ADVANCES IN GEODESY AND GEOINFORMATION
(formerly GEODESY AND CARTOGRAPHY)
Vol. 74, no. 1, article no. e58, 2025

© Polish Academy of Sciences
https://doi.org/10.24425/agg.2024.150687

Original paper

Evaluation of cartographic functional styles for wind energy mapping

Rita Viliuviene*, Linas Bevainis

Vilnius University, Vilnius, Lithuania
e-mail: rita.viliuviene@chgf.vu.lt; ORCID: http://orcid.org/0009-0004-7075-5529

e-mail: linas.bevainis@gf.vu.lt; ORCID: http://orcid.org/0000-0001-9860-4440

*Corresponding author: Rita Viliuviene, e-mail: rita.viliuviene@chgf.vu.lt

Received: 2024-10-07 / Accepted: 2024-12-05

Abstract: Functioning of maps in different areas of human activity provides the right context for the formation of cartographic functional styles. The community that participates in this map-related activity gains knowledge. When developing a system of cartographic functional styles, it is important to consider how users value cartographic functional styles. The purpose of the research is to evaluate cartographic functional styles based on the results of the target group survey. In order to achieve the goals of the research, the framework of the system of cartographic functional styles has been prepared, consisting of the main components that determine the cartographic functional style. Maps illustrating characteristic features of different styles are included. A questionnaire for the survey was prepared. Stylistic analysis of modern maps, analysis of information sources was carried out during the research. The maps are produced using data from different data sources and GIS software. 4 maps on the current topic of wind energy are the results of this activity. 104 respondents from different fields of activity took part in the survey. The results of the survey show that as many as 85 percents of the respondents basically agree with the statement that maps in general are characterized by a variety of cartographic functional styles. The respondents give high priority to the target audience for which the map is intended in the system of functional styles. Based on the results of the survey, the framework of the system of cartographic functional styles has been specified.

Keywords: cartographic functional style, cartographic language, visual expression, map stylistic analysis, wind energy mapping

1. Introduction

Cartographic functional styles not only help to convey the main content (hydrography, transport network, population distribution), but are indispensable when it comes to selecting, combining and composing the means of expression so that the map can convey an additional social aspect. This allows the map to be targeted at a specific group of users (professionals, the public), to draw users' attention to a problem, to encourage them to take a certain action (purchase a product, leave an area). Research on cartographic functional styles is essential.

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The functioning of maps in various fields of human activity provides the right conditions for the formation of cartographic functional styles as varieties of language. The community involved in this map usage practice is a source of knowledge in which valuable practice-based knowledge crystallizes. When improving a system of cartographic functional styles, it is important to take into account the users' evaluation of cartographic functional styles. However, in order to improve something, it is first necessary to establish such a framework on which to base the initial evaluation. Such a framework for cartographic functional styles has been proposed in this research. Based on this framework, a questionnaire for the focus group survey was prepared.

The purpose of the research – evaluation of cartographic functional styles based on the results of a target group survey. In order to achieve the objectives of the study, it is methodologically important to find criteria that are logical and work effectively in practice. Methodological issues are addressed by drawing on advances in stylistics from other disciplines, such as linguistics. The framework of the system of cartographic functional styles has been developed on the basis of a stylistic analysis of modern maps. As with identifying the social aspect in modern maps, the same cartographic functional styles are useful for creating the desired social aspect in newly created maps.

Examples, i.e., maps, have also been prepared to illustrate the characteristic features of cartographic functional styles. These provide a visual representation of the style tools applied in order to unambiguously identify and specify the stylistic features (completeness, precision, clarity, etc.) and the stylistic means (bolding, framing, visual metaphors, etc.) to be used. To illustrate the functional styles on the map, we have chosen an important topic that requires public attention and contributes to the Sustainable Development Goals: wind energy (Kent et al, 2020; Kraak et al., 2020; Olabi et al., 2023). The maps are produced using Quantum Geographic Information System (QGIS) software and data from different data sources. Maps illustrating different styles can help to reduce subjectivity and uncertainty in evaluation process of cartographic functional styles during target group surveys. In the online questionnaire, the answers are accompanied by options for the possible answers. When choosing an answer, users assign their priorities to selected components of cartographic functional styles.

In the framework of the system of cartographic functional styles, it is appropriate to distinguish pairs of stylistic features dichotomously, choosing a different basis for classification. They are selected based on the results of stylistic analysis of modern maps. Clarity/ambiguity, concreteness/abstractness and other pairs of stylistic features of the language, which are important for the clear and complete presentation of information on the map, were identified as a result. Stylistic features determining language expression are also determined. Additionally, a stylistic feature describing the suggestiveness of the language (characteristic of the style of advertising maps, propaganda maps) is included. There may be more stylistic features, but the above mentioned are common to all maps.

The logic behind the theoretically defined system of cartographic functional styles was used to create the questionnaire for the target group survey. The target group of users was asked to evaluate the appropriateness of stylistic means and stylistic features on the map, when the target audience, field of use of language, language functions and subject matter are different, but the coverage (Lithuania), map content (wind energy

mapping), and the spatial data set are constant. Maps of wind energy differ in intent: the map "Wind energy in Lithuania" is for inventory of geographical features, the map "Remaining capacity for connection of new wind power plants in Lithuania" – to identify problems and demonstrate the situation from the scientific researchers' point of view, the map "Wind energy in Lithuania: development projects" – to show the development trends of wind energy in Lithuania in different regions of the territory, and map "Wind farms in our landscape" – to make the public believe in the idea.

Analysis and evaluation of concepts and definitions play an important role in this research (Gajda, 1992; Bartminski, 2013). After naming the concept, the characteristics that can be the criteria that solve a specific scientific problem are searched for.

The concepts needed to reveal the stylistics of cartographic language are used in different systems of semiotic signs, such as verbal, musical, artistic, architectural. Some examples of terms are: "figurativeness", "concreteness", "expressiveness", "liveness", accents, harmony, symmetry, abstractions, metaphors, the idea of ??user point of view and perspective in relation to representing the image isometrically and many others (Kress and Leeuwen, 2020). The same terms and ideas are used in different contexts to describe expression in arts, linguistics, fashion, and to communicate daily life experiences can be understand as it were is the only one – human – speech and many its expressions, where verbal language is one of the expressions.

The study of cartographic functional style is based on the theory of functional styles that belongs to linguistics. The creation of this theory is considered by linguistic specialists to be one of the greatest achievements of modern stylistics (Zuperka, 2012). According to the theory of functional styles created and developed by the structuralists of the Prague Linguistic School, language is studied not only as a structural system, but also as a functional system. This allows us to determine the function of the means used in the language as a system (Karaliunas, 1997).

