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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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GIS TECHNOLOGIES IN THE STUDY OF NATURAL RESULTS ESPECIALLY DANGEROUS DISEASES IN KAZAKHSTAN

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Abstract.

Introduction: This study explores the application of GIS technologies in analyzing and visualizing spatial structures of especially dangerous infections (EPI) in Kazakhstan. International collaborations have facilitated projects studying the focal patterns of diseases, improving data analysis and visualization. Extensive electronic databases resulting from field research on EPI foci have elevated the study's depth. The dynamics of natural foci, influenced by intraspecific structures of infection carriers, are impacted by industrial and agricultural developments, urban expansions, and climate change. The study notes changes in the enzootic territory, affecting mammal migration and consequently altering natural focus boundaries. Industrial activities, rotational methods, and habitat changes contribute to the increased epidemic potential in enzootic areas. Despite anthropogenic and climatic influences, the prevalence of plague remains high in Kazakhstan, with a trend towards expanding enzootic territories.

Materials and Methods: Unified electronic databases on plague, tularemia, anthrax, and other zoonoses, developed for GIS analysis, enable mapping and visualization of natural foci. Electronic maps aid in determining enzootic territory boundaries, assessing infectious disease activity, and planning preventive measures based on risk assessment. ESRI's ArcGIS Desktop 10.8 with Arc Toolbox modules facilitated data processing in the geoinformation environment. Data includes epidemiological examination results, species composition of carriers, and laboratory test outcomes, enhancing comprehensive analysis and decision-making for anti-epidemic measures.

Results and Discussion: The study in Kazakhstan identifies and details six natural and twenty autonomous plague foci, categorizing them by main carriers and observing an expansion of natural hotspots. The enzootic territory is classified into four geographic zones, further divided into 105 landscape-epidemiological regions. Laboratory studies inform electronic maps for analyzing plague's dynamic situation. Anthrax prevalence, primarily in chernozem and chestnut soils, is assessed, revealing 1,778 unaffected settlements and spatially clustered points. An epidemiological index aids in zoning for anthrax trouble. Tularemia's landscape occurrence is classified into four types, with spatial analysis revealing clusters and potential epidemic danger in specific regions. Geographic information technologies highlight high-risk areas, justifying preventive measures for dangerous infections.

Conclusion: The results obtained serve as a scientific justification for the priority of preventive measures within the boundaries of administrative territories characterized by a high degree of potential epidemic danger and objectively indicate the prospects for the introduction of GIS technologies into the practice of epidemiological surveillance of particularly dangerous infections.

Key words. GIS technologies, especially dangerous infections, focal patterns, electronic databases, enzootic territory.

Introduction.

In recent years, GIS technologies have been increasingly used in work and in scientific research on particularly dangerous infections carried out by anti-plague institutions of the Republic of Kazakhstan. These works were initiated thanks to international cooperation, as a result of which, together with foreign scientists, a number of projects were carried out to study the spatial structure of the foci of diseases. Since the introduction of the Geographic Information System (GIS), it has become a powerful tool for solving many geospatial problems, which makes it possible to collect, visualize and analyze large volumes of geospatial data. Extensive electronic databases have been created, which brings their study to a higher level.

Plague and some other particularly dangerous and zoonotic infections, as a natural phenomenon, exist in the form of natural foci. The spatial structure of natural foci is largely determined by the intraspecific structure of the population of the main carriers of infection. The conditions for the existence of vector populations and the pathogen itself depend on it [1].

In recent decades, due to the increasing influence of anthropogenic factors associated with agricultural and industrial development of territories, human impact on nature is becoming more diverse, and its pace is increasing. Along with traditional types of economic activity – animal husbandry and agriculture, industrial development of the territory is carried out – mining, expansion of the boundaries of cities, creation of new industrial zones. These factors influence changes in the structure of the population, the development of the transport network, etc., which entails the migration of mammals inhabiting these areas, which are carriers of pathogens of various infections. Global climate change, which has led to the change of vegetation cover in some regions and the landscape in some regions, cannot be discounted. As a consequence of the above, the territories of natural foci of OOI change their borders.

Intensive development of focal areas has an impact on the spatial and biocenotic structure of natural foci, which can lead to activation and increase the stability of foci sites. The development of an enzootic plague-prone territory leads to an increase in the epidemic potential of focal areas due to such social factors as an increase in the activity of migration processes among the population, the development of communications, the sphere of social and household purposes, the creation of joint ventures with foreign investors for the extraction and processing

of mineral raw materials, with the introduction of the shift method, creating real conditions not only for infection people, but also for the removal of infection outside of natural foci, in addition, rodents in desert areas – plague carriers intensively populate the dried-up areas of floodplains of rivers and the bottom of the Aral Sea. The tendency to expand the boundaries of foci acts against the background of increased anthropogenic impact on natural landscapes and gives every reason to assume the possibility of further expansion of the boundaries of foci and the circle of carriers. To resolve the issue of the epizootic status of a potentially focal area, additional research using modern methods is needed. The activity of natural plague foci in Kazakhstan currently remains high, however, in recent decades, there has been a tendency to expand the boundaries of the enzootic territory, which is mainly caused by climate change, leading to a change in vegetation cover, a change in the chemical composition of the soil, as well as human development of the territory. All these factors are of great importance for carriers to choose the optimal habitat and, as a result, affect the change in the boundaries of plague foci [2].

Materials and Methods.

The creation of unified electronic databases on the epizootic and epidemic activity of natural foci of plague, tularemia, anthrax and other zoonoses is the basis for working in a GIS environment. The development of electronic maps of natural foci of the listed diseases visualizes the results obtained and helps analyze the data obtained. With the help of electronic mapping, the exact boundaries of the enzootic territory are determined, and an analysis is carried out to assess the epizootic activity of natural foci of infectious diseases. The obtained research results are used to differentiate the territory according to the degree of risk of infection of people and are the basis for planning sanitary and preventive (anti-epidemic) measures [3]. Replenishment of electronic databases with the results of epidemiological examination is carried out by filling out previously developed, uniform for the entire anti-plague service, spreadsheets in Excel format, which provide for the placement of complete attributive information - on the location, extent, and intensity of the annual epidemiological examination, as well as the results of laboratory tests obtained. The tables contain data on the species composition of caught warm-blooded carriers and carriers of infections, the coordinates of the places where they were caught, a landmark (address), and the results of laboratory tests.

To process data in the geoinformation environment, the software developed by ESRI, Inc. (USA) - ArcGIS Desktop 10.8 with Arc Toolbox modules-Spatial Analyst, Spatial Statistics, Analysis was used.

Results and Discussion.

Over many decades of the plague-enzootic territory located within the borders of the Republic of Kazakhstan, 6 natural and 20 autonomous plague foci were identified and described in detail (Figure 1).

According to the type of the main carrier, the territory enzootic for plague is divided into 4 groups - gophers, gerbils, marmots and mixed - field vole-gopher-marmot plague foci (Figure 2). All of them are unequal in the degree of activity of the manifestation of the epizootic process and epidemiological significance. In recent years, desert foci with the main carrier - the great gerbil (Rhombomys opimus).

In recent years, the area of natural hotspots has increased by more than 110,000 sq. and this trend continues, especially along the northern and eastern borders of the plague-enzootic territory due to the peripheral populations of the main carriers of the infection (great gerbil, small gopher, gray and red marmots) [4].

Based on the totality of soil and climatic indicators, geomorphological structure and relief, the plague-enzootic territory in Kazakhstan is divided into four natural geographic zones: mountain, foothill, steppe, and forest-steppe, each of which differs in soil types, relief, and vegetation cover, affecting the quality and type of vegetation that forms the food supply for rodents that are carriers of plague. In turn, each plague focus, based on the combination of all these factors, is divided into landscape-epidemiological regions (LER). Each LER within one plague focus is different from another. In total, there are 105 such sites on the territory of natural plague foci (Figure 3).

