Application of geoinformational systems for veterinary geology

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Abstract. Every organism is constantly exposed to biotic and abiotic environmental factors. Geological objects (soil, minerals, water, etc.) and factors play a great role in the development of a huge number of animal diseases. The diseases are endemics, for instance endemic osteodystrophy, enzootic ataxia in sheep, boric enteritis in sheep, white muscle disease and deficiency in microelements). As a result, Veterinary Geology as a new branch of veterinary medicine is being formed. Veterinary Geology studies the influence of natural and anthropogenic geological objects and processes on animal health and quality of animal products and use of minerals for treatment of animal’s diseases of different etiology. Study of the epizootic situation and the role of geological objects and processes in the animal health allow to develop successful preventive and control measures. The overview presents the areas of application, directions and prospects for the development of veterinary geology in modern conditions. The importance of application of geoinformational systems (GIS) as an optimal tool for assessing, analyzing and managing risks in this branch of knowledge is shown.

1. Introduction
Every organism is constantly exposed to biotic and abiotic environmental factors. Geological objects (such as soil, minerals, water, etc.) and geological factors play a great role in the development of a huge number of animal diseases. The diseases are endemics, for instance endemic osteodystrophy, enzootic ataxia in sheep, boric enteritis in sheep, white muscle disease and deficiency in microelements). The main causative factors at play are geochemical and chemical composition of soil and water of different geochemical zones. These factors affect the development of pathological processes. As a result, Veterinary Geology as a new branch of veterinary medicine has been formed.

2. Subjects for veterinary geology research
Veterinary Geology is a branch of veterinary medicine, which studies the influence of natural and anthropogenic geological objects and processes on animals’ health and the quality of received products, and employment of minerals for treatment of animal diseases. The study of the epizootic situation and the role of geological objects and processes in animals’ health condition allows to develop successful strategies for preventive measures and control.
The most well-known subject for veterinary geology – is a big group of endemic illnesses of agricultural and wild animals, which cause is geochemical factors. The examples related to these illnesses are endemic osteodystrophy, sheep enzootic ataxy, sheep boric enteritis, endemic goitre, white-muscle disease and other kinds of micro-elements lack or surplus. This illness group is characterized by particular geochemical zones which soil and water content do influence pathological processes development [1, 2]. Nevertheless, at present, despite the current problem actuality, the systematic research of endemic diseases and natural factors impact on animal health and quality of production, obtained from the animals, on Russia territory are of sporadic character and, hence, difficulties occur to create authentic integral picture of epizootological situation on these diseases [8, 17]. Pointed necessity has been appearing for the creation of atlases for agricultural and wild-capture animal element status for Russia on federal as well as on regional levels. It's worth to point that similar atlas "Element status of Russia population" (edited by Skalny A.V. and Kiselev M.F.) has been already worked out for medical practice [3].

The knowledge of territory element status will allow to assess and forecast authentically the epizootological situation and manage it by the way of inclusion into feeding process of properly balanced premixes [4].

On the other side, economic intensive industrialization, begun at the end of 19th century and continuing till now, has led to drastic growth of various nature anthropogenic contaminants impact on animal health. As a result, significant efforts are needed in determination of natural environment contaminant sources, their classification and so on. Although most animal health problems involve diseases caused by pathogens, inorganic poisons can also affect animal health; among these poisons are arsenic, cadmium, and mercury. Currently much concern exists about environmental levels of mercury because the amalgamation of gold by mercury in small-scale mining operations has caused widespread mercury pollution.

The bioavailability of essential and toxic elements plays a major role in the aetiology of environment-related diseases and this is influenced to a marked degree by the mobility or non-mobility of the elements concerned in the “rock-soil” environment. The laterites, so typical of the environment, often function as “scavengers” of cations and anions and these, therefore, control the distribution of the elements in the ‘geochemical provinces’ to a marked degree. There are numerous external and internal factors that are responsible for the concentration and partitioning of elements in laterites.

The third scientific direction, that has a wide perspective for the development, is a mineralogy. Last years, serious results have been obtained on the application of treatment natural resources (shungite rocks, Mumiyo, loams, zeolites and zeolitolites) in medical practice. Morphology, material and element constitution of pathogenic for human organism bio-mineral forms are being investigated.

That is worth to point separately on, geological material popular at present – shungite. The material is accessed to be 2 billion years old. Shungite represents the natural formation abundant of carbon (<98%) and silicon. Raw mat shungite major stores are focused on North-Western part of Onega district in Petrozavodsk region. Balneological properties of shungite rocks were stated at the 18th century beginning. Today, shungites are demanded in veterinary as an ingredient of medicines and supplementary feeds for pig and poultry breeding [5].

3. Application of Geoinformational Systems for Veterinary Geology

One of the key aspects of application of geoinformational systems (GIS) is the employment of its capacities in the risk-assessment and risk-management of endemics. This is primarily a management technology that allows to use resources for controlling these diseases.

Epizootological GIS allow to collect, store and analyze information and is capable of displaying it on maps, and reporting on the situation according to set parameters. Using GIS for doing research work on epizootic processes and the geography of animal diseases has already performed greatly in improving the methodology of epidemiological analysis and is likely to do so in future [6].

Special GIS can show the existing relationship between the natural and socio-economic conditions, on the one hand, and animals’ health, on the other. Analysis of information on the incidence of
diseases within specialized GIS makes it possible to establish a relationship between the spread of a disease and geological conditions of the area and visualize this relationship.