The analysis of information sources shows that in the field of map stylistics, scientific research has been conducted in the direction of the concept of map style concept clarification, map style formalization, the framework for the style system setting (Beconyte and Viliuviene, 2012; Christophe et al., 2016). These activities are strongly related with artistic, also aesthetical, part of map style, orientation to rendering techniques in order to create the effect of the chosen style, but the approach of functional stylistics and the achievements of the theory of the functional stylistics was not taken into account. The following examples of artistic styles of maps are distinguished: playful, extravagant, lyrical, etc. (Beconyte and Viliuviene, 2012), watercolor (Christophe and Hoarau, 2013). The styles of topographic maps of European countries with old cartographic traditions are distinguished in the studies conducted by A. Kent (Kent, 2008, 2009). The classification of map design styles has been published in 2002 (Dumbliauskiene, 2002). The map design styles, playing important role in cartographic communication process, are related with map purpose (function) in the classification. Some aspects of mentioned methodology, f. e. the criteria that describe design style are organised as oppositions like alignment/contrast, accent/background, are used in the framework of the system of cartographic functional styles. These studies detail and significantly contribute to the subject of cartographic functional stylistics, but for a greater understanding of functional stylistics, more general

studies of it in cartography are needed a long time ago. A generalized classification of functional styles was published by Slovak cartographer Jan Pravda in the 1990s. Jan Pravda identified the following functional styles of the map: inventoric, scientific, popular, and artistic (Pravda, 1990). This classification describes in general terms the cartographic functional styles and is therefore suitable for use as supporting information for further research in the field of map stylistics. Functional styles are closely related to analysis of functions the cartographic transcriptions perform. Canadian cartosemiotician Hansgeorg Schlichtmann identified the following intentions of cartographic language: signification, clarification, and emphasis (Schlichtmann, 2003). These findings are valuable in understanding the principles of cartographic language functioning in various areas of human activity where a map is needed. Although linguistic cartographic paradigm is in the background of other cartographic paradigms for some time (Azócar Fernández and Buchroithner, 2014; Kitchin et al., 2009), we can face it in some new publications (Chabaniuk and Dyshlyk, 2024).

When we talk about functional cartographic styles, we are talking about comparing the existing image with an image of stylistically neutral stylistics. Stylistic neutrality is such representation of an object on the map, when the least number of graphic expressions is used, i.e. only as much as is necessary for the minimum recognition of the object.

The research carried out has an element of novelty. While users have naturally accumulated useful information about cartographic functional styles, before the research it was not clear how to ask them in a simple way about such a complex subject as "cartographic functional style" and how to demonstrate the styles as a whole. The research helped to solve this problem and creates conditions for further scientific progress.

The survey results provide a general overview of users' preferences, and draw mapmakers' attention to details that may have seemed irrelevant at first. This allows further mapping to be carried out in a much more confident and targeted way. Ultimately, it is the users themselves who benefit. In addition, research benefits science. Since we get to know the style system that works in practice directly from user evaluations, by refining the theoretical style system according to the actual situation, we reduce the gap between the theoretical and actual sides of the cartographic functional style system. At the same time, we reduce the spontaneous development of the system, we get closer to the understanding of style norms, because functional styles, as language varieties, oblige us to consider the limits of the cartographic style and comply with cartographic language norms.

2. Materials and methods

2.1. Stylistic analysis of modern maps

As in natural language research, the rules of cartographic language are revealed by analysing the fact system of the language, which manifests itself through examples of activity, i.e. completed communication, existing maps. For this reason, an analysis of modern maps is carried out to determine the cartographic system of functional styles and name the components. The research combines descriptive, stylistic analysis and interpretive methods.

According to the representatives of grounded theory (Svedaite-Sakalauske et al., 2019), actual material is an asset that has accumulated potential cognitive possibilities. The value of its informativeness depends on the competence of the researcher, for example, the selection of material according to the criteria that determine the limits of the study of the problem or topic. From a methodological point of view, it is important to find such criteria that would be logical and work effectively in practice, would be useful during scientific analysis. Thus, it can be said that insights and conclusions are obtained from these practical examples.

During the research, a stylistic approach to the problem analysis is followed. Style is studied in terms of the functioning of cartographic language. This means that functional stylistics does not try to cover and explain all the aspects of functioning of cartographic language, but is limited to stylistic or social aspect of the functioning of cartographic language in cultural society. As already mentioned, the study adheres to the concept of functional style as varieties of cartographic language, the stylistic features and means of which are determined by language functions, the field of language use, and the subject matter.

Maps from various areas of cartographic language use were selected for the study. Classic paper maps and interactive electronic web maps are explored. Functional stylistics is related to cartographic language functioning in modern society, so the modern maps and still functioning examples, which may include older cartographic production, are studied.

Stylistic research in the aspect of language functioning is a relatively simple thing, because only that is fixed and visible is analysed, but not the depth, the meaning, uniqueness of the thought conveyed on the map, unless the very fact of the presence of such features, f. e. visual metaphors. In this paper, artistic style is defined as a separate functional style of cartographic language. Individual styles are not investigated in the research. Stylistic analysis and the methodological instruments provided by it are used to describe characteristic styles resulting from the functioning of cartographic language in society; an interpretive approach is used to provide insights into the issues at hand. Stylistic means compete with each other for relevance in the map. The choice of stylistic means must be motivated and justified, so the possibility of comparing means of expression is the essence of style. If there was nothing to compare it to, there would be no style itself. Evaluating (and determining) style requires identifying the norm so that deviations from the norm can be judged. The difference between stylistically neutral and stylistically marked counterparts is the difference between language with additional features (a social aspect) and stylistically neutral language. Certain criteria are used to determine the cartographic functional style, which allows comparison of the available map with a map of neutral stylistic expression.