Based on the results of laboratory studies of the examination of natural plague foci, electronic maps are being developed that make it possible to manipulate the obtained data for various types of analysis - visualization of the epizootic situation today (Figure 4), retrospective analysis and forecast for the next season.

Almost every year, human cases of anthrax are recorded in Kazakhstan. One of the main factors characterizing the epizootological and epidemiological situation in the Republic of Kazakhstan regarding anthrax is information about the number of years of anthrax activity in these points. The relative incidence rate of anthrax in humans in the last decade ranged from 0.01 to 0.24 per 100 thousand population.

On the territory of Kazakhstan, 1,778 permanently unaffected settlements with anthrax are registered, 2,433 epizootic foci (where animals were infected), about 2,000 soil ones, where animals that died from anthrax are buried [5] (Figure 5).

In Kazakhstan, the administrative territories most unfavourable for anthrax are located in the zone of distribution of chernozem and chestnut soils, that is, in the forest-steppe and steppes, as well as in the high-altitude mountain zone (Figure 6). Outbreaks of anthrax are not recorded in places located above 2000 m above sea level [7].

In past years, burial sites for dead livestock, slaughter or death were carried out without the necessary procedures to prevent the spread of the pathogen, which led to the formation of anthrax foci. The persistence of the pathogen in the soil is facilitated by climatic, soil and geographical conditions. A higher number of IDPs is observed in territories with developed livestock farming - in the south of Kazakhstan, where sheep farming is developed and there is a high population density, and in the northern regions, where mainly cattle are raised (Figures 7 and 8).

To determine the level of trouble in the territory of Kazakhstan with respect to anthrax, a generalized indicator (epidemiological index) was used, characterizing the intensity of the epizootic and epidemiological situation, and taking into account both the proportion of troubled points and the degree of their activity, which was calculated using the formula:

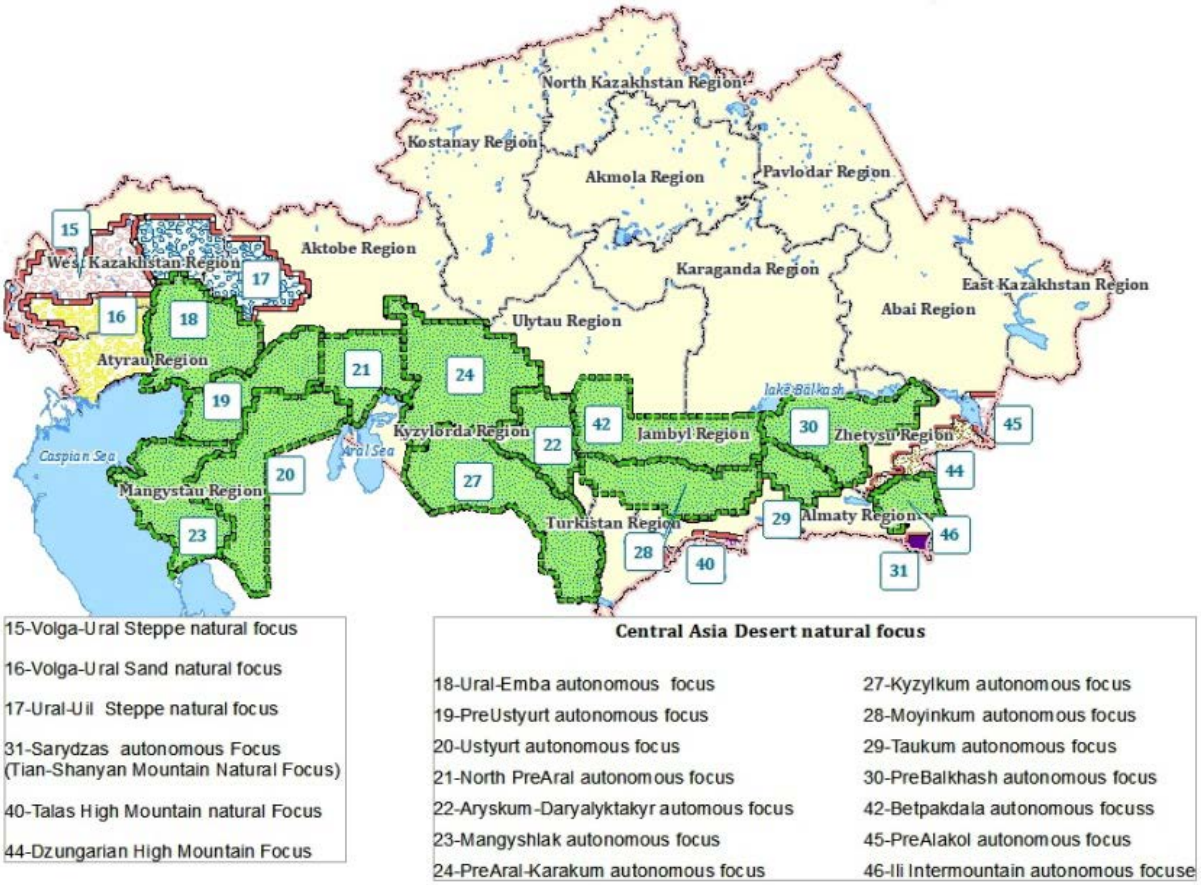

Figure 1. *Foci of plague on the territory of the Republic of Kazakhstan.*

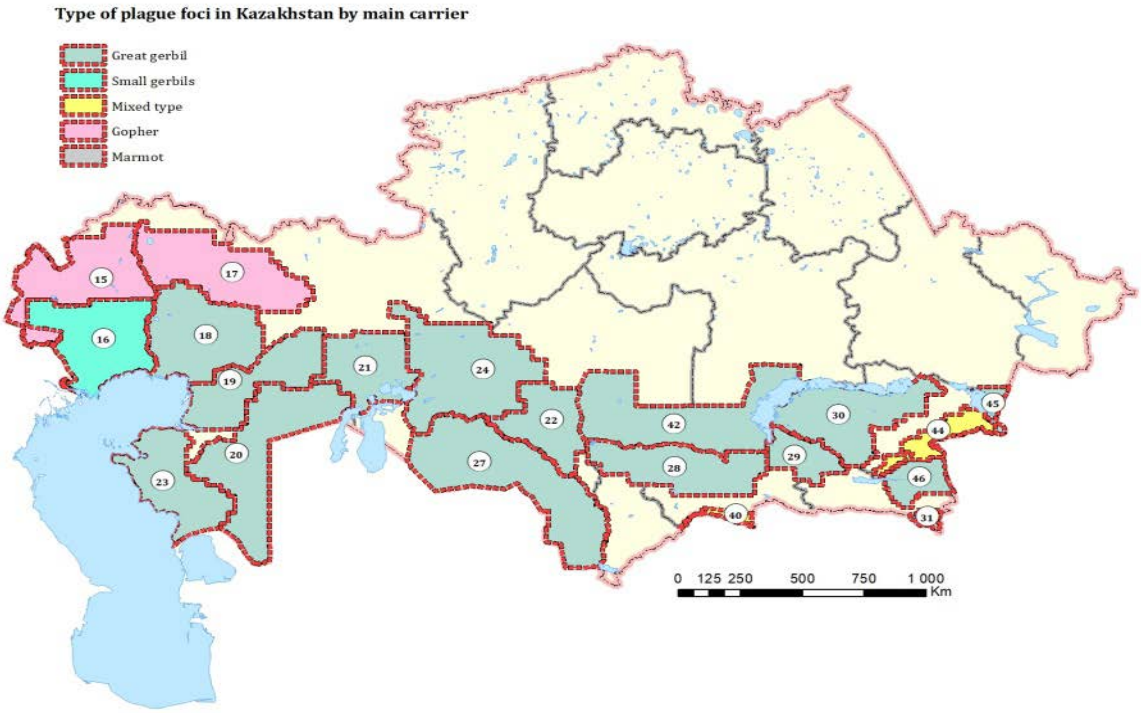

Figure 2. *Typification of plague foci according to the main carrier.*

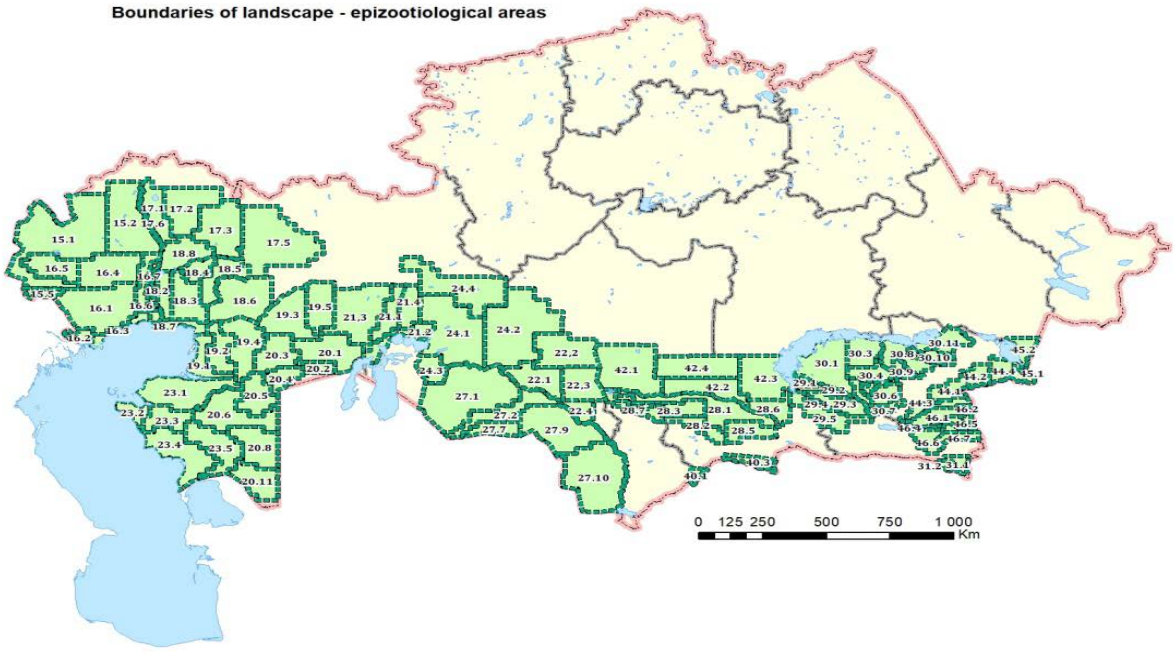

Figure 3. *Division of the territory of natural plague foci according to landscape type into landscape-epidemiological regions (LER).*

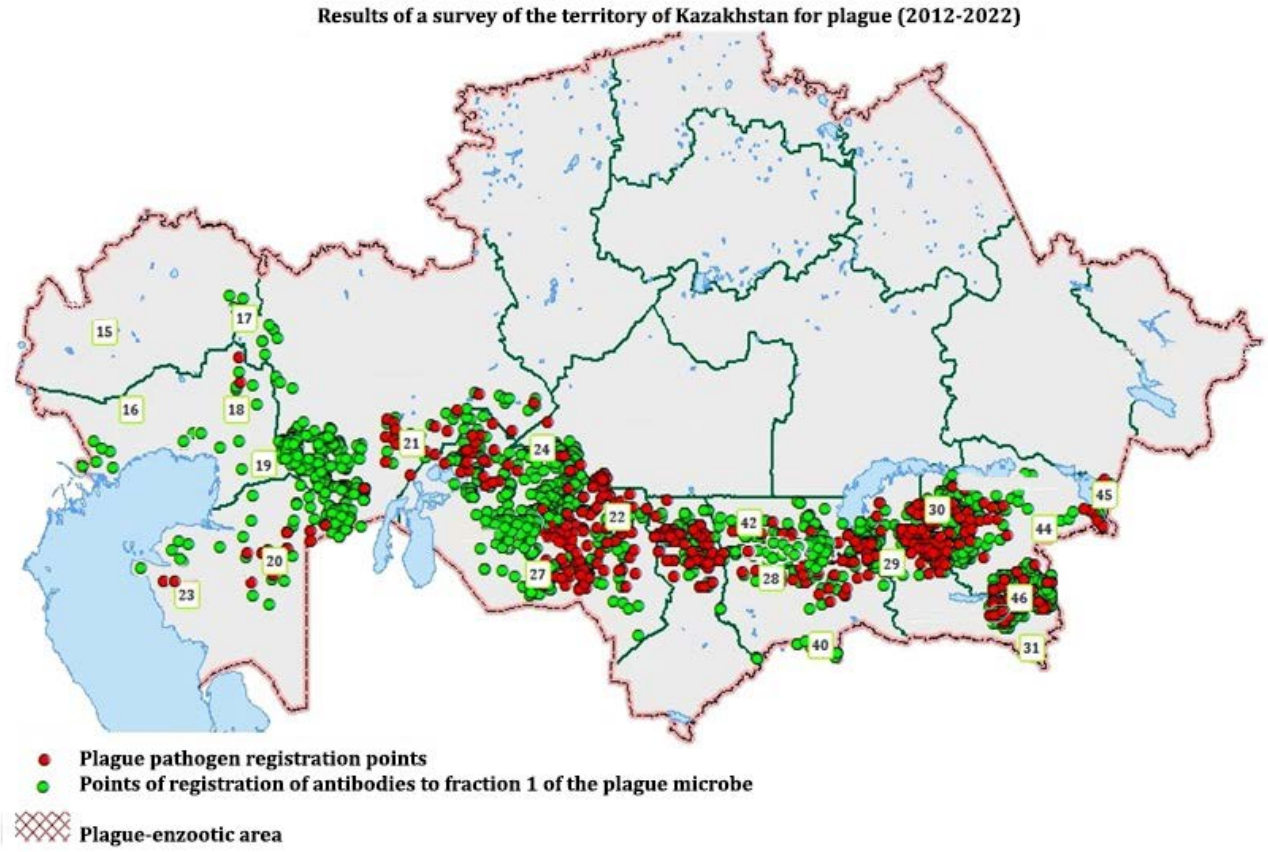

Figure 4. *Results of a plague survey of the territory of Kazakhstan for the period 2012-2022.*

