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## The structure of Volume III of the *National Atlas of Lithuania* and techniques of cartographic visualization

**Abstract.** National atlases provide comprehensive information about nature, population, social and economic situation of the country. In 2017 the process of compiling and publishing the *National Atlas of Lithuania* (*Lietuvos Nacionalinis Atlasas*) was finished. The goal of the authors is: in the context of the whole *National Atlas* to present a thorough analysis of the structure of content and cartographic visualization methods of Volume III. This volume focusses on social and economic phenomena in Lithuania. The authors discuss the principles of compiling the whole *National Atlas of Lithuania* and presents its structure in a concise manner. Following the classification of traditional mapping methods, specific examples of mapping in Volume III are presented, advantages of mapping techniques are discussed and the structural analysis of mapping methods is also conducted. The conclusions and the discussion part present the problems encountered while compiling Volume III as well as solutions to them.

**Keywords:** national atlas, social and economic phenomena, structure of atlas, mapping methods

### 1. Introduction

The majority of world countries publish national atlases, that is, representative cartographic works, which present a comprehensive characteristic of countries in their present territories. Many countries have published a number of editions of atlases, which allows actualising and updating information presented in publications of encyclopaedic character. Lithuania has looked forward to such a publication for almost a hundred years. It is true that Lithuanian geographers, soil scientists, geomorphologists, geologists, hydrologists prepared the first few cartographic works, which described separate components or peculiarities of the nature in the country as early as the interim period.

However, the available human resources, time and funds of that time were not enough for preparing one integral publication, i.e. an atlas. *Atlas of Geography* for gymnasium, compiled by Pelikšas Šinkūnas and published by the Lithuanian polygraphic company in 1938, was a considerable achievement in the interwar period. This was the first cartographic publication of larger volume for schools, where the maps were made by well-known specialists of that time.

On the initiative of Professor Vaclovas Chomskis, the Laboratory of Cartography was established in the Faculty of Natural Sciences of Vilnius University in the 1960s. Its staff members carried out analytical spatial research on natural, demographic, social and economic

phenomena and made a big number of complex thematic maps. The goal of all these activities was to compile and to publish a complex (national) atlas (R. Bugorevičienė, 1999; A. Pilipaitis, 1999).

The authors of the maps of the *National Atlas* had a goal to create a clear, integral and memorable spatial image of mapped phenomena and processes, which reflected the development of the country at the turn of two centuries. The maps in the *Atlas* were characterised by comprehensiveness and complexity of the mapped phenomena and were drawn up on the basis of the conducted multidimensional scientific research, the implemented analytical projects and the statistical data collected by various institutions (A. Pilipaitis, 2008; G. Beconytė, 1999, 2001; A. Česnulevičius, 2008; A. Česnulevičius, G. Beconytė, 2006; D. Valiukas et al., 2015).

## 2. The historical overview of compiling Lithuanian atlases

The first *National Atlas of Lithuania (Lietuvos Nacionalinis Atlasas)* which met the criteria for a national atlas, was prepared in the period of 2014–2017. *The Atlas of Lithuanian SSR*, which was published in 1980, only partially complied with the requirements for national atlases. In addition, the information presented in that atlas became out of data over 37 years. Lithuania underwent essential geopolitical, economic and social changes over that period and they changed the status of the country.

The initiative to publish the new national atlas emerged in the 1980s, when Lithuania was still incorporated into the USSR. The structure of the future atlas was foreseen, the data needed for drawing up the maps were collected and the authorship sketches of the maps were prepared. Due to political transformations, the atlas was not published as it had been planned. Later, after the country went through the changes in the economic and social structure, the previously made maps lost their relevance. However, the idea to compile and publish a fundamental cartographic work, which would reflect the country's political, economic, social, cultural and historical development and the existence of the Lithuanian nation was never abandoned (P. Gaučas, J. Milius, 1999).

