Environmental pathology of city inhabitants in Lithuania

Ruvinas Ptašekas[1],
Ingrida Zurlytė[4],
Mečislovas Meilūnas[5],
Sigitas Dapkūnas[3],
Danutė Stoškuvienė[1],
Genadijus Jonauskas[4],
Marija Ramanauskaitė[1],
Julius Ptašekas[4],
Romualdas Sabaliauskas[2],
Natalija Šliachtič[4]

[1] *Dept. of Pathology and Forensic Medicine,*
M. K. Čiurlionio 21,
LT-2009 Vilnius, Lithuania
danute.stoskuviene@mf.vu.lt

[2] *Public Health Division Ministry of Health,*
Vilnius str. 33,
LT-2001 Vilnius, Lithuania
romualdas.sabaliauskas@sam.lt

[3] *Dept. of Software engineering of Vilnius university,*
Naugarduko 24,
LT-2006 Vilnius, Lithuania
sigitas.dapkunas@sc.vu.lt

[4] *Environment and Health Division of State Public Health Centre*
Kalvarijų 153,
LT-2049 Vilnius, Lithuania
ingrida@post.omnitel.net

[5] *Dept. of Difference Equations and Numerical mathematics,*
Naugarduko 24,
LT-2006 Vilnius, Lithuania
mecislovas.meilunas@fm.vtu.lt

The increasing frequency of developmental failures, injuries of the children's nervous system, lung, stomach, colon cancer in adults in the large cities of Lithuania urged to look for the relation of these pathologies with environmental pollution. Three priorities were identified in the research: a) to define areas with the most frequent occurrence of diseases, b) to determine the harmful agents of environmental pollution in human biomedia, c) to define the sources of pollution. In Vilnius, a relationship was found for carbon monoxide, nitrogen dioxide, heavy metals, formaldehyde and benz(a)pyrene pollution of the air, water and soil. Two zones were established in Vilnius, where the direct correlation was most explicit. In Šiauliai, the zones of environment-related diseases were identified in relation to soil, drinking water and air pollution along the transport lines. In Klaipėda, the frequency of diseases shows a strongest correlation with air and water pollution with sulphur dioxide and heavy metals. The identified priorities were taken into account in the National Environmental Health Action Program.

Key words: environmental pathology, city inhabitants

Statistical data show that at the end of the eighties, comparing with the sixties, in Vilnius there were over twice as many cases of prematurity (miscarriages, preterm deliveries), developmental failures, injuries of the children's nervous system and some malignant tumours (lungs, stomach, colon cancer). The increasing frequency of these pathologies is probably related to the increasing environmental pollution of the city. Therefore, the main stress of general environment in the capital or any other industrial city should be laid on the frequency of ecogenic diseases.

The practice of environmental medicine is arranged by branch structures of public health and is supported by other departmental units too. The co-operative relations of environmental activities between the structures of environmental medicine and adjacent departments have been formed according to the general hierarchic principle of environmental cycles and their components, as well as according to the actual demands of environmental medicine and their realization conditions (Ptašekas J. et al., 1996; Ptašekas et al., 1997a). In this paper earlier published (Ptašekas J. et al., 1996; Ptašekas J. et al., 1995; Ptašekas, 1999; 1996; Ptašekas et al., 1997a; Ptašekas et al., 1998a; Ptašekas et al., 1998b; Ptašekas et al., 1997b; Zurlytė et al., 1998) and discussed work (not published) (Official…, 1996; Official…, 1994; Official…, 1995; Official…, 1997) is summarized.

First of all, it is reasonable to form correctly the primary environment cycles and to coordinate activities of the sections in individual cycles and only then, on the base of the effectively functioning local cycles, valuable results of a recreational activity of the departmental and joint regional cycles could be obtained.

The priorities of environmental medicine according to its three chains of practice are as follows: 1) to define areas with the most frequent occurrence of eventually ecogenic diseases, 2) to determine the harmful agents of environmental pollution in human biomedia, 3) to verify the ecopathogenicity of pollutants and eliminate the paraecogenic factors (professional, habitual) from the verification structure.

The purpose of the first chain in this study is a mathematical and ecological evaluation of the geographic distribution of dysontogenetic (spontaneous abortion, preterm delivery and dysplasias), pediatric (heavy metal neurotoxicosis and alopecia), oncologic (lung, gastric and colon carcinoma, melanoma, leucaemia and lymphoma) pathology and haematologic prepathology (diminishing of hemoglobin concentration, of the count of granulocytes and lymphocytes, increase in the count of eosinophils). The data would be evaluated environmentally on their comparison with the environmental pollution.

The authors propose in the initial part of this study the problem, structure and methods. The problem is based on the data that during the last twenty years the frequency of the mentioned eventual ecogenic diseases has increased 1.5 to 3 times. The structure of the investigation contains the screening registration of the mentioned morbidity in inhabitants of Vilnius in 1991, Šiauliai in 1993 and Klaipėda in 1995 with the geographic and mathematical analysis of the illness cases and their correlation with environmental pollution of those cities. Among

the mathematical methods, the D index and the summarised coefficient of ecopathologic hazard (EPHC) of the areas should be mentioned. The D index connects the frequency and manifestation degree of a certain disease in each area. The EPHC integrates the values of the D index of all the mentioned diseases in each area and makes it possible to choose the areas where the eventual ecogenic morbidity is more or less frequent. The data on the geographical distribution of the diseases are presented.

Geographical and pathological investigations of the distribution of developmental failures, prematurity, neoplasms, heavy metal neurotoxicosis and alopecia in children in the areas of Vilnius have been carried out (Ptašekas et al., 1997a; 1997b). Among 216 areas of the city, the diseases listed above have been most frequently registered in 10 areas. Those ten areas were divided into four adjoining groups: the first in the south, the second in the west, the third in the north-east and the fourth in the north-west part of the city (Fig. 1a).

Additionally, the geographical distribution data on 261 children with neurotoxicosis and 194 children with alopecia in the areas of Vilnius were analysed (Ptašekas et al., 1996; Ptašekas, 1999). The levels of lead, chromium and nickel were determined in urine (the content getting into the organism and eliminated from it) and in the hair (the content accumulated in it). In areas 28–24, 23–22, 30–24 of Šnipiškės, Karoliniškės and Žirmūnai communities, children were most frequently affected by neurotoxicosis and alopecia (Fig. 1b). Those diseases could be related to the emission of heavy metals (Fig. 1c), as here they geographically coincide with the emission of heavy metals into the air.

The second chain consists of laboratory and mathematical indentification of contaminated human biomedia in correlation with a geographical study of technogenic environmental pollutants.

The frequency of possible ecogenic diseases was correlated in each area with carbon monoxide, nitrogen dioxide, heavy metals, formoldehyde and benz(a)pyrene pollution of the air, water and soil (Ptašekas et al., 1995; Ptašekas et al., 1998). Two zones were established in Vilnius where the direct correlation was most explicit, and the eventuality of environmental diseases was most real. In those areas, prevention of environmental damage is most urgent (Fig. 1d).