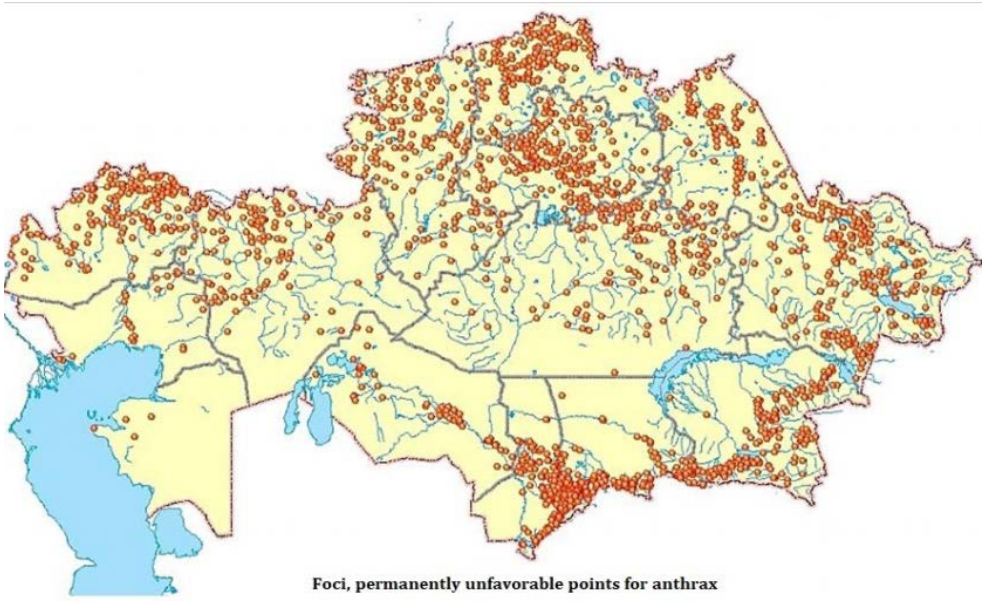

Figure 5. *Territorial distribution of Inpatient dysfunctional anthrax points (IDP) (by region) on the territory of the Republic of Kazakhstan.*

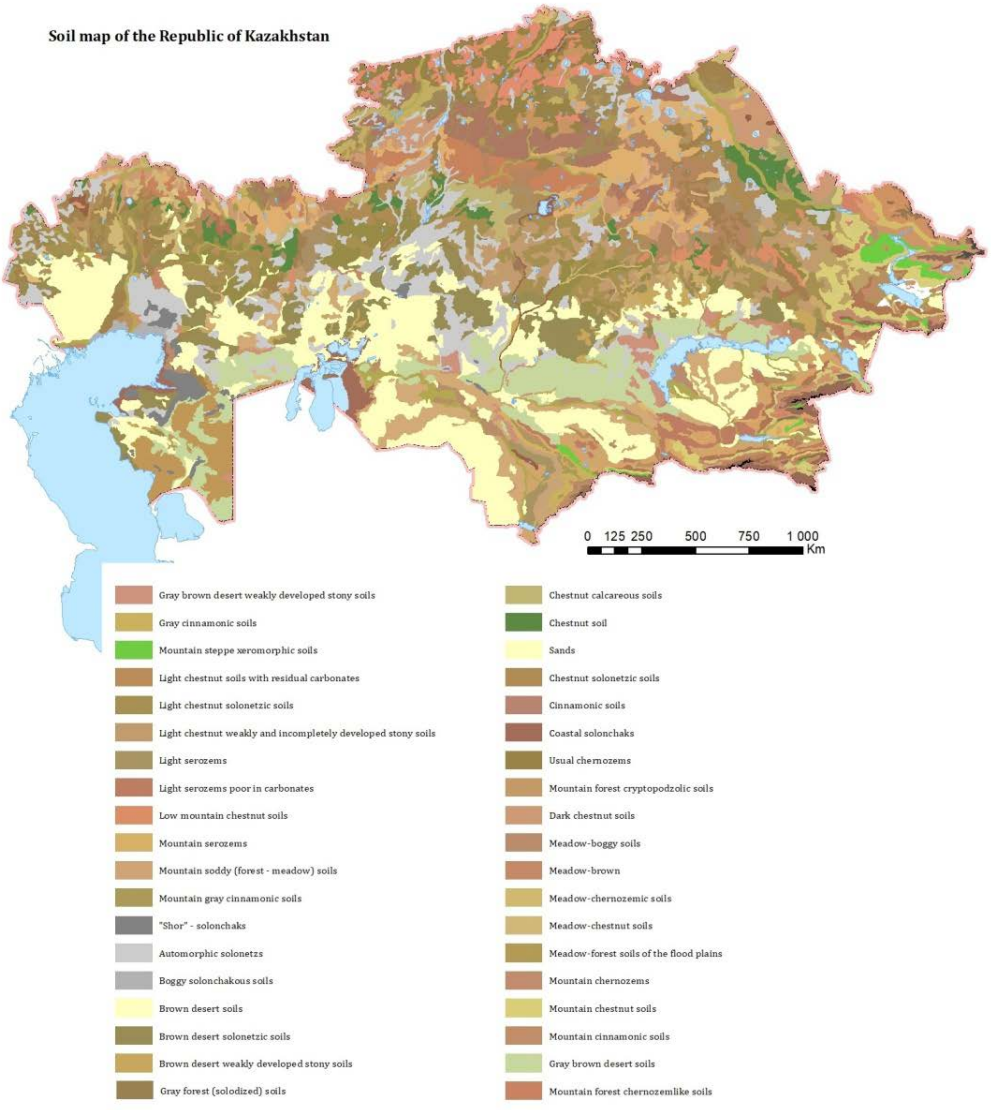

Figure 6. *Main types of soils on the territory of Kazakhstan.*

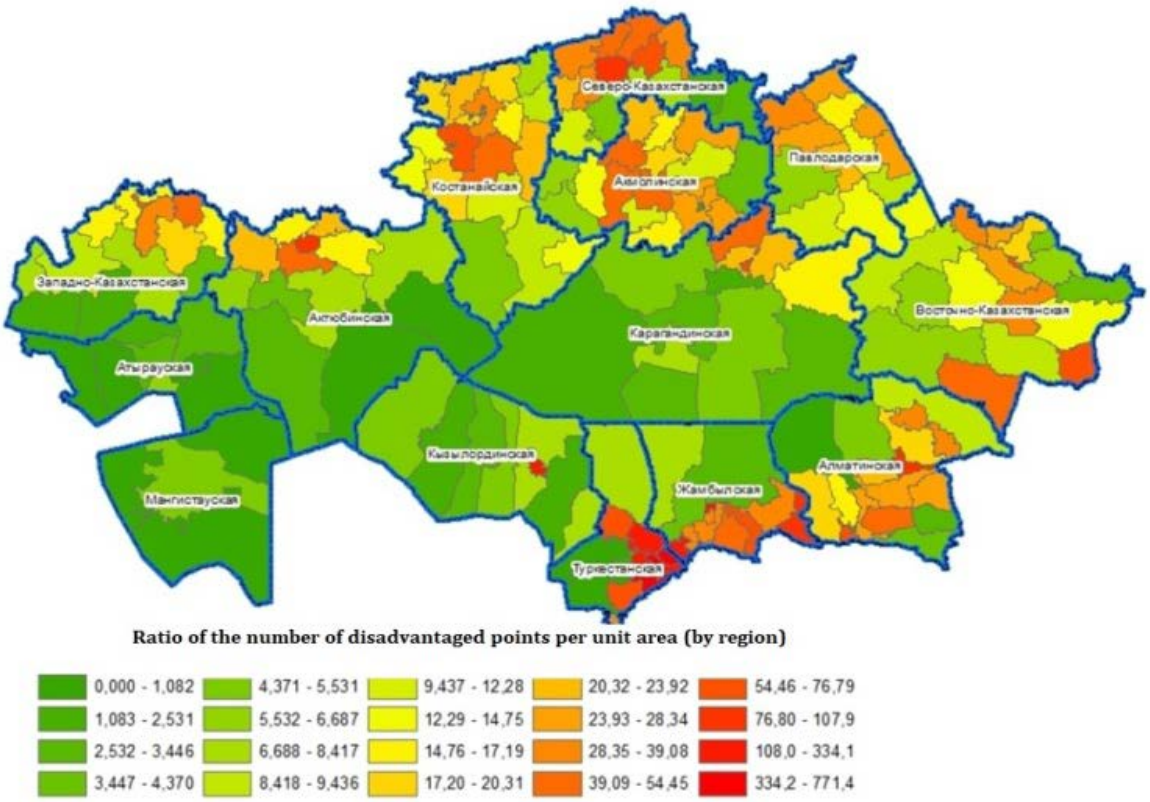

Figure 7. *Quantitative distribution of IDP for anthrax in the Republic of Kazakhstan.*

