Northern labyrinths: potential for interdisciplinary research and a resource for international tourism

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Abstract. The article presents the scientific rationale for the project of creating a geographic database on northern labyrinths - ancient stone structures and petroglyphs located on the coasts and islands of Northern Europe. The aim of the project is to conduct interdisciplinary research of labyrinths-gnomons (tools for orientation in space and time according to the Sun) as a source of information about ancient marine communications, development of navigation technologies, as well as coastal changes in the Arctic region and climatic rhythms of our planet. The research algorithm includes standard methods of complex geographical descriptions; solution of the equation based on the main trigonometric function; analysis of stable relationships in the system "object - landscape - geographic space - Earth - Universe". The relationship of the structure of labyrinths performing instrumental functions with the geographical latitude, as well as with the long-period rhythms of the planet, which are most clearly manifested in the Arctic region, is considered. The influence of navigation technologies on the physical development of geographic space and its modeling at the local (toponyms), regional (territorial systems and communications) and global levels (modern scientific picture of the world and ancient information models preserved in mythopoetic form) is shown. It is concluded that the creation of a regional geographic database on labyrinths will contribute to the preservation of cultural heritage sites, replenishment of the resources of international tourism in the Arctic region, the development of scientific communications uniting scientists from the northern countries.

1 Introduction

The northern labyrinths are mysterious prehistoric and medieval structures in the form of spirals. They are of great interest to scientists, independent researchers and tourists. Typically, the labyrinths are lined with wild stone or turf, and are located near water or on terraces. The largest number of labyrinths are concentrated on the islands and coasts of northern Europe. Especially many objects have survived on the shores of the Baltic Sea. Their highest density was noted on the Bolshoi Zayatsky Island in the White Sea - more than 30 objects on the area of 1.25 km2. Similar objects are situated in the Mediterranean and the Caucasus, they are found on all continents except Antarctica.

In culture, labyrinths and their images personify happiness - a harmonious human state associated with the fullness of human life, as well as with the understanding of the consistency of all parts of the world around humankind. In the urban environment, the sign is rethought with an exaggerated emphasis on certain semantic elements (for example, in Christian churches, an emphasis is placed on the "wandering of the soul" and the complexity of choosing the path of life). Artificial polarization of meanings made the interpretation of the sign contradictory. However, the geometry of the labyrinth retains the memory of its original instrumental function, using the orientation in geographic visual space and time.

The authors of the article offer a study of the labyrinths based on the methodology of the Russian school of cultural geography. The object of study of *cultural geography* is the geocultural space as the integrity of nature and culture. Culture is understood as a collective experience of adaptation (super-biological adaptation). The natural environment of the sites is studied using field and cameral methods of geography, landscape science, geomorphology, mathematical and evolutionary geography. The socio-cultural context of cultural heritage objects is considered taking into

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account the data from archeology, anthropology, ethnography, cultural studies and historical geography.

In 2008 – 2010, with the help of the technology of sundialcalendars, the rational purpose of the northern labyrinths, located in the White Sea - on Bolshoy Zayatsky Island of the Solovetsky Archipelago, was determined. In 2010-2021, a navigational concept of information modeling of the world was developed, which explains the cosmism of the main national holidays, the integrity of traditional culture and consciousness [1, 2]. The concept was confirmed and developed in studies of rock carvings of the labyrinths located in the Caucasus. The navigational concept is consistent with the characteristics of earlier objects - the location of natural/man-made zoo- and anthropomorphic sculptures on ancient routes and the orientation of megalithic complexes [3, 4, 5].

The navigational functions of heritage sites open up new possibilities for exploring the past, because astronomical instruments reflect not only the age of the relief and catastrophic events, but also the angle of inclination of the Earth's axis, and associated with it mode of illumination, the speed of axial rotation, the magnitude of the gravity force, the rate of denudation and sedimentation. To extract this information contained in the structure of labyrinths and their position in the landscape, it is necessary to create a geographic database (hereinafter referred to as the DB).

To create a geographic database, a number of organizational problems must be solved. First of all, there is the problem of spatial accessibility associated with the location of objects in different states. In addition, the pandemic has created restrictions on direct contact. Under such conditions, the role of coordinated actions of research groups that work on the ground according to a single program increases.

