

ISSN 2518-1467 (Online),
ISSN 1991-3494 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ

Х А Б А Р Ш Ы С Ы

ВЕСТНИК

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН

THE BULLETIN

THE NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN

PUBLISHED SINCE 1944

4

JULY – AUGUST 2020

ALMATY, NAS RK

NAS RK is pleased to announce that Bulletin of NAS RK scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of Bulletin of NAS RK in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential multidiscipline content to our community.

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НАН РК сообщает, что научный журнал «Вестник НАН РК» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Вестника НАН РК в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному мультидисциплинарному контенту для нашего сообщества.

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«Қазақстан Республикасы Ұлттық ғылым академиясының Хабаршысы».

ISSN 2518-1467 (Online),

ISSN 1991-3494 (Print)

Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы»РҚБ (Алматы қ.).

Қазақстан Республикасының Ақпарат және коммуникациялар министрлігінің Ақпарат комитетінде 12.02.2018 ж. берілген № 16895-Ж мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Мерзімділігі: жылына 6 рет.

Тиражы: 2000 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18,
<http://www.bulletin-science.kz/index.php/en/>

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Типографияның мекенжайы: «NurNaz GRACE», Алматы қ., Рысқұлов көш., 103.

Г л а в н ы й р е д а к т о р
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«Вестник Национальной академии наук Республики Казахстан».

ISSN 2518-1467 (Online),

ISSN 1991-3494 (Print)

Собственник: РОО «Национальная академия наук Республики Казахстан» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и коммуникаций и Республики Казахстан № 16895-Ж, выданное 12.02.2018 г.

Периодичность: 6 раз в год.

Тираж: 2000 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел. 272-13-19, 272-13-18.

<http://www.bulletin-science.kz/index.php/en/>

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Адрес типографии: «NurNazGRACE», г. Алматы, ул. Рыскулова, 103.

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Bulletin of the National Academy of Sciences of the Republic of Kazakhstan.

ISSN 2518-1467 (Online),

ISSN 1991-3494 (Print)

Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty).

The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Communications of the Republic of Kazakhstan No. **16895-Ж**, issued on 12.02.2018.

Periodicity: 6 times a year.

Circulation: 2000 copies.

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,

<http://www.bulletin-science.kz/index.php/en/>

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Address of printing house: «NurNaz GRACE», 103, Ryskulov str, Almaty.

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GEOGRAPHICAL INFORMATION SYSTEMS IN ARCHAEOLOGICAL CARTOGRAPHY OF SOUTH KAZAKHSTAN

Abstract. The article presents available data on mapping based on archaeological exploration with the subsequent involvement of modern GIS technologies. Before the start of work on the compilation of archaeological maps, there was made an analysis of the history of the appearance of similar documents. Research data were taken from both domestic and neighboring countries. It should be noted that current technologies allow you to create maps with accurate data and with detailed reference to the terrain, while using all the available data: these are high-quality space images, radar and GPS data, orthophotomaps with altitude maps. This in turn will give a more detailed understanding of the functioning of the Karaultobe-type monuments being studied. To compile an archaeological map, a database was collected consisting of information about Karaultobe and settlement monuments of the Ispijab historical and cultural district. The main data are the results of exploration and surveys of monuments such as Karaultobe. The analysis was based on experimental methods in GIS. The basis of the maps is radar and GPS data. For analysis, the article used the capabilities of ArcGIS - a special geographic information software product. With the help of special tools, surveys of individual sites and facilities were carried out. The coordinates of each Karaultobe and the altitude map were used separately for analysis. The points themselves, this is a set of data obtained using GPS in field research, in particular because of archaeological exploration. The altitude map is high-resolution radar data (30 meters) available on the US Geological Survey website. Data on the position of the Karaultobe towers, obtained using GPS, were corrected from satellite images to avoid errors. During the work, a digital map was created that can be used to display visibility data from monuments and their work in conjunction with settlement monuments in the region. Objects such as Karaultobe and towns with settlements of the region are studied during the creation of archaeological maps. The basic Karaultobe were chosen as the studied objects. These objects have a characteristic trapezoidal shape and large dimensions with a long range of visibility from them. Settlement structures are chosen based on assumptions about the interaction of towns and settlements with watchtowers. Maps are created for work that includes displaying study analyses as a database, which allows you to further supplement and correct all the information collected. The work on creating the map within the project is aimed at producing a series of maps. This series displays the main map, which displays all objects, as well as individual more detailed maps of the selected regions and maps with the results of terrain analyses. In the publication, authors do not use all maps, but individual, dimensioned options, with simplified annotations. In general, as a result of the creation of a cartographic base on the topic of research, not only maps were prepared, but also a comparative analysis of Karaultobe. Based on these, an important detail in the analysis is the compilation of a table with Karaultobe data. Several Karaultobe chains were analyzed and the boundaries of visibility between them were determined. The results of the analysis are important due to the fact that on the basis of the data obtained it is possible to reconstruct the missing ones as a result of the destruction of Karaultobe, to reproduce their former height. It is also possible to determine the way Karaultobe functions not only in terms of visual contact with settlement monuments, but also as a complex warning system.

