

# Ecological maps of Lithuania: subject, cartographical methods, perspectives

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Compilation of ecological maps was assumed in Lithuania in the 70s of the 20th century. Since then, ecological mapping has undergone marked transformations. The timeframe of four decades may be divided into periods based on the dominant content of maps:

1. Environmental maps (preserved territories, natural monuments, etc.).
2. Maps describing the ecological state of discrete components (water pollution, air pollution, etc.).
3. Generalized ecosystems maps. They are mainly designed for depiction of the ecological state of separate geospheres: atmosphere, hydrosphere and lithosphere.
4. Synthetic or sozological maps of different geospheres (geochemical, hydrochemical, ecological state, etc.).

A few trends of ecological mappings developed: scientific, educational and informational. All these types of maps are compiled using almost identical methods: areas, signs, localized diagrams, motion signs (vectors), qualitative and quantitative backgrounds, and isolines.

The perspective of ecological mapping is associated with sozological maps whose content is able to embrace all componential ecological maps.

**Key words:** ecological maps, cartographical methods, periods of ecological mapping

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## INTRODUCTION

The natural environment is one of the major factors pre-determining the quality of life. The ecological state of densely populated European and North American regions became an object of concern in the second half of the 20th century. Mapping represents one of the ways of observation and assessment of the environment. In the second half of the 20th century, ecological maps started to appear in abundance.

In Lithuania, compilation of ecological maps was assumed in the 70s of the 20th century. The first ecological maps were designed for nature protection. They mainly plotted state nature reserves and natural monuments. Since then, the ecological mapping has undergone considerable transformations. The content of maps has changed essentially. A shift was made from plotting objects and territories to plotting processes and the ecological state of the country's territory.

## PERIODS OF ECOLOGICAL MAPPING

The long time frame of four decades can be divided into stages based on the dominant content of maps.

In *the first stage* (the sixth and seventh decades of the 20th century), maps contained information about natural monuments, state reserves and sanctuaries.

In *the second stage* (the seventh and eighth decades of the 20th century), maps of the state of natural components were compiled: water and atmospheric pollution and local geochemical maps. It should be emphasized that the then maps of natural components included information only about separate industrial objects exerting an impact on the state of the whole ecosystem. The quantitative indices were rarely given. The content would rather be presented in qualitative notions: high, medium and low levels of pollution. To tell the truth, the latter prevailed.

The maps of *the third stage* (the ninth and tenth decades of the 20th century) contained generalized data about the ecosystems. They were mainly designed for depiction of the ecological state of separate geospheres: atmosphere, hydrosphere and lithosphere. At that time, sufficient data were available for revealing the ecological state of urban areas. The first maps of the ecological state of the largest Lithuanian cities were compiled.

The ecological state of the environment became an object of public interest in the eve of and especially right after the restoration of Lithuania's independence. The environmental impacts of large industrial enterprises and communal constructions became an object of concern. It is important to note that the then leaders of the state had an "environmental" attitude. A few national programmes were developed. They were designed to

evaluate the actual state of the natural environment in Lithuania. The impact of the Ignalina NPP on the surrounding ecosystems (hydrosystems in particular) was investigated in detail. The ecological state of the former military sites was also studied. The former Ministry of Building and Urbanistics supported a project designed for assessing the ecological state of the whole territory of Lithuania. Researchers from the Institute of Geology and Geography participated in the project. The research resulted in maps at a scale 1 : 50 000, describing the influence of country's geological substratum on landscape functioning.

In the fourth stage (the tenth decade of the 20th century and the first decade of the 21st century), synthetic maps describing the state of different geospheres were compiled. An attempt was made to compile the first sozological maps embracing nature research, land management and economic attitudes towards the environment. Their compilation required comprehensive local data characterizing the country's territory in natural, economic, infrastructural and social aspects. The compilation of this kind of maps is based exclusively on modern mapping technologies and demonstrates a qualitatively new perception of environment.

**TENDENCIES OF ECOLOGICAL MAPPING**

In a few decades, a few trends of ecological mapping developed: scientific, informational, applied and educational. These maps differ in content yet are comparable in mapping techniques.

*Scientific ecological maps.* The valuating content is the main distinguishing feature of these maps. Compilation of this type of maps requires very exhaustive localized information about a mapped territory. Topographic and thematic databases are used for their compilation. Until the end of the 20th century, such databases were only in a rudimentary stage. Among the first such databases we can mention the one at a scale 1000000 containing very poor ecological information (Fig. 1).