The initiators of the *National Atlas of Lithuania* include geographers, natural scientists, historians, economists, sociologists working in Lithuanian research institutions and specialists from other fields. The idea to compile the *National Atlas of Lithuania* originated in Vilnius University and its implementation united specialists from the Institute of Botany, the Institute of Ecology, the Institute of Geology, the Institute of Geography, the Lithuanian Institute of History, the Institute of Forestry, the Institute of Social Sciences, the Institute of Agriculture, the Geological Survey of Lithuania, Vilnius Gediminas Technical University and other research, management and industrial institutions. In 2005 the scientific editorial college was established and its members determined the main conception of the *Atlas* and made decisions about the content of its chapters and specific maps.

Developing the conception of the *National Atlas* and its content, making decisions about graphic presentation of maps and their editorial forms, the compilers aimed to create a cartographic publication, which would satisfy the needs of as a wide group of its potential users as possible. Attaining this goal, a homogenous integral publication was compiled, which consists of thematic volumes that focus on the territory of the Lithuanian state and its development, its situation in the European and global context, the country's nature and history as well as economic and social development.

The maps of the *Atlas* are divided into thematic chapters comprising a homogenous collection and consistently reveal the depth of the analysed themes. Moreover, an attempt was made to retain the volume of all the parts of the *Atlas* and their chapters the same.

## 3. The general structure of the *National Atlas of Lithuania*

The initial programme of the *National Atlas* provided for 4 volumes, which include the following parts:

Lithuania in Europe and the world, nature and landscapes (Volume I),

Historical development of Lithuania (Volume II),

Economic development of Lithuania (Volume III),

Social development of Lithuania (Volume IV).

After the first volume of the *Atlas* was pre-

pared and published, it was decided to join the volumes on the economic development and the social development compiling one volume that would focus on territorial administrative division, population, social situation and development, economic situation and development.

The main maps of the *Atlas* are published at the scale 1:1,000,000. This is a scale, which allows detailed mapping of phenomena for all the territory of Lithuania. Generalized, more summarized phenomena and processes are mapped applying smaller scales (1:1,500,000, 1:2,000,000 and 1:4,000,000). The common-geographical background (hydrographic and road network, settlements, political and administrative borders) of maps is linked to the scales of specific maps, that is, they have a relevant level of detail (degree of generalization), which allows appropriate presentation of the mapped phenomena and processes. The borders of municipalities were chosen as basis for administrative division of the country mapping the borders of counties together. Historical maps represent borders of administrative division (lands, voivodships, counties, vicinities) of the respected period.

Every chapter of the *Atlas* begins with a short description of the theme. This is an introductory part of the chapter, which enables a user to better understand the analysed theme. Textual information is also presented in separate maps.

The unified structure is foreseen for all the parts of the *National Atlas of Lithuania* and it embraces:

1. Preface to the volume of the atlas,
2. Introduction of the volume,
3. General legend of the volume of the atlas,
4. Explanatory texts to the chapters of the volume,
5. Specific thematic maps,
6. Explanatory texts in English.

The content of a specific theme was disclosed applying the following consistency: a complex map of a theme (1:1,000,000) → partial maps of a theme (1:1,500,000, 1:2,000,000) → elementary maps of a theme (1:2,500,000, 1:3,000,000, 1:4,000,000). The content of a theme was revealed in 4–16 maps (1–4 sheets).

The maps of the *National Atlas of Lithuania* were drawn up employing 10 methods of cartographic visualization, such as choropleth, isochromatic, isoline, cartograms, cartodiagrams,

localized diagrams, signs, linear signs, areal and linear cartodiagrams. Moreover, to ensure more comprehensive representation of phenomena, additional techniques of information representation were used: cross-sections, tables, diagrams, photo images and schemes (table 1).