2.2. Practical part of the research

The examples of cartographic functional style were created in the experimental part of the research. The examples of functional styles have been prepared on the chosen topic (wind energy in Lithuania). Ministry of the Environment of the Republic of Lithuania, the National Land Service under the Ministry of the Environment of the Republic of Lithuania, the National Energy Regulatory Council, the Lithuanian Wind Energy Association, the Lithuanian electricity transmission system operator LITGRID, and the OpenStreetMap

Foundation are providers of data that were used for wind energy mapping in Lithuania. The data is as follows:

- attribute data (technical characteristics) of the powerlines from the interactive map "Connection of Electricity Generating Renewable Power Plants to the 330-110 kV Transmission Network" which is publicly available in the website of the Lithuanian electricity transmission system operator LITGRID (Lithuanian electricity transmission system operator LITGRID, 2023);
- spatial data of the wind energy power plants for the Republic of Lithuania available for download from the website of the OpenStreetMap Foundation (OpenStreetMap Foundation, 2023);
- list of the permits to develop electricity production capacity available from the website of the National Energy Regulatory Council (National Energy Regulatory Council, 2023);
- spatial data of the land cover available in the ERM_250LT – Georeference Spatial Data Set of the Territory of the Republic of Lithuania at scale 1:250 000 according to the requirements of the international project EuroRegionalMap available from the website of Lithuanian Spatial Information Portal (Lithuanian Spatial Information Portal, 2023);
- spatial data of the State border and boundaries of the administrative units – EBM_100LT Georeference Spatial Data Set of the Territory of the Republic of Lithuania at scale 1:100 000 according to the requirements of the international project EuroBoundaryMap available from the website of Lithuanian Spatial Information Portal (Lithuanian Spatial Information Portal, 2023);
- spatial data of the geographical names available from the state Cadastre of the Georeference data base of the Republic of Lithuania available from the website of Lithuanian Spatial Information Portal (Lithuanian Spatial Information Portal, 2023);
- spatial data of 110, 330, 400 kV electric power lines and electrical substations available from the GDR50LT – Georeference Spatial Data Set for the Territory of the Republic of Lithuania at the scale of 1:50 000 available from the website of Lithuanian Spatial Information Portal (Lithuanian Spatial Information Portal, 2023);
- static map of the wind farms in Lithuania available in the website of the Lithuanian Wind Energy Association (Lithuanian Wind Energy Association, 2023).

The main geographical objects of the territory of Lithuania presented on the maps: wind energy plants, wind farms, electric lines and electric substations, road network, hydrographic objects, protected areas, forests, built-up area. Wind energy maps in Lithuania illustrating different functional styles of maps were created using the open-source geographic information system software Quantum Geographic Information System (QGIS).

The wind energy maps as examples of different cartographic functional styles, allow the author to demonstrate in graphic way the differences and similarities between different cartographic functional styles. The style examples are part of the framework of the system of cartographic functional styles. The style examples are not a fixed cartographic production. Map functional styles are fine-tuned as needed, such as when valuable insights are gained from user surveys or more style details are identified.

2.3. Target group survey

The survey was conducted by electronic means. An electronic mail with a description of the study and a link to the Internet questionnaire was sent to the users. Addressees – persons who use maps in their activities. The survey is anonymous. Questions are sorted by difficulty. It starts with an overview, which is also an introduction to the topic under consideration. At the end of the survey, questions about the respondents are included: field of activity, the experience in using maps. The questions are accompanied by maps illustrating cartographic functional styles.

3. Results

3.1. Defining the framework of a system

In order to identify the essential components of the system of cartographic functional styles, it is necessary to identify the factors determining the style. Analogous to linguistic functional stylistics, in cartography the system of functional styles consists of three main components: the function performed by the language, the field of use of language and the subject matter. All of these factors to some degree include the aspect of the auditory the map is addressed. The structure of cartographical functional styles is presented in Table 1.

Table 1. The structure of cartographic functional style

Cartographic functional style: determining factors			
The function performed by cartographic language			
Signification	Clarification	Emphasis	
Field of use of cartographic language			
Public society	Social community	Professional society	
Subject matter			
Planning	Inventory	Assessment	Regulation
Research	Teaching	Orientation	Navigation
Advertising	Cooperation	Forecasting	etc.

Signification function of the cartographic language indicated in the table above is associated with the selection, grouping, transformation and other data processing and presentation techniques on the map. This representation is the closest to the objective presentation of information, when no group of geographical objects, phenomena or processes is highlighted or emphasized, and marking is carried out using as many means of graphic resolution as are necessary for the recognition and matching of objects in the cartographic image. In order to perform the function *of clarification* and *emphasis* by means of cartographic language, more or more diverse means of graphic expression and composition principles are used to create a multi-level cartographic image in order to clarify the problem, create accents on the map, convey information in an evocative

and effective way. On the map, usually one of these functions prevails, the others are complementary to the dominant one. A set of stylistic means leads to a certain *stylistic feature*, and a complex of stylistic features provides the background for the functioning of cartographic language (Table 2).

Table 2. The components providing the basis for the cartographic language to function

The function performed by cartographic language: creating factors		
Stylistic features of cartographic language		
Conciseness/Completeness	Accuracy/Generalization	
Clarity/Ambiguity	Temperance/Figurativeness	
Abstractness/Concreteness	Calmness/Expressiveness	Neutrality/Suggestiveness
Stylistic means of cartographic language		
Framing	Accent	Hyperbole
Naming	Metaphor	etc.

There may be more stylistic features of the language, but Table 2 lists those that are characteristic of cartographic functional styles and have a different level of manifestation. The stylistic features of the language, which ensure the regularity and logic of the information conveyed through visual expression on the map, are the basis of good style and are important for any map. The description of stylistic features in the cartographic context is presented in Table 3.

Table 3. The description of stylistic features in the cartographic context

Area image (built-up area)	Stylistic features (binary opposition between the stylistic neutrality of the language and its stylistic aspect)				
	Stylistic neutrality		Stylistic aspect		Description
		Conciseness		Completeness	Object selection and grouping logic
		Accuracy		Generalization	Detail of graphic representation of objects
		Clarity		Ambiguity	Clarity of graphic representation of objects
		Temperance		Figurativeness	Decoration of objects
		Abstractness		Concreteness	Similarity of objects, creation of sensibility
		Calmness		Expressiveness	Vividness of the description of the scene
		Neutrality		Suggestiveness	Building impact and influence

Emphasis, contrast, antithesis, dissonance, hyperbole, framing, naming, repetition, metaphor, rhythm and others are the *stylistic means* are also used in other fields of activity (science of logic, linguistics, art, composition) and help to generate the impression of depth or object size, to convey the materiality of the surface, to highlight accents and convey other realities of the geographical space, to present historical events or forecasts, to show hypothetical surfaces (precipitation amount, accessibility of zones) (Viliuviene, 2022). Different expressions are used in different fields of activity to demonstrate the same object or idea, e.g. the same mountain, but different expressions can be used in geodesy, cartography, photography, philology, art, philosophy, or daily activity. Each activity has its own set of expressions. Finally, the *stylistic integrity* ensures the linking of stylistic means and the creation of a unified composition on the map, revealing the geographical space to the human.