When drawing up a research program and creating tourism projects, it is important to take into account the sensitivity of Arctic natural complexes to global change. It is due to the low biomass, low rate of biological circulation and permafrost. The current rise in global temperatures and an increase in anthropogenic load cause the most noticeable changes in all natural components and accelerated restructuring of native landscapes. These processes pose a potential threat to the objects of cultural heritage of the Arctic. The main factors in the preservation of labyrinths can be: 1) special status and role in the modern life of the indigenous population, 2) organization of interdisciplinary research on a natural-science basis, 3) inclusion of the objects in economic projects for the development of the recreation and tourism industry.

The aim of the article is to develop an algorithm for a complex study and involve sociologists, ethnographers, archaeologists, local historians, tour operators and interested representatives of other specialties from countries where ancient labyrinths and their images on the rocks (petroglyphs) have survived.

2 Methods of studying the labyrinths as ancient orienteering tools

The project of creating a geographic database on ancient northern labyrinths is based on cameral and field research methods. An important source of information is also scientific publications, which provide a versatile description of objects (unfortunately, the literature often does not contain reliable data on the geo-position of objects). For further paleogeographic reconstructions, only those objects for which the possibility of determining the noon, solstice and equinox days has been established can be selected.

The method of determining the instrumental functions of labyrinths is based on the correlation between the elements of their spatial structure and the parameters of the illumination mode (height and azimuth of the Sun). The main element of sundials and calendars is the gnomon (object giving the shadow). The height and location of the gnomon, at which the extreme positions of the shadow coincide with the diameters of the inner and outer arcs of the labyrinth, can be established using equation (1) based on the trigonometric identity ($H = \tan \alpha \cdot A$). Both sides of the equation give the same result - the height of the gnomon and describe the ratio of the angle of incidence of the sunlight (α) and the length of the shadow (A): the left one is for summer, the right one is for winter. To the distances measured from the center to the extreme arcs of the labyrinth (in this example - 1 m and 5.5 m), we must add a correction x in order to accurately determine its position in the center [6]:

$$\text{tg } 48{,}47\ (1 + x) = \text{tg } 4{,}97\ (5{,}5 + x) \qquad (1)$$

The greatest number of functions ("compass", clock, calendar) are performed by labyrinths symmetrical relative to the geographic meridian. In them, the diameter of the arcs in the northern direction marks the length of the noon shadow. In other objects, the boundaries of astronomical seasons and other dates are determined only by the azimuths of sunrise/sunset.

The universal algorithm for researching objects with instrumental functions includes the following stages: 1) application of standard methods of description (measurement, comparison); 2) characterizaion of the enclosing landscape (taking into account the evolution of the natural and climatic situation in the Holocene and geological and geomorphological features, including dominant systems in fracturing of rocks and in the extent of lineaments - linear tectonic structures that are expressed in the landscape); 3) astronomical and paleo-astronomical calculations of the calendar azimuths of sunrise/sunset and the Moon (taking into account the differences between the physical and astronomical horizons), height of the sundial-calendar gnomon and position of the midday shadow by seasons (for geographical coordinates of the object); 4) establishing correlations of the spatial characteristics of the object under study, the enclosing landscape and significant astronomical indicators recorded at a given point; 5)

comparison of instrumental capabilities of the object with local and regional tasks of life support in different historical epochs (including analysis of the object location in the system of transport communications). Comprehensive studies of the primary purpose and use of ancient sites also include analysis of the cultural context (adjacent archaeological sites, toponymy, linguistics, mythology, sacred landscape and folk traditions) [7].

3 Geographical reasons for the diversity of labyrinth gnomons

The special geographical location of the Arctic region predetermines the increased dynamism of natural conditions and the display of this diversity in astronomical instruments created on the basis of universal solar technology. priorities of orientation by the Sun in the Arctic are associated with the phenomena of polar days and nights, which occur during the summer period of dynamic economic activity. The most significant calendar dates in extreme climatic conditions are equinoxes, dividing the year into two contrasting parts - warm and cold. The severity of nature, variability of all landscape components and special (more convenient) conditions for astronomical observations well explain the high level of navigational knowledge noted for the peoples of Northern Europe by ancient authors [8]. Let us consider the most significant geographical factors that determine the diversity of stone labyrinths, their location in the landscape, distribution in the regions of Northern Eurasia and the main differences in the drawings.