Key words: Karaultobe, watchtowers, cartography, GIS, topography, archeology, exploration, landscape.

Introduction. Drawing up an archaeological map is an important and integral stage in the study of the examined territory. Usually, mapping of territories and landscapes occurs after large-scale exploration, during the compilation of sets and inventories. Cartographic studies of archaeological monuments conducted in the 20th century are currently used in the work of archaeological expeditions and in individual works. The method of compiling maps previously implied a simplified display of monuments on the place of relatively modern cities and large rivers. The analysis of limited group monuments was carried out without involving cartography data. The absence of GIS technologies in the past did not provide an opportunity to determine the review and visibility of monuments relative to each other. In the middle and at the end of the 20th century, the result of work in South Kazakhstan (current Turkestan Region) was the Archaeological Map of Kazakhstan [2] and the Set of Monuments of the South Kazakhstan Region [3]. After long-standing cartographic studies that poorly affected Karaultobe in the Turkestan Region, a modern "Map of Karaultobe monuments of the Ispijab district" was compiled as part of the project "Ispijab Watchtowers" using GIS technologies (Geographical Information Systems) based on exploration work of 2018-2019 [4, p.175-184].

Earlier, when studying historical topography, researchers of the Turkestan region drew attention to the structures popularly called "Karaultobe". The term "Karaultobe" is complex. It consists of two parts - "karaul" and "tobe". The word "karaul" is Turkic in origin and translates as "guard". The word "tobe" is used in the Kazakh language and means "hill" or "peak". Hence, the name "Karaultobe" is a guard hill.

A study of Karaultobe showed that watchtowers as a phenomenon are characteristic of the Ispijab historical and cultural district. It is very important that the cities and settlements surrounding Ispijab began to function and develop during the period of spread of the Otrar-Karatau culture. The towns and settlements of Martobe, Ulugtobe and Karatobe are located in close proximity to Sayram itself and arise at the end of the first millennium BC [5, p.70].

At the beginning of the data analysis, a question arose about the nature of the landscape, on the basis of which the map will be built. In modern territories, it is often possible to find prominent anthropogenic effects, including historical ones. The type of landscape suitable for the topic we are studying is defense. The defense landscape in historical times suited all types of fortress structures that had a relief. For example: shafts and ditches, and in our case, specially built structures in the form of watchtowers. These are thoroughly constructed high hills dominating the landscape. During the compilation of the map of objects, local toponyms were used: hydronyms (river names) and oikonyms (city names).

Also, a typological classification was previously carried out. Based on this classification, two types of Karaultobe were identified - basic and sentinel. The basic Karaultobes are impressive in size. These structures have a clear trapezoidal shape. Their diameter reaches 130 m, the height ranges from 8 to 18 m. All these characteristics give the hill excellent visibility on the horizon. Sentinel Karaultobes are small. The diameter of the base is no more than 50 m, the height does not exceed 5 m. These parameters were enough to function around certain centers. This is explained by the fact that natural elevations were chosen for sentinel points [6, p. 21-29].

Before mapping, preparatory work was carried out to compile and complete the database with all the identified Karaultobe for 2018-2019. In total, 65 watchtowers - Karaultobe and 27 settlements and fortifications of the Middle Ages entered into the database. Of these Karaultobe, 26 basic facilities were analyzed. The database also included information on identified settlements located in the foreseeable vicinity of Karaultobe-type facilities. Each Karaultobe and urbanized object is assigned a number in the database list (figure 1).

Methods. During the work, maps are created based on landscape analysis using ArcGIS. As a result, information was obtained confirming some data from archaeological exploration. Similar works with the analysis of the visibility of such objects were previously published, among them it is worth noting the work on the use of GIS in the study of Alan fortifications [7, p.65-72]. There is also similar work on the results of the analysis of the Kislovodskaya basin, where the author describes in more detail the method of using GIS for visibility analysis [8]. For the analysis prepared as part of the Karaultobe monument study project, the ArcGIS capabilities were used, in particular, using the View shed tool. The coordinates of each "tower" and the elevation map were used separately for analysis. The points themselves are a set of data obtained using GPS during archaeological exploration. And the elevation map is SRTM (Shuttle Radar Topography Mission) data available on the website of the US Geological Survey [9].