The third chain presents a mathematical verification of the effect of the pollutants identified in the environment and human biomedia on a higher incidence of diseases in definite areas, i. e. verification of their pathogenicity. Following the verification of the risk level of etiologic factors, eventual ecogenic diseases could be considered real. On the
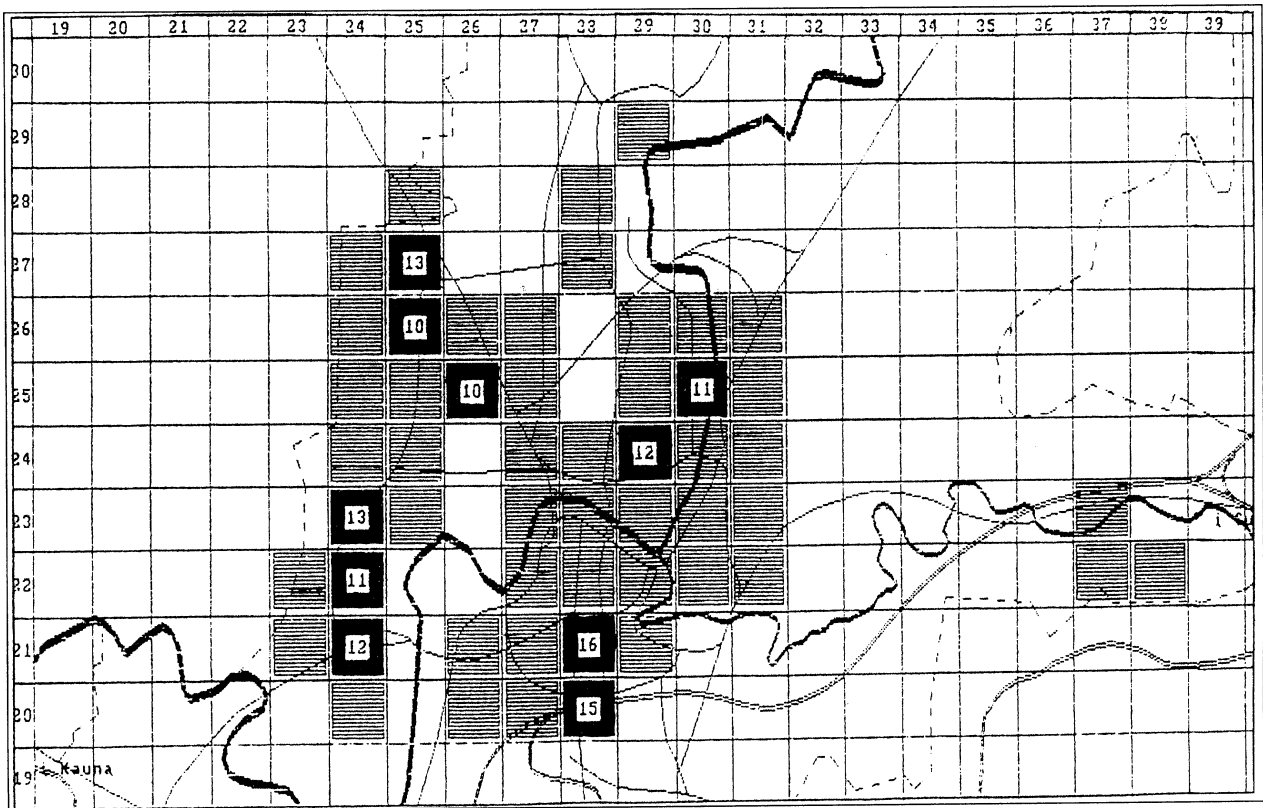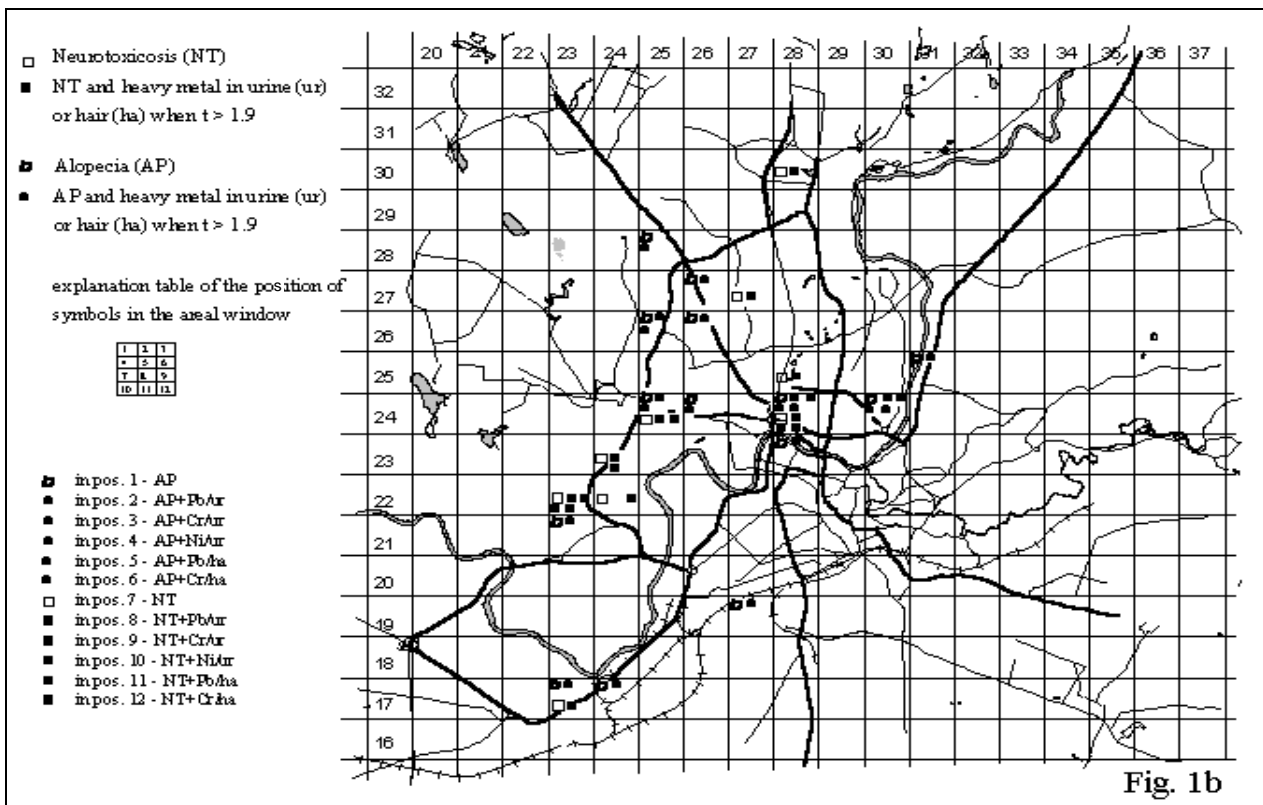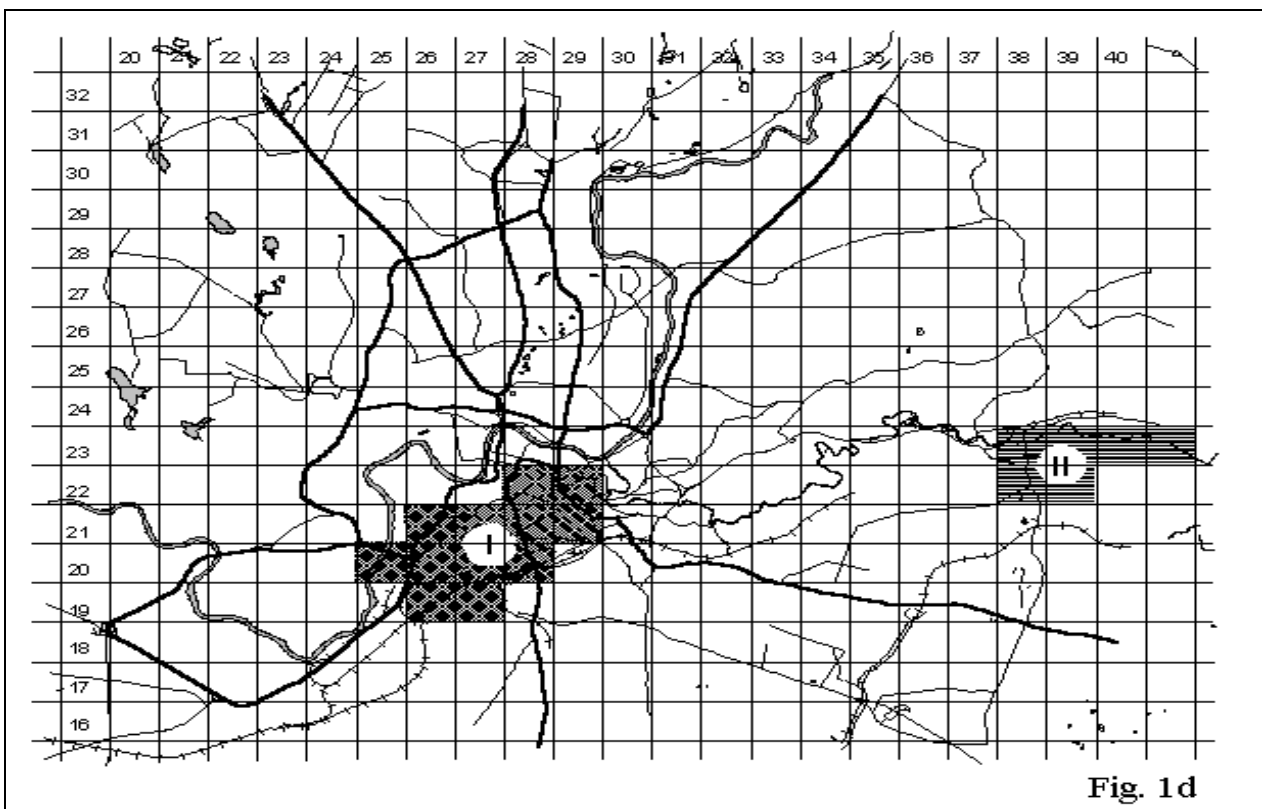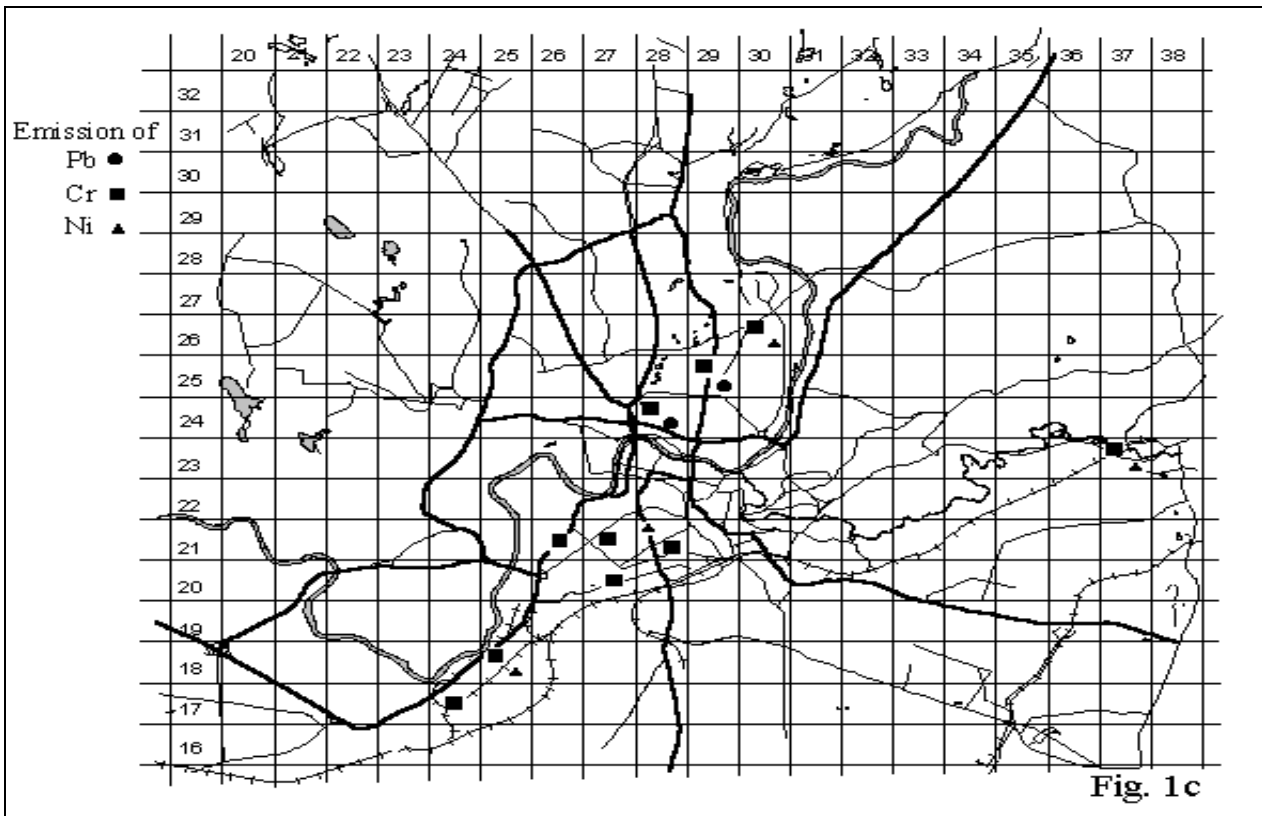
Fig. 1a