3.2. Creating style examples

In order to expand the capabilities of the framework of the system of cartographic functional styles, style examples were prepared. For this purpose, maps of four different main functional styles were created (Fig. 1).

In Figure 1, the main infrastructure related to wind energy in Lithuania is marked on the map "Wind energy in Lithuania", accents are not used. The name of the map is formulated accordingly. Meanwhile, the map "Remaining capacity for connection of new wind power plants in Lithuania" uses highlights, that is, those power lines and substations where there is no more remaining power for the connection of newly planned wind power plants are highlighted. On map "Wind energy in Lithuania: development projects" the means suitable for visualizing the state's desire to demonstrate positive trends in the development of wind energy to municipal residents and sector developers have been selected, on map "Wind farms in our landscape" focuses on visual references to the region's stable energy structure, green energy, energy security and independent development. In other words, the prepared wind energy maps seek validity and motivation in the selection and use of stylistic means.

The possibility of comparing samples with each other adds value to the framework of the system of cartographic functional styles. Although in general cases it is enough to compare each of them with the assumed image of neutral stylistics to reveal the characteristics of cartographic functional styles. However, in this case, to obtain a greater effect, a multi-level evaluation is possible, where the available images are first compared with an assumed neutral stylistic image, and then with each other. To schematically demonstrate the anatomy of cartographic language expression in different contexts of cartographic language functioning, the breakdown of expression into structural layers (area elements, patterns, linear elements, signs, inscriptions) helps (Fig. 2).

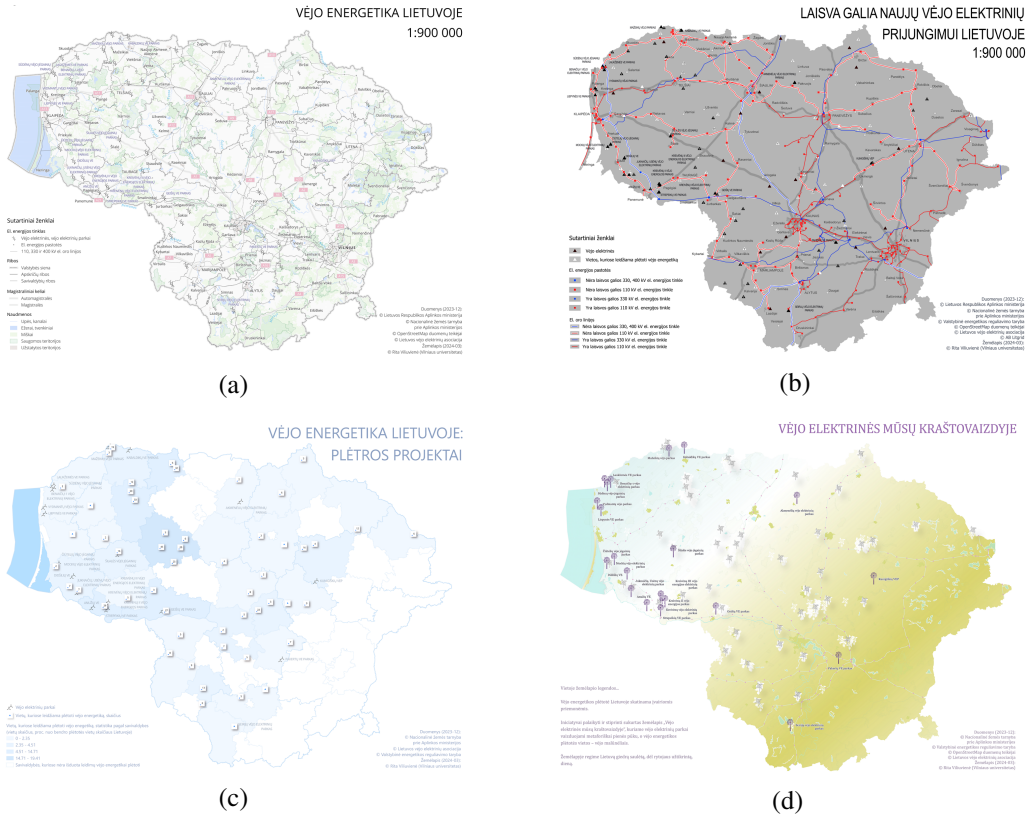

Fig. 1. Maps illustrating different cartographic functional styles: "Wind energy in Lithuania" (left top map), "Remaining capacity for connection of new wind power plants in Lithuania" (right top map), "Wind energy in Lithuania: development projects" (left bottom map), "Wind farms in our landscape" (right bottom map)

The map "Wind energy in Lithuania" represents a total of 1808 geographical objects, "Remaining capacity for connection of new wind power plants in Lithuania" – 1771, "Wind energy in Lithuania: development projects" – 418, "Wind farms in our landscape" – 921 objects (Fig. 3).

The number of graphical features, annotations and technical characteristics provided varies between the maps: the map "Remaining capacity for connection of new wind power plants in Lithuania" has the highest number of annotations, while the map "Wind farms in our landscape" has none. The number of area objects on maps "Wind energy in Lithuania" and "Wind farms in our landscape" is the same; the map "Remaining capacity for connection of new wind power plants in Lithuania" has the highest number of point-type signs; although the map "Wind energy in Lithuania: development projects" has relatively fewer graphical features, the colours of the statistical territorial units play a key role in this map. The above examples of styles are not a definitive communication and require refinement of the characteristic features of cartographic functional styles, but for this it is necessary to know the preferences of the users' cartographic styles.

