Cartographic approach to comparative urban planning analysis of the territory

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Abstract. The analysis of the urban planning territory has been improving for a long time, including the achievements in urban planning and cartographic representation of the territory. Using the thematic map, which represents the centers of ancient agriculture, i.e., the origin of the urban planning territory, the hypothesis of preservation and urban development of such territories is put forward. This hypothesis was tested by utilizing the online cartographic tool called “Atlas of Light pollution map” and by creating urban planning zones based on settlements in the North Caucasus region of Russia.

Keywords: information modeling technologies, urban development, World Atlas of the zenith artificial night sky brightness (Atlas of Light pollution map), urban planning zones, hearths of ancient agriculture, decision support system

1 Introduction

In the field of urban planning cartographic analysis in today’s world, where digital technologies are continuously advancing, it is important to explore and adopt new tools [1-12]. However, it is crucial to remember that these digital capabilities should not be the sole focus, as they should complement and enhance our understanding of the phenomena under study, rather than overshadowing their fundamental essence.

During the initial phase of hypothesis formulation, it is vital to depict the relationships and dependencies that require evaluation using uncomplicated and easily accessible methods, without the need for costly software or extensive source materials. In order to facilitate informed decision-making regarding the future urban planning development of a particular area, a hypothesis has been proposed suggesting that territories where evidence of ancient agricultural sites exists are presently transformed into urbanized territories.

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It is clarified that agriculture is the oldest, but not the only form of human economic activity on Earth throughout subsequent settlement development.

2 Materials and methods

To test the hypothesis, the territory of the North Caucasus region of the Russian Federation was chosen. On the map “Hearth of Ancient Agriculture” (author V.A. Shnirelman) [13], this territory is partially assigned to the “Western Asian” primary hearth of ancient agriculture and to the zone of spread of agriculture in the 6th-5th millennium BC (hereinafter also “hearths of ancient agriculture”) (Fig. 1).

The method of rapid urban planning analysis was used [14], which is based on the use of an open web cartographic resource - World Atlas of the zenith artificial night sky brightness (Atlas of Light pollution map) [15,16]. The approach of constructing zones of urban development impact of settlements, urban planning zones was used [17-20].

The following programs were used: Archicad 24, Photoshop CS6, as well as maps as of 01.01.2023 from web cartographic resources: OpenStreetMap (openstreetmap.org), Google Maps (https://www.google.ru/maps), Yandex Maps (https://yandex.ru/maps).

The territory of the spread of agriculture (6th-5th millennium BC) covers such republics of the North Caucasus region as Adygea, Dagestan, Ingushetia, Kabardino-Balkaria, Karachay-Cherkessia, North Ossetia, Chechnya, partly Krasnodar Krai and Stavropol Krai (within the boundaries of the administrative-territorial division of 9 constituent entities of the Russian Federation as of 01.01.2023) (Fig. 2).

Settlements with a population of 100 thousand or more people (as of 01.01.2023) were selected for research in the North Caucasus region [21].

As a result of the study of the North Caucasus region, schemes of urban planning zones were prepared for settlements of more than 100 thousand people, taking into account their number (rank) (Fig. 2, 3). To simplify the preparation of diagrams for each settlement, an urban planning zone was constructed from the geographic center of the settlement on a scale of 1 cm = 100 km.

A comparative analysis of urban planning zones of settlements, hearths of ancient agriculture [13] (built in graphic editors) and color representation on the web cartographic resource lightpollutionmap.info [16] of accurate modeling of the propagation of light in the atmosphere (Atlas of Light pollution map based on high-resolution satellite data DMSP) was carried out (Fig. 3).

The scientific interest lies in the correlation and spatial arrangement of settlements with a population of more than 1 million people (rank 1) in the territory of ancient agriculture: Krasnodar; settlements with a population of 500-1000 thousand people (rank 2): Makhachkala, Stavropol; settlements with a population of 250-500 thousand people (rank 3): Vladikavkaz, Grozny, Nalchik, Novorossiysk, Sochi (Fig. 3, a); settlements of 100-250 thousand people (rank 4): Adler, Anapa, Armavir, Cherkessk, Derbent, Essentuki, Kaspiysk, Khasavyurt, Maykop, Mikhailovsk, Nazran, Nevinnomyssk, Pyatigorsk (Fig. 123, b). On the Atlas of Light pollution map, urban developed areas are clearly visible in colors from white to yellow in the color palette of the map legend (Fig. 3).