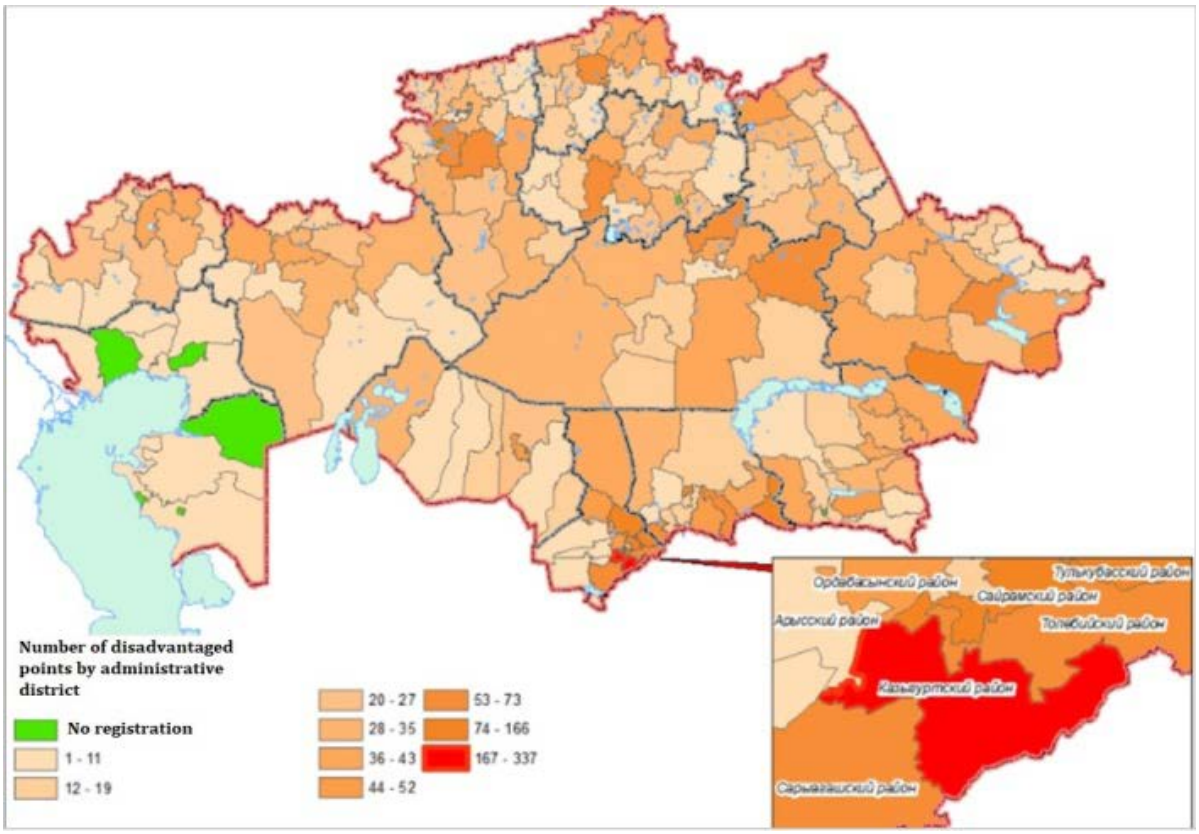

Figure 8. *Distribution of IDP on anthrax in quantitative terms by administrative regions.*

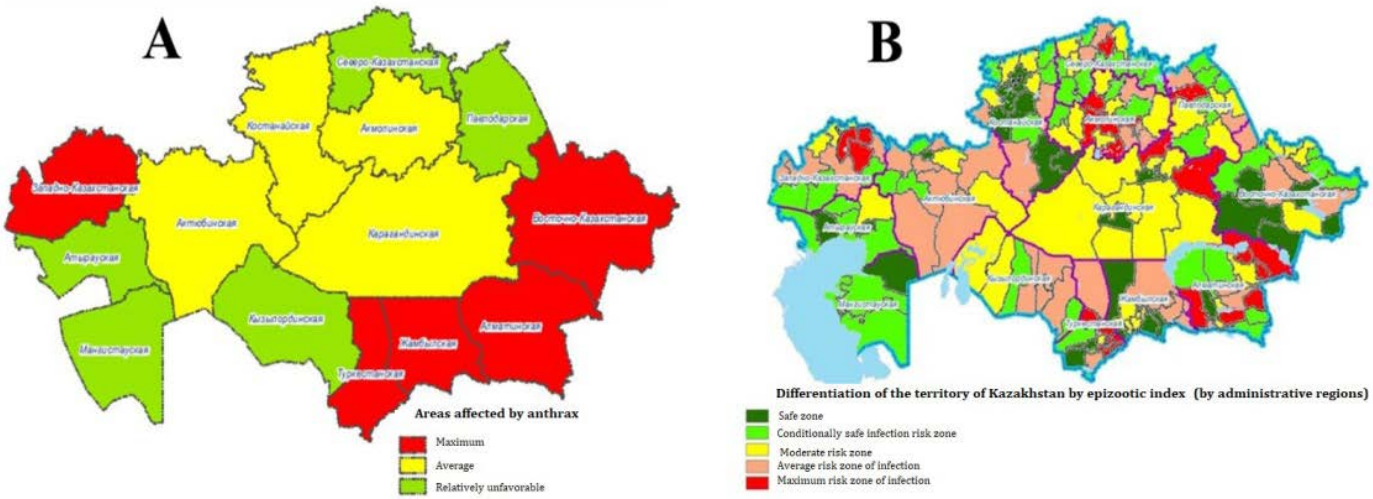

Figure 9. *Differentiation of regions of Kazakhstan according to the degree of freedom from anthrax (A - regions, B - administrative districts).*