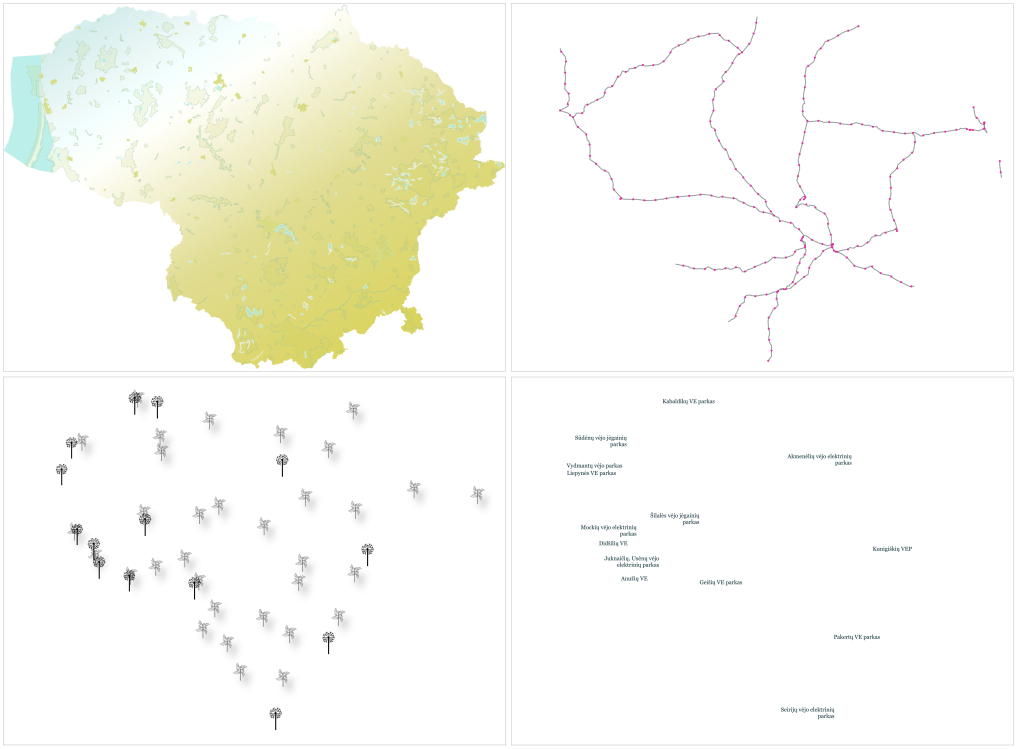

Fig. 2. Comparison of cartographic language expressions (map "Wind farms in our landscape" as an example)

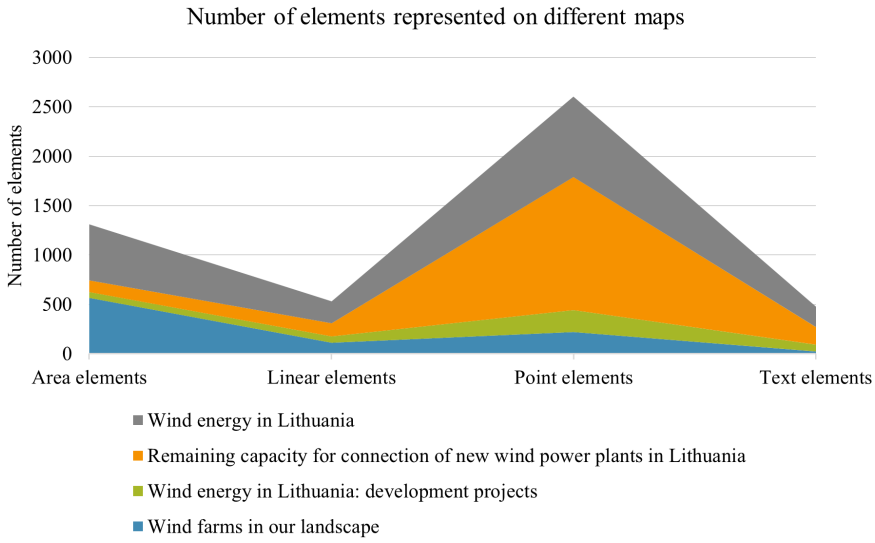

Fig. 3. Number of geographic objects in maps of different cartographic functional style

3.3. Analysis of survey results

For research purposes, the survey was organized in the period from 13.06.2024 to 22.07.2024 and lasted a little longer than one month. Information about participation in the survey was sent to organizations operating in Lithuania or specific specialists whose activities are related to maps, such as mapping, their practical application, research, publication, etc. Contact details (electronic mail addresses) are collected from publicly available information on the Internet. In total, the letters were sent to 1,450 different recipients, from educators and librarians, communication specialists and policy makers to cartographers and GIS specialists, nature and environment experts and renewable energy specialists. The invitation to participate in the survey, the link to the online questionnaire was distributed by electronic mail. The questionnaire was published online using a publicly available survey form. Answers to questions are collected and stored automatically using a survey form.

The online questionnaire consists of the following structural parts: the survey title "Functional map styles", a short description of the survey (paragraph 1), the illustration "Cartographic functional styles as an example of wind energy maps" and the questionnaire.

The survey consists of 10 questions: 8 questions about cartographic functional styles and 2 questions about research participants. The survey starts with 3 general introductory questions about cartographic functional style, followed by 4 questions about cartographic functional styles based on the given examples of cartographic functional style in the topic of wind energy. Multiple-choice questions are presented with alternatives for correct answers, leaving the possibility to provide answer as free text by pressing "Next". Answers to these questions are provided based on 4 examples of different cartographic functional styles prepared by the surveyor and attached to the survey. 104 respondents participated in the survey and filled out the questionnaire. The survey is anonymous. Respondents are from various fields with experience working with maps. Such experiences range from mapping to usage, from novice to expert.

According to the answers of the survey participants to the question "What is your field of activity?", the survey participants represent various fields related to the use of maps. Responses were grouped into the following aggregated fields of activity: culture (15%), politics (5%), science (14%), education (18%), business (14%), engineering (18%), technology (16%).

According to the experience of using maps, the majority of the research participants (87%) attribute themselves to the users with experience of using maps. The rest (13%) attribute themselves as a group of participants who do not have additional knowledge compared to the average user. The participation of all groups in the survey gives a complete picture. Statistical information about the respondents can be seen in the diagram (Fig. 4).

Looking at the answers to the questions presented, to the question "Do you agree with the statement that maps in general are characterized by a diversity of cartographic functional styles?", the vast majority of research participants agree with the above statement (85 percent of respondents) (Fig. 5).

This question is general in nature and serves as an introduction to the survey. At the same time, the question is important. This allows us to see the main assessment of the respondents – approval or rejection of the statement – regarding the formation of