Fig. 1b

1. Integrated map of morbidity of inhabitants and environmental pollution in Vilnius city (1991).

Fig. 1a. Areas with the highest ecopathological hazard coefficient (black with indication of EPHC value); around them are situated periareas where the D indices of hematological prepathology are significantly higher than their city means (grey)

Fig. 1b. Distribution of D indices of neurotoxicosis and alopecia syndromes and increase of heavy metals in biomedia. t – the relative value of index D of the area *versus* the town mean (M)

Fig. 1c

Fig. 1d

Vilnius map continuation from Fig. 1a, 1b

Fig. 1c. Localization of lead, chromium and nickel air emissions
Fig. 1d. Zones of environmental hazard (higher – I and lower – II)

grounds of the Vilnius city environmental pathology monitoring realized 1996, the optimal criteria of eco-pathogenic informativeness adapted for eventually environmental diseases were evaluated (Ptašekas et

al., 1998). Those criteria were based on the: a) risk degree of the illness; b) completion of the research; c) dominance of the environment for the disease development. Basing on those criteria, after multifactorial correlations the following signals of human pathology for the next observation were selected: a) heavy metal neurotoxicosis in children; b) developmental failures; c) pulmonar carcinoma.

Similar investigations have been carried out in the Šiauliai city. Ecopathological investigations in Šiauliai and within the Environment and Health Monitoring Program were continuously carried out in the period 1993–1994. Complex evaluation of the ecological situation and morbidity with pathology of potentially ecogenic origin allowed identifying the zones of ecopathological threat within the city, the priority of pollution sources influencing human health and providing situation management recommendations.

In the beginning of investigations the ecological situation of the Šiauliai city was unfavorable because of its geographical position and types of prevailing economic activities: high contamination levels of drinking water and ambient air pollution. Even after a substantial reduction of economic activities the main sources of pollution still are industrial enterprises, boiler houses and transport, and drinking water quality is a problem in these city areas where there is no centralized water supply.

The first stage of Environmental and Health Monitoring Program in this city was aimed at the definition of risk zones by mapping the data on chemical contamination of ambient air, soil and drinking water, identifying "hot spots" and comparing with geographical areas where an increased morbidity from diseases of potential ecological origin was identified. The data were analyzed and presented in maps according to the master plans of the cities (RSPHC, 1994, unpublished observations; Ptašekas J. et al., 1996). Morbidity data were obtained from hospital charts, evaluated according to the principle of geographical location, taking into account geodemographical indices and local possibilities for demographical breakdown in the areas within the city. Several groups of pathology were selected to evaluate a possible environmental impact on human health. They were as follows: congenital malformations, preterm deliveries, tumors (melanoma, leucosis, lung, gastric and intestine cancer) in adults (Fig. 2a); toxic encelophalopathies (Fig. 2b), alopecia, general neurological pathology and hematological prepathology in cohorts of children (decreased hemoglobin level, number of granulocytes, lymphocytes and eozinofiles).