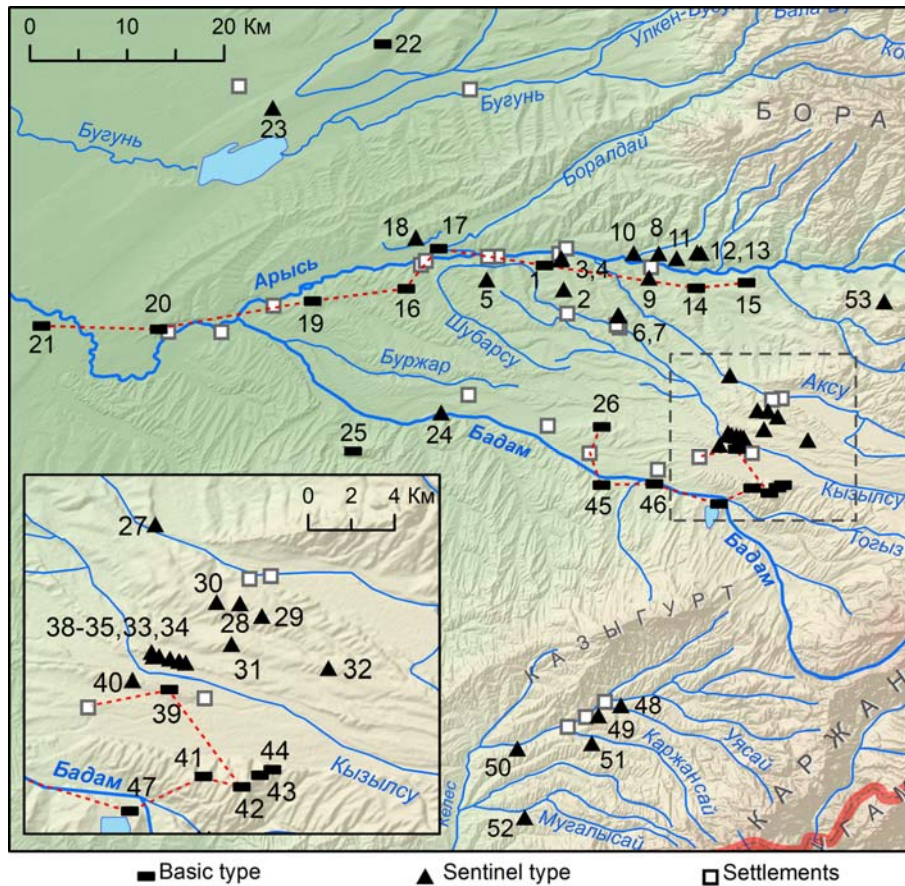


Figure 1 – Archaeological map of Karaultobe-type monuments of Ispijab district

Data on the position of Karaultobe obtained using GPS were corrected by satellite imagery to avoid errors. However, the elevation from the available coordinates was not used at all. This is because SRTM altitude data, although accurate, can go against GPS data due to minor errors in both sources and the 30-meter SRTM grid. At the same time, the results of the analysis may be affected by SRTM inaccuracies in areas of increased vegetation, as well as metal and concrete structures, buildings of various configurations in areas of development [10]. As part of the analysis, the modern height of the structures was not taken into account. The absence of data on the initial size of the structures does not allow the correct analysis of the visual connection of Karaultobe itself and settlement structures (with the exception of individual trial analyses, which are also considered in this article). The results of the analysis showed visibility not from Karaultobe themselves, but the surfaces of the places next to them. This was enough for a reliable analysis of the visibility of objects.

The very height of the Karaultobe structures cannot be noted without detailed field archaeological surveys of each object, which to some extent would give reliable data regarding their height. In this case, the results of the analysis are most important due to the fact that it is possible to try to reconstruct the strategy or plan for choosing places for building "towers" around certain towns and settlements, creating a complex of a Karaultobe-type structure in a certain district.

At the moment, a lot of data has been obtained confirming various assumptions or revealing new details of the choice of places for construction earlier identified objects. In the process of analysis, it became clear the purpose of certain objects that, as previously assumed, were not part of a particular chain. This implies not only their strategic purpose, but also their chronological connection. The results of the analysis suggested the possible position of unrecognized guard hills when there is no mutual visibility between the two neighboring Karaultobe.

Basic objects are selected for landscape analysis. These objects are conditionally divided into two chains: southern and northern. The northern chain covers almost all the basic Karaultobe along the middle

course of the Arys River. The southern chain covered the basic facilities along the Badam River, which are concentrated around large settlements, such as Shymkent and Sayram settlements.