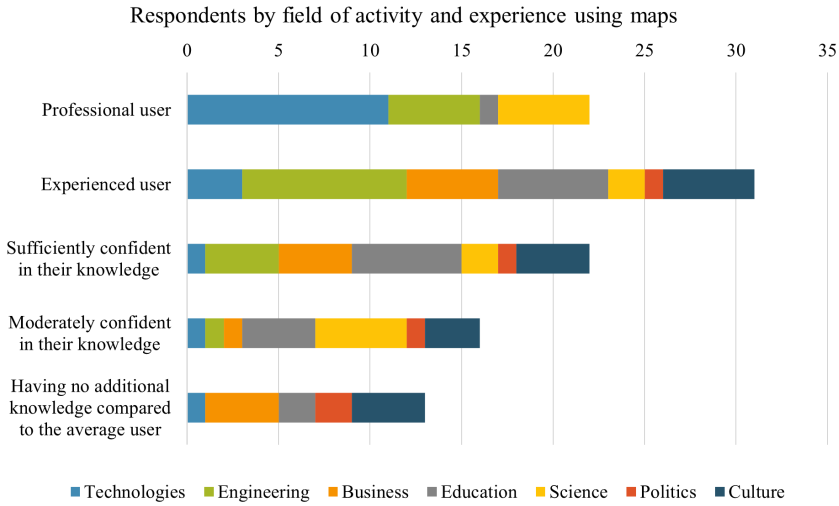

Fig. 4. Respondents by field of activity and experience using maps

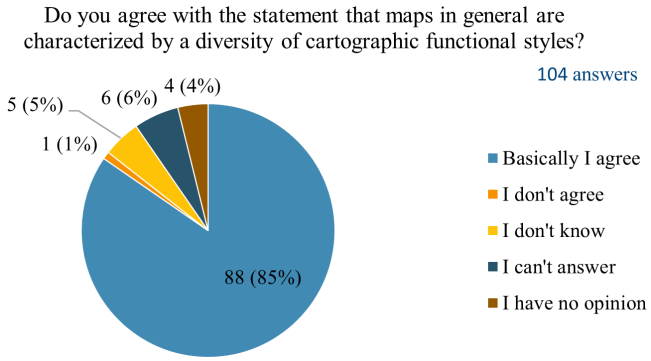

Fig. 5. Summarising the statistics and presenting the answers to the question "Do you agree with the statement that maps in general are characterized by a diversity of cartographic functional styles?" in a graph

functional styles in cartography. Since it was not clear before the research what kind of answer to expect, it was important to find out whether the respondents agreed with the idea of ??the existence of cartographic functional styles. In a survey, to the question "What stylistic features of cartographic language are the basis of rational style on a map?" clarity, accuracy and concreteness are the main choices of the respondents (Fig. 6).

As can be seen from the additional information provided by the research participants, it is important to clarify the terms: what is good style or what are the differences in meaning, for example between clarity and accuracy. As can be seen from the diagram, in all groups of survey participants, liveliness, originality and suggestiveness do not determine a good cartographic style. In response to the question "What determines the functional style of cartographic language on a map", 66 percent of the survey participants chose "subject matter", 60 percent – the target audience, and 50 percent – the function performed by the language (Fig. 7).

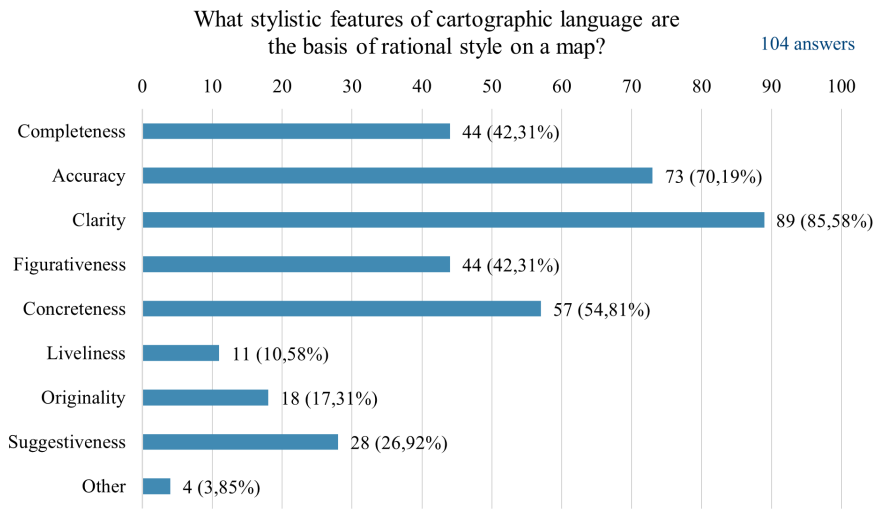

Fig. 6. Summarising the statistics and presenting the answers to the question "What stylistic features of cartographic language are the basis of rational style on a map?" in a graph

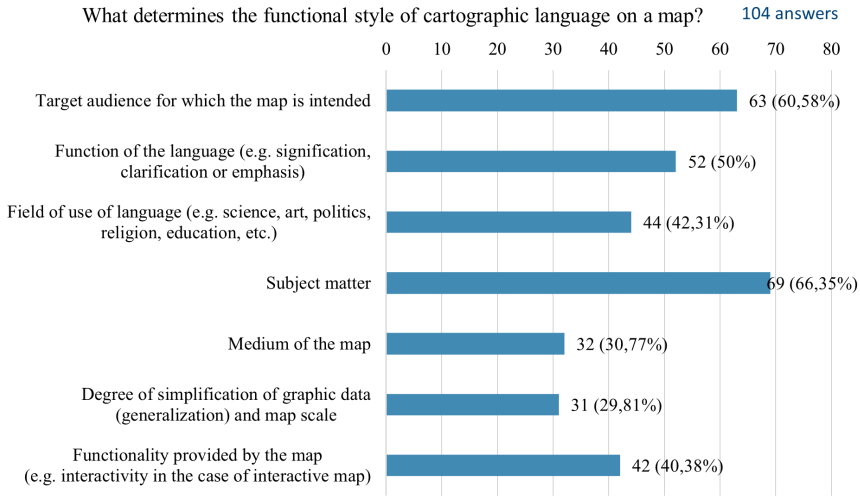

Fig. 7. Summarising the statistics and presenting the answers to the question "What determines the functional style of the cartographic language on the map?" in a graph

It is necessary to pause and comment on the priority given by the research team to the point "Target audience for which the map is intended". The choice "Target audience to which the map is addressed" is among high priorities of survey participants. One of the explanations for such a choice could be that the cartographic language, being one of the forms of public communication, like the public language, which responds to the needs of today's users to quickly obtain the most important and relevant information, is prepared when there is a specific need or a specific situation. In this case, the role of the target audience in the functioning of cartographic language increases significantly. Otherwise,

the concept of the target audience, as narrower, is covered by the concept of a wider field of use of cartographic language.

The users' answers to the question "What is the predominant function of cartographic language in the maps presented" can be summarized as follows: on the map "Wind energy in Lithuania", the function performed by cartographic language is signification, on the map "Remaining capacity for connection of new wind power plants in Lithuania" – clarification as the predominant function and emphasis as the main function as an additional function, on the map "Wind energy in Lithuania: development projects" – emphasis as the main function and clarification as an additional function, on the map "Wind farms in our landscape" – emphasis is the main function performed by cartographic language function (Fig. 8).