After overlapping and analyzing the mapped data on environmentally suspected diseases and chemical pollution, two risk zones within the Šiauliai city were identified and prioritized. The zone of highest risk was identified within the boarders of the city areas number 23 and 25, in the centre of the city. In this zone the major city polluter – the Šiauliai boiler house as well as two big factories (of bicycles "Vairas" and TV equipment "Tauras") are situated. The zone also has a borderline with the railway (Fig. 2c). In this zone, a high rate of tumors and neurological disorders was defined and was twice and 2.25 times higher than the city average parametres (0.1% and 6.5%, respectively). The concentrations of dust, nitrogen dioxide and benz(a)pyrene exceeded the maximum allowable concentrations in the zone. The highest summarized soil contamination with heavy metals was also detected in this zone, as well as relatively high drinking water contamination levels (Fig. 2d).

Later on, additional investigations of ambient air, soil, drinking water and transport intensity were carried out (Ptašekas et al., 1995). Besides, in the risk zones and the relatively clean (control) zone the levels of heavy metals and benz(a)pyrene were investigated in the biological media of inhabitants (children and pregnant women). Higher levels of some heavy metals detected in the biomedia of city inhabitants are the consequences of a long-term and harmful exposure to environmental pollution: levels of lead, cadmium, copper and zinc in the biomedia of Šiauliai city inhabitants were higher in the risk zone than in the control zone: lead blood level 2 times, lead in hair 2.6 times, copper in children's urine 4 times, zinc in the urine of pregnant women 3.7 times (RSPHC, 1995 unpublished observations; RSPHC, 1997 unpublished observations). Levels of heavy metals in the biomedia of children living in the risk zone of lower risk did not exceed the acceptable norms.

Levels of benz(a)pyrene in the urine of children living in the risk zone of highest priority were three times higher than this index for children in the control zone and were higher than for children in the second priority risk zone. Soil contamination with benz(a)pyrene in the central part of the city was ten times higher than in the other territory. Additionally, investigations on benz(a)pyrene were carried out in two secondary schools: one in the centre of the city with a very intensive traffic situation and the second one in a relatively clean, "new" area. For children aged of 15–16 years the level of benz(a)pyrene was twice as high as in the control school, and they were a higher risk of the adverse effect of benz(a)pyrene.