The last decade of the 20th century was marked by the outbreak of comprehensive localized geological databases compiled by the Lithuanian Geological Survey. The information contained in these databases is also important in the ecological sense: groundwater, its state and pollution, geochemical indices of surface sediments, etc. At the end of the 20<sup>th</sup> – beginning of the 21st centuries, there appeared more of similar databases:

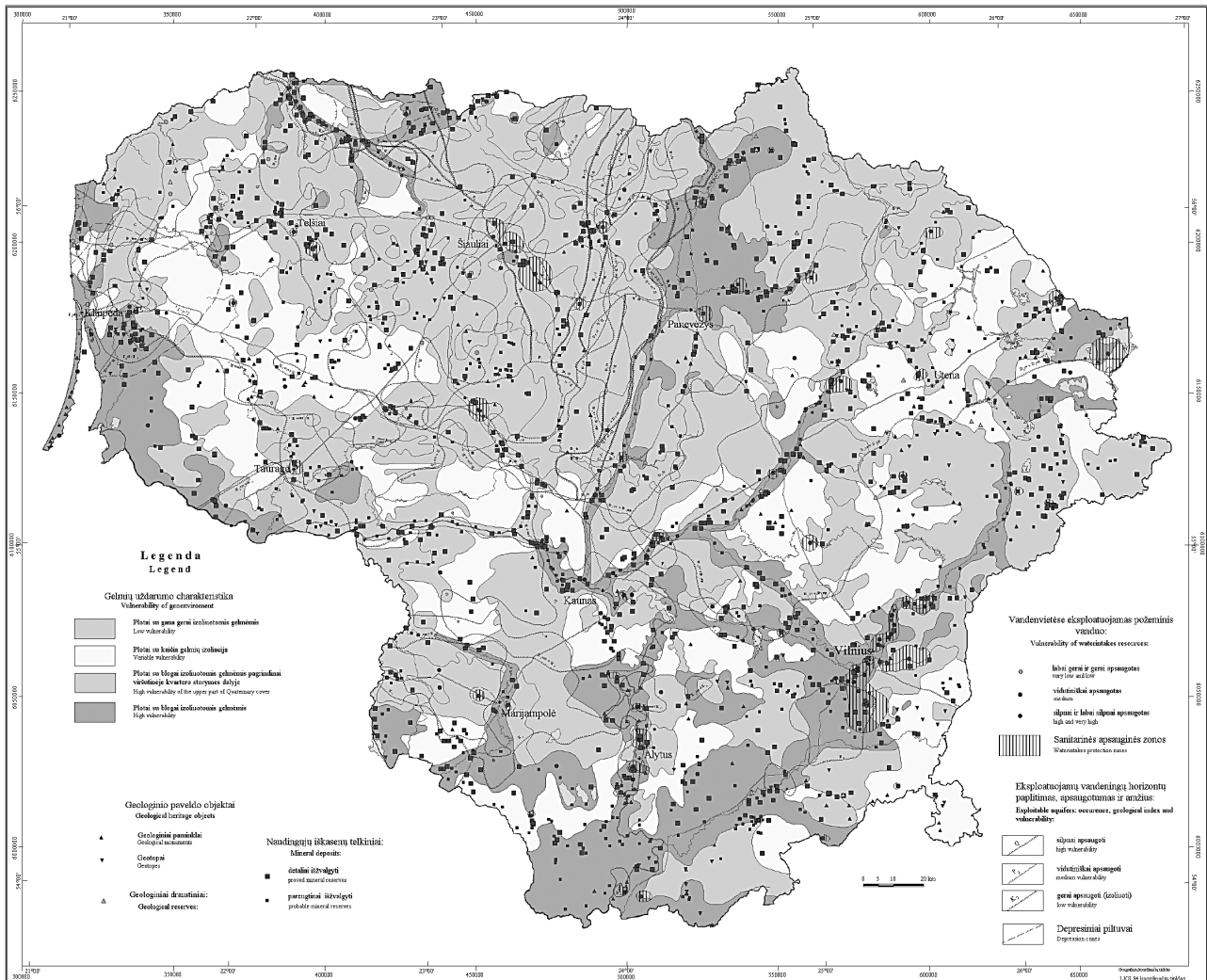


Fig. 1. Ecological map of Lithuania  
1 pav. Lietuvos ekologinis žemėlapis

at the National Land Survey and subordinate GIS Centre and at the National Land Management Institute.

