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CLINICAL SIGNIFICANCE OF GEOGRAPHIC INFORMATION SYSTEMS IN DIAGNOSTICS OF REGIONAL POPULATION HEALTH DISORDERS

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Introduction. Three good reasons are forcing medical managers in Ukraine to study more deeply the methods and capabilities of Geographic Information Systems (GIS).

Firstly, the ongoing reform of national health care, which changes the state budget type to insurance. This requires a revision of the logistics and principles for the distribution of diagnostic and transport equipment, medical supplies, medical personnel and financial resources for the most equitable distribution of resources for the population. The issue of social justice in the field of health protection of the urban and rural populations is relevant for any country [1,2,3]

The second reason is the intensification of the study so-called "routes of the patient" (RP). RP is an algorithm for the movement of a patient by structural units of a healthcare institution (or various healthcare institutions) that are involved in providing care for a specific condition or disease [4,5]

The third reason is related to the growing understanding by medical workers of the importance of the factors of the natural environment in which the population lives, children are born and grow up. Epidemiological methods for studying the development and spreading of infectious diseases have been successfully transferred to the study of the epidemiology of non-communicable diseases. The latter include health disorders caused by adverse environmental factors (cultural, social, natural and economic).

This research was carried out as a study of the demography of the population of the Odessa region, performed by Odessa National Medical University. The article confirms the correctness of the choice of the GIS method for solving medical and social problems.

Background to the use of GIS methods in medicine. The development of evidence-based medical management, as well as the increasing cost of quality medical services, has led to creation the concept of optimal “patient route” [6].

This is facilitated by the development the epidemiology of non-communicable diseases, characterized by a long-term the chronic human health disorders. These people need lifelong health monitoring and, as a rule, the services of several specialists (multidisciplinary medical teams, MMC) [7].

The concept of integrative medical care for the population developed by the World Health Organization (WHO) justifies the need to form partnerships between medical workers and family members of a sick person. At the same time, part of the practical skills caring for a sick person is transferred to family members through training and the most complete informing the population about the causes of health disorders, measures for early diagnosis and prevention.

This approach has proven to be highly effective in practice, as it really helps stakeholders and decision makers find the optimal logistics in organizing a local public health system. [8].

The Main part. Odessa region [Figure1] is a highly developed industrial region, the industry of which plays a significant role in the structure of the national economic complex of Ukraine and the southern economic region. There are more than 400 large and medium-sized industrial enterprises in the region, which represent industries: from the production of oil refining products, mechanical engineering, metallurgical production and the production of finished metal products, the chemical and petrochemical industry, light industry and other areas.

The land fund of the region is 3.3 million hectares, including 2.6 million hectares (78.8%) - agricultural land. The river network of the region belongs to the basins the Black Sea, Dniester, Southern Bug. On the territory of the region, there are about 200 rivers more than 10 km long, many of which are subject to drying up in summer. The main rivers are Danube, Dniester, Kodyma and Savranka. The Danube Delta and the Dniester flood plains are swampy in places. Large rivers play of great economic importance for navigation, irrigation and hydropower.

Resort Resources. Odesa region occupies a leading place in Ukraine in terms of the wealth of resort resources. Favorable climatic conditions of the coastal zone, extensive beaches and the warm sea made it possible to create good climatic resorts here.

Geography. The Odesa Region is located on the vast territory of southern Ukraine, in the Black Sea lowland, gradually descending to the Black Sea, and captures the Black Sea coast in its northwestern part. Also, it is located on the southwestern part of the East European Platform, while the western and northern part of the Mediterranean folded geosynclinals belt. The wealth of mineral resources of Ukraine is due to the peculiarities of the geological structure of its territory.

The territory of the region is characterized by a variety of landscape and geophysical data. The region has a developed transport infrastructure (river and seaports, airfields, highways and railways), tourist and routes, extensive agriculture centers.