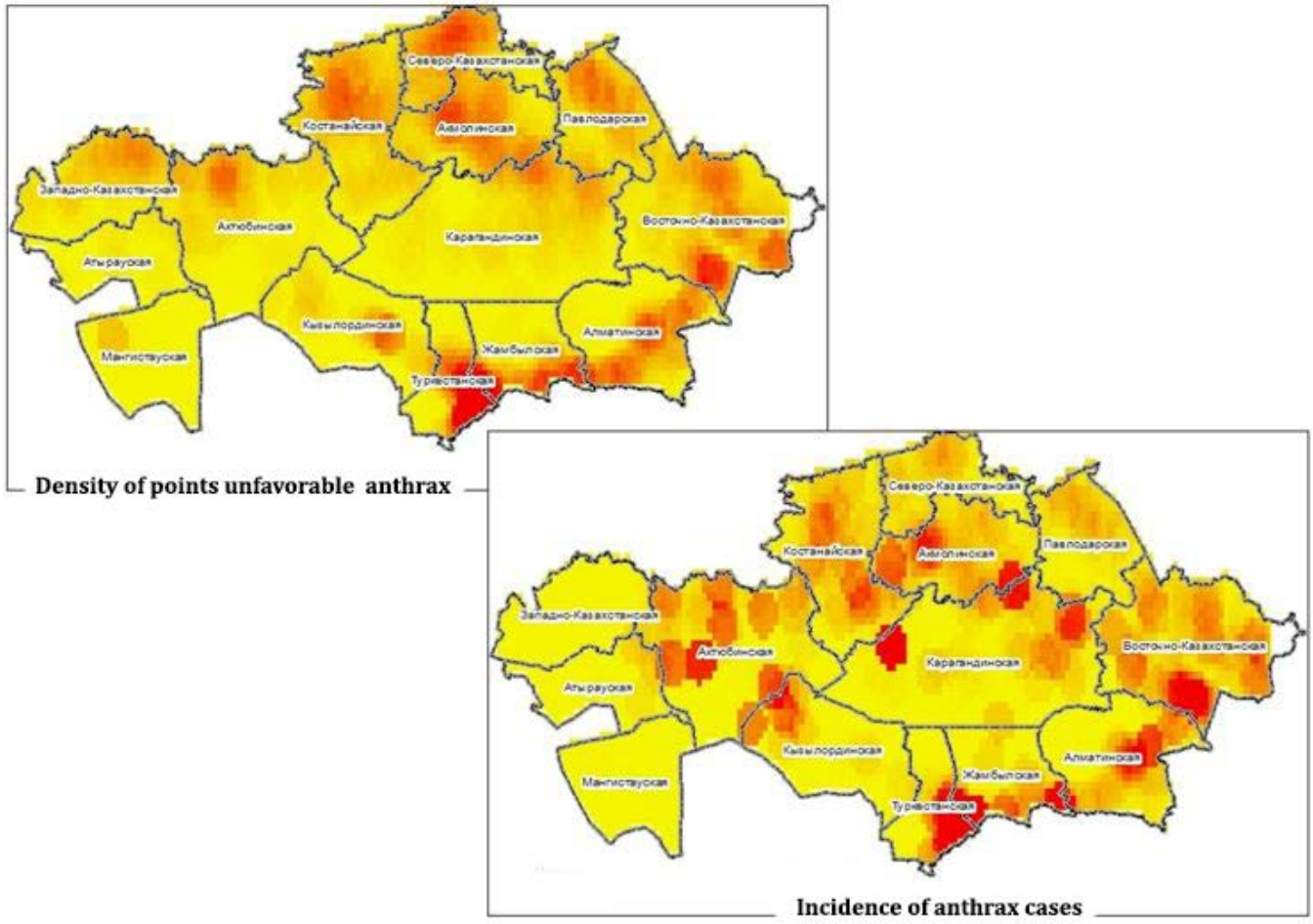

Figure 10. *Density of incidences and frequency of anthrax registrations on the territory of Kazakhstan.*

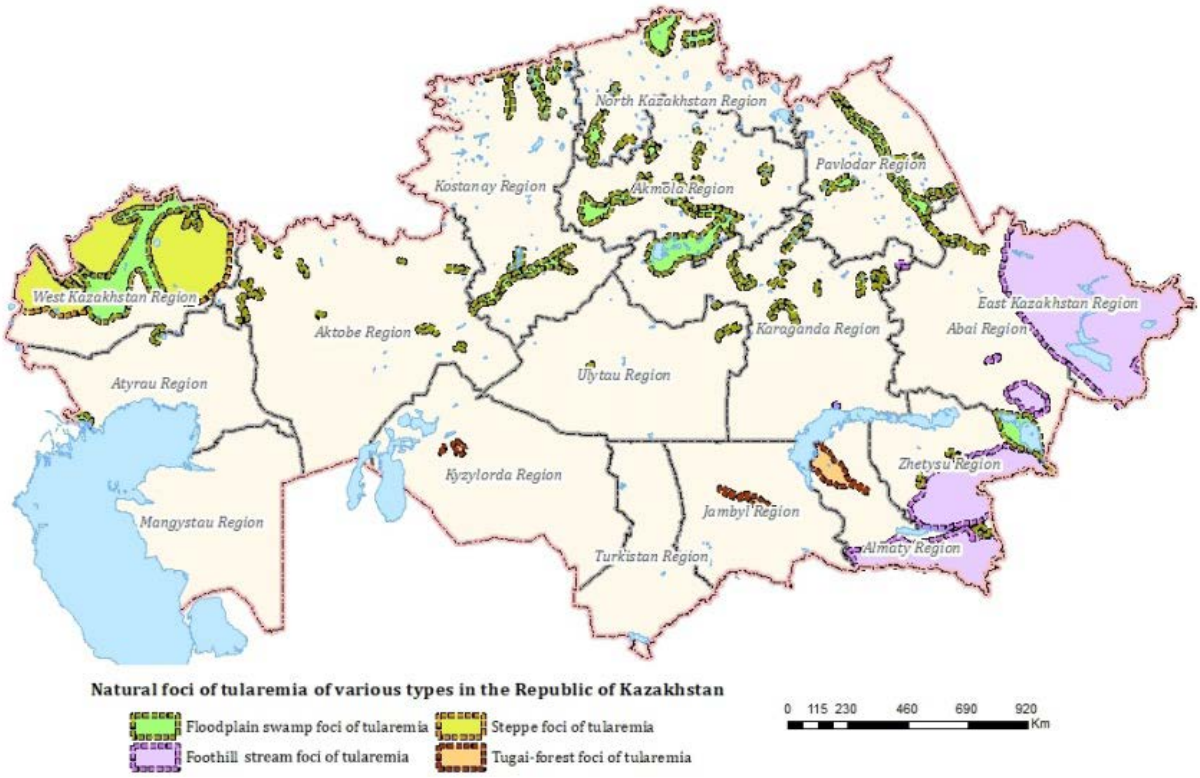

Figure 11. *Types of natural foci of tularemia on the territory of the Republic of Kazakhstan.*