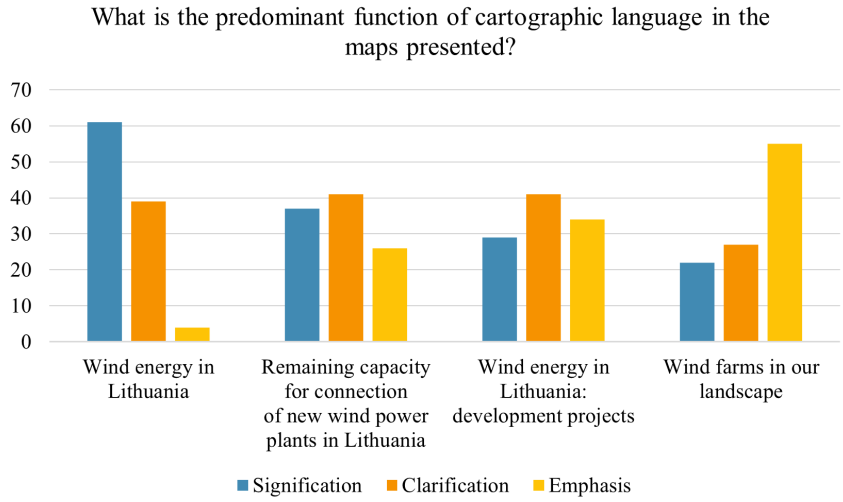

Fig. 8. Summarising the statistics and presenting the answers to the question "What is the predominant function of the cartographic language in the maps presented?" in a graph

The answers to the question "What stylistic features of the cartographic language are described by the presented maps?" we can clearly identify "completeness, accuracy, concreteness" for the map "Wind energy in Lithuania", and "originality, liveliness, figurativeness" for the map "Wind farms in our landscape" (Fig. 9).

The map "Remaining capacity for connection of new wind power plants in Lithuania" is schematic, and the accuracy of the cartographic language is not characteristic of the map. Meanwhile, the accuracy of the map "Wind energy in Lithuania: development projects" could only be due to the numerical expressions contained in it, which may give the impression of accuracy. From this it could be concluded that the term "accuracy" can require additional clarification. The answers to the question "Name the most appropriate cartographic functional style (term) for the presented maps" are as follow (Fig. 10).

Most of the survey participants associated the map "Wind energy in Lithuania" with the term "Inventory", the map "Remaining capacity for connection of new wind power plants in Lithuania" with "Scientific", the map "Wind energy in Lithuania: development

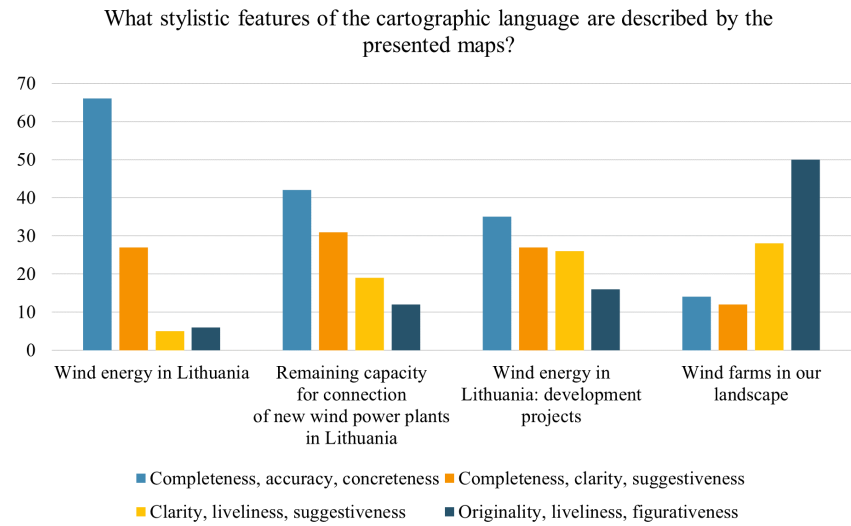

Fig. 9. Summarising the statistics and presenting the answers to the question "What stylistic features of cartographic language are described by the presented maps?" in a graph

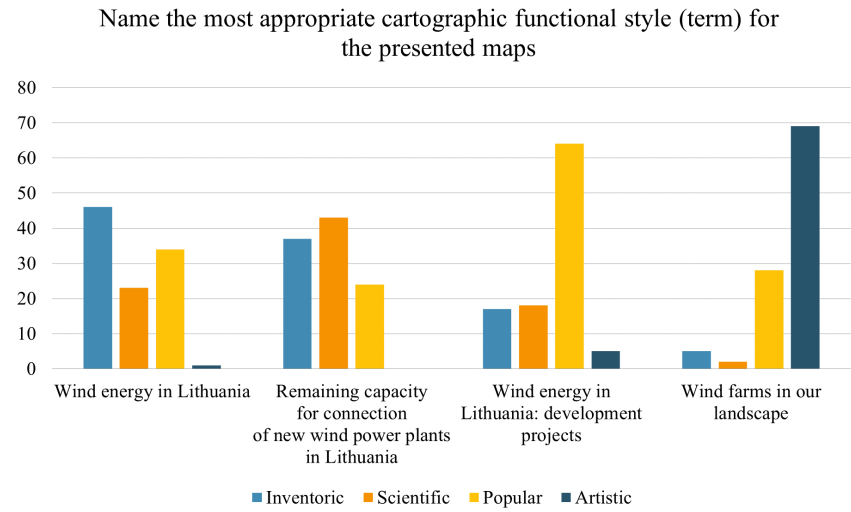

Fig. 10. Summarising the statistics and presenting the answers to the question "Name the most appropriate cartographic functional style (term) for the presented maps" in a graph

projects" with "Popular", and the map "Wind farms in our landscape" with the "Artistic". The answers to the question "Rate the appropriateness of stylistic means on the given maps, where in the rating scale "1" means "not suitable", "5" means "suitable"", the answers are as follows (Fig. 11).