The national research programme “Lithosphere” was beneficial to the ecological assessment of the earth crust and its surface. The revised and newly collected data allowed compiling geoecological maps. Along with traditional components (geochemistry of sediments, groundwater, engineering geological conditions, etc.), these maps contain assessments of the level of protection of the earth crust from pollution and possible adverse geological (karst) and geomorphological (erosion and deflation) phenomena. Thematic survey maps at scales 1 : 500 000 and 1 : 200 000 were compiled.

*Informational ecological maps.* These maps are designed for operative valuation and decisions. Their content is strictly specialized. Data for such maps are collected by daily observations at meteorological and hydrological stations of the Lithuanian Hydrometeorological Survey and at stations of global, regional, national and local monitoring (Fig. 2).

The compilation of informational maps was based on two European (in terms of territory) databases embracing the information of land management: CORINE and Natura 2000.

*Applied ecological maps.* They are designed for territorial planning and comprise part of the basis used for compilation of preserved territories and land management on municipal, city and local levels. Geoecological maps were the first applied ecological maps evaluating the geological potential of territories,

the protection level of the earth crust, the impacts of extraction of minerals on the ecological state of regions and adverse geomorphological processes. The geoecological maps were compiled for Ignalina, Trakai, Prienai, Alytus, Varėna and Šiauliai municipal territories (Fig. 3).

*Educational ecological maps.* They are designed to form the attitude of students towards the surrounding environment. The first such maps were published in the “World Atlas” of 1996 designed for comprehensive schools. The atlas contains general maps of natural zones and local maps characterizing specific territories: landscape of Kazakhstan virgin lands, the Gang River Delta, East China, the Nile River valley, etc. The ecological aspects of environment are introduced already in the elementary schools. This is illustrated by the World Atlas visually presenting the hydrological cycle, animate world, Lithuanian animal kingdom and preserved territories. The ecological state of Lithuania and the world is comprehensively presented in the Atlas of General Geography for Schools published in 2005 by the Cartographic Centre of Vilnius University (General Atlas... 2005; World Atlas, 2004) (Fig. 4).

Unfortunately, publications of this kind for higher schools, which would facilitate the studies of natural sciences, are lacking. Scientific ecological, informational ecological and applied ecological maps are used as teaching aids for students of higher schools.