Administrative division. The region is stretched from north to southwest and until 2020 included 26 administrative districts and three natural physiographic zones: Forest-steppe (north), Steppe (east) and Trans-Dniester (southwest), differing in geological, ecological and socio-economic parameters [9](Pic. 1). The center of the region is the city of Odessa with a population of 1 million inhabitants. The population of the region as of January 1, 2021 was 2,368,107 people, including the urban population of 1,591,976 people, or 67.2%, the rural population of 776,131 people, or 32,8 % .

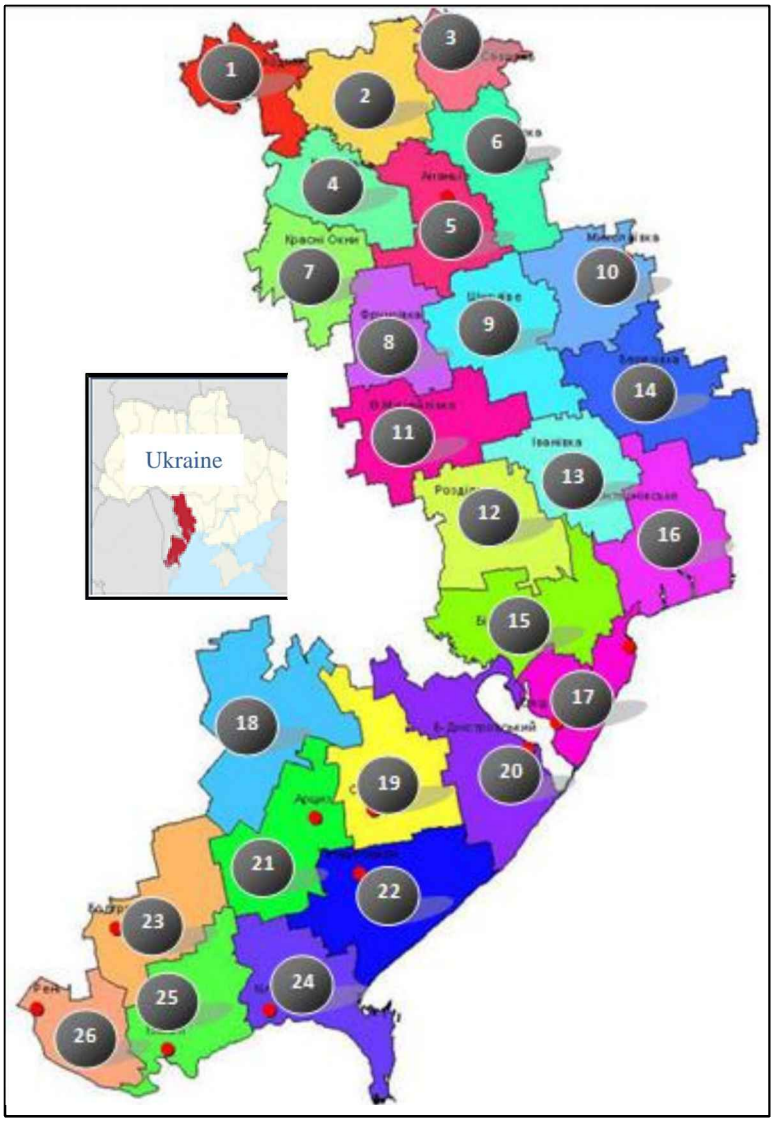

Figure 1. Administrative division of Odessa region

Districts of Odessa region	
1	Kodymsky
2	Baltsky
3	Savransky
4	Podolsky
5	Ananyevsky
6	Lyubashevsky
7	Oknyanskiy
8	Zakharyevsky
9	Shiryaevsky
10	Nikolaevsky
11	Veliko-mikhaylovsky
12	Razdelnyansky
13	Ivanovsky
14	Berezovsky
15	Belyaevsky
16	Limansky
17	Ovidiopolsky
18	Tarutinsky
19	Saratsky
20	Belgorod-Dnestrovsky
21	Artsyzsky
22	Tatarbunarsky
23	Bolgradsky
24	Kiliysky
25	Izmailsky
26	Reniysky

