MAPPING AND ANALYSIS OF ANTHRAX CASES IN HUMANS AND ANIMALS

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Abstract

Anthrax is a rare but severe disease caused by the gram-positive, rod-shaped bacterium Bacillus anthracis, a toxin-producing, encapsulated, facultative anaerobic organism. Anthrax occurs naturally in the soil and mainly affects livestock and wildlife. It can cause severe diseases in both humans and animals. Anthrax, an often-fatal animal disease, is spread to humans through contact with infected animals or their products. People become infected with Anthrax when the spores enter the body.

Keywords: Anthrax, Geodata, Infection, Cartography, GIS Analysis

Introduction

Anthrax is a rare, acute bacterial disease that spreads to animals and humans. The bacterium is caused by Bacillus anthracis, which spreads as a spore in the soil and even remains there for several decades. Anthrax is especially common in herbivores. After grazing on large-grained grass, animals receive wounds in the gastrointestinal tract, allowing bacteria to be placed in the wound, damaging the host organism and causing death. There are three ways of spreading the disease: contagious, alimentary, and aspiration, the first of which is promoted by blood-sucking insects.

As it is clear from the records, Anthrax has existed in Georgia since ancient times, Even though anti-Anthrax actions are constantly taking place in the country, Anthrax still poses a significant threat to our country today.

Methods and Materials

We carefully analysed 1,664 cases of Anthrax in humans and 621 cases in animals, up to 1,430 locations in soil (animal burial grounds, slaughterhouses, BP roads, construction sites, etc.) recorded in Georgia. The data are taken from the National Centre for Disease Control and Public Health of Georgia, which scientists have researched for over 70 years.

Originally, these data were handwritten, with many inaccuracies. The geographical coordinates are corrected, and the exact location of the settlements is indicated. Some cases went beyond the state borders of Georgia, so the accuracy of the manuscript coordinates was corrected.

Data was entered into the ArcGIS programme. We have compiled over a hundred thematic, complex, and analytical maps: relief, landscape, forest cover, soils, plants, protected areas, etc. Then, on all the compiled maps, the Anthrax detection coordinates were used to obtain the corresponding variables at the Anthrax detection sites: Anthrax distribution relief height, exposition, climate, soil types, soil acidity, structure, minimum and maximum air temperature, vegetation, landscape, and wind direction.

Distances were measured between settlements and Anthrax hotspots and between Anthrax hotspots and drinking and non-potable water. We also calculated the Anthrax intensity at each point (in some cases, it was 224 times for 70 years) to analyse which geographic variable determines the distribution and intensity of Anthrax.

We have compiled climate maps of Georgia, the central database of which is https://www.ecad.eu/download/ensembles/download.php: elements: daily mean temperature TG, daily minimum temperature TN, daily maximum temperature TX, daily precipitation sums RR, where the database is available in regular grids of 0.1 and 0.25 degrees. To create a map, we took multi-year diary data (1965–2010) and calculated the multi-year average. Because the data on this website can only be viewed at 45 degrees east longitude, we have completed climate maps with data from local meteorological stations. After data aggregation, the data grid was recreated via kriging.

Results

Geographical components have a positive effect on the spread of Anthrax. One of the main geographical components is the soil and climate.

Impact of Soil on Anthrax

The soil is a reservoir of Anthrax spores, as evidenced by numerous studies. The most favourable places for the Anthrax bacterium are black soil, brown soil, and alluvial soil, which the river brings and deposits. Humus also contributes to the spread of spores (4% or more than 4%). These are: red soils, humus-carbonate soils, ash soils, black soils, especially on arable lands, and mountain-meadow cord soils with the highest humus content. Is -8, 26–18, 81%.