In recent years there is a growing concern for allergy morbidity in urban population. It is constantly growing, among children in particular. Taking
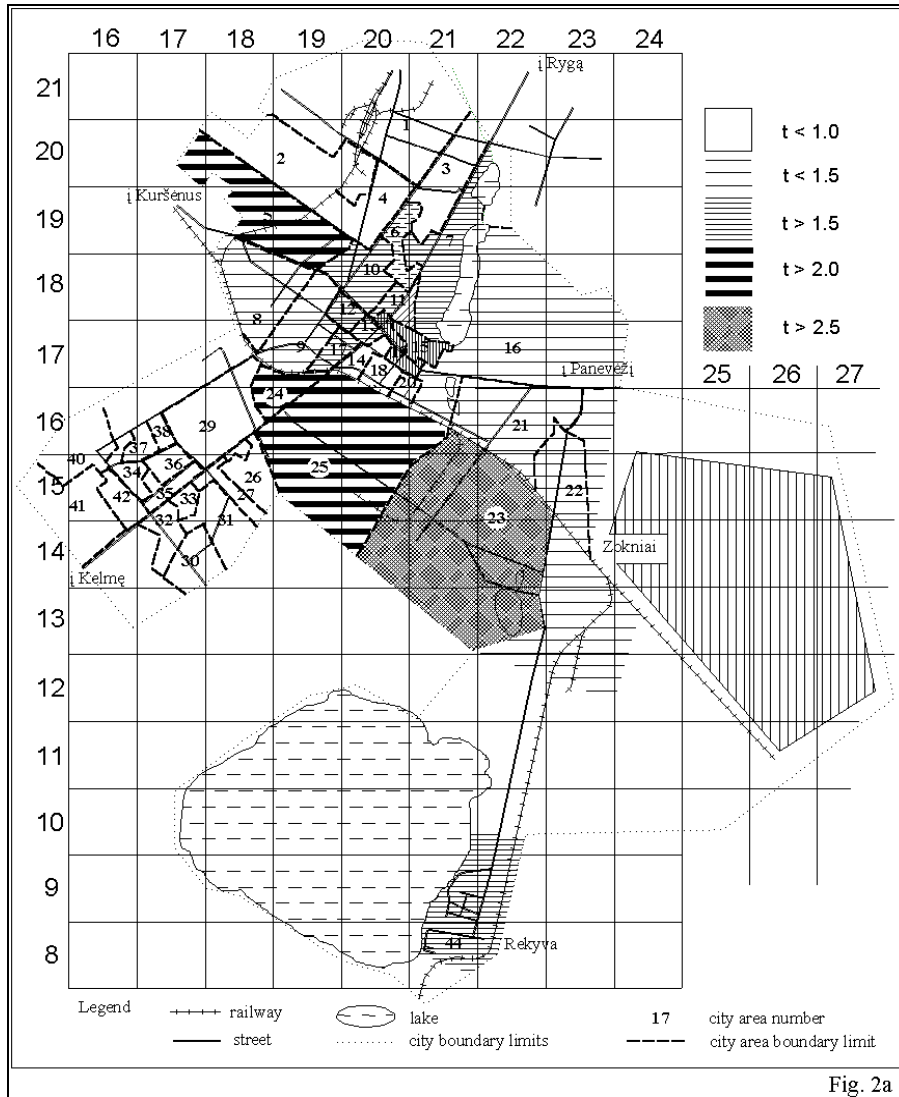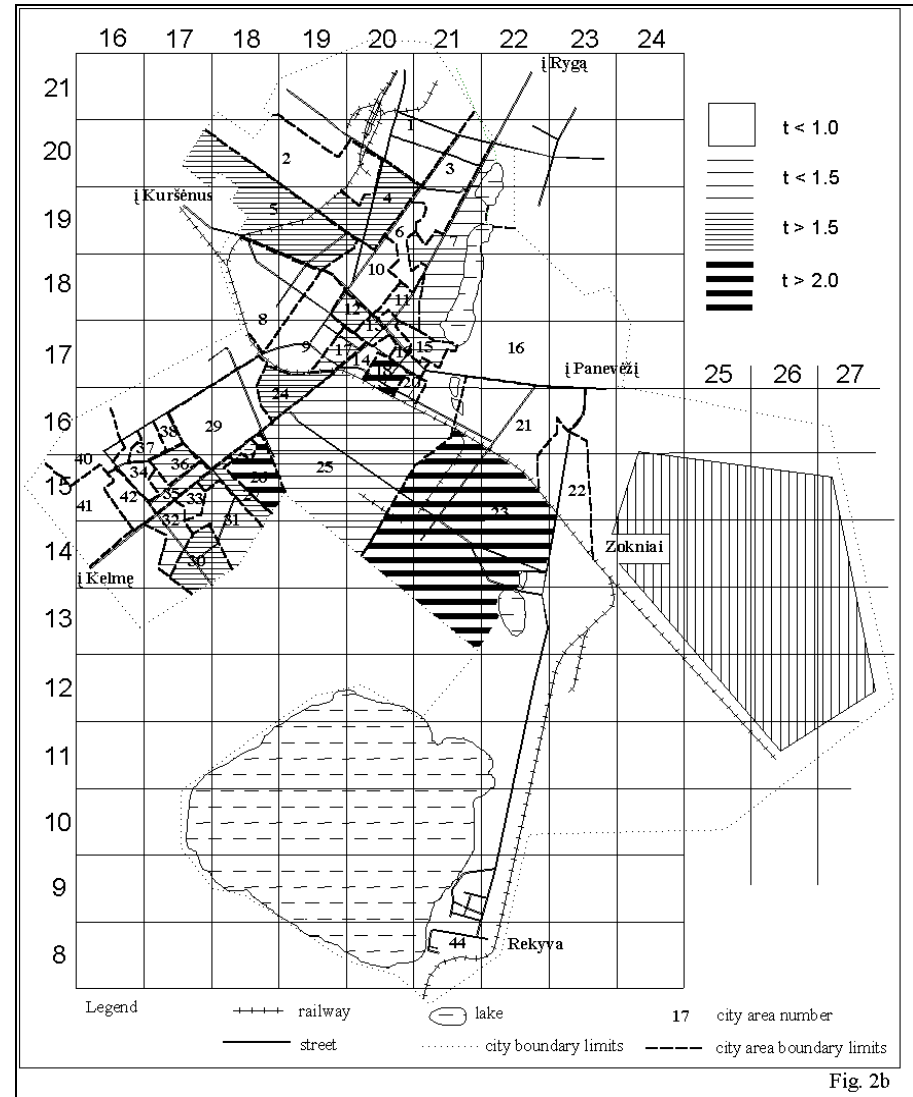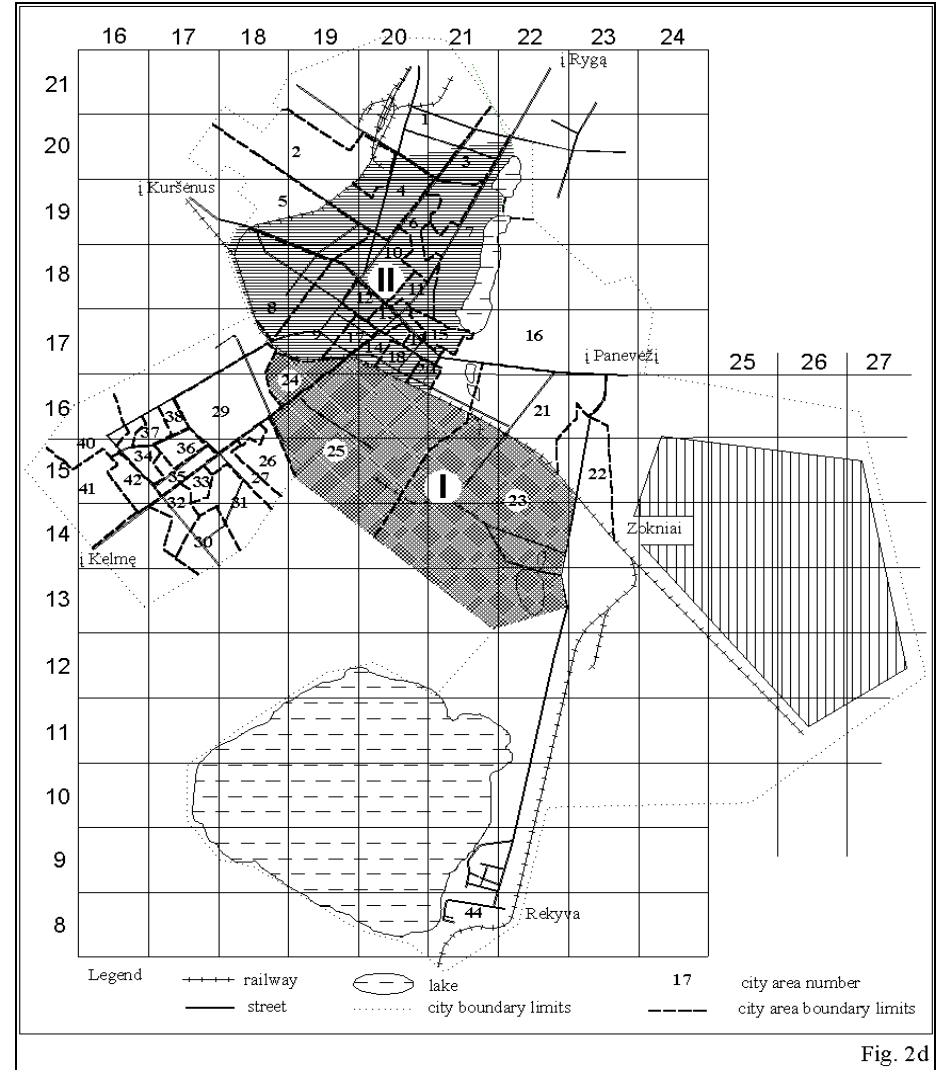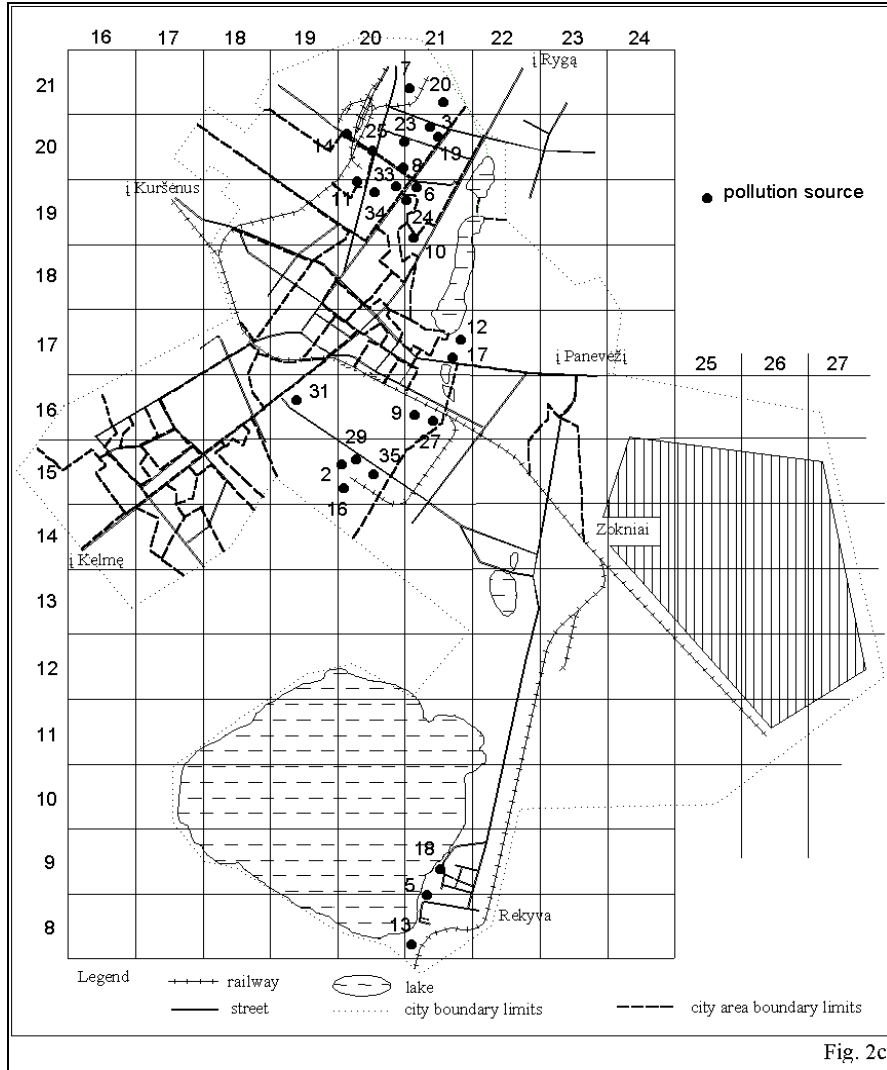
Fig. 2a — legend: t < 1.0, t < 1.5, t > 1.5, t > 2.0, t > 2.5

Fig. 2b — legend: t < 1.0, t < 1.5, t > 1.5, t > 2.0

Legend: railway — lake — 17 city area number — street — city boundary limits — city area boundary limit

į Ryga, į Kuršėnus, į Panevėžį, į Kelmę, Zokniai, Rekyva

2. Integrated map of morbidity of inhabitants and environmental pollution in Šiauliai city (1993). *t* in Figs. 2a and 2b is the relative value of index D of the area *versus* the town mean (M).
Fig. 2a. Relative value of integrated D index of oncological disease frequency and severity by city areas
Fig. 2b. Relative value of integrated D index of neurological pathology frequency and severity by city areas

Fig. 2c. Localization of stationary pollution sources. In the northern part of the city food processing industry, the bus park, oil storage facilities are localized; in the centre of the city the city boiler-house, bicycle, television and leather industrial objects are situated; in the south there are a local boiler-house, a factory of gas equipment

Fig. 2d. Zones of environmental hazard (higher – I and lower – II). In the east, for about 50 years a military airport has been situated

Šiauliai map continuation from Fig. 2a, 2b

this into account, the geographical distribution of this pathology was evaluated in the Šiauliai city too. More allergies were registered for children living in the centre of the city, but the incidence in the relatively clean Dainai district usually used as a control area, was high, too (Zurlytė et al., 1998).

