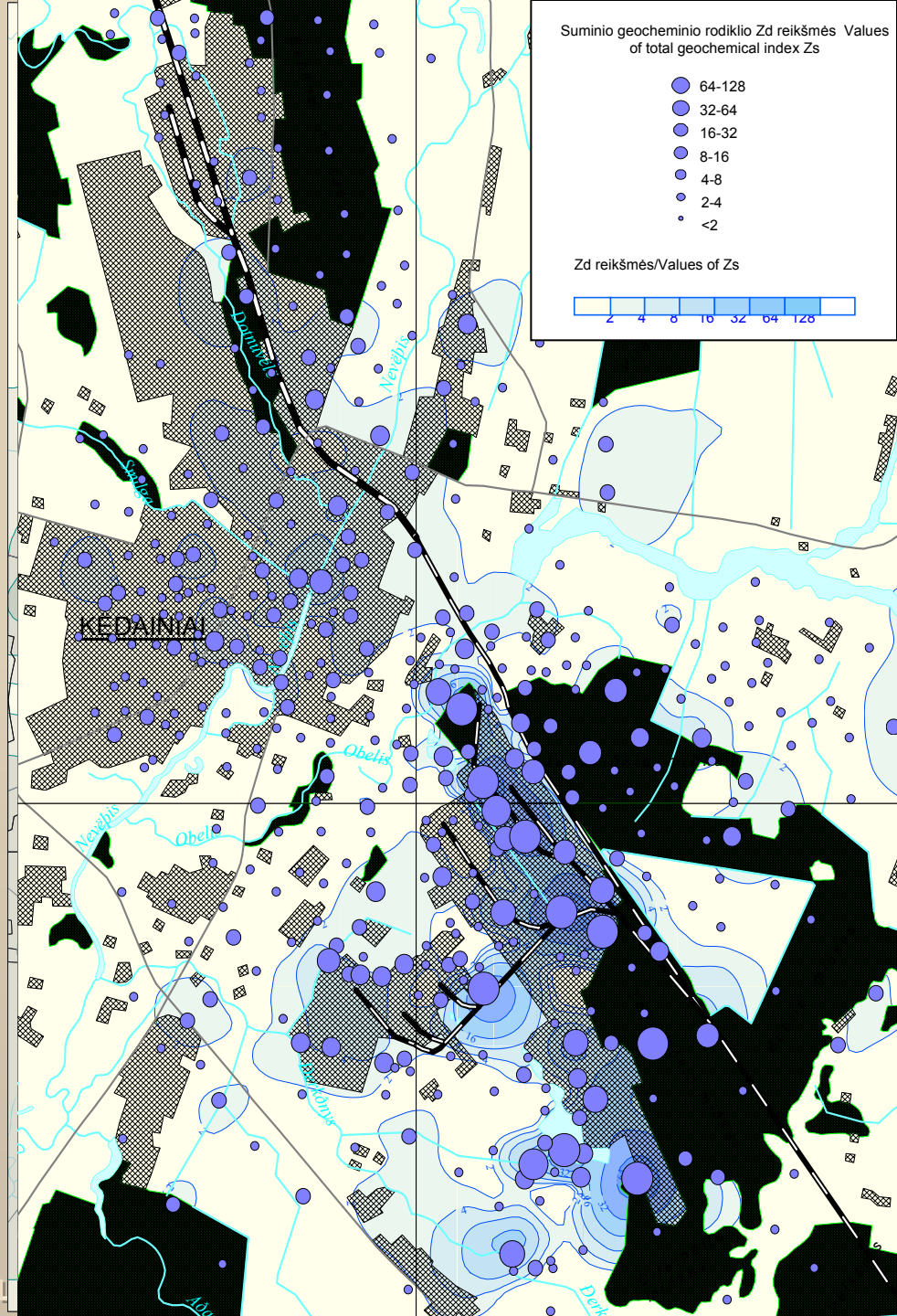
Geochemical mapping of ***Kėdainiai*** town in 1989–1992 and revision-monitoring in 1997:

- main elements-pollutants – Sr, La, P – waste & emissions of phosphorous fertilizers industry
- municipal elements-pollutants - Cu, Zn, Pb, Ag, Sn – typical in urban areas
- impact area to soil from JSC “Lifosa” was detected