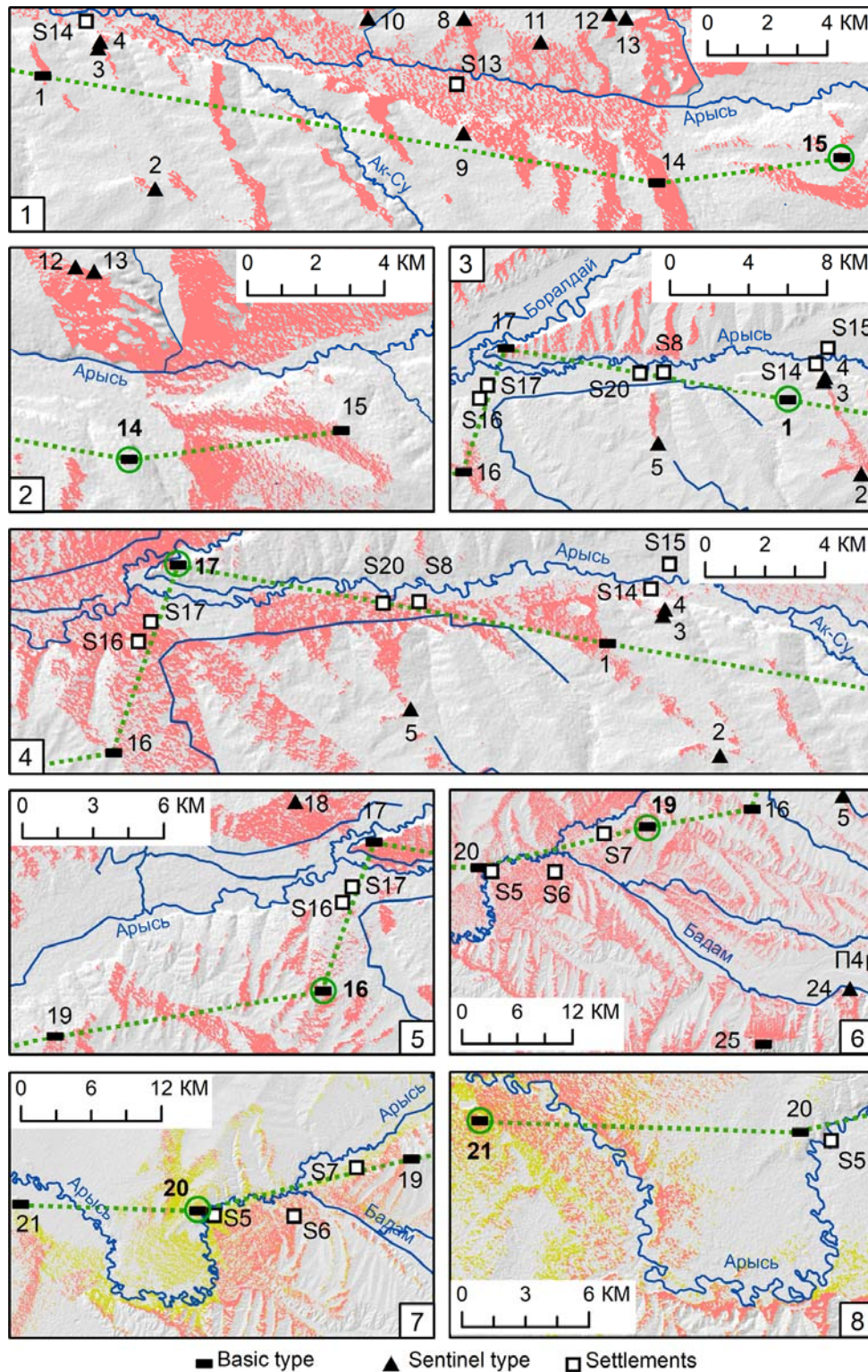


Figure 2 – Results of landscape analysis in the ArcGIS environment (Northern chain).

Red shows visibility from different positions of a certain Karaultobe:

- 1 - Mashat (15); 2 - Karabulak (14); 3 - Akkoyly-1 (1); 4 - Chubarovka-2 (17);
- 5 - Chubarovka-1 (16); 6 - Koltogan (19); 7 - Akdala (20); 8 - Darmino (21)

Main part. The results of the analysis discussed in this article are reflected in mini-maps in the form of compressed material, where each one shows a certain Karaultobe and its visibility from different positions (the visibility on the maps is shown in red). The object itself is highlighted by a circle. The site where Karaultobe Mashat (No.15) was erected, according to the results of the analysis, was visible from neighboring basic objects, between which a stipple line is drawn. These are the facilities of Karabulak (No.14) and Akkoyly (No.1) Karaultobes. These watchtowers are located almost at the same height, which was supposed to create visibility between them. However, there are questions regarding their distance and visibility under different weather conditions (table). Here the results of the analysis show that object No.15, like object No.14, was visible from the sentinel "towers" (figure 2, 1-2). The results obtained during the analysis confirm the conclusions made during archaeological exploration. Sentinel Karaultobes, either on the sidelines or along the chain, served as an intermediate signal point.

Karaultobe location table

| Northern chain | | | | |
|----------------|-------------------------|--|--|-----------------------------------|
| № | Name of a monument | Distance to the next monument (in meters, excluding visibility under different weather conditions) | Visible from the next monument (this table does not consider the height of the structure, but the surface where it is located) | Higher than the previous monument |
| 15 | Mashat Karaultobe | 6250 | yes | – |
| 14 | Karabulak Karaultobe | 18943 | no | no |
| 1 | Akkoyly-1 Karaultobe | 13230 | yes | no |
| 17 | Chubarovka-2 Karaultobe | 7219 | yes | no |
| 16 | Chubarovka-1 Karaultobe | 10989 | yes | yes |
| 19 | Koltogan Karaultobe | 19406 | yes | yes |
| 20 | Akdala Karaultobe | 14361 | no | no |
| 21 | Darmino Karaultobe | – | – | no |
| Southern chain | | | | |
| 39 | Sayram-1 Karaultobe | 8317 | yes | – |
| 42 | Karatas-2 Karaultobe | 2554 | yes | yes |
| 41 | Karatas-1 Karaultobe | 4437 | no | no |
| 47 | Badam-3 Karaultobe | 8585 | yes | no |
| 46 | Badam-2 Karaultobe | 6511 | yes | no |
| 45 | Badam-1 Karaultobe | 9719 | yes | no |
| 26 | Shymkent Karaultobe | | – | no |

The basic Akkoyly Karaultobe (No.1) was poorly viewed from the neighboring object No.17 - Chubarovka-2 Karaultobe. During a visual inspection during archaeological exploration, elevation No.1 was viewed from five objects of the Karaultobe sentinels, which was confirmed by the analysis (figure 2, 3). Here it should be noted that the analysis shows a potential place for the location of the base or sentinel signal point between facilities No.1 and No.17 along the left bank of the Arys River. An analysis of the landscape with the help of ArcGIS indicates a strategically profitable area for the construction of a watchtower.