Geographic features of the Odessa region. According to the geological surveys conducted in 1985-1990, a number of structural-geological, geophysical, landscape-geological and hydrogeochemical anomalies were revealed on the territory of the Odessa region (the latter include zones of technogenic origin). The so-called "medical-geological anomalies" were identified - as zones with areas of mass diseases [10]. The most well-known and studied are anomalies and damage zones associated with imbalance and behaviour of chemical elements in water, soil, atmosphere, etc. (Table 1). These are areas with abnormal content of fluorine, lead, strontium and other elements.

Table №1

Geophysical and hydrogeological anomalies in the Odessa region [10]

Forest-steppe zone	
Administrative districs:	**1.** Balta-Ananyevskaya gravimagnetic anomaly with intensity up to 13,000 gamma and 15-20 mGal. **2.** Savransko-Lyubashevskaya magnetic anomaly with intensity up to 8000 - 14000 gamma. Mosaic gravitational field up to 20-30 mGal. ✓ *Point and area anomalies of the contents of uranium, radon, copper, lead and mercury, strontium, americium (Pic.4A)*
Ananyevsky	
Baltsky	
Kodymsky	
Podolsky	
Oknyanskiy	
Lyubashevsky	
Savransky	
Steppe zone	
Administrative districs:	**3.** Zakharyevsko-Velikomikhailovsky magnetic anomaly up to 3000 - 8000 gamma. Gravitational field 20-40 mGal. **4.** Ivanovo-Shiryaevskaya anomaly is a gravitational anomaly of complex structure. Negative gravity anomaly 15-20 mGal. Alternation of large negative magnetic anomalies with small positive anomalies of 150-400 gamma. **5**. Zakharyevskaya hydrogeological* anomaly in combination with soil pollution with pesticides. ✓ *Gvozdavsky and Odesa fault (the territory of Lyubashevsky, Nikolaevsky and Berezovsky districts) - a zone of increased permeability of the earth's crust.*
Berezovsky	
Veliko-mikhaylovsky	
Ivanovsky	
Nikolaevsky	
Razdelnyansky	
Zakharyevsky	
Shiryaevsky	
Trans-Dnistrian zone	
Administrative districs:	**6.** Liman hydrogeological anomaly, combined with soil pollution with pesticides. **7**. Artsyz-Tatarbunarskaya zone - structural - tectonic anomalies, hydrogeological anomalies, soil pollution with pesticides. **8**. Belgorod-Dniester hydrogeological anomaly. **9**. Kiliya hydrogeological anomaly ✓ Point and area anomalies of uranium content (Pic.4A)
Artsyzsky	
Belgorod-Dnestrovsky	
Belyaevsky	
Bolgradsky	
Izmailsky	
Kiliysky	
Limansky	
Ovidiopolsky	
Reniysky	
Saratsky	
Tarutinsky	
Tatarbunarsky	
**Note: Hydrogeological anomalies associated with ammonia and nitrate pollution groundwater [10].*	

Geochemical causes explain the massive appearance of such diseases in people as caries, silicosis, diseases of the spine, digestive organs, blood diseases, etc.

According to a study on the characteristics of landscape complexes in Ukraine, assessed as objects for assessing the impact of chemical elements on human health, the

Odesa region belongs to the so-called ecological and geochemical province depleted in zinc (Zn), molybdenum (Mo) and cobalt (Co): "Zn, Mo, Co - province" in the Forest-steppe and Trans-Dniester zones [9]. A targeted program of the national study of Ukraine, dedicated to the relationship between the geochemical composition of soils and the health status of the population living in these areas, it was found that for provinces with Zn, Mo, Co - deficiency, such diseases in children as anaemia, nephritis and diabetes can be nature of the endemic. At the same time, an endemic focus should be understood as an area where certain diseases are recorded with more or less constancy for a long time [10]. Figure 2 shows the adverse environmental factors in various zones of the Odessa region. It can be seen that the greatest environmental load falls on the Forest-Steppe zone, where, along with gravitational and magnetic anomalies, there are faults in the earth's crust and many point soil anomalies containing uranium, radon, mercury, lead, copper and cesium.