3.1 Geographical latitude

The points of the ends of the labyrinth spirals form a regular square only at the latitude of Moscow - 55°50'N (Figure 1) because here (and at the same latitude - in the southern hemisphere) the azimuth of sunrise in the days of the solstices is 45° - assuming a straight line of the horizon. To the north of this latitude, the points are shifted to the meridian line, and to the south - to the parallel drawn through the point of installation of the gnomon (Table 1).

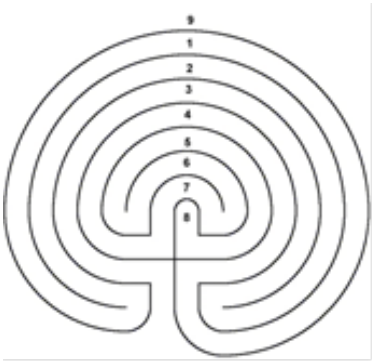

Fig. 1. The points of the ends of the spirals form a regular square only at latitude 55°50'

Table 1. Sunrise azimuths on the days of the solstices in the latitudes of the temperate zone

N (º)	22.12	22.06
66.5	180.00	0
65	160.00	20.03
60	142.86	37.40
55	135.00	45.00
50	128.41	51.82
40	121.29	58.74
30	117.39	62.74
23.5	115.60	64.40

Table 1 also shows that to the north of the parallel of 55°50'N the azimuths of sunrise on the days of solstice change more dynamically than at latitudes south of it. It can be assumed that such differences in the conditions of solar navigation were one of the reasons for drawing the Arctic border at this latitude (56°N - according to Eudoxus).

To the North of the Arctic Circle, the solstice days fall on polar days and, when the Sun does not cross the horizon line (hence, there are no rising/setting phenomena). Under these conditions, the classical bispiral form of the labyrinth is not relevant, and its appearance may indicate borrowing from other regions.

3.2 Changes to the lighting mode in the course of long-period rhythms

In the Arctic region changes in the light regime during the long-period rhythms of the planet (1850-year rhythm of moistening Shnitnikov-Maksimov, 26,000-year equinox precession cycle, 41,000-year Milankovitch cycle, etc.) are most pronounced. Consequently, objects of this region could accumulate the greatest amount of information. The oldest labyrinths are located in the White Sea and are dated approximately 7000 years ago. For this time (climatic optimum of the Holocene), a warmer climate, a decrease in sea ice coverage and a high productivity of the landscape are noted (the territory of the modern tundra was covered with high-quality forests). The main part of labyrinths in Europe belongs to the Middle Ages - this indicates the long-term preservation of the tradition associated with them.

Of great importance for the development of research on labyrinths and other navigation instruments is the doctrine of the rhythm of natural processes by E.V. Maksimov (Figure 2). The graphs show that the structure of the rhythm is the same regardless of the duration. We can see an immutable sequence of periods: warm-dry (WD), warm-moist (WM), cold-moist (CM), cold-dry (CD). In addition, the global climate model reflects several universal rules: 1) the pulsating nature of rhythms reflects the pulsating nature of the matter development; 2) rhythms have a universal manifestation on Earth and in Space; 3) rhythms manifest synchronously in all natural processes; 4) rhythm implies

a change in the intensity of natural processes over time; 5) rhythms have a reciprocating character of development: in the active phase "two steps forward – step back", in the decay phase of – "two steps back – one step forward"; 6) no rhythmic process is set by a "zero" background, but always against the background rhythm of a higher rank; 7) the internal structure of asymmetric rhythms reflects an abrupt change in the tempo of natural processes [9].

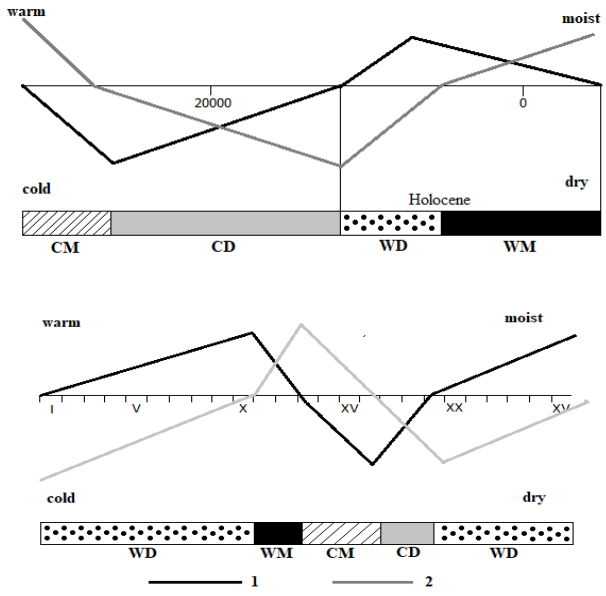

Fig.. 2. The structure of climatic rhythms: on the left- the 41,000-year-old rhythm of the Pleistocene of Milankovitch; on the right - the 1850-year-old rhythm of the Holocene of Shnitnikov-Maksimov [9].