In the next case, the situation changes and it turns out that the potential place for Karaultobe, which would see object No.1, no longer sees object No.17 (figure 2, 4). An additional analysis of the terrain landscape was also carried out, while visibility from the nearest settlements was checked. Early medieval monuments Kultobe and Kostobe-1 are located on the left bank of Arys. From Kultobe and Kostobe-1, 5 km to the east, the aforementioned Karaultobe Akkoyly-1 is located. This Karaultobe is basic in purpose and has a large size, predominates on the ground. Akkoyly-1 Karaultobe is located on the steep slope, which allows you to control movements along the valley to the north by dozens of kilometers.

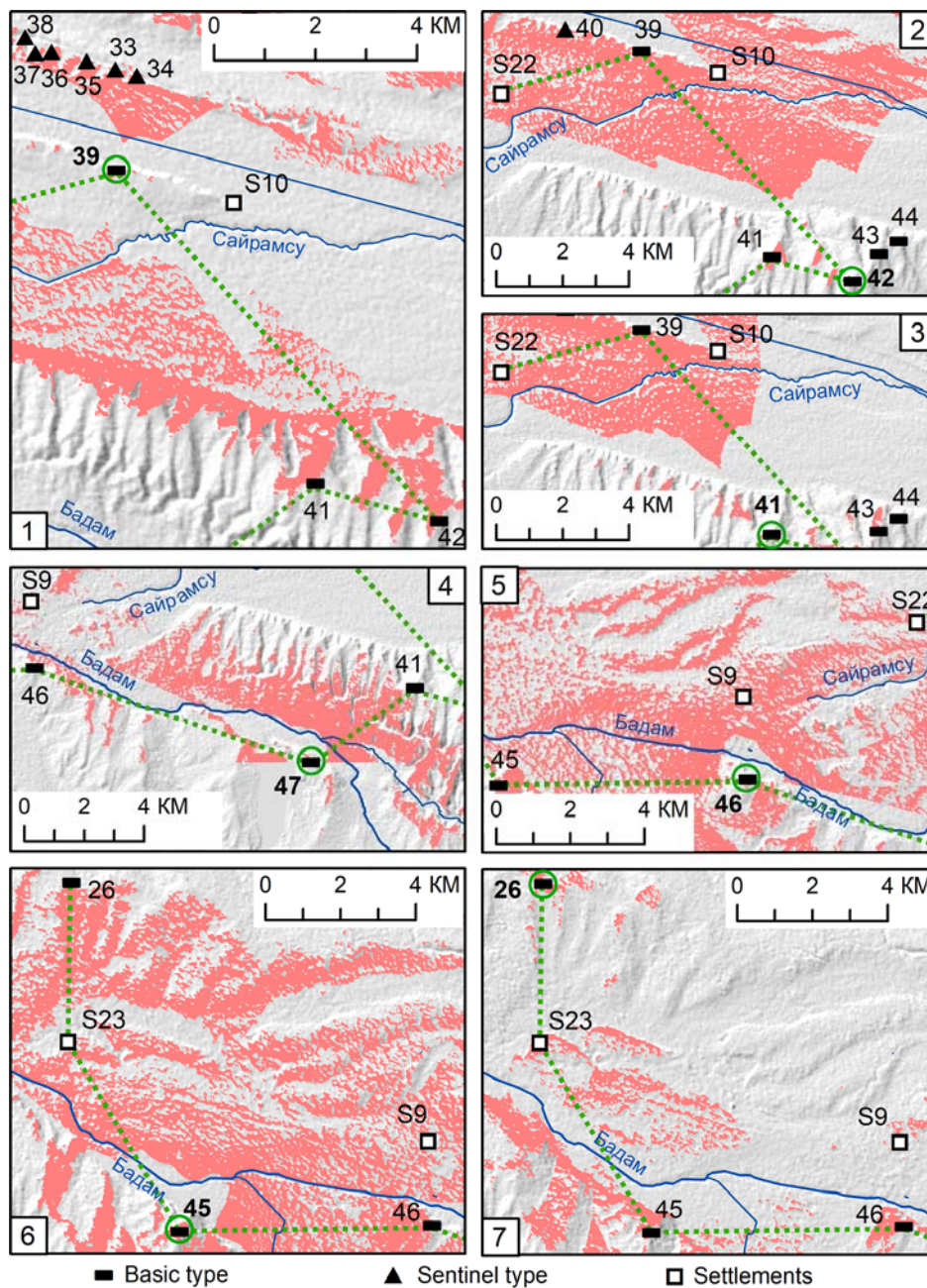


Figure 3 – Results of landscape analysis in the ArcGIS environment (Southern chain).
 In red, visibility from different positions of a certain Karaultobe is shown:
 1 - Sayram-1 (39); 2 - Karatas-2 (42); 3 - Karatas-1 (41); 4 - Badam-3 (47);
 5 - Badam-2 (46); 6 - Badam-1 (45); 7 - Shymkent (26)

The basic facilities of Chubarovka-1 Karaultobe (No.16) and Koltogan (No.19) (figure 4), being in a rather flat and high terrain, were a strategic place where such object could be located, since from this point appears rather good view of the adjacent territory. Judging by the analysis, object No.16 was viewed from almost all positions where the neighboring Karaultobes were located (figure 2, 5-6). This is confirmed visually, that is, these two objects dominate the terrain, and they are higher than neighboring basic objects (table 1).