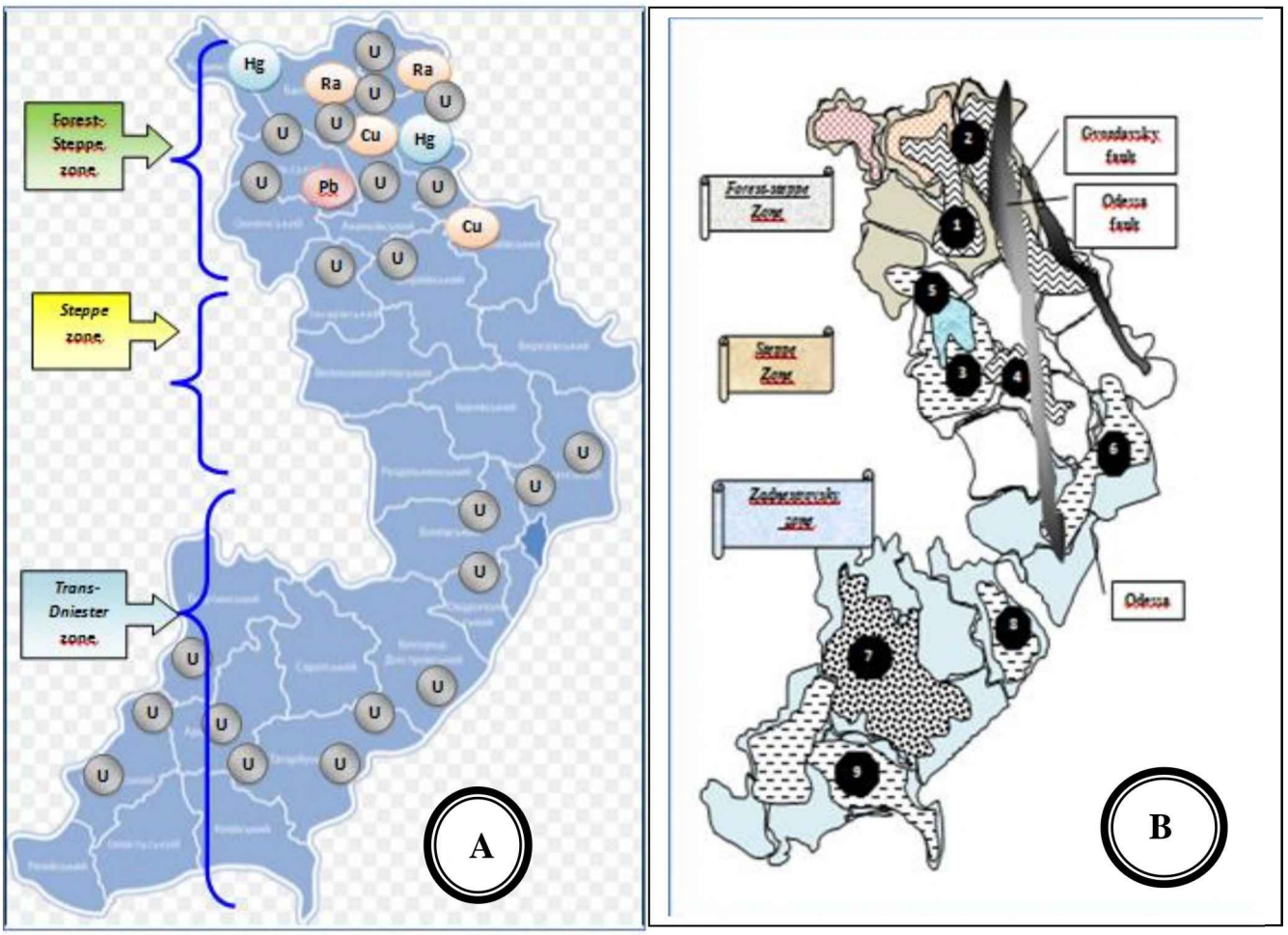

Figure 2. Point and area anomalies of the contents of uranium, radon, copper, lead, mercury, strontium, americium (A); Geophysical, landscape-geological and hydro-geochemical anomalies of Odesa Region (B).

The Transnistrian zone also, in addition to hydrogeological anomalies, contains a large number of point deposits of uranium ores.

The most favourable situation is the Steppe zone, which is crossed by two faults in the earth's crust: Gvozdavsky and Odessa.

Assessment the state of health the population of Odessa Region. Regional health authorities for a long time used the annual collection of information, traditional for the budget system, reflecting the state of population health.

Assessment the state of health the population of Odessa Region. Regional health authorities for a long time used the annual collection of information, traditional for the budget system, reflecting the state of population health. At the same time, the settlements were located in a column in stable alphabetical order, and the information of interest to the administration of the region was located in the next column of numbers. Such an administrative approach made it possible to quickly calculate the average level of the region indicator, identify the rating of the districts, the highest and lowest levels of the indicator values. This method levelled the territorial features the health indicators of the population and did not combine them with the features of the area where people live. All identified differences were interpreted from the point of state paternalism view: the degree of equipment (the number of beds in district hospitals) and the staffing of medical institutions: doctors, nurses, laboratory assistants.