Legend: 1 - temperature, 2 – humidity.

Instrumental objects reflect astronomical conditions at the time of their creation and could retain in their structure information about the features inherent to our planet in the distant past. According to M. Milankovich, the inclination of the Earth's axis changes from 22.1° to 24.5° over 41000 years, which leads to cyclical changes in heat supply and climate. At the same time, the Arctic Circle shifts in the range from 67°54' to 65°30'.

Taking into account the displacement of the Arctic Circle, three zones can be distinguished in the area of the labyrinths of Northern Europe, differing in the light mode: 1. Polar – to the north of the extreme possible position of the Arctic Circle; 2. circumpolar - near the present position of the Arctic Circle (± 1-1.2°); 3. Temperate zone labyrinths, located to the south. In accordance with this division, most labyrinths of the Baltic Sea are located in the temperate zone: the labyrinths of the White Sea are located in the circumpolar zone of the eastern part of the range, only a few objects have survived in the Arctic (according to historical evidence, on the Kola Peninsula, many labyrinths were dismantled in the 19th century).

3.3 Changes in the natural environment and the location of labyrinths in the landscape

The landscape that houses man-made objects has changed over the millennia. Even the most stable component of the landscape - the relief of the earth's surface - has undergone changes. The coastal relief is influenced by several geographic factors: 1) the rate and direction of tectonic movements of the land, 2) natural fluctuations in sea level, 3) the ratio of exogenous abrasion and accumulative processes (erosion/alluvial shores). As a result of the combined action of all these factors, the position of the coastline and the geo-position of the labyrinths changed. Thus, Stone Age labyrinths are often found on high coastal terraces (for example, on B. Zayatsky Island), while younger objects are located near water (Keretsky labyrinth in Krasnaya Luda); some of them are destroyed by waves (labyrinth on Saarema Island, Estonia). Comparison of the age of an objec with its position above sea level makes it possible to estimate the rate and direction of geographic processes.

The age of the relief established by different methods (bioindication, archaeological, geomorphological, limnological) varies greatly. For example, according to the estimates of geomorphologists, the drainage of the peninsula, where the Kandalaksha labyrinth is located, occurred about 1,000 years ago. However, the age of the accompanying archaeological finds reaches 1-2 thousand years BC. Another example: according to the dates of the lakes, the land of Bolshoy Solovetsky Island at an altitude of 13 m is no more than 4000 years old, but on the neighboring Bolshoy Zayatsky Island, the radiocarbon analysis of archaeological finds shows 5000 years. The objective reason for such discrepancies is the different rate of tectonic uplifts (key tectonics, differentiated uplifts), which does not allow extrapolating the obtained results to the neighboring land areas. The peculiarity of bioindication methods is the limited time span, which can be dated. For example, the lichen thallus lives no more than 1000 years, after this period, the process of colonizing the surface begins anew. Perhaps, it is the bioindication methods that rejuvenate the age of most labyrinths of Northern Europe. All this increases the value of new methods based on paleo-astronomical and arche-astronomical data.

4 Labyrinths as navigational elements of water communications

4.1 Toponyms and legends as a source of information about ancient navigation tools

In the work "Historical geography of chronicle Russia" V.I. Paranin (1990) showed that archaic toponyms mark the geographical position of objects (geo-position) in the territorial system. The main landmarks are the directions of the sides of the horizon, determined by the Sun. Toponyms denoting the sides of the horizon directly or indirectly reflect the properties of the Sun in a particular position (high, hot, red; low, cold, white) [10]. For example: the Krasnaya Luda Peninsula is the southern point in the once established spatial system.