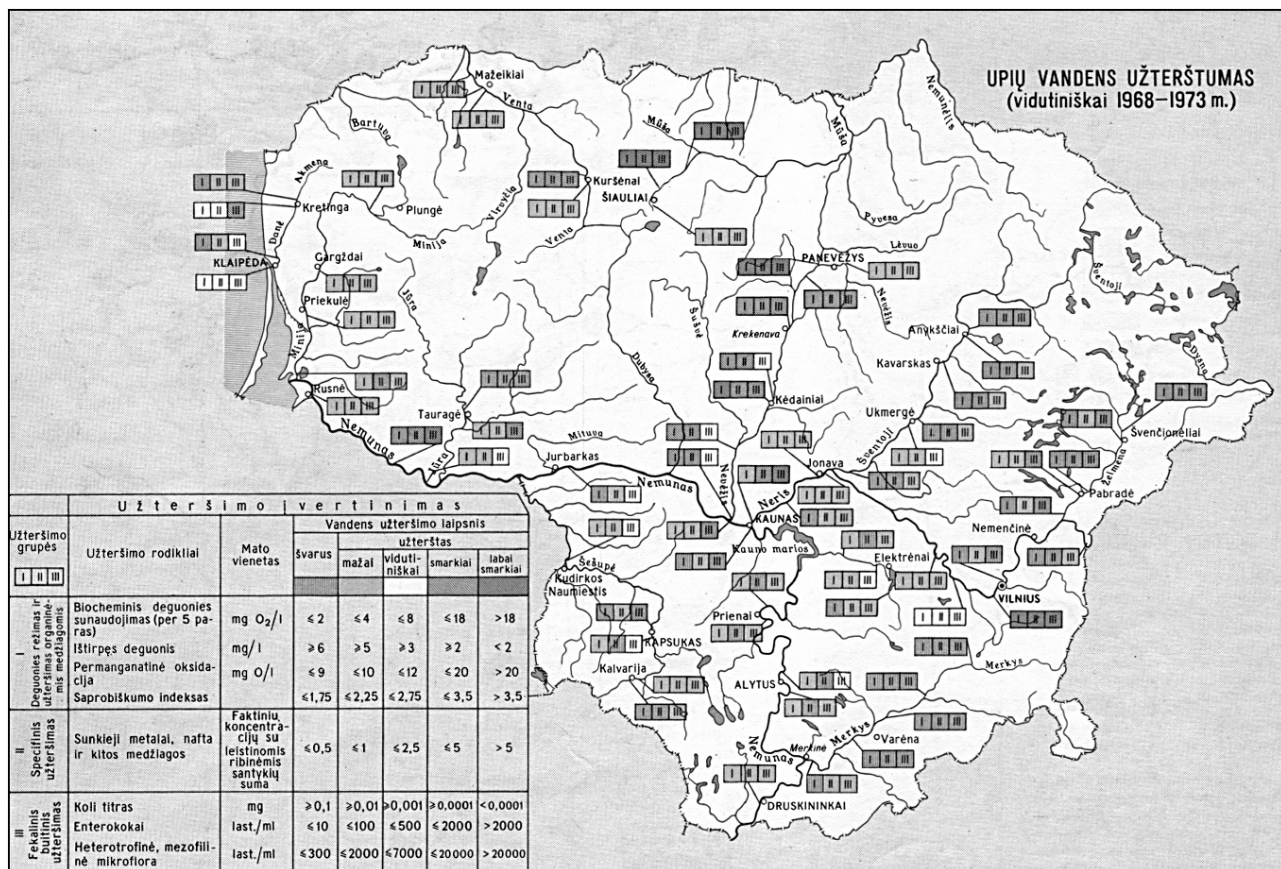


Fig. 2. Pollution of surface waters  
2 pav. Paviršinio vandens tarša

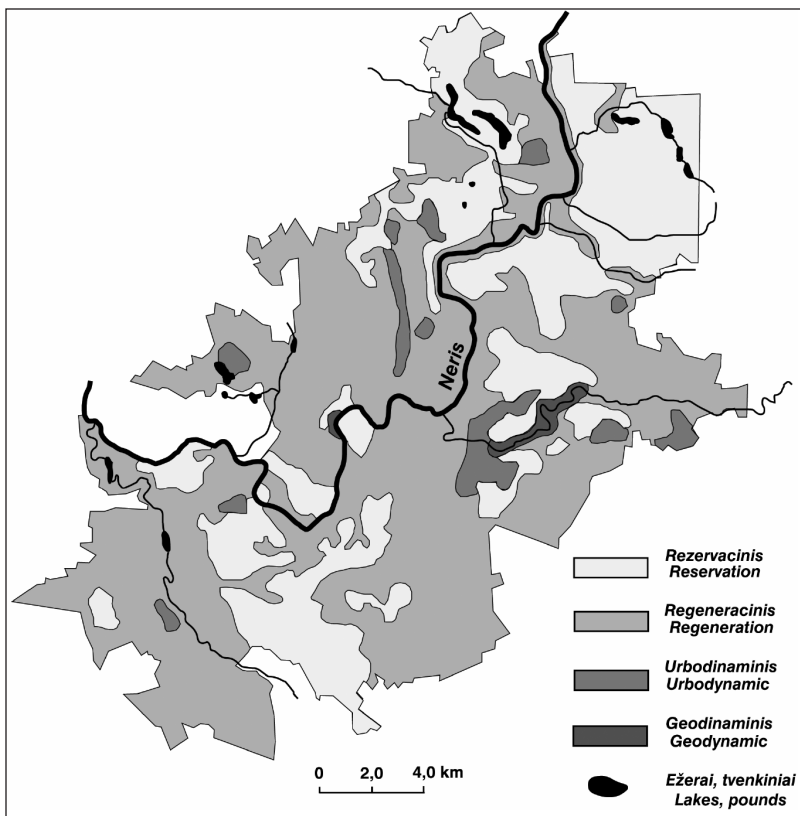


Fig. 3. Map of geodynamical types of Vilnius relief  
3 pav. Geodinaminiai Vilniaus miesto teritorijos reljefo tipai



Fig. 4. Map of Lithuanian fauna  
4 pav. Lietuvos faunos žemėlapis



third variant allows depicting a greater number of superposing areas. The coloured landmarks considerably increase the informativeness of a map and facilitate its analysis. Application of all variants enables depicting up to 8 different areas (Atlas of Lithuanian SSR, 1981).