Table 1. Methods of cartographic visualization of Lithuanian national atlas maps

Visualization method	Number of maps		
	First volume	Second volume	Third volume
Signs	51	68	20
Linear signs	38	47	14
Cartogram	52	120	171
Cartodiagram	26	43	143
Localized cartodiagram	6	22	10
Linear cartodiagram	9	31	1
Choropleth	78	13	1
Isochromatic	69	0	0
Isolines	55	0	1
Areal	47	39	1
Cross-sections	3	0	0
Tables	14	1	1
Diagrams	23	17	90
Photo images	4	3	5
Schemes	0	0	1

#### 4. Volume III of the *National Atlas of Lithuania*: the structure and mapping techniques

Volume III of the *National Atlas of Lithuania* (fig. 1) reflects political, economic, social, cultural and historical changes that occurred at the turn of the 20st– 21st centuries. The *Atlas* consists of six large chapters that illustrate the development of the administrative division at the end of the 20th century – the beginning of

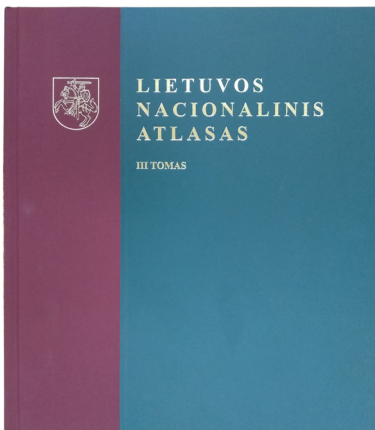


Fig. 1. Cover of Volume III of the *National Atlas of Lithuania*

the 21st century; dynamics of population, its national structure, professed religions and prevailing political attitudes; social situation of the population in the country and its development in recent decades; economic situation of the country, development of its agriculture and forestry; excavation of mineral resources and

developed industries; the national transport system, transport of cargo and passengers, forms and volumes of communications services. A chapter consists of the sets of maps in separate themes that reflect the structure of mapped phenomena and their developments. Such a principle enabled the authors of the maps to comprehensively reveal the essence of the phenomena and processes, to visually present their spatial distribution, territorial regularities and changes.

The section representing the development of territorial-administrative division of the country is the smallest in its volume. It takes one chapter, which contains a map of administrative division of the country in 2016 and the development of the country's administrative division since 1940. The chapter also presents topographic maps of Lithuanian cities and more important towns: Vilnius, Kaunas, Šiauliai, Panevėžys (scale 1:70,000), Klaipėda, Palanga (scale 1:60,000), Neringa (scale 1:120,000), Alytus, Marijampolė, Utena, Telšiai, Tauragė, Druskininkai, Visaginas and Birštonas (scale 1:50,000).

The second part of the *Atlas* (Population, social situation and development) consists of two chapters: "Population" and "Social situation

Table 2. Methods of mapping and map scales of third volume of the *National Atlas of Lithuania*

Chapter	Number of maps	Scale	Main mapping methods
Administrative division of the state	20	1:50,000, 1:60,000, 1:70,000, 1:12,0000, 1:1,000,000, 1:2,000,000	Signs, linear signs, areal, cartogram
Population	40	1:1,000,000, 1:1,250,000, 1:1,500,000, 1:2,000,000, 1:2,500,000, 1:4,500,000	Signs, linear signs, areal, choropleth, isochromatic, cartodiagram
Social state and development	65	1:90,000, 1:100,000, 1:1,000,000, 1:1,250,000, 1:1,500,000, 1:2,000,000, 1:2,500,000	Signs, linear signs, areal, choropleth, isochromatic, cartodiagram, isolines
Agriculture and forestry	59	1:1,000,000, 1:1,250,000, 1:1,500,000, 1:2,000,000, 1:2,500,000, 1:4,000,000	Signs, isochromatic, areal, choropleth, cartodiagram
Natural resources and industry	23	1:1,000,000, 1:1,500,000, 1:2,000,000, 1:20,000,000, 1:78,000,000	Signs, linear signs, areal, choropleth, cartodiagram
Transport and communication	26	1:1,000,000, 1:1,500,000, 1:2,000,000, 1:2,500,000, 1:4,000,000.	Signs, linear signs, areal, choropleth, isochromatic, cartodiagram

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Lietuvos gyvenviečių tinklas buvo formuojamas ilgas amžius, o tiksliai jį pildyti pradėta sunkioresis centralizacijos valdyme. Po antrojo pasaulinio karo, 1960 metais, Lietuvos gyvenviečių plėčia buvo prailginama planinio šūko tikslais. 1946 metais miesto statusą suteiktas 54 gyvenvietės, 5 papildiniai pradėjimas ir 49 apibūtinami pavadinimai. 1951 metais Lietuvos buvo 70, 1979 metais – 92, 1989 metais – 114 miestų. Dėl pramonės ir transporto sąlygų visada plėčia.