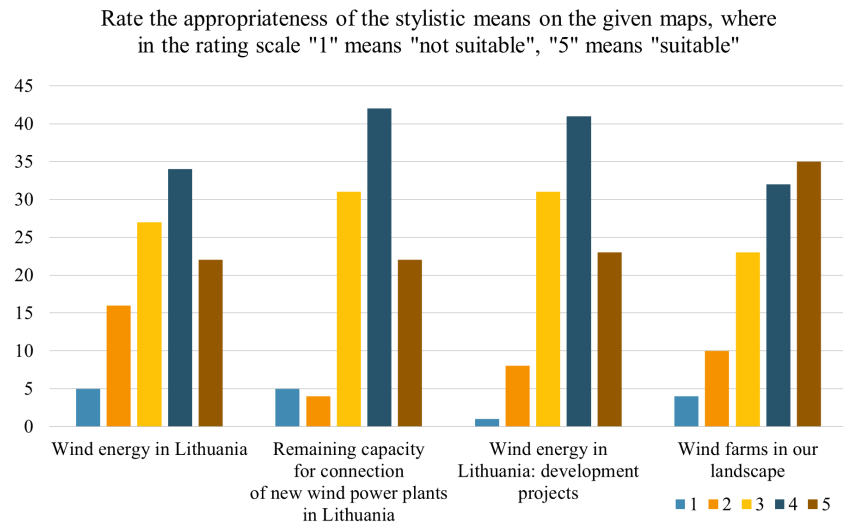

Fig. 11. Summarising the statistics and presenting the answers to the question "Rate the appropriateness of stylistic means on the given maps, where in the rating scale "1" means "not suitable", "5" means "suitable" in a graph

Answers to the question "What stylistic means determine the artistry in the presented map "Wind farms in our landscape" (Fig. 12).

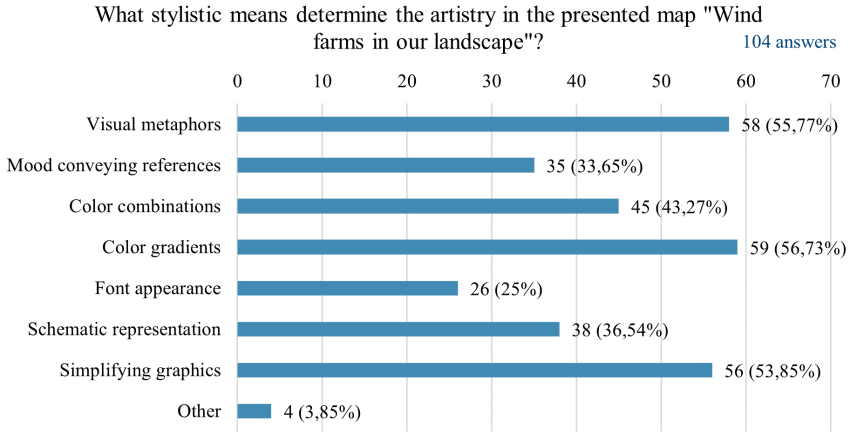

Fig. 12. Summarising the statistics and presenting the answers to the question "What stylistic means determine the artistry in the presented map "Wind farms in our landscape?" in a graph

Among the answers, the following stylistic tools are noticeable when creating an artistic cartographic style: color gradients, visual metaphors, simplifying graphics. The framework of system of cartographic functional styles can be refined after the survey and presented in the following structure (Table 4).

Table 4. Overview of cartographic functional styles of wind energy themed maps

Cartographic functional style	Scope of cartographic language	Subject content	Cartographic language functions	Stylistic features of cartographic language	Stylistic tools of cartographic language	Style Tools feature
Wind energy in Lithuania						
Inventoric	Administrative activities of society	Property inventory	Signification	Completeness Accuracy Specificity	Framing Naming Hyperbole	Informational
Remaining capacity for connection of new wind power plants in Lithuania						
Scientific	Community activities of the society	Scientific research	Signification/ Clarification	Completeness Clarity Suggestiveness	Grouping Argumentation Framing Accents Abstractions Naming	Informational/ Appellative
Wind energy in Lithuania: development projects						
Popular	Professional and community activities of the society	Assessment of the situation	Clarification/ Emphasis	Clarity Liveliness Suggestiveness	Accents Graduation	Appellative/ Informational/ Aesthetic effect
Wind farms in our landscape						
Artistic	Social activities	Dissemination of ideas	Emphasis	Originality Liveliness Imagery	Metaphors Rhythm Stylization Asymmetry Accents	Aesthetic effect/ Emotional impact/ Appeliative

Wind energy maps are an effort to adapt the most characteristic features of cartographic functional styles. The more we learn about the characteristics of styles, the better we begin to know the norms of each style.

4. Discussion and conclusions

By carrying out user evaluation, we get closer to the style system in practice, to observe the actual style norms. This allows us to refine the theoretical framework of the style system. In this way, the gap between the theoretical and practical sides of the style system is reduced. For the sake of optimality, the survey is limited to the most important questions on cartographic functional styles, using key concepts in the formulation of the questions, and providing examples of styles to compare different styles with each other, to see them at a glance, and to get an overall picture. Nevertheless, the survey indicates that respondents' interest in research is relatively low. This may be due to the complexity of the subject of the study, the presentation of overview images rather than detailed ones, or other reasons to be

taken into account for further investigations. Nevertheless, the results of the survey provided useful information on how users evaluate cartographic functional styles, which is important to take into account when applying a functional style to maps and improving the framework of cartographic functional style system. The following conclusions can be drawn:

1. The function performed by the cartographic language, the field of use of the cartographic language and the object of content are the main features of the cartographic functional style system. The functions of the cartographic language are expressed through stylistic features, which are realized through stylistic means.
2. In order to extend the capabilities of the cartographic functional style system framework, examples of styles have been developed. Maps of four different main functional styles (inventory, scientific, popular and artistic) were developed. To illustrate the cartographic functional styles on the map, an important topic requiring public attention and contributing to the sustainable development goals was chosen, i.e., wind energy.
3. The results of the survey demonstrate that even 85 percent of the research participants basically agree with the statement that maps are generally characterized by a diversity of cartographic functional styles. Such research results are the basis for asserting the presence of cartographic functional styles in cartography and for further research into functional stylistics.
4. Judging by the users' responses, the style examples clearly identify stylistic features such as completeness, accuracy and concreteness, or originality, liveliness and figurativeness, the former being associated with the inventory cartographic style and the latter with the artistic style.
5. The audience (or addressee) of a map is important for the functioning of a cartographic language, as evaluated by users. This suggests that the addressee should be distinguished as a separate factor in the cartographic functional style system.

Author contributions

Conceptualization: R.V., L.B.; collection and assembly of data: R.V.; data analysis and interpretation: R.V.; article writing: R.V.; critical revision R.V., L.B. and final approval of the article: R.V.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Acknowledgements

The research was carried out in state-funded doctoral studies at the Department of Cartography and Geoinformatics, Vilnius University. The authors are grateful to the staff of the Department for their support and productive discussions during the research.

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