Rare attempts to link the geographical features of the region and the incidence of the population did not receive support from the regional administration.

The disunity of the sanitary service and the practical activities of state and regional medical institutions also slowed down interest in geographic information systems for a long time.

In 2017 territorial asymmetry was revealed in the prevalence of diseases associated with the short stature of children. A significant excess of the average regional level of children with growth hormone deficiency (GHD) was found in the forest-steppe zone of the Odessa region [9, 11].

In the present study, a different methodological approach was carried out, retrospective, based on data on the entire population of the Odessa region for 1980, 1990 and 1995. The work used open data from the organizational and methodological department of the Health Department of the Odessa Regional State Administration.

For a graphic representation prevalence of the most frequent diseases in the Odessa Region, we used the coding of pathological conditions based on the International classification of Diseases and Causes of the Death 10th edition. The prevalence of the following health disorders by geographical areas was studied: malignant, cerebrovascular and endocrine diseases, mental disorders, diseases of the nervous system, cardiovascular, digestive, respiratory, musculoskeletal, hypertension, coronary heart disease, diabetes mellitus, liver cirrhosis, congenital anomalies.

The visualization of statistical data, based on the requirements of the GIS method, clearly demonstrated a significantly higher morbidity in the geopathogenic Forest-steppe zone of Odessa region (Figure 3), where prevalence of diseases was 1,5-2,0 times higher. The minimum morbidity of the population was noted in the Steppe zone.