Pabrėžiant Lietuvos gyvenviečių tinklą ir centrus buvo pakeičiusios padidiusios miesto dydžio kintamumo tendencijos. Per turo dešimtmecius (1959–1989 m.) kaimo sumažėjo nuo 25 143 iki 19 153, 1967–1983 metais viena vienišas kaimas nuo 656 iki 101. Sumažėjo Lietuvos gyvenviečių struktūra didėjęs plėtos tempas 1970–1980 metais pradėtas vengti, o 1990 metais sistemos išlaidos, kur buvo numatyti skirti II regionas. Regionas tapo sudėtinga miškinga administracinis regionas, o šiuo – teoriniams mikroskalinis Tolia

daž į regionų ir rajonų centrus buvo pritaikta didelis kaimo gyvenimo. Dėl pramonės intensyviai darbu plėčiui Mažeikiai, Jena, Kėdainiai ir kitai miestai. Miesteliai ir kaimai buvo sudaryti į kategorijas: centines, paupietines ir nevykusias gyvenvietes. Pateiktas buvo sudarytas vienaip ar kitaip. Tada gyvenviečių sistemos pertvarkymas baigėsi 1990 metais, kai antrosios pusės bėtos į sudėtingą turį, gyvenvietės pradėtos pildyti naujomis kaimo gyvenimo sąlygomis.

XX amžius pabrėžė Lietuvos bėvos skaitams planiniam šūko palyginimo kaimo gyvenviečių tinklas. XX amžiaus pabaigoje Lietuvos pradžioje kaimo gyvenviečių depopuliacija XXI amžius pradėjo apimtį didėjęs iki mūkama Lietuvos miestų.

Lietuvos Respublikos gyvenamosios vietovės skaitomas į mišius ir kaimo gyvenvietes višoves. Miesto gyvenamosios vietovės pradėtas mišius – karpininkai užsėjos gyvenamosios vietovės, turintis daugiau kaip 3 000 gyvenimo

Mažiau kaip 3 000 gyvenimo turintis miestai, rajonų miestai bei miesto tipo gyvenvietės, turintis miesto statusą, pradžioje miestams. Kaimo gyvenamosios vietovės pradėtas miesteliai. Miesteliai – kompaktiška užstatytos gyvenamosios vietovės, turintis 500–3 000 gyvenimo, joms pagrįstai yra administracinis, kultūrinis centras, mokykla, biblioteka, medicinos punktas. Kaimai – gyvenamosios vietovės, neprikiramos prie miestų ir miestelių, o atskiri žemės ūkio valdomos valdomos miesteliai. Visos gyvenvietės turi individualias pradėtas, skirtojas pagal funkcijas bei hierarchiją: pramonės, mokymo, transporto, pošto, rekreacijos, žemės ūkio, padangos, religinės, polifunkcinės (socialinė, apdirbimų ir savivaldybės centrai). Pagal dydį skiriamos amžiosios, miesto, vietinės ir didesni gyvenvietės; miestai ir kaimai skirtojas skaitas. 2016 metais buvo 103 miestai, 21 900 kaimų ir miestelių (iš jų 3 000 kaimų be gyvenimo).

Per 2001–2011 metų laikotarpį amžiosios miestų (bėvo 106, dabar – 103) bei itin sumažėjo kaimų (bėvo 18 461, dabar – 16 762) ir miestelių (bėvo 1 735, dabar – 1 687). Be to, iš dabar esančių kaimų ir miestelių skaitomas apie 10 proc. kaimų ir apie 52 proc. miestelių neturi gyvenimo ir yra prie šiek tiek ribos.