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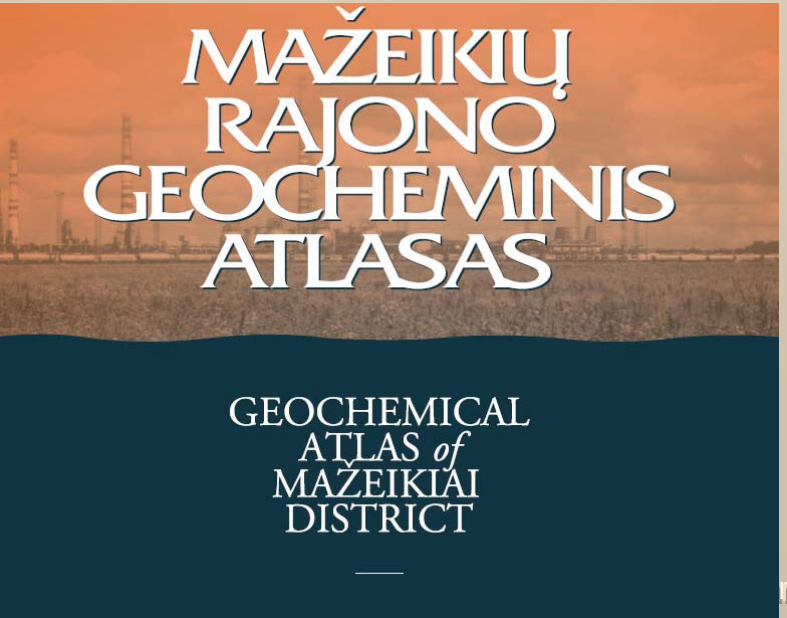
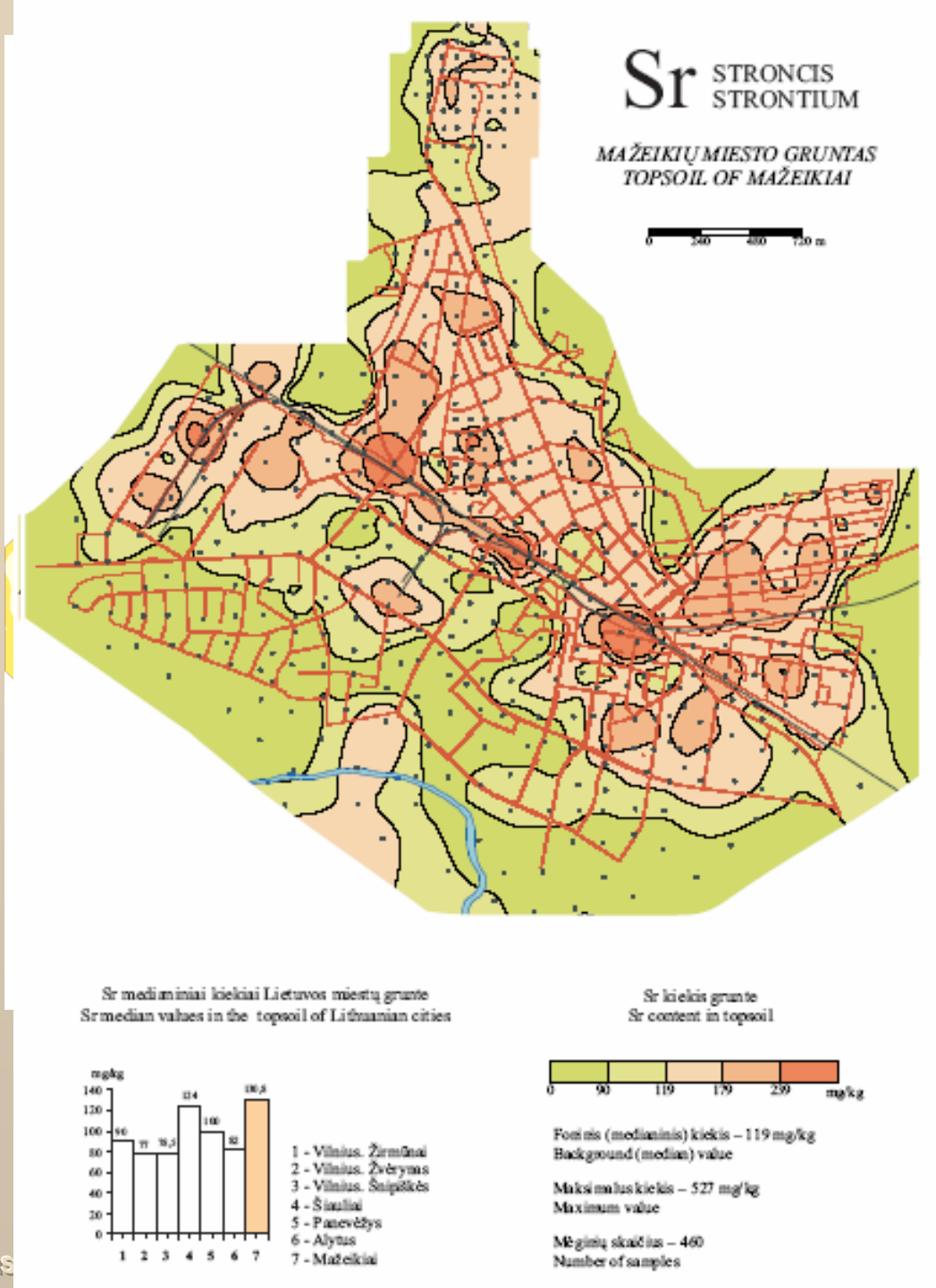
Geochemical mapping of ***Mažeikiai*** town in 1999–2000:

- contamination of topsoil (92% of samples) is at the permissible level according the total index of contamination Z_s, main element-contaminant – Zn
- anomalies of heavy metals were found in the old town, along railway





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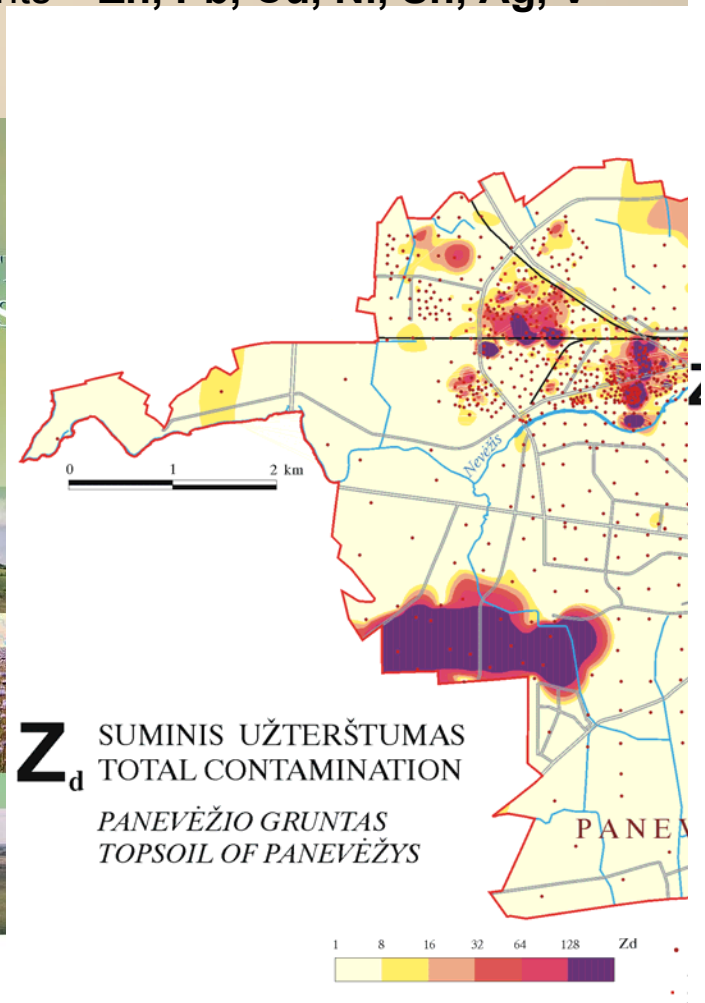
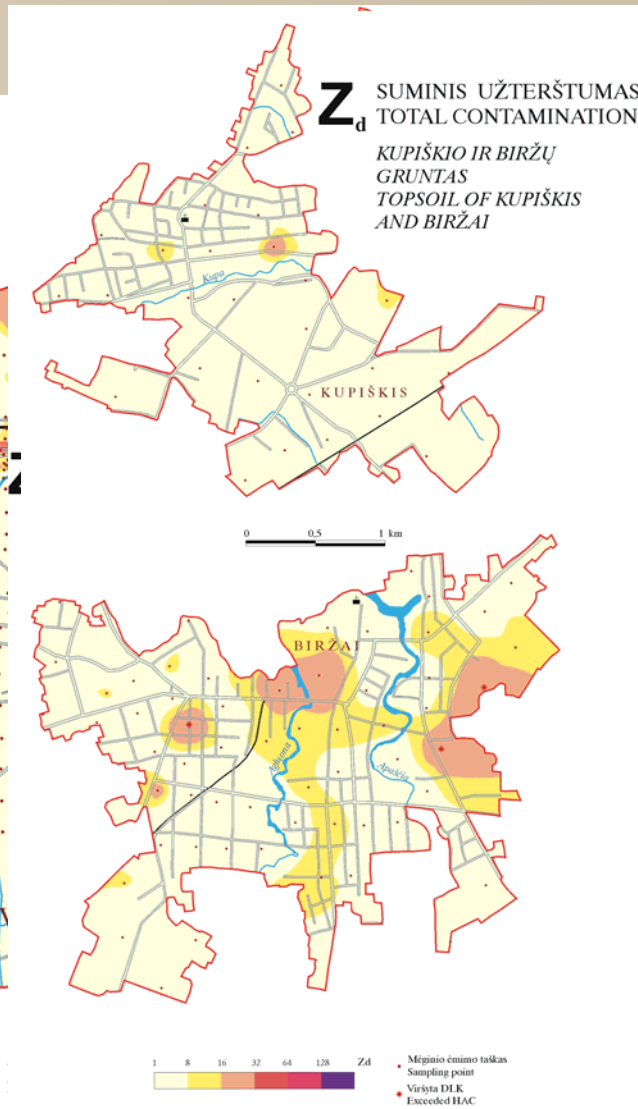
GEOLOGICAL SURVEY OF LITHUANIA

