Diachronic analysis of historical and modern landscapes of the Herakleian peninsula

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Abstract. The Herakleian Peninsula has a unique geographical location and a long history of development. The methods of historical and geographical research of this territory have been considered. The historical landscapes development dynamics research of the Peninsula has been conducted with the use of cartographic material, satellite images interpretation and a field observations of the territory within the selected time slices. Map analysis of the economic subsystem of the anthropogenic landscapes of the Herakleian Peninsula has been made. Areas of the South-Western and North-Eastern parts of the Peninsula which preserve the historical features of the modern land use formation have been singled out with regard to the specifics of the arrangement of land allotments (klers) in the ancient system of agriculture.

1. Introduction
Processes affecting dynamic components are continuously taking place in landscapes. The formation of modern landscapes is influenced both by natural and anthropogenic factors, whose interaction does not coincide in time. This poses the challenge for researchers to study the historical features of the landscape development.

The Herakleian Peninsula with an area of about 126 km² is a part of the Chernorechensky physical-geographical region of the Piedmont forest-steppe region located in the South-Western part of the Crimea [1]. A part of Greater Sevastopol is also located within the boundaries of the Peninsula. Due to the peculiarities of the geographical location, the diversity of the relief, the combination of unique bioclimatic and soil resources, the Peninsula is notable for its heterogeneity and is divided into two parts: the section of the Main Ridge of the Crimean Mountains and the section of the Foothills. This geographical location determines the presence of common features for the Foothills and for the Southern coast of the Crimea: mountainous terrain, forest vegetation, sub-Mediterranean subtropical climate; plants and animals characteristic of it [2].

The forest-steppe belt predominates on the territory of the Herakleian Peninsula. Forest phytocenoses, pine and oak forests occupy a large part. Previously, the steppes had occupied the Southern slopes and the flat plains. Now, fescue-feather grass steppes are found in some areas. Natural
lands have undergone great changes under the influence of human activities. They have been transformed into residential, agricultural, urban and other territories. The territory of the Peninsula is unique in terms of specificity of soil and climatic relations. Agricultural loads of various types account for 25 centuries. The continuity of land use, the distribution of agricultural land and resettlement centers in the landscapes are also of particular interest. The Herakleian Peninsula became such a center back in the VI century BC, and since then has experienced multiple effects of human activity. Anthropogenic pressure was carried out by the Greek colonists and later by the Russian people who still inhabit the Peninsula. In the study of modern landscapes, it is important to pay attention to the emergence and functioning of belligeric objects. At the same time, the military past of the city of Sevastopol must be taken into account. It played a key role in the Crimean War of 1853 - 1856. Also, the Civil War of 1917-1922 and the Great Patriotic War of 1941-1945 had a great influence on the city. In the course of hostilities numerous fortifications were built: bastions, barrows, trenches and other structures. Subsequently being used as military installations and historical monuments, they make a great contribution to the landscape diversity of the territory.

2. Relevance and statement of the problem
The method of diachronic analysis has been used for the first time to study the landscape structure of the Herakleian Peninsula. The basis of this method is a coupled analysis and consistent study of historical changes in the territorial organization of nature, population and economy of a particular territory. The obtained information about the stages of historical development can be used for landscape maps, landscape planning maps, etc. It is also important to take into account the features of the historical development of the territory for making the development plans for the city of Sevastopol.
When historians and geographers conduct the research, the main source of information are maps of different historical periods. Land development is a historical process that can only be displayed by a series of maps. They have the same lithogenic basis and are of the same scale. They should display the most dynamic elements of nature and economy [3]. In addition, satellite space survey data can be used in the study of the territory of the Herakleian Peninsula. They are highly detailed, multi-time and often updated, which allows, with proper interpretation, to study the spatial organization of traces of ancient agrolandscapes, to conduct surveys of boundary systems in the zones of ancient states. Earlier, with the help of such images, [4, 5, 6], data had been obtained on the spatial organization and geometric features (shape and size) of ancient surveying systems of the Chersoneses Khora on the Herakleian Peninsula, which we have used in our analysis. The need to use multi-temporal data in the reconstruction of spatial organization is determined by the fact that many linear forms (primarily shafts of surveying systems or their traces) are difficult to identify when they are examined directly on the ground. In addition, in some seasons of the year, they can be covered with vegetation, and can be recognized only by the texture of the images [7] or, as a result of studying the properties of soils within the boundaries of antique land allotments [6, 8, 9].
In the full study of the development of geographical objects, special attention must be paid to the content of time slices, they should contain information that is comparable in the analysis. In this regard, Zhekulin V.S. has formulated some principles for making the time slices [7]:
1. It is necessary to make a synchronic analysis of all material, which is manifested in the study of any environmental component in conjunction with other components. The historical-geographical time slice takes into account the relationship between nature, population and economy in the period under study.
2. It is necessary to pay attention to the relationships between nature, population and economy, which are characteristic for the historical period under study. The nature of the relationships considered is determined by the level of social development. Leading relationships are identified depending on the objectives of the study, for example, between the features of agricultural technology and the nature of the landscape. This is due to a change in the types of interaction between society and nature, which is reflected in changes of farming systems.
3. A temporary slice should be made within the whole territory. A large number of fundamental works of scientists cannot be compared with modern research results because the territories are not comparable. To avoid such situation, it is important to select initially a single territorial area of the research. This principle implies the possibility of comparing the data obtained with the information for other periods.

4. When making a historical slice, it is necessary to define clear time boundaries. Slices are performed not by time intervals, but by individual stages of development of the territory. This allows to identify the historical cycles of the territory development.