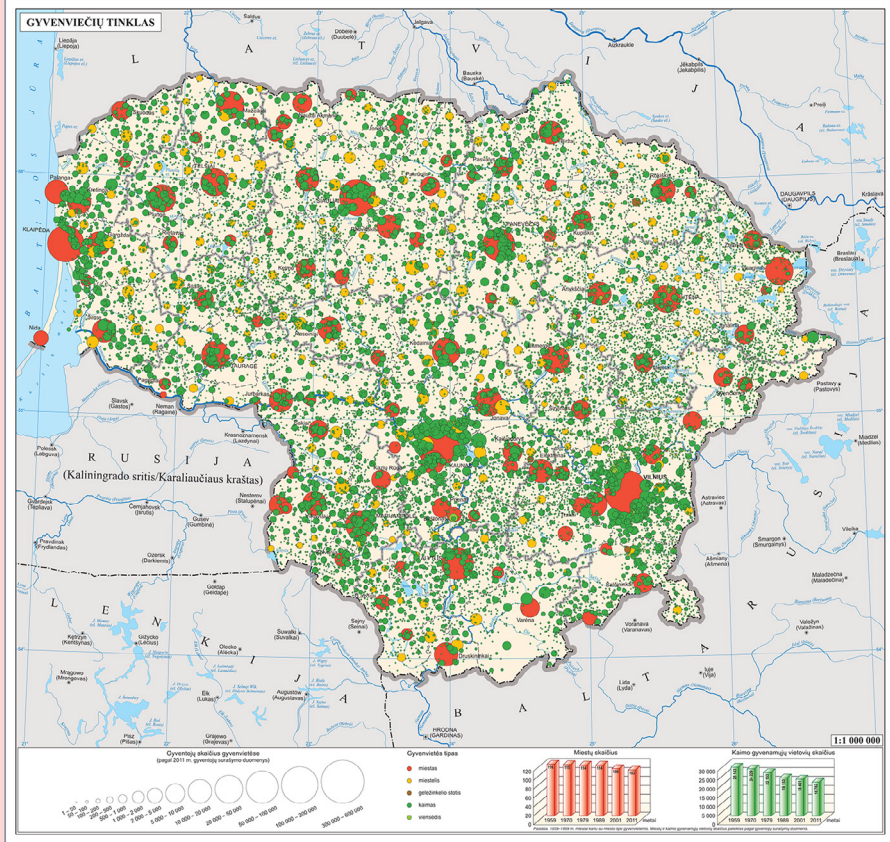


Fig 2. The settlements network – their types and number of inhabitants, with explanatory text (reduced – original scale 1:1,000,000)

and development’. The network of settlements (fig. 2), density of population and its dynamics, density of population in cities, natural decrease or increase in population, proportion of men and women and its dynamics, marriages, divorces, dynamics of number of families, numbers of children in families (fig. 3), the structure of the age of population and its changes, national

composition of population, internal and external migration of population, religious communities and their distribution and dynamics of political views of population are mapped in this chapter. The total number of maps in this chapter equals 40 (table 2).

The next chapter in this part of Volume III introduces the mapped phenomena of (un)em-