The investigation in Klaipėda was carried out in 1995–1998 and renewed in 2001 (RSPHC, 1996, unpublished observations). The Klaipėda city living areas are surrounded by pollution sources nearly from all sides (Fig. 3c), and ambient air in the living environment is often in the zone of pollution. Sulphur dioxide, volatile organic compounds, nitrogen oxides and particles are the main emissions from stationary pollution sources. By the data of ambient air monitoring in Klaipėda, air is mostly polluted with formaldehyde, as in the period of five years its mean concentrations exceed the norms. Most unfavorable in terms of air pollution is the area in the northern part of the city – Melnragė (Ptašekas R., 1996), where the rate of congenital malformations and the level of severity was the highest in the city, too (Fig. 3a). In this area a petrol terminal is located. A significantly higher level of congenital malformations compared to the city mean values was identified in areas 1, 5 and 6 of the city where a boiler house, a fish processing enterprise and fishing harbor as well as wood processing, ship repair facilities are located. In the areas of the southern part of the city (3, 4 and especially in 6), a higher level of children hematological prepathology was identified (Fig. 3b).

A summarized analysis of data collected on ambient air pollution, drinking water quality and morbidity with environmental pathology as well as prepathology allowed to define two zones with a threat of environmental pathology (Fig. 3d). The zones were prioritized according to the estimated severity of health disorders and localization of pollution sources. The zone of higher threat (I) was defined in the southern part of the city with a highest hematological prepathology and a high rate of congenital malformations. The lower threat zone was identified in the northern part of the city with the predominant influence of transport and industrial pollution.

The investigations described above show the importance of correct environmental conditions for the health of urban population. The data analysis and presentation by applying the principle of geographical distribution allowed to identify "hot spots" within the borders of the city. This information was used for developing the municipality environmental health action plan and defining its priorities. It is important that the decision-making process on the strategic development of the city as well as on various types of economic activities would take into account not only the economic aspects and interests but also the possible consequences of these decisions to the health of inhabitants.

According to recommendations of the World Health Organization and in order to improve the coordination of public health and environmental protection activities, the National Environmental Health Action Plan (NEHAP) is under elaboration in Lithuania. The NEHAP of Lithuania is considering the aspects of human health and diseases, including quality of life, that are determined by physical, chemical and biological environmental factors. It is also related to assessment, control and prevention of the environmental factors that may have an adverse effect on the health of the present and future generations.

The NEHAP development in Lithuania has its international and national background. The main international documents are the WHO Health for All Strategy for XXI, European Environment and Health Charter, Helsinki Declaration (Second Ministerial Environment and Health Conference), European Environmental Health Action Plan, Agenda XXI, Orhus Convention, UN/ECE documents, London Declaration, Protocol; on Water and Health, Charter "Transport, Environment and Health" (Third Ministerial Environment and Health Conference), EU legal acts and programs.
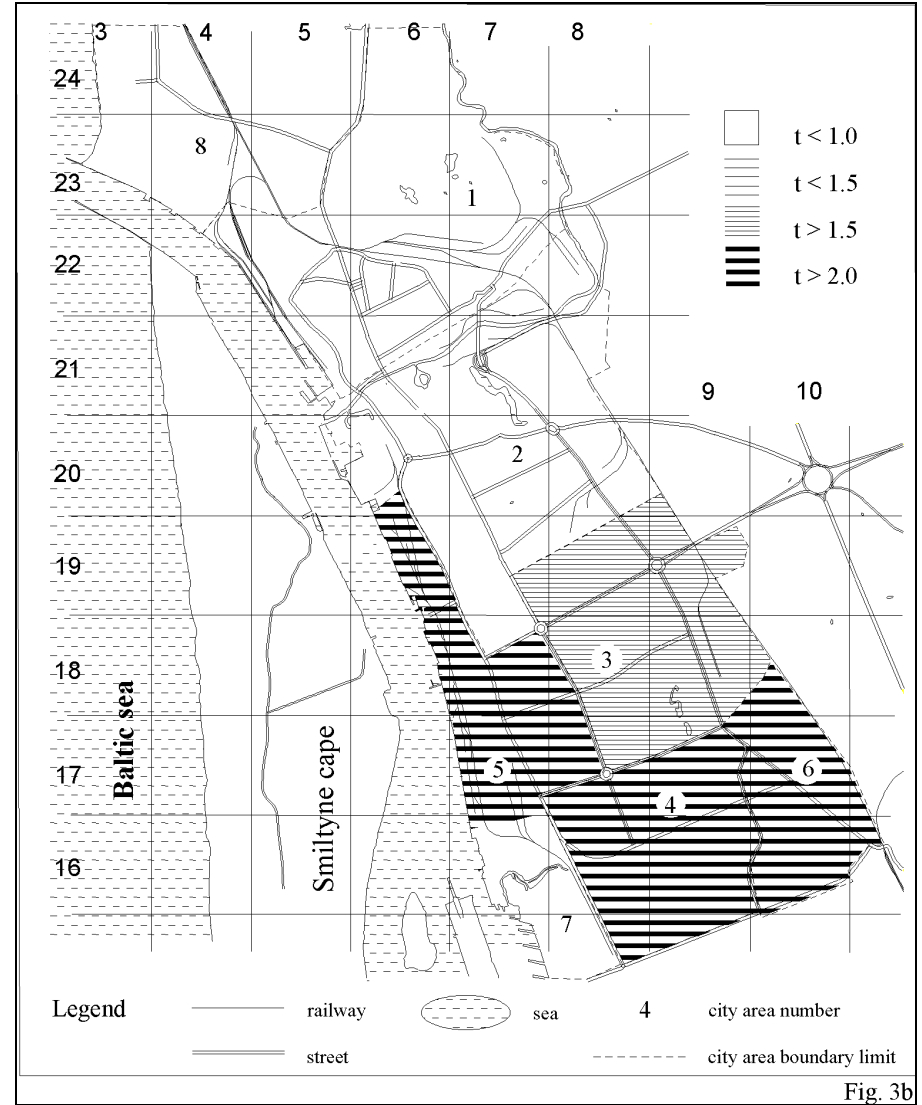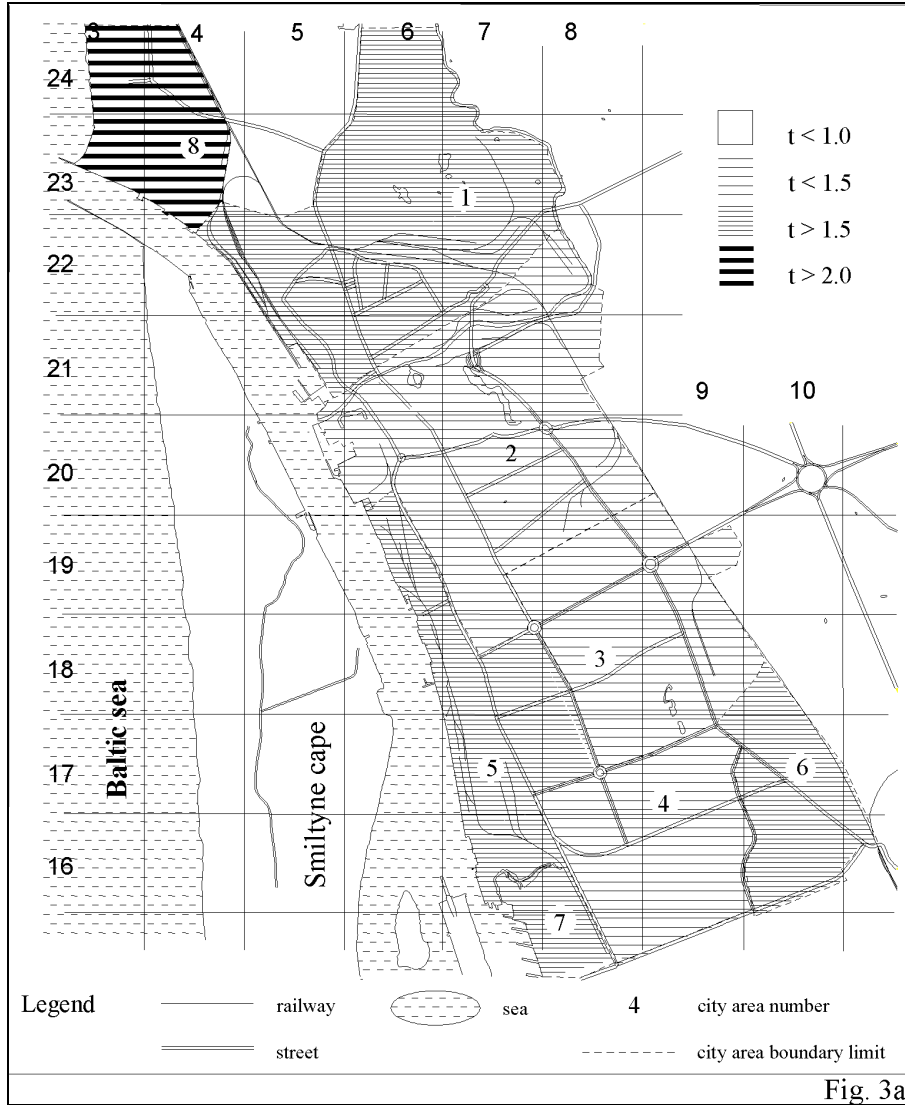
The National Environmental Protection Strategy and Action Program, National Health Program, National Acquis Adoption Program, National Public Health Strategy form the national background for the NEHAP.