Following the data received, it becomes clear that at the Chubarovskoe town, which had a fortified structure, as well as at the Chubarovskoe settlement on the left bank of the Arys River, at the confluence of the small Shubarsu River, there was a direct connection with the basic Karaultobe in the oasis. 4 km south of the Chubarovskoe town and 5 km south of the Chubarovskoe settlement is the

aforementioned basic Chubarovka-1 Karaultobe. In the Middle Ages, from Chubarovka-1 Karaultobe, significant territories around it were visible for several kilometers, primarily approaches to the town and settlement in the valley were controlled. Also, from Chubarovka-1 Karaultobe, Koltogan Karaultobe, which is located 11 km to the west, is very clearly visible.



Figure 4 – Basic "watchtower" - Koltogan Karaultobe

The following objects in the northern chain are Akdala Karaultobe (No.20) and Darmino (No.21). According to the landscape analysis, object No.21 does not have a view towards the previous object, also from object No.20 there is no visibility relative to object No.21. Based on this, a test analysis (the results of which can be considered conditional) was carried out to obtain additional data, at which the estimated height of the structures themselves was added to the points under investigation. To avoid maximum inaccuracy, the data added for the height analysis were taken from the preserved ruins of the "towers" themselves. Based on the fact that the preserved ruins of object No.20 are about 9 m, and the ruins of object No.21 are 12 m, the mutual visibility of the listed erected "towers" is not questioned. However, the strategy and method for choosing the locations of these "towers" are not entirely clear, and only assumptions can be made about their purpose.

Akdala Karaultobe is located on the left bank of the Arys River, 7 km west of the settlement of Karaspantobe. The main function of Akdala Karaultobe, apparently, was to protect and prevent the fertile valleys of the right bank of the Arys River, up to the bend of the channel in the southern part. In early medieval and medieval times, a number of settlement monuments were located here, but the settlement of Karaspantobe, one of the urban centers of the region, stands out most of all here. A very large part of the oasis around the settlement of Karaspantobe in the Middle Ages was surrounded by a long wall and was protected on the south side, but from the north and north-west beyond Arys there were large areas of grazing land that needed protection. 15 km west of Akdala Karaultobe, on the left bank of the Arys River is the aforementioned Darmino Karaultobe. This monument is also basic. Darmino Karaultobe, apparently, served as one of the connecting points between large districts.

Returning to the results of the main analysis along the southern chain, Sayram-1 Karaultobe (No.39), located along the high terrace, was chosen as the first object. The result of the landscape analysis shows that this object was well viewed from the south side, where such objects as Karatas-1 Karaultobe (No.41) and Karatas-2 (No.42) were located, in addition, the visibility area of object No.39 stretches northwest of these objects (figure 3, 1). Note that the sentinel Karaultobe, located north of object No.39, is the Kyzylsu Karaultobe complex. These sentinel Karaultobes stretched along the neighboring ridge with a ravine area

north of them, and from the base Sayram-1 Karaultobe clearly saw and controlled the valley and signals from the Kyzylsu complex. This is also confirmed by the results of archaeological exploration.

The second illustration shows that object No.42 was located at an elevation higher than the previous one (table 1) and was visible from object No.39 and from the very settlement of Sayram (S22) (figure 3, 2). The situation is the same with the next object No.41, because the two objects are located close to each other (figure 2, 3).

The next object of this chain was located southwest across the Badam River, along its right channel - Badam-3 Karaultobe (No.47). This position was viewed both from the previous object No.41 and from the next object - Badam-2 Karaultobe (No.46). The latter, in turn, was well viewed from the settlement of Karatobe (S9), which is located north of it, and even from the very settlement of Sayram (figure 3, 4-5).

A similar situation is observed in the settlement of Shymkent (S23), from where there was a good view towards Badam-1 Karaultobe (No.45) (figure 3, 6). The result of an analysis of the landscape of this area shows that during the construction of such structures the strategic elevations were chosen, where the watchtowers were located. Thus, good visibility of the entire district through the Karaultobe complex was created.

The last object in the southern chain is Shymkent Karaultobe (No.26), located north of the Shymkent settlement. As the result of the analysis shows, this object was in line of sight from the position of object No.45, despite the relatively long distance. From the settlement itself, there was also a view into the lowland and towards Shymkent Karaultobe on the crest of the elevation. These data were obtained only from the analysis of the landscape, since visually this was difficult to determine due to the dense population of the territory of the modern city.