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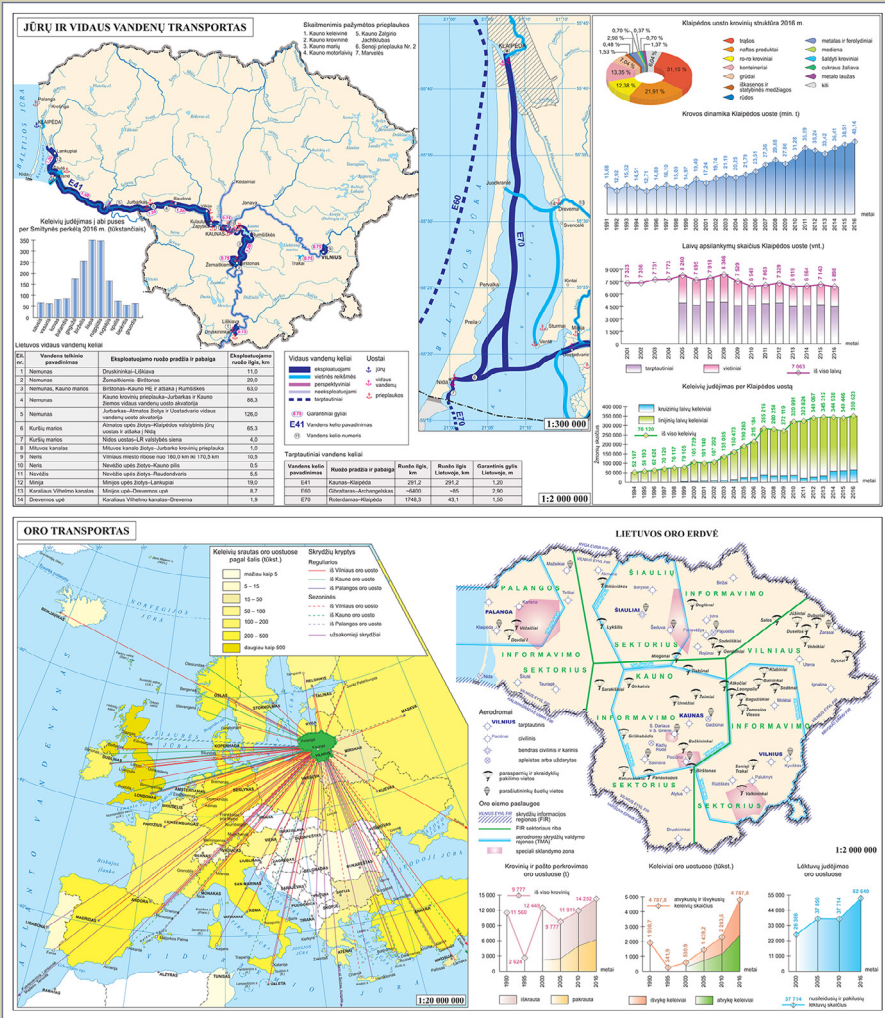


Fig 4. Maritime and inland waterway transport (above); air transport (below); airports and airfields (reduced – original scales 1:2,000,000, 1:300,000 and 1:20,000,000)

rance service institutions, development of volumes of their provided services, tourist sites, their distribution and attendance, flows of domestic and foreign tourists, territorial organisation of environmental protection and territorial development of investments to environmental protection. There are 65 maps in the chapter

and the data on their scales is presented in table 2.

The third part of the Atlas (Economic situation and development) consists of three chapters: "Agriculture and forestry", "Natural resource mining and industry" and "Transport and communications". The first chapter focuses on the

general structure of utilised agricultural area and its dynamics, fertility of utilised agricultural area, structure of private agrarian holdings, energy supply of utilised agrarian holdings; crop structure, grain crops, technical crops, fodder crops, potato and vegetable areas and their dynamics; fertility of utilised land; development of ecological farms; total number of animals; numbers of cattle, pigs, sheep, goats, horses; numbers of rabbits, geese, duck; milk production; meat production; poultry; apiculture; revenue from agriculture; territorial organisation of forests; timber resources and timber purveyance; territorial organisation of hunting; territorial organisation of fishery; volumes of inland and sea fishery. There are 59 maps in the chapter.

The next chapter "Natural resource mining and industry" introduces the mapped mining of building materials, oil, peat and groundwater extraction; electricity production, electricity production from renewable sources; separate industries (manufacturing, wood, food, beverages, textiles, leather and fur); added value generated by industries; distribution and development of foreign investments; volumes of country's export and import. The chapter introduces 23 maps.