The NEHAP is based on the principles of understanding and solidarity, sustainable development, cooperation of all social partners, prevention, "polluter pays", subsidiary, public participation, democracy.

The long-term goal of the NEHAP is protection and promotion of inhabitants of Lithuania by improving environmental health management and ensuring environmental quality not posing threat to human health and improving health status of population. The objectives are the following:

– Strengthen public health surveillance and environmental protection institutions and promote their cooperation.

– Integrate health and environment aspects in the main economy development programs and strategies.

– Form the awareness and understanding of environmental health problems and their solutions by politicians, specialists and broad public.

– Inform public on environment and health relations and promote participation in decision-making.
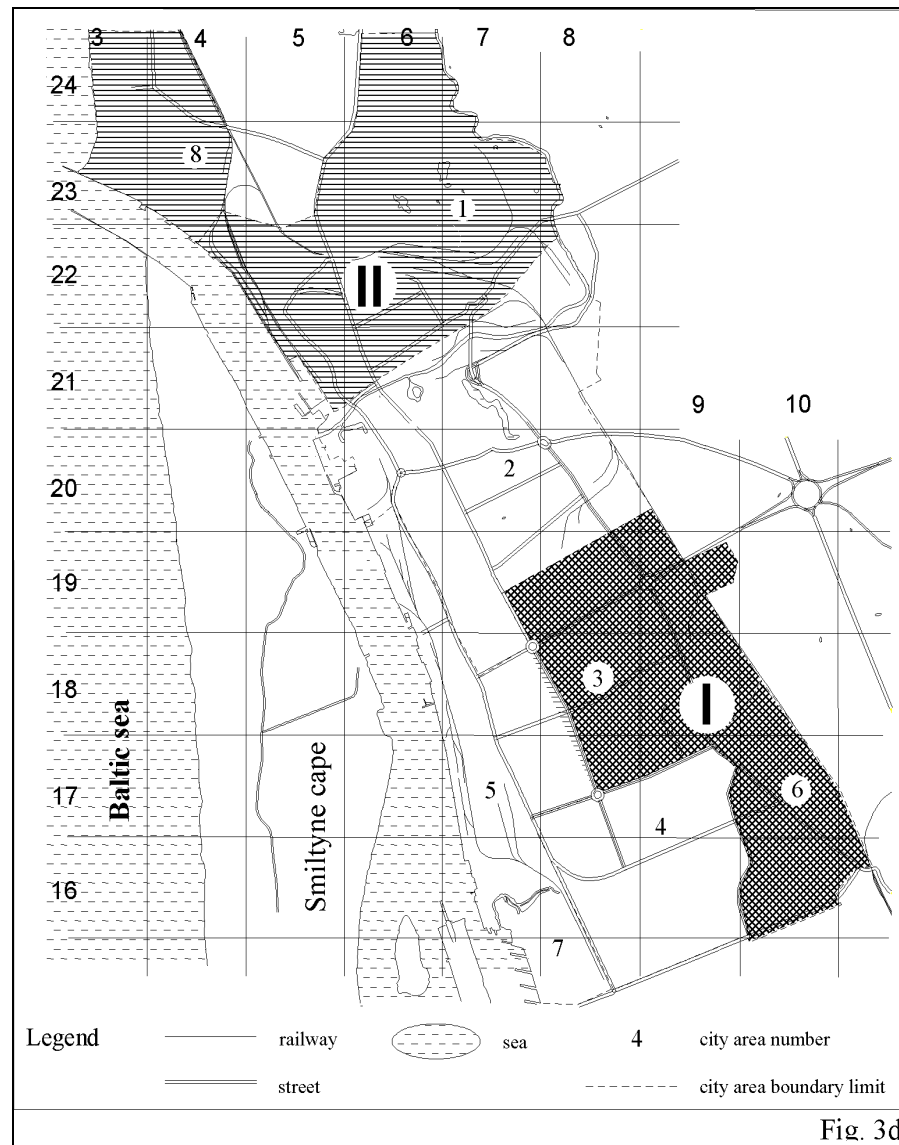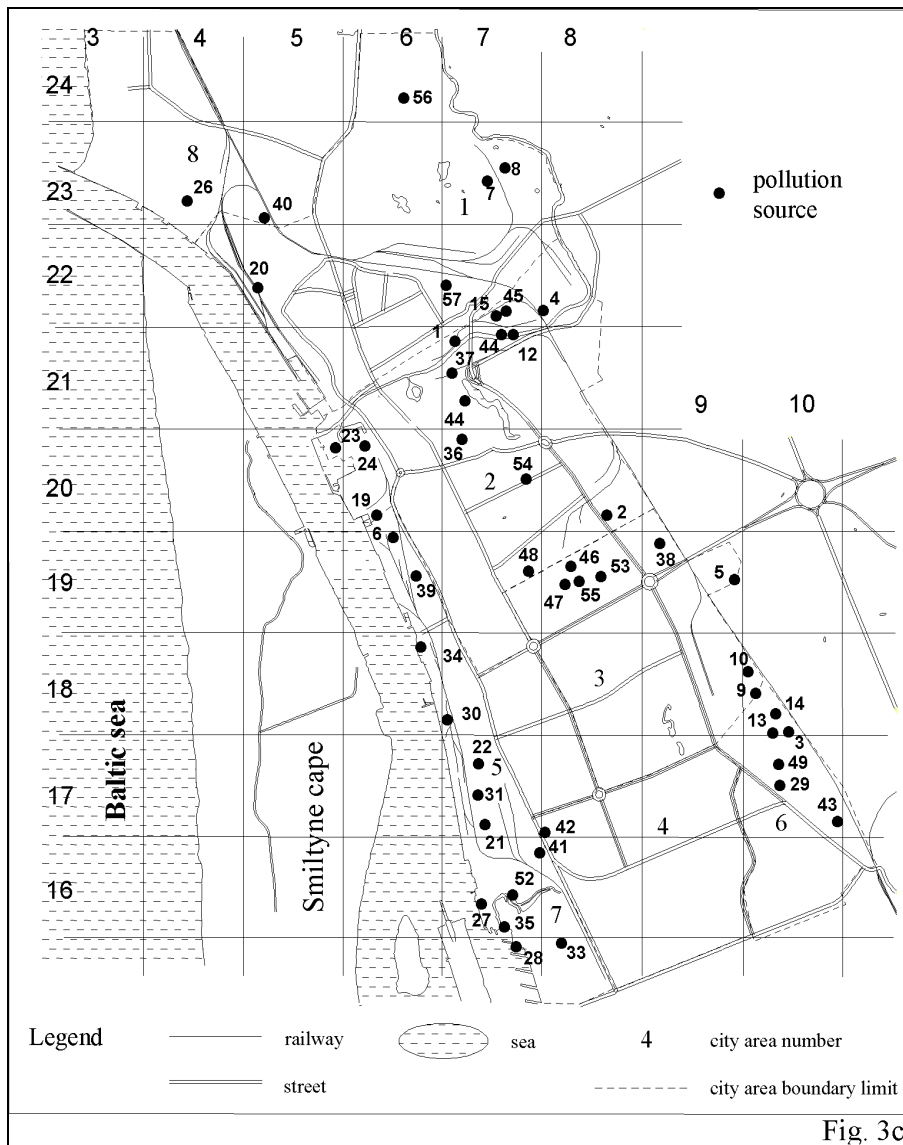
Fig. 3a