In addition, the use of GIS to successfully carry out environmental monitoring of pollution of various origin (toxic substances, radionuclides, heavy metals) and an assessment of the environmental safety and stability of a geological environment.

Now to the importance of study of the epizootic situation, factors and mechanisms of the impact of geological objects and processes on animal health.

Above all, this sort of study allows us to develop preventive measures necessary for a successful solution of problems within the agroindustry complex and implementation of various projects.

Secondly, the use of GIS to successfully carry out environmental monitoring of pollution of various origin (toxic substances, radionuclides, heavy metals) and an assessment of the environmental safety and stability of a geological environment.

Hence the third area of GIS application is the assessment and quality management in the production of organic food. This type of food products is becoming increasingly popular, especially in developed countries. The quality of GIS as a data carrier makes it possible to assess the environmental safety of the territory in a long retrospective.

It is worth to note geo-ecological assessment method of breakout risk of Antrax. The method vividly shows correlation between areas of Siberian plague active focuses and soil type; the method allows to forecast realistically the disease breakout [7].

Finally, the vital realm in the future, we think, will be the question settlement on the possibility of infectious disease agent transfer by global air flows together with dust. Professor Jose Centeno, the Chief of Food and Drug Administration (USFDA) of US Health and Social Services Ministry pointed out that dust, transferred by transatlantic winds from Sahara Desert, was observed on the USA territory. He also outlined that given dust contained significant amount of microorganisms. On that basis, we can suspect that pathogenic organisms can be transferred with this dust that can substantially influence the global epizootological processes [8].

From our point of view, territorial geological characteristics are also very necessary to be taken into account while the construction of animal burials.

4. Geochemical factor influence on the appearance and development of infectious diseases

Nevertheless, geological factors have an impact not only on epizootic process of endemic non-infectious diseases but of some infectious and invasion ones [8]. First of all, one should mention soil epidemic meaning, it constitutes that agents of many infectious diseases (vast group of soil infections) as well as helminth eggs and larvae can be longtime preserved and transmitted to animals.

Rotshield E.V. [9, 10] has come out with ecological conception of infectious process on the base of the research; the conception points out on the real existence of causative connection between infection appearance among living organisms and impact on them of ecological factors of their outer and inner environment. While, these factors can cause provocative as well as suppressing action on pathogenic organisms.

It should be especially noted that geological factors affect not only the epizootic process of endemic non-communicable diseases, but also some infectious and invasive diseases. First of all, it is worth noting the epidemic significance of the soil, which consists in the fact that many infectious diseases (a large group of soil infections) and eggs and larvae of helminths can be retained and transmitted to animals for a long time.

This is the basis for the Geo-ecological method for assessing the risk of anthrax outbreaks, developed in the laboratory of the epizootology of VIEV. The method shows the correlation between the areas of the active outbreaks of anthrax and the type of soil and allows predict of outbreaks.

In the applied GIS VIEV, the data about more than 70K outbreaks of anthrax in the Russian Federation within the period from 1900 to 2016 were collected. Overlaying of the soil map and epezootological map anthrax statistically confirms the statement about the timing of disease outbreaks to certain types of soil, and over time this trend is increasing [11].
The lack of synthesis of essential amino acids and, as a consequence, a strictly local binding to the donor's habitat, leads to the fact that the location in the soil of Bacillus anthracis colonies is likely to have a mosaic-matrix structure, with a relatively low percentage of colonization. This assumption is confirmed by the extremely rare discovery of the causative agent of anthrax in bacteriological studies of old cattle graves. Considering the extensive bacterial contamination in the past that occurred before the introduction of the ubiquitous practice of burning corpses of dead animals, in all territories where soils with a developed layer of humus and previously had pastures, roads, cattle tracts, the potential danger of preserving active soil sources remains at present and will persist extremely long time. The probability of an animal meeting with the soil colony of Bacillus anthracis is very low, which explains the very long periods of silence of the soil foci of the disease, but it increases with technogenic or natural disturbance of the soil cover, flood, drought, provoking the transition of the vegetative forms of bacteria into the most dangerous spore forms.

For soils with a low content of humus, the scenario is most likely that colonies of Bacillus anthracis bacteria, when germinated annually, fall into the conditions of amino acid starvation, are gradually depleted and die in a few years.

In conditions of desert or permafrost, another scenario may be realized when the dispute of Bacillus anthracis in a permanently unfavorable environment can persist in an unchanged spore state for almost unlimited time.

Geological characteristics of the territories, in our opinion, should be taken into account in the construction of cattle cemeteries.

5. Conclusion
The vitality of problems studied by veterinary geology demands elaboration and usage of innovative instruments for the assessment and management of risks. From our point of view, the relation of endemic diseases to particular geographic and geochemical zones allows to apply successfully Geoinformational Technology and Geoinformational System for their monitoring that is a vital direction for veterinary medicine in the frames of Russian Federation Presidential Decre 12.05.2009 № 537 "About National Safety Strategy of Russian Federation till 2020" ("...support of state social-economic policy aimed on the formation of scientific and technological forecast system").

Over the course of the 21th century, geoscientists and epidemiologists gained a greater understanding of the many ways in which the environment of Earth can affect the animal health. Incidents of metal poisoning and the identification of specific relationships between dietary constituents and health became representative examples of more general human reactions to exposures to the geochemical environment. The clearest example of the relationship between geology and animal health is when the presence of too much or too little of a single element in the environment is found to cause or influence disease as a result of being transferred into the animal body through dust in the soil or air or via water or food [12].

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