Assessment of topsoil contamination in towns **Panevėžys, Pasvalys, Biržai, Rokiškis, Kupiškis** is presented in Geochemical Atlas of Panevėžys County, 2004;

- the worst contaminated is **Panevėžys** town – administrative and industrial seat of County – content of some element in 60% of samples was higher than MPC
- dangerous and extremely dangerous contamination was found in **industrial areas** and close to them; old towns and areas along railways were contaminated at medium dangerous level
- main contaminants – **Zn, Pb, Cu, Ni, Sn, Ag, V**



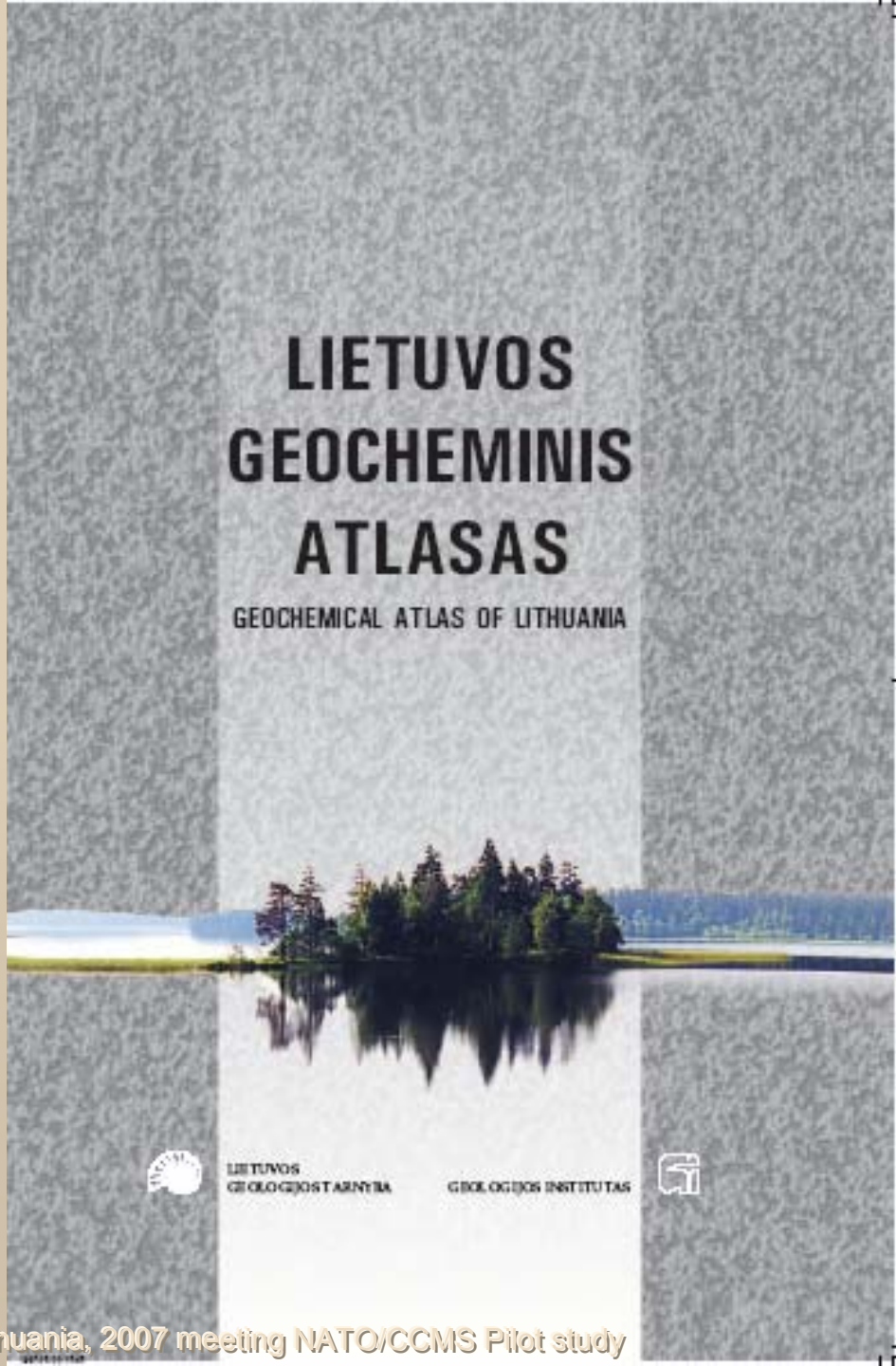


GEOLOGICAL SURVEY OF LITHUANIA

Assessment of topsoil contamination level at every urban area is carried out in comparable way, i.e. using element contents *versus* **background values**

Background values of elements in soil of various **texture** (sand, loamy sand, loam, clay, peat), different **genesis** (glacial, glaciofluvial, glaciolacustrine) and of different administrative districts are published in

Geochemical Atlas of Lithuania, 1999



CONCLUDING REMARKS

- Geochemical **data** of urban soil in Lithuania **is circumstantial** enough:
  - geochemically **mapped** are **the main urban areas**:
    - with highest population density,
    - with the most hazardous pollution sources – enterprises (former and present),
    - with socially important sites (change of site function, e.g. from industrial or military to residential),
  - national geochemical **data is comparable** to the international data due to:
    - participation in the laboratory intercalibration projects,
    - participation in the international geochemical projects (BSS, Geochemical Atlas of Europe, NEG)
  - most of geochemical data is well organized and is kept in **DB "Rock Chemistry"** of LGT
  - LGT administers **DB of "Pollution Sources",** too
- National **legislation** concerning assessment of soil contamination **is developed**:
  - **hygiene standards** with obligatory limit values of toxic substances (heavy metals, pesticides, hydrocarbons, PAH and PCB) **are prepared**,
  - standards valid in topsoil of residential, recreational and agricultural areas
  - **non-valid in industrial areas and subsoil**
  - required **actions** in contaminated areas at different level often **are missed**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Thank You for attention