For the study, urban planning zones of settlements in the neighboring state of Georgia were also built: from the centers of Tbilisi (rank 1) and Kutaisi (rank 4). Taking into account the mountainous terrain and national policies of different states, the zones of socio-economic and urban planning influence of Georgian settlements can be neglected in this study.
Spread of agriculture

7th millennium BC
6 - 5th millennium BC
4 - 3rd millennium BC
2 - 1st millennium BC
1st millennium BC

The chronology of the spread of agriculture is given without taking into account the calibration of radiocarbon dates; the date is taken to be the time of the final establishment of agriculture; in poorly studied areas, dating is approximate or conditional.

Fig. 1a) Hearths of ancient agriculture. Scale 1: 165,000,000. Special content developed by V. A. Shnirelman [13], b) Fragment of the map "Western Asian" hearth of ancient agriculture showing the borders of the North Caucasus region of the Russian Federation.
zone of spread of agriculture in 6th-5th millennium BC "Western Asian" hearth of ancient agriculture

Fig. 2 Resettlement of the population of the largest and large cities of the North Caucasus region within the boundaries of ancient agriculture. Compiled based on data from the map “Hearths of Ancient Agriculture” [13], Rosstat [21] and Google maps.
Fig. 3 Relative location of urban settlement zones on the territory of the North Caucasus region within the boundaries of ancient agriculture: a) more than 250 thousand people, b) 100-250 thousand people. Compiled according to Figure 2 and World Atlas 2015 [16].

3 Discussion and conclusion

The approach proposed in the paper is informative, accessible for making decisions about urban development of the territory and does not require the use of expensive and special skills in the operation of geographic information systems, for example, products from ESRI, Trimble, Hexagon, Bentley Systems, AutoDesk and others. This approach is clear and sufficient for the initial testing of the hypothesis.

Using the example of the North Caucasus territory, which is partially located on the territory of the "Western Asian" center of agriculture and the zone of spread of agriculture in 6th-5th millennium BC, the hypothesis is confirmed that the hearths of ancient agriculture are currently highly urbanized territories.
The largest and large settlements of the North Caucasus are clearly visible on the web mapping resource—the Atlas of Light Pollution Map. These colors are located within the boundaries of urban planning zones of settlements. And the concentration and relative location of settlements are clearly presented within the boundaries of the territory of ancient agriculture.

Zones of urban development impact of settlements, depending on the ranks of settlements [14, 17, 18], can be constructed by analogy, taking into account the ratio of urban planning zones and zones of urban development impact of settlements as 1/4.

At the same time, this approach can be applied in more complex programs, and the construction of urban planning zones of settlements can be carried out in a geographic information system (GIS), including not from the geographic center of the settlement, as presented in this study, but from the perimeter of the settlement. At the same time, if we take into account that the administrative boundaries of settlements do not fully reflect the homogeneity of urban development of the territory, then comparison with the Atlas of Light Pollution Map is the best opportunity to get an idea of the current urban development of the territory.

In the future, using the proposed approach, it is possible to analyze the remaining 6 primary hearths of ancient agriculture (Southeastern, East Asian, Sahara-Sudan, Guinea-Cameroon, Mesoamerican mountain, Andean) and 16 secondary hearths of ancient agriculture [13], including the Bugo-Dniester, located on the territory of modern Russia (the spread of agriculture in 2-1st millennium BC).

Identification of patterns of mutual location with centers of ancient agriculture is important in order to support decision-making on urban development of territories. It seems that the outlined cartographic approach of comparative urban planning analysis of the territory is universal for any territory in the world, which was previously presented for one of the African countries in terms of the use of socio-economic zones, urban planning zones and light illumination [19], but without comparison with the hearths of ancient agriculture.

The proposed cartographic approach of comparative urban planning analysis of the territory can be used for other significant types of human economic activity that are territorially tied to the area.

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