Toponyms related to navigation technologies (astronomical instruments or events) can also be added to this group of names. For example, the name of Boshoy Zayatsky island, due to the dense arrangement of astronomical instruments, acquires a new semantic connotation, not associated with hunting for animals (zayats is Russian for hare) or collecting eggs (za-yayitsky literally for eggs. Yayitsa is Russian for eggs). The word "hare" ("janis") in the traditional culture of the peoples of NW Russia, Finland and the Baltic States is used to designate the days of the summer solstice. Comparison of the long-eared hare with the shape of the gnomon's shadow graph on the summer solstice can explain the choice of this image (as a comparison: Seth, brother of Isis and Osiris, the main gods in the cosmogonic mythology of Ancient Egypt, also appears in the image of a hare). The epithet "sunbeam" - a patch of reflected light - is also associated with navigation technologies. It is known that the reflected or directed beam has an independent meaning - as a pointer, which at a certain time illuminates the elements of ornament or objects that play the role of a dial. But the auxiliary role of a reflecting surface (e.g., water) is also great - to increase the total luminous flux, in order to localize the shadow more accurately. In fairness, it should be noted that June is the peak of hare reproduction, which could be an associative basis for fixing the connection between the astronomical cycle and phenological phenomena in nature.

Ancient legends about the "rejuvenating" apples of Freya and the Minotaur are directly connected with the labyrinths, in which the images appear: an apple (the labyrinth looks like an apple in section), a spear (gnomon) and a rope (a flexible tool that can replace a compass, a ruler, a right triangle). Mythopoetic plots with the participation of a bull acquire new content, if we take into account that the bull = an image of time.

4.2 Archaeological and historical evidence of ancient communication networks

The most ancient is the description of the Northern Sea Route, left by the ancient Greek traveler Pytheas, who reached "the last Fule (Thule) by ship". It is generally accepted that the word "thule" is the name of an island. However, it is difficult to imagine several islands with the same name. On the other hand, in the languages of the peoples living in the area of the northern labyrinths, "thule" means "light" (Karelian language) and "instrument" (English).

The first known settlements on the White Sea coast of Karelia date back to the Middle Mesolithic, which coincides with the climatic optimum of the Holocene. The plots of the White Sea petroglyphs show that this time is characterized by a high level of navigation development (images of boats with a capacity of up to 10 people, sea animals catching, etc.). At the end of the 15th - beginning of the 16th century the trade route from Pomorie to Sweden passed here. In 1837, Elias Lönnroth, a researcher of the Karelian epic wrote in his diary that "from mid-March to the end of May, carts pass through Keret to Kandalaksha and from there people go fishing and hunting in the Arctic Ocean".

4.3 Symbolism of signs, derived from technologies for measuring space and time

Galileo Galilei's ingenious idea that Nature speaks to us in the language of geometry, the letters of which are simple figures - circles, lines, triangles - "without them, wandering in a labyrinth is in vain." Comparison of the structure of labyrinths with the graphs of the light and shadow movement of the gnomon allows us to make sure that the primary symbolism of geometric signs and their artistic transformations correlates with the vital processes of nature. The points located to SW and SE from the center of the labyrinth (the ends of the spirals) constrain the graph of the shadow of the longest day, creating the contour of the pyramid. The points at NW and NE from the center of the labyrinth constrain the graph of the shortest winter day, reminiscent of belligerently raised horns. Drawing shadow graphs for a year gives the labrys, a two-sided two-horned axe: according to the legends, the goddess of chaos Neith (Ancient Egypt), the Titanide Rhea and Zeus, the god of light (Ancient Greece).

The two spirals of the classical labyrinth also symbolize the observed natural processes - the spiral trajectories of the rising and falling sun between the solstice days. These spirals are similar in shape, but opposite in direction and meaning. At the same time, they are inseparable in an integral annual cycle, and are one as day and night, light and shadow. The embodiment of these spirals can be considered the images of two snakes: in the labyrinth, in the gnomon-caduceus, as well as the serpent in the hands of the Cretan mother goddess and the snakes "holding the sky" (in the myths of the peoples of the world). Many signs and images are the result of the division and personalization of parts of a single time, hence their ability to reincarnation (for example, Zeus appears in the images of a snake, bull, eagle, etc. like the Sun passing through different constellations of the Zodiac).

5 Conclusion

The northern labyrinths can be viewed as a valuable source of information on the development of nature and culture. To carry out systematic studies, it is necessary to create a database indicating: 1. geographic coordinates of the central points; 2. true (geographic) azimuths; 3. shape of the physical horizon (circular panorama); 4 age of relief elements (coastal terraces) on which labyrinths are located; 5. dating of labyrinths obtained on the basis of paleoastronomical calculations.