Fig. 3b

Legend of both maps:
- t < 1.0
- t < 1.5
- t > 1.5
- t > 2.0

Legend — railway, street, sea, 4 city area number, city area boundary limit

3. Integrated map of morbidity of inhabitants and environmental pollution in Klaipėda city (1993). *t* in Figs. 3a and 3b is the relative value of index D of the area *versus* the town mean (M)
Fig. 3a. Relative value of integrated D index of congenital malformation frequency and severity by city areas
Fig. 3b. Relative value of integrated D index of hematological prepathology frequency and severity by city areas

Klaipėda map continuation from Fig. 3a, 3b

Fig. 3c. Localization of stationary air pollution sources
Fig. 3d. Zones of environmental hazard (higher – I and lower – II) in Klaipėda city

The issues of environmental health monitoring, legal basis and creation of information systems, risk assessment and management, air, surface and drinking water quality improvement, food safety, working environment, housing quality, health care waste and soil contamination reduction are considered and targeted at ecopathology prevention. The NEHAP is a strategic perspective document, and its actions could be justified using the data of environmental health monitoring activities. The NEHAP foresees a further development of environmental health monitoring programs in urban areas for monitoring the main "ecological" diseases and analysis of their ecogenicity, analysis of the quality of environmental components, identification and justification of environmental pollution impact on health and/or positive effects of improved environment, generation of recommendations for environmental health risks management, evaluation of the environment and health management effectiveness, evaluation of intersectorial cooperation effectiveness.

References

1. Official manuscript of the State Public Health Centre (RSPHC). Environment and Health Monitoring of Biggest Cities of Lithuania. Klaipėda city. (RSPHC, in Lithuanian). Vilnius, 1996.
2. Official manuscript of the State Public Health Centre (RSPHC). Environment and Health Monitoring of Biggest Cities of Lithuania. Šiauliai city. (RSPHC, in Lithuanian). Vilnius, 1994.
3. Official manuscript of the State Public Health Centre (RSPHC). Environment and Health Monitoring of Biggest Cities of Lithuania. Šiauliai city. (RSPHC, in Lithuanian). Vilnius, 1995.
4. Official manuscript of the State Public Health Centre (RSPHC). Health Monitoring and investigations of children's exposure to heavy metals in 1997 in Šiauliai city. (RSPHC, in Lithuanian). Vilnius, 1997.
5. Ptašekas J., Ciunienė E., Barkienė M., Zurlytė I., Jonauskas G. et al. Environmental and health monitoring in Lithuanian cities: exposure to heavy metals and benz(a)pyrene in Vilnius and Šiauliai residents. Journal of Environmental Pathology, Toxicology and Oncology. 1996. Vol. 15. P. 135–141.
6. Ptašekas J., Ciunienė E., Jankevičienė R., Runkelytė J., Zurlytė I. Environment and Health Monitoring in Lithuania: exposure analysis of heavy metals and benz(a)pyrene in Vilnius residents. Wiec – Inec. Biannual meeting. 1995. Vol. 15.
7. Ptašekas R. Environmental pathology of city inhabitants (in Lithuanian, English sum.). Vilnius: Academia, 1999. 104 p.
8. Ptašekas R. Medical aspects of ecology. 2. The actual activities of ecological medicine (in Lithuanian, English sum.). Ekologija. 1996. Vol. 4. P. 3–11.
9. Ptašekas R., Dapkūnas S., Ramanauskaitė M. Connection between the morbidity of Vilnius inhabitants and ecological damage to the environment. 1. Problem, structure of investigation, methods, the main results of geographic distribution of diseases (in Lithuanian, English sum.). Ekologija. 1997a. Vol. 3. P. 10–17.
10. Ptašekas R., Ramanauskaitė M., Meilūnas M. Geography of Vilnius inhabitants' morbidity used in ecogenicity evaluation of diseases (in Lithuanian, English sum.). Ekologija. 1998a. Vol. 3. P. 25–28.
11. Ptašekas R., Ramanauskaitė M., Ptašekas J. Environmental aspect of geographical pathology among inhabitants of Vilnius. Medicine Biologie Environnment. 1998b. Vol. 26. P. 71–78.
12. Ptašekas R., Vaitkienė D., Ptašekas J. Connection between the morbidity of Vilnius inhabitants and ecological damage to the environment. 2. Sequence results of geographical distribution of diseases, discussion of results, proposals (in Lithuanian, English sum.). Ekologija. 1997b. Vol. 4. P. 67–75.
13. Zurlytė I., Barkienė M., Sliachtic N., Krankalis R., Klimas R., Ceburnis D., Milukaitė A. Exposure to heavy metals and benz(a)pyrene in Šiauliai residents. In: Scientific and practical issues of indoor air studies in residential and occupational environment. International conference. Vilnius, 1998.

**Ruvinas Ptašekas, Ingrida Zurlytė, Mečislovas Meilūnas,
Sigitas Dapkūnas, Danutė Stoškuvienė,
Genadijus Jonauskas, Marija Ramanauskaitė,
Julius Ptašekas, Romualdas Sabaliauskas,
Natalija Šliachtič**

APLINKOS VEIKIAMŲ LIETUVOS MIESTŲ GYVENTOJŲ PATOLOGIJA

S a n t r a u k a

Dažnėjantys Lietuvos didžiuosiuose miestuose apsigimimai, vaikų nervų sistemos pažeidimai, suaugusiųjų plaučių, skrandžio ir storžarnės vėžys paskatino ieškoti šių ligų ir aplinkos taršos ryšių. Šioje paieškoje buvo trys prioritetai: a) paryškinti, kuriuose miestų arealuose ligos dažniausios, b) susieti aplinkos taršą su jos ekvivalentais žmogaus biologinėse terpėse, c) nustatyti taršos šaltinius, turinčius įtaką sveikatai. Vilniuje, atskiruose arealuose, tokias sąsajas pasisekė surasti, paveikus oro, vandens ir dirvožemio anglies monoksidui, azoto dioksidui, sunkiesiems metalams, formaldehidui ir benz(a)pirenui. Išryškintos sostinės dvi zonos, kuriose sergamumas ir aplinkos taršos dydžiai raiškiausiai koreliavo. Šiauliuose nustatytos aplinkos dirvožemio geriamojo vandens ir oro užterštumo pagal transporto magistrales sąsajų su ligomis zonos. Klaipėdoje ligų dažnis labiausiai koreliavo su oro ir vandens užterštumu sieros dioksidu ir sunkiaisiais metalais. Nurodyti prioritetai įtraukti į Lietuvos Nacionalinę aplinkos sveikatinimo veiksmų programą.

Raktažodžiai: aplinkos patologija, miestų gyventojai