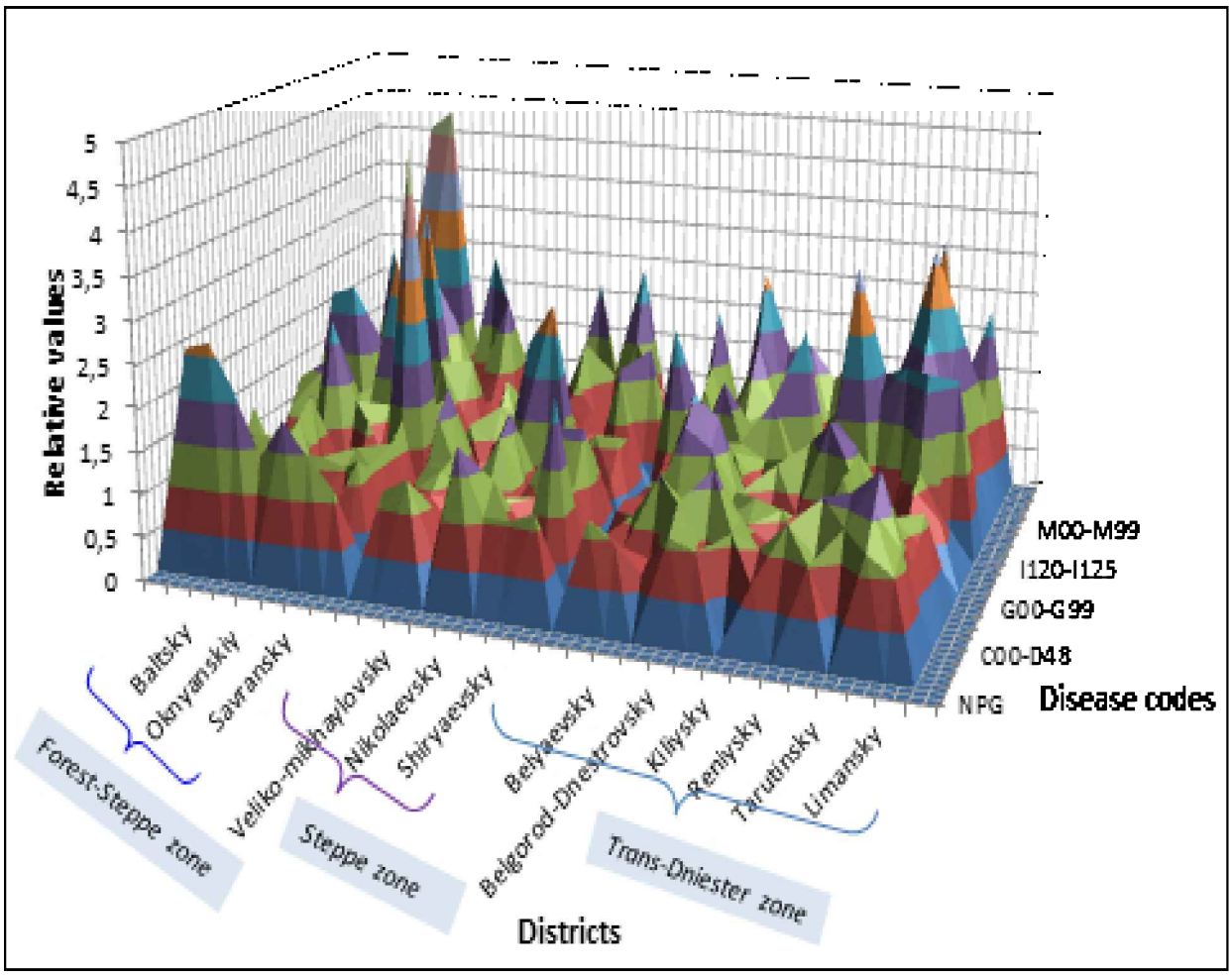

Figure 3. Visualization of the uneven distribution of diseases among the population of various districts of Odessa region. The predominance the level of diseases in the forest-steppe zone is noticeable.

Conclusions.

1. The use of GIS principles in medical management helps to form optimal epidemiological logistics: monitoring the health status of the population, distributing medical services and forming patient routes.
2. The presence of natural hazards implies the organization of a continuous and multidisciplinary local public health support service.
3. The organization of obtaining reliable, objective information about the geophysical features the area of residence, the presence of geopathic factors allows health authorities to draw up a long-term strategy for minimizing the harm caused by natural factors to health.
4. Using foreign positive experience, it is expedient to create and develop social programs and reference networks at the regional and national levels with the participation of both governmental structures and non-governmental public organizations.

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