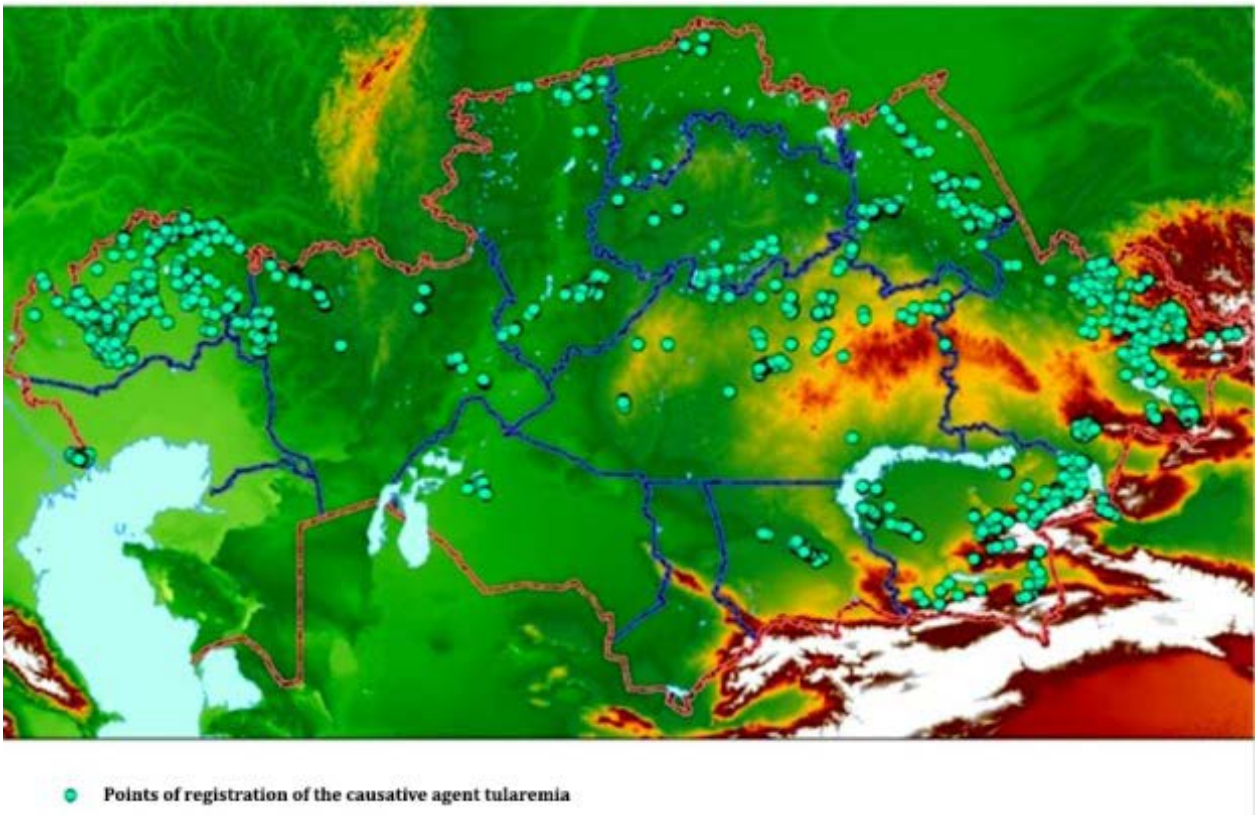

Figure 12. *Landscape map of Kazakhstan with registration points F.tularensis.*

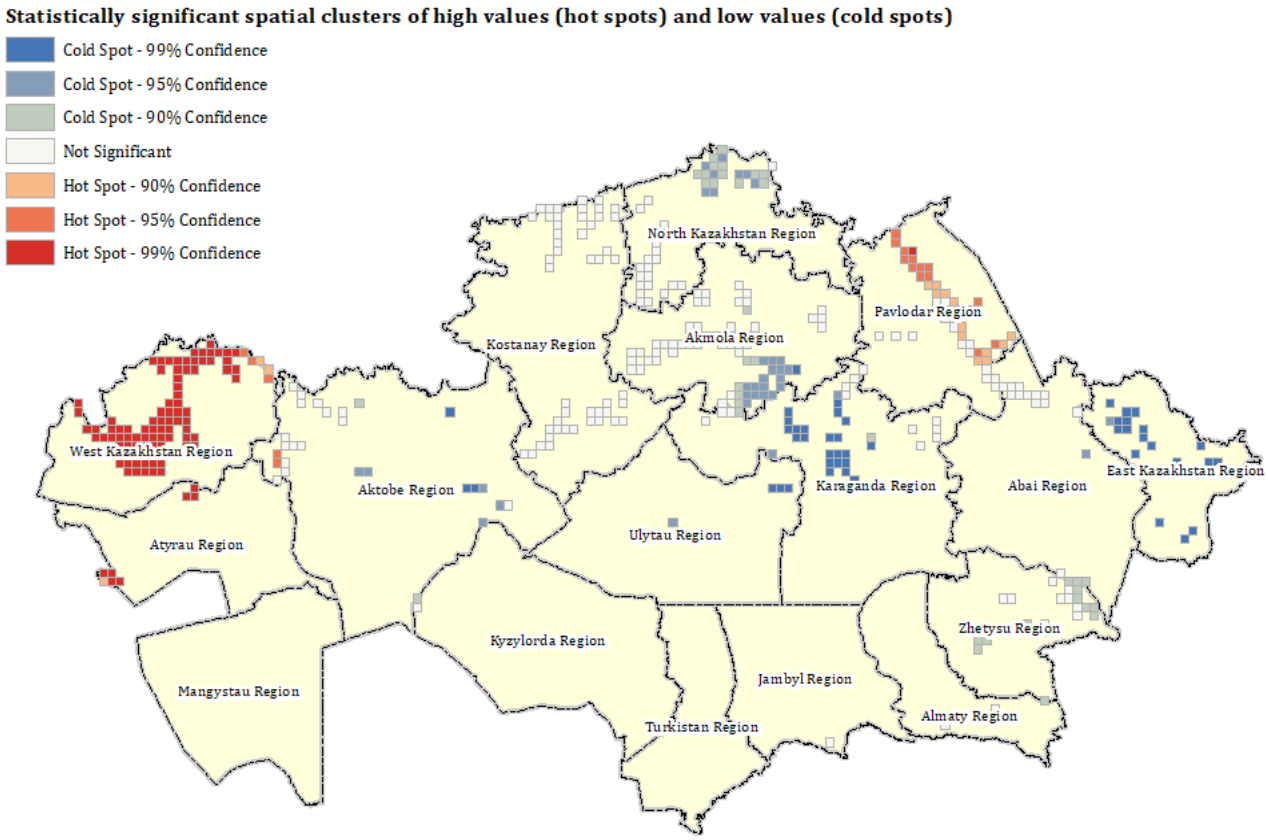

Figure 13. *Identification of "hot" and "cold" clusters on the territory of Kazakhstan.*

Figure 14. *Differentiation of territory according to the degree of activity of natural foci of tularemia.*

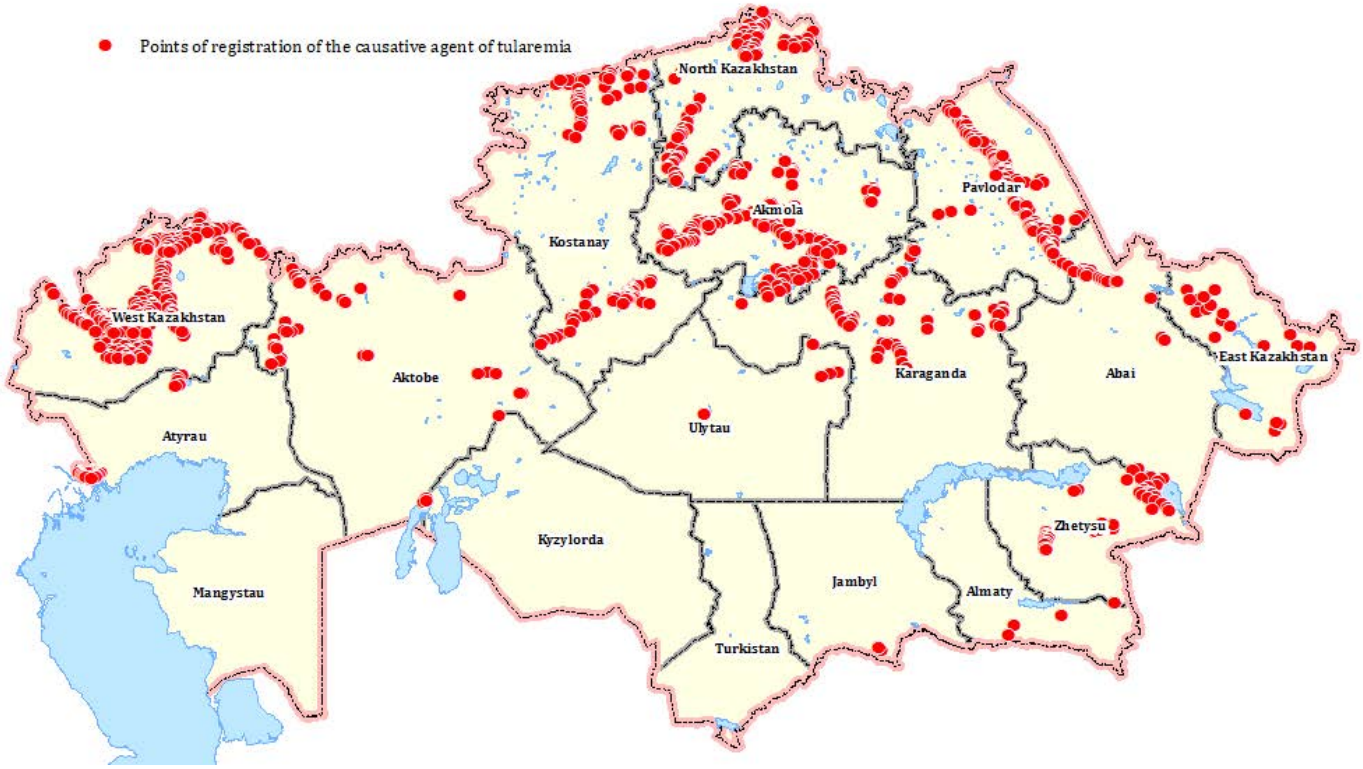

Figure 15. *Points of registration of the causative agent of tularemia on the territory of the Republic of Kazakhstan.*