The third chapter "Transport and communications" presents the mapped road and pipeline network; numbers of passenger cars and their distribution; traffic volume on roads; distribution of road accidents; transport of passengers and cargo by automotive and railway vehicles; transportation by maritime, inland waterway and air transport (fig. 4); post offices; mobile telecommunications operators and coverage of their services; accessibility of internet services. The chapter has 28 maps and the structure of their scales is presented in table 2.

The maps of Volume III of the *National Atlas of Lithuania* are drawn up using 9 techniques of cartographic visualization: choropleth, isopleth or isoline, cartodiagram, localized diagram, signs, linear signs, areal and linear diagram mapping methods. The isoline method is used to present the distribution of registered acts (crimes) in cities; relative quantitative values of different phenomena in municipalities of the country are presented in choropleth; dynamics of population density in municipalities – in cartodiagrams; localised diagrams mark the network of settlements; religious communities are pre-

sented with graphic signs; linear signs show high voltage electricity transmission networks; recreational territories are visualized using areal method and traffic intensity is mapped applying linear diagrams. Moreover, structural schemes (the national system of education) are used as additional elements in the *Atlas* (table 2).

## 5. Discussion

Working on Volume III of the *National Atlas of Lithuania*, its compilers faced certain challenges. The majority of them were related to insufficient volume of available data, their non-detailed localisation, different criteria applied while collecting state statistical data and others. The main encountered challenges:

1. Data irregularities in terms of time. The data for some phenomena were collected episodically. The consecutive data year by year were not available.

2. Spatial irregularities of data. Some data were of local character and represented only several municipalities or counties.

3. Heterogeneity of data. 1 January 2008 a new statistical classification of economic activities entered into force, which is in line with Regulation (EC) No. 1893/2006 of the European Parliament and of the Council of 20 December 2006 establishing the statistical classification of economic activities. This introduced essential changes in the data collection accumulated after 2008.

4. Statistical indicators of collected data. In 2008 the indicators of collected statistical data were also changed. Since then physical quantities (units, tonnes, m<sup>3</sup> and others) have been frequently replaced by monetary values (monetary value of production or monetary value of sold production). Due to movements in prices it was complicated to evaluate the physical volumes of production.

5. Data confidentiality. Some data were unavailable because they fell within the category of confidential data.

6. Identification of physical location of objects. A number of enterprises and companies tend to present location of their headquarters only. In the meantime, production is carried out in other locations, which are not included into the data accumulated by Statistics Lithuania. This is particularly characteristic of enterprises that



specialise in mining, manufacturing industries and in processing of agricultural products.

The compilers of the *Atlas* managed to cope with all the above-mentioned and other undefined problems. It is also symbolic that Volume III of the *National Atlas of Lithuania* was published on the eve of the Centennial of the Restored State of Lithuania. Like the previous volumes, this issue is expected to have the place it deserves among other fundamental scientific works and to contribute to scientific, social and cultural analysis of the country, to deepen awareness of its society as well as to be useful to everyone who seeks knowledge.

## 6. Conclusions

The *National Atlas of Lithuania* is an unique cartographic publication, which provides a comprehensive presentation of the nature, society of the country, its social and historical development. This is a publication of encyclopaedic

character, which presents fundamental knowledge of Lithuania.

Diverse information, which is available in the maps of the *Atlas*, allows their users to conduct a complex evaluation of phenomena and processes that occur in the country as well contributes to building an integral holistic and synthetic view of Lithuania.

The maps of the *National Atlas of Lithuania* are compiled employing various mapping techniques and the extent of their application in different volumes of the *Atlas* also differs. The maps drawn using choropleth (70 maps), isochromatic (67 maps), isoline (56 maps) and geometric signs (52 maps) methods prevail in Volume I. The frequency of mapping methods in Volume II is as follows: choropleth (117 maps), maps of geometric signs (69 maps) and those of linear signs (45 maps). Choropleth (174 maps) and cartodiagrams (136 maps) are most frequently used in the maps of Volume III. Other mapping techniques are rarely employed in the maps of this volume.

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