Conclusion. Analysis of the terrain of the landscape during cartographic research and exploration made it possible to obtain new data on the visibility of Karaultobes relative to each other and settlement monuments. During the study of cartography, excavation and exploration data, an assumption is made on the chronology of the construction of the basic "watchtowers" - Karaultobe. Undoubtedly, there is a certain system of interaction between basic facilities and settlements in several areas. The basic Karaultobe was used for a long time, judging by the monuments already studied, until the late Middle Ages. Initially, they were erected on high floodplain terraces, near early medieval settlements and fortifications. Judging by the ceramics identified from Shymkent and Ordabasy Karaultobes, it dates from the 1-4 centuries AD [1, p.174-175; 6, p.23].

From almost every basic Karaultobe, the following similar monument is visible. Karaultobe, being near the monuments and along important routes, was given information about the approaching enemy in time. The result in compiling the map was the appearance of characteristics that allow remotely using GIS technologies to determine the visibility from one Karaultobe of another similar monument. These data are also supported by exploration data, but only through mapping, it became clear how certain Karaultobe operated in the general warning system in their area of location. In the future, more detailed archaeological research, along with analytics, will be able to clarify the principles and conditions for the construction of Karaultobes, studied in the framework of the "Ispijab Watchtowers" Project.

The works were carried out according to the project No. AP05133957 "Watchtowers" of Ispidzhab".

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ГЕОГРАФИЧЕСКИЕ ИНФОРМАЦИОННЫЕ СИСТЕМЫ В АРХЕОЛОГИЧЕСКОЙ КАРТОГРАФИИ ЮЖНОГО КАЗАХСТАНА

Аннотация. В статье представлены имеющиеся данные по составлению карт на основе археологических разведок с последующим привлечением современных ГИС-технологий. Перед началом работ по составлению археологических карт был сделан анализ истории появления похожих документов. Были взяты данные исследований как отечественные, так из ближнего зарубежья. Следует отметить, что нынешние технологии позволяют создавать карты с точными данными и с детальной привязкой к местности, при этом используя все имеющиеся данные: это высококачественные космические снимки, данные радаров и GPS, ортофотопланы с картами высот. Это в свою очередь даст более детальное понимание о функционировании

изучаемых памятников типа Караултобе. Для составления археологической карты была собрана база данных, состоящая из информации о Караултобе и поселенческих памятниках Испиджабского историко-культурного округа. Основные данные – результаты разведок и обследований памятников типа Караултобе. Анализ был произведен на основе экспериментальных методов в ГИС. Основа карт – это данные радаров и GPS. Для анализа в статье использовались возможности ArcGIS – специального геоинформационного программного продукта. С помощью специальных инструментов проводились обследования отдельных участков и объектов. Координаты каждого Караултобе и карта высот использовались для анализа отдельно. Сами точки – это набор данных, полученных с помощью GPS при полевых исследованиях, в частности в результате археологических разведок. Карта высот – это данные радаров высокого разрешения (30 метров) доступные на вебсайте Геологической службы США. Данные о положении башен Караултобе, полученные с помощью GPS, были скорректированы по спутниковым снимкам во избежание погрешностей. Во время работ создана такая цифровая карта, которая может быть применима для отображения данных по видимости с памятников и их работы в комплексе с поселенческими памятниками региона. Изучаемые в ходе создания археологических карт объекты типа Караултобе и городища с поселениями региона. В качестве изучаемых объектов были выбраны базовые Караултобе. Данные объекты имеют характерную трапециевидную форму и крупные размеры с большой дальностью видимости с них. Поселенческие структуры выбраны исходя из предположений о взаимодействии городищ и поселений со сторожевыми башнями. Карты созданы для работ, которые включают в себя отображение анализов исследования в виде базы данных, что позволяет в дальнейшем дополнять и корректировать все собранные сведения. Сама работа по созданию карты в рамках проекта нацелена на составление серии карт. В этой серии будут отображены основная карта, где отображены все объекты, а также отдельные, более подробные карты выделенных регионов и карты с результатами анализов ландшафта местности. В публикации авторами используются не все карты, а отдельные, уменьшенные в размерах варианты, с упрощенными аннотациями. В результате создания картографической базы по теме исследования, подготовлены не только карты, но и сравнительный анализ Караултобе. Исходя из этого, важной деталью в проведении анализа является составление таблицы с данными Караултобе. Были проанализированы несколько цепочек Караултобе и определены границы видимости между ними. Результаты анализа являются важными по причине того, что на основании полученных данных появляется возможность реконструировать отсутствующие в результате уничтожения Караултобе, воспроизвести их былую высоту. Также возможно определение способа функционирования Караултобе не только в плане визуального контакта с поселенческими памятниками, но и в виде сложной системы предупреждения.

Ключевые слова: Караултобе, сторожевые башни, картография, ГИС, топография, археология, разведки, ландшафт.