The method of signs is widely used in ecological maps. It is especially popular in educational ecological maps. Graphic signs are used in the World Atlas for primary schools: maps of elemental natural forces, animate world of oceans and nature of continents. Graphic signs allow a very vivid differentiation of depicted objects and phenomena. Geometric signs are also used in ecological; scientific, informational and applied ecological maps.

Linear signs are not as popular in ecological maps. They usually mark the objects depicted for orientation: roads and the hydrographic network. In the map of the geological potential, linear signs mark palaeoincisions. Vectors used in the ecological maps mark the trend of processes. The vectors are of different colours (qualitative differentiation), different forms (qualitative differentiation in one-colour maps) and different size (quantitative differentiation). As was mentioned, vectors show the trends of processes: extreme natural phenomena, polluted groundwater dispersion, etc.

The ecological maps also apply mapping techniques – localized diagrams, cartograms and cartodiagrams – for a comprehensive depiction of local objects. Localized diagrams depict groundwater quality changes whereas cartograms and cartodiagrams depict the amounts and penetration rates of underground pollution.

The ecological maps are supplemented with profiles, graphs and diagrams. Profiles depict landscape types, graphs show the amounts of precipitation, diagrams demonstrate the composition of pollutants.

## PERSPECTIVES OF ECOLOGICAL MAPPING

The first ecological maps were environmental in their content. They would depict natural objects and most important preserved natural territories: national reserves and sanctuaries, and natural monuments. They were inventory maps which almost did not reflect the ecological aspects. In four decades, the content of ecological maps has undergone essential changes. An important shift from inventory mapping of objects and territories to the depiction of environmental processes and ecological state has been made.

Sozological maps have been recently gaining popularity all over the world. They are a group of thematic maps where anthropogenic degradation, environmental, land management and remediation aspects are synthetically represented in a mapped territory. Sozological topographic maps (at a scale 1 : 50 000 and larger) are most widespread in Europe. Their content is as follows:

- forms of natural environment preservation measures;
- degradation level of natural environment components (surface, soils, forests and the like);
- projects impoverishing the natural environment and the character of investments;
- measures preventing the degradation of the natural environment;
- remediation measures.

Maps of this kind can be compiled only on the basis of available comprehensive and detailed localized information. This means that sozological maps will serve as a basis for economic development and local and regional planning. At present, geoecological maps (mapping and evaluating not only measures of nature protection, but also measures of economic development) are closest in their content to sozological maps.

## CONCLUSIONS

1. Compilation of ecological maps was assumed in Lithuania in the 70s of the 20th century. In a few decades, the content of maps has changed essentially. A shift has been made from depicting objects and territories to depiction of processes and the ecological state of the country's territory.

2. Four stages may be distinguished in the time frame of ecological mapping. In the first stage, maps depicting preserved natural objects prevailed. Maps of the ecological state of natural components were compiled in the second stage. The third stage was marked by compilation of maps generalizing the ecological state of ecosystems and separate geospheres. Synthetic maps describing the state of separate geospheres appeared in the fourth stage. Attempts were also made to compile the first sozological maps combining nature research, land management and economic aspects of environment.

3. A few trends of ecological mapping have developed in a few decades: scientific ecological maps (characterized by valuation content); informational ecological maps (designed for operative valuation and decisions); applied ecological maps (designed for territorial planning) and educational ecological maps (designed for the formation of environmental attitude).

4. Ecological maps depict objects, phenomena and processes. Depending on the character and size of objects, the space occupied by phenomena, and the trend and intensity of processes, relevant depiction methods are applied: qualitative background, quantitative background, isolines, areas, signs (geometric and graphic signs), linear signs, localized diagrams, cartograms and cartodiagrams. Ecological maps are supplemented with profiles, graphs and diagrams.

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## LIETUVOS EKOLOGINIAI ŽEMĖLAPIAI: TURINYS, KARTOGRAFAVIMO BŪDAI, PERSPEKTYVOS

### *Santrauka*

Lietuvoje sudarinėti ekologinius žemėlapius pradėta XX a. 8-ajame dešimtmetyje. Pirmieji ekologinio pobūdžio žemėlapiai buvo skirti gamtosaugai – juose dažniausia nurodyti valstybiniai draustiniai, gamtos paminklai. Nuo to laiko ekologinis kartografavimas išgyveno ženkliai transformacijas. Iš esmės pasikeitė žemėlapių turinys: nuo objektų ir teritorijų vaizdavimo pereita prie procesų ir visos šalies teritorijos ekologinės būklės.