Scientific tourism can make a great contribution to the implementation of the project, as a supplier of GPS-data on geo-location and objects and as a new stimulus for the development of ancient communications.

References

1. G.N. Paranina, Northern Labyrinths – gnomon and models of geographical space, *Elsevier Proc. Soc. and Behavior. Sci*., **19**, pp. 593-601 (2010)
2. A. Paranina and R. Paranin, Primary navigation purpose of the petroglyphs: reconstruction on the basis of the gnomon, *OALib Journal*, **4**, pp. 1-13 (2017)
3. A. Paranina, et al., Cross-disciplinary Research of Objects of Ancient Heritage on the Example of Stone Labyrinths and Petroglyph, *TransNav*, **11(4)**, pp. 729-734 (2017)
4. A.A. Grigoryev, et al., Stone objects of Russian Fennoscandia: potential for recreational use, *IOP Conf. Ser.: Earth Environ. Sci.*, **302(1)**, 012148 (2019)
5. L.S. Marsadolov, et al., Problems of preservation of prehistoric cultural heritage objects in the Arctic, *IOP Conf. Ser.: Earth Environ. Sci*., **302(1)**, pp. 1-8 (2019)
6. A. Paranina and R. Paranin, Study of Northern Labyrinths as Elements of a Navigation Network, *TransNav*, **10(3)**, pp. 451-456 (2016)
7. L.S. Marsadolov, et al., An integrated approach to the study of megalithic legacy, *Bulletin of Tomsk St. Univer. Hist.*, **22(2)**, pp. 72-75 (2013)
8. V.I. Paranin, *History of the barbarians* (St. Petersburg, Russian Geographical Society, 1998) p. 283
9. O. Pomortsev and E. Kashkarov, Theory of rhythms E V Maximov Geography: Problems of Science and Education, *63rd Herzen Readings, April 22-24, 2010, St. Petersburg*, pp. 8-13 (2010)
10. V.I. Paranin, *Historical geography of chronicle Russia* (Petrozavodsk, Karelia, 1990) p. 152
11. L.V. Larchenko and R.A. Kolesnikov, Regions of the Russian Arctic zone: state and problems at the beginning of the new development stage, I. J. of eng. and technol. (UAE), 7, **14(3)**, pp. 369-375 (2018)
12. L.V. Larchenko, et al., Resources for sustainable development of Russian Arctic territories of raw material orientation, *IOP Conf. Ser.: Earth Environ. Sci.*, **302(1)**, 012121 (2019)
13. L. Larchenko, et al., Industrial Innovation Clusters of Saint Petersburg: Problems and Development Prospects, *SPBPU IDE '19: I. Sci. Conf. on Innovat. in Digital Economy*, **57** (2020)
14. V.D. Sukhorukov, et al., History and Geography of The Russian Arctic in the Domestic Travelogue, *IOP Conf. Ser.: Earth Environ. Sci*., **625(1)**, 012010 (2021)
15. D.V. Sevastyanov, et al., Recreational environmental management and Arctic tourism as a new trend in the strategy for sustainable development of the Arctic countries, *Ecol., Environ. & Conservation*, **23(4)**, pp. 480-487 (2017)
16. D.V. Sevastyanov, et al., The Barents Sea Region: current status and boundaries of the possible, *IOP Conf. Ser.: Earth Environ. Sci.*, **625(1)**, 012008 (2021)
17. Yu.N. Gladkiy, et al., History and perspectives for the expansion of the Russian Arctic to the Ecumene *IOP Conf. Ser.: Earth Environ. Sci*., **434(1)**, 012005 (2020)
18. Yu.N. Gladkiy, et al., Geophysical determinants of wind energy development in the Far North of Russia, *IOP Conf. Ser.: Earth Environ. Sci.*, **459(2)**, 022071 (2020)
19. Yu.N. Golubchikov, et al., Arctic tourism: state and prospects for Russia, *Geography, Environ., Sustainab.,* **11(4)**, pp. 5-13 (2018)
20. A.A. Grigoryev, *Prehistoric development of the Arctic: geographical aspects Doistoricheskoe osvoenie Arktiki: Geograficheskie aspekty* (St. Petersburg, Asterion, 2018) p. 226
21. A.A. Grigoriev, et al., Prospects for the rational use of water bodies of the northwestern federal district of Russia in the tourism sector**,** *IOP Conf. Ser.: Earth Environ. Sci.*, **381(1)**, 012032 (2019)