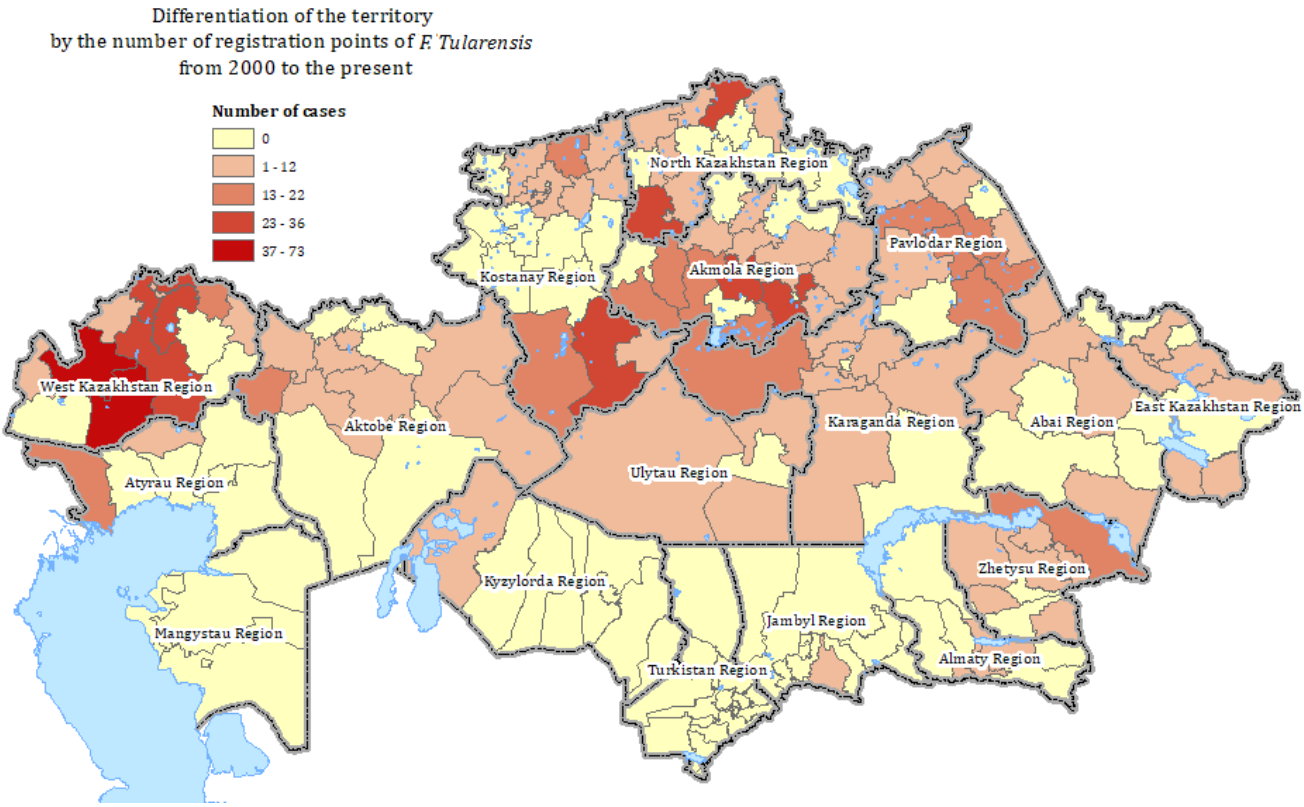

Figure 16. *Differentiation of the territory by the number of registration points of F. Tularensis (by administrative districts).*

$$È.Ý. = \frac{n \times t}{N \times T},$$

where I.E. – epizootic index

n – number of points that showed activity during the observation period

t – number of years during which manifestations of activity were observed

N is the number of all settlements in the study area

T – number of years of observation [6,7].

As a result, an epizootological and epidemiological zoning of the territory of Kazakhstan was carried out according to the degree of anthrax trouble by administrative districts and regions (Figure 9).

When processing the same data using the Spatial module Analyst for visualizing the density of the location of IDPN on the territory of the Republic of Kazakhstan and the number of years of repeated infections in the same territory, it is clearly seen that the results obtained correspond to those obtained when ranking by the epizootic index (Figure 10).

When studying data on tularemia in the geoinformation program, a study of the epidemic and epizootic situation on tularemia in Kazakhstan in the period from 2000 to 2020 was carried out and the epidemiological status of tularemia was determined in the territory of all regions of the Republic of Kazakhstan, a comparative retrospective analysis of the epizootic and epidemic situation was carried out, a list of all populated areas was compiled points located in the territories of all 50 natural foci of tularemia, the area of each foci was calculated.

Landscape and geographical features of Kazakhstan - humidity, temperature conditions and vegetation cover, which contribute to the settlement of carriers and carriers of the disease and the rooting of the pathogen in natural conditions, contribute to the wide spread of tularemia in the territory of the Republic. The landscape occurrence of tularemia foci is represented by four types of foci: foothill-stream, floodplain-marsh, tugai and steppe (Figure 11) [8].

As a result of an analysis of the landscape location of areas of persistent manifestation of tularemia, it was found that most often manifestations of tularemia are recorded in the valleys of large and small rivers, wetlands on podzolic, bog-podzolic, soddy-slightly podzolic and soddy-medium podzolic soils (Figures 12 and 13).

Tularemia pathogen reports from 1980 to 2020 were examined for clustering using average nearest neighbour analysis. Clustering was detected ($z = -6.32514$, $P < 0.00$). The results of the Getis-Ord analysis showed hot spots (areas of high density of cases) near the west of Kazakhstan and cold spots (areas of low density of cases) in the central, south-eastern, north-eastern, and eastern regions (Figure 13).

Based on the results of an analysis of the spatial characteristics of epizootic and epidemic manifestations of tularemia, the territory of Kazakhstan was divided into regions according to the degree of activity of natural foci of tularemia and the number of cases of registration of the pathogen. The territory with a high degree of potential epidemic danger includes a group of 6 regions of Kazakhstan - West Kazakhstan, North Kazakhstan, Pavlodar, Akmola, East Kazakhstan, and Almaty regions (Figure 14) [9].

Available data on the coordinates of terrain points where the presence of the pathogen was registered (from carriers or carriers of F. tularensis) and settlements within the boundaries of which cases of tularemia were noted (Figure 15) were processed by the Spatial application Analyst. As a result, an electronic map was obtained showing the number of cases of registration of the pathogen by administrative districts (Figure 16) [10,11].

Territories that are disadvantaged by various epizootics are under constant supervision of specialists of the sanitary and epidemiological service. To date, there has been an epizootic lull in the plague in the western regions of Kazakhstan. As for anthrax, the registration of the pathogen is observed in regions defined as "maximum" and "high" levels of infection risk. The tularemia situation throughout Kazakhstan is stable. Epidemiologists in their activities constantly interact with various organizations that carry out work, for example, on the laying of highways, or the construction of various facilities. During the construction of the Western China – Western Europe highway, a buffer zone of 10 km was determined using GIS, and a list of points with anthrax problems located within the buffer was compiled. Special attention of epizootologists is paid to sections of the highway located in the territories of natural foci of particularly dangerous infections.

Conclusion.

The results obtained serve as a scientific justification for the priority of preventive measures within the boundaries of administrative territories characterized by a high degree of potential epidemic danger and objectively indicate the prospects for the introduction of GIS technologies into the practice of epidemiological surveillance of particularly dangerous infections.

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