Remiantis sudarytų žemėlapių turiniu, galima išskirti šiuos keturis dešimtmečius.

*Pirmajame etape* (XX a. 6-asis ir 7-asis dešimtmečiai) vyravo žemėlapiai, kuriuose pateikiami su gamtos apsauga susiję objektai: gamtos paminklai, valstybiniai draustiniai, rezervatai.

*Antrasis etapas* (XX a. 7-asis ir 8-asis dešimtmečiai). Sudaromi atskirų gamtos komponentų būklės žemėlapiai: vandens ir oro taršos, vietos geocheminiai. Šiuose žemėlapiuose nurodyti tik paskiri pramonės objektai, darantys įtaką visos ekosistemos būklei. Labai retai juose buvo pateikiami kiekybiniai rodikliai, o visas turinys nusakomas kokybinėmis sąvokomis.

*Trečiasis etapas* (XX a. 9-asis ir 10-asis dešimtmečiai). Žemėlapiuose pateikiami apibendrinti ekosistemų duomenys, nusakantys atskirų geosferų ekologinę būklę – atmosferos, hidrosferos, litosferos. Tuo laikotarpiu sudaryti pirmieji didžiųjų Lietuvos miestų ekologinės būklės žemėlapiai.

*Ketvirtasis etapas* (XX a. 10-asis dešimtmetis – XXI a. 1-asis dešimtmetis). Kuriami sintetiniai atskirų geosferų būklę apibūdinantys žemėlapiai. Šiuo laikotarpiu bandoma sudaryti ir pirmuosius sozologinius žemėlapius, sujungiančius gamtotyrinį, kraštotvarkinį ir ekonominį požiūrius į supančią aplinką. Šie žemėlapiai sudaromi remiantis

moderniomis kartografavimo technologijomis ir atspindi kokybiškai naują aplinkos suvokimą.

Per kelis dešimtmečius išryškėjo mokslinė, informacinė, taikomoji, edukacinė ekologinio kartografavimo kryptys.

Ekologiniuose žemėlapiuose pateikiamas objektų, reiškinių ir procesų vaizdas. Vaizdo pateikimo būdų naudojimas priklauso nuo objekto pobūdžio ir dydžio, reiškinių apimamos erdvės bei procesų kryptingumo ir intensyvumo. Plačiai taikomi du kokybinio fono metodo variantai: spalvinis ir štrichinis. Kiekybiniai teritorinės sklaidos rodikliai yra pateikiami kiekybinio fono metodu, naudojant vien spalvės įvairaus atspalvio spalvų skales bei štrichavimą. Izolinijomis ekologiniuose žemėlapiuose perteikiami homogeniniai reiškiniai. Siekiant sustiprinti vaizdumą, tarpai tarp izolinijų spalvinami harmoningai kintančiais vienos spalvos atspalviais. Arealai žemėlapiuose pateikiami keliais būdais: kontrastingomis spalvomis, štrichu arba riboženkliais. Pirmieji du variantai taikomi tuomet, kada kaimyniniai arealai nepersidengia, trečiasis variantas leidžia parodyti daugiau persidengiančių arealų. Ženklių metodas ypač populiarus edukaciniuose ekologiniuose žemėlapiuose. Vaizdūs ir geometriniai ženklai leidžia labai aiškiai išskirti vaizduojamus reiškinius ir objektus. Retesni ekologiniuose žemėlapiuose linijiniai ženklai, lokalizuotos diagramos, kartogramos ir kartodiagramos. Ekologiniai žemėlapiai papildomi profiliais, grafikais bei diagramomis.

Pastaruoju metu populiarėja sozologiniai žemėlapiai, kuriuose sintetiškai pateikiami kartografuojamos teritorijos antropogeniniai degradaciniai, gamtosauginiai, kraštotvarkiniai ir rekultivaciniai aspektai. Jų turinys apima gamtinės aplinkos apsaugos priemonių formas, gamtinės aplinkos komponentų degradacijos lygį, gamtinę aplinką alinančios ūkinės veiklos, gamtinės aplinkos degradaciją stabdančių priemonių ir rekultivacinių priemonių vaizdavimą.

Šiuo metu artimiausi sozologinių žemėlapių turiniui yra geoekologiniai žemėlapiai, kuriuose įvertintos ir kartografuotos ne tik gamtosauginės, bet ūkio plėtros priemonės.