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ОҢТҮСТІК ҚАЗАҚСТАННЫҢ АРХЕОЛОГИЯЛЫҚ КАРТОГРАФИЯСЫНДАҒЫ ГЕОГРАФИЯЛЫҚ АҚПАРАТТЫҚ ЖҮЙЕЛЕР

Аннотация. Мақалада археологиялық барлау жұмыстары негізінде және заманауи геоақпараттық жүйелер технологиясын қатыстыра отырып құрастырылған карта түріндегі мағлұматтар ұсынылған. Археологиялық карталарды құрастыру жұмыстарын бастағанға дейін осыған ұқсас құжаттардың пайда болу тарихы сарапталды. Жергілікті зерттеулер нәтижесімен қоса, жақын шетел нәтижелері де қарастырылды. Қазіргі технологиялар қолда бар мәліметтерді пайдалана отырып, яғни жоғары сапалы космос суреттері, радарлар мен GPS мәліметтері, биіктік карталарын беретін ортофотопландар секілді жоғары сапалы карталар алуға мүмкіндік береді. Бұл өз кезегінде Қараултобе типтес ескерткіштердің қызметі мен қалыптасуы жайлы толығырақ түсінік береді. Археологиялық картаны құрастыру барысында Испиджаб тарихи-мәдени аймағының Қараултобе және қоныс-мекен типтес ескерткіштері жайлы мағлұматтар жиналған дереккөз қалыптастырылды. Басты мағлұматтар – барлау және зерттеу жұмыстарының нәтижесі. Талдау жұмыстары геоақпараттық жүйедегі эксперименталды әдістеме негізінде жүргізілді. Карталардың негізі – ол радарлар мен GPS мәліметтері. Мақалада сараптама үшін ArcGIS секілді арнайы геоақпараттық бағдарламалық өнімнің мүмкіндіктері пайдаланылды. Арнайы құралдар арқылы бөлек аумақтар мен нысандар зерттелді. Сараптамаға әрбір қараултобе координаттары мен биіктік картасы жеке пайдаланылды. Нүктелердің өзі – археологиялық барлау жұмыстары барысында GPS құрылғысы арқылы алынған мәліметтердің жиынтығы. Биіктік картасы – АҚШ-тың Геологиялық қызметінің вебсайтында бар жоғары сапалы (30 метр) радарлардың мәліметтері. GPS құрылғысы арқылы алынған Қараултобенің орналасуы жайлы мәліметтер қателік жібермеу мақсатында спутникті суреттер арқылы түзетілді. Жұмыс барысында ескерткіштерден көз көрерлік

аумақ пен олардың қоныс-мекендермен кешенді байланысын бейнелейтін цифрлы карта құрастырылды. Археологиялық карталарды құру барысында зерттелген нысандар – Қарауылтөбе типтес ескерткіштер мен осы аймақтағы қалашық, елдімекендер. Зерттеу нысаны ретінде негізгі қарауылтөбелер таңдалды. Бұл нысандар өзіндік бір трапеция тәріздес пішімі бар ірі көлемді болып келген. Елдімекен құрылымдас ескерткіштер осы қарауыл мұнараларымен әрекеттестік болу мүмкіндігі қарастырыла отырып таңдалды. Аталмыш карталар барлық жиналған мәліметтерді алдағы уақытта толықтыруға және түзетуге мүмкіндік беретін дереккөз ретінде құрастырылған. Жоба аясындағы карта құрастыру жұмыстары, жалпы бірнеше карталар топтамасын жасауға бағытталған. Бұл топтамада барлық нысандар енгізілген басты карта және де бөлек аймақтар бойынша егжей-тегжейлі карталар, сол сияқты төңіректің ландшафты бойынша талдау жұмыстарының нәтижесі топтастырылған карталар. Мақалада авторлар барлық карталарды емес, тек басты, көлемі кішірейтілген, мазмұны жеңілдетілген карталарды пайдаланды. Сонымен, зерттеу тақырыбы бойынша картографиялық база құру жұмыстарының нәтижесінде тек карта құрастырылып қана қоймай, сонымен қатар қарауылтөбелер салыстырмалы талданды. Осыдан шыға, талдау жасау барысында басты бөлік ретінде Қарауылтөбе жайлы мәліметтер жұмылдырылған кесте түзу болды. Бірнеше қарауылтөбелердің тізбекшесі талданып, олардың арасындағы көріну-көрінбеу мүмкіншіліктері анықталды. Жүргізілген талдаудың маңыздылығы алынған мәліметтер негізінде олардың жойылып кеткен нүктелерін реконструкция жасай отырып, олардың сол замандағы биіктігін болжай алуында. Сол сияқты қарауылтөбелер елдімекендермен жай ғана байланыс ретінде емес, оларды күрделі ескерту жүйесі ретінде қарастыруға мүмкіншілік пайда болды.

Түйін сөздер: Қарауылтөбе, қарауыл мұнаралары, картография, геоакпараттық жүйелер, топография, археология, барлау, ландшафт.

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www.nauka-nanrk.kz

ISSN 2518-1467 (Online), ISSN 1991-3494 (Print)

<http://www.bulletin-science.kz/index.php/en/>

Редакторы *М. С. Ахметова, Д. С. Аленов, А. Ахметова*
Верстка на компьютере *Д. А. Абдрахимовой*

Подписано в печать 14.08.2020.
Формат 60x881/8. Бумага офсетная. Печать – ризограф.
21,6 п.л. Тираж 500. Заказ 4.