When conducting diachronic analysis, it is important to determine correctly the origin of a geographical object, to study the stages of development or changes of the object of study and to determine the general development trends, as well as to formulate reasonable assumptions about the development of objects. Transformation and environmental changes occur in the process of human development of the territory. The historical process of development of the territory consists of three stages: 1) geographical discovery and exploration of the territory; 2) the resettlement of people in this territory; 3) the formation of the economic structure, social relations, the resettlement system. The development of the territory is accompanied by the use of natural resources, landscape changes [3]. According to this historical process, we have distinguished the main stages of the diachronic analysis of the territory: the VI-th century B.C. – X-th century A.D.; X-th century A.D. – XVIII-th century A.D.; first and second half of the XIX-th century; mid-XX-th century; modern stage.

The base for diachronic analysis of the Herakleian Peninsula has been created with the help of a large volume of cartographic, statistical, historical, literary and archival archaeological material on the development of the territory from the VI-th century B.C. till now. The main cartographic materials for further analysis were maps and other statistical and analytical information posted in literary sources [2-10].

The possibilities of geographical information systems (GIS) have been used during cartographic work and spatial analysis; due to it a series of electronic map-schemes of the land cover of the Herakleian Peninsula has been compiled. Image construction was carried out on the basis of maps placed in the public domain and tied to one cartographic basis, at a scale of 1:100000. The contours of the selected areas have been compared under the analysis of the historical development of the territory. It should also be noted that some inaccuracies in the analysis may be connected with the imperfection or incompleteness of the mapping information on the maps being used.

3. Research results and their practical significance

The first settlement on the Herakleian Peninsula was the outpost Telapil, Chersonese-I. It was captured by the Greek colonists in the ancient period (VI-th century B.C.). The ancient Greek polis was located on the site of the modern city of Sevastopol. The agricultural district was directly adjacent to it. For the lands of this territory was characteristic the demarcation into plots, which had their own characteristics. The entire agricultural territory was divided into rectangular sections (klers), which were separated from each other by walls and straight roads [8]. After decoding of aerial photographs taken during the Great Patriotic War, we have identified the following areas (figure 1).

According to the chart maps given in [10], the following types of land coverings have been distinguished on the territory of the Herakleian Peninsula at different periods of its development: settlements, roads, vineyards and territories under other agricultural crops; forests, shrubs and marshes. On all maps-schemes, the general orientation of agricultural plots is clearly visible, which coincides with the direction of the allotments of ancient Chersonese. Settlements are located in the coastal zone.

When maps of all time periods are superimposed on one base, the outlines of the objects are not coincident. This is due to imperfection of the material being mapped and distortions when changing the projections. This also can be explained by the gradual development of the territory, what is noticeable in agricultural and forest-shrub zones. Despite all the discrepancies, the unchanged nature of land use in the territory under consideration is clearly visible. Most of the territory of the Peninsula
has been used for agricultural land throughout the entire time period. Distribution of forests and shrubs also occurs within certain areas. When the agricultural land surveying network is superimposed on the final map, it can be argued that the main part of the agricultural fields is based on the system of agriculture of ancient Chersonese - the choir (figure 2).

![Figure 1. Aerial photograph decoding [10].](image)

We can talk about modern landscapes according to the results of decoding of the satellite images and field observations (figure 3). Currently, strongly transformed landscapes are observed on the Peninsula. Practically there is no unoccupied land for any activity. Residential landscapes occupy the greater part of the Herakleian Peninsula; these include multi-unit buildings, in which a large part of the population resides, and low-rise individual buildings (country cooperatives, gardening associations). The nature of the development is heterogeneous, apartment buildings alternate with summer cottages, which is mainly determined by the features of the relief. Most of them are intended for personal gardening. Also, the city has a historically developed separate area – Balaclava.
Figure 2. A coupled cartographic analysis of the territory of the Herakleian Peninsula with the imposition of the boundaries of the land allotments of the Chersoneses choir.

On the modern map, it is difficult to trace the historical conditionality of formation of modern landscapes, due to the strong transformation of the territory. But with a careful analysis of the map, we can distinguish areas of the South-Western and North-Western parts of the Peninsula. At the moment, they are covered with low-rise buildings, for which personal farming is characteristic, that is, these territories are used for agricultural production, as in historical times with the ancient land use system.
**Figure 3.** Map of the economic subsystem of anthropogenic landscapes of the Herakleian Peninsula in 2019. Legend: transport landscapes: 1 – railways, 2 – roads, residential landscapes: 3 – high-rise buildings, 4 – low-rise buildings, 5 – industrial and communal landscapes, agricultural landscapes: 6 – agricultural territories, 7 – vineyards, environmentally stabilizing landscapes: 8 – forest plantations, 9 – territories of historical significance, 10 – recreation zones, 11 – water bodies, 12 – belligerative landscapes and territories of special purpose, 13 – unoccupied land.

4. Conclusions
The formation of nature and landscapes of the Herakleian Peninsula is due to the zonal – geographical features of the territory. The structural basis of modern landscapes is the settlement - the city of Sevastopol, and the adjacent agricultural territories;

Diachronic and landscape analysis of the Herakleian Peninsula has shown that, with the growth of the city and a small territorial shift of the boundaries of agricultural fields, the basis of the city, having been laid several centuries ago, still remains . It is also necessary to take into account the historical development of the territory and the continuity of land use under the landscape planning of the territory of the Herakleian Peninsula.

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