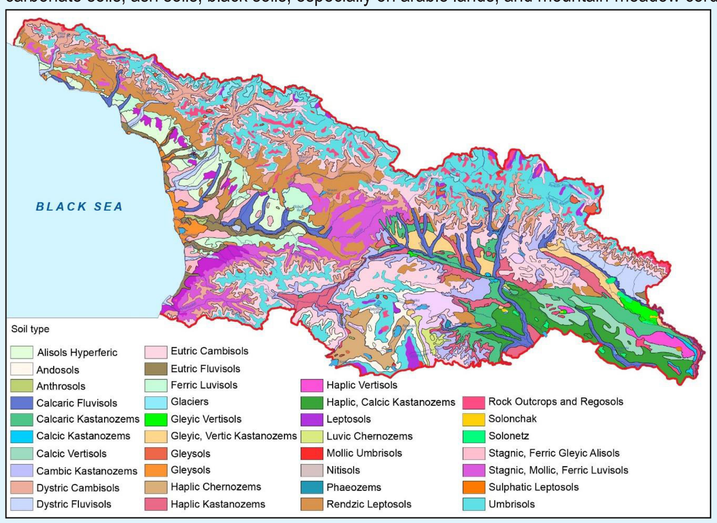

Figure 1

Analytical maps showed that Anthrax is found in all municipalities of Georgia, although the prevalence and intensity are very different. For example, the intensity of Anthrax is highest in Shida and Kvemo Kartli, followed by Kakheti, and Samtskhe-Javakheti. This is because livestock is mainly developed in these regions. (Figure 5).

The spread of Anthrax is facilitated by the movement of cattle on the roads. Seasonally, these trails operate from July to October. At this time, the surrounding areas, settlements, and populations are threatened as Anthrax bacilli are excreted in the urine, faeces, blood, and other biological fluids of infected animals. Animal-eating insects that feed on the carcasses of infected animals may also play the role of mechanical carriers in causing and spreading the disease. When exposed to free oxygen, environmental conditions affect the Anthrax bacillus, which produces dormant (non-plant) spores, is resistant to environmental conditions, and maintains infectivity and viability in soil, animal fur, water, and plants for decades. Diseases from the soil are easily spread by rainwater and irrigation canals within a radius of several kilometres (Figure 6).

One of the main factors in the spread of infections is the geographical component — climate. Because of this, we have

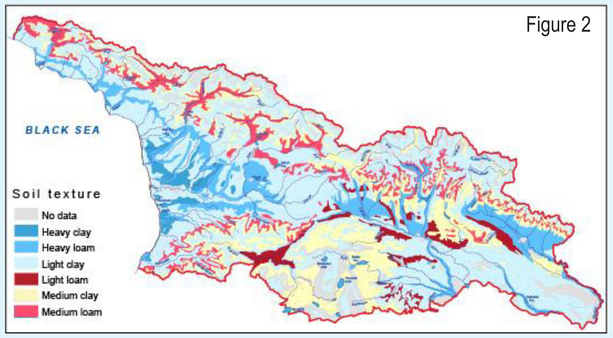

Figure 2

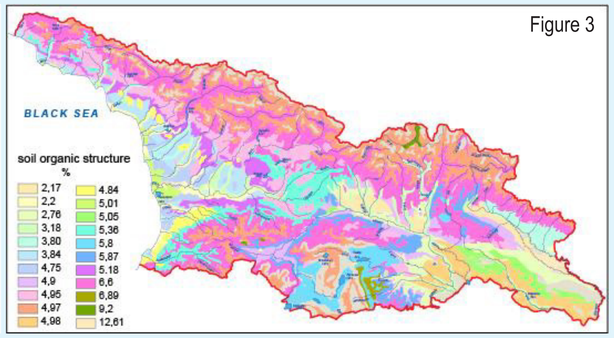

Figure 3

compiled climate maps of Georgia: elements daily mean temperature TG, daily minimum temperature TN, daily maximum temperature TX, and daily precipitation sum RR. Where the database is available in regular grids of 0.1 and 0.25 degrees, to create a map, we took multi-year diary data (1965–2010) and calculated the multi-year average. Because the data on this website can only be viewed at 45 degrees east longitude, we have completed climate maps with data from local meteorological stations. After data aggregation, the data grid was re-created via kriging: the average temperature of Georgia, the absolute maximum, the annual average (calculated from daily maximums), the annual average (calculated from daily minimums), and precipitation (multi-year average calculated from daily total) (Figures 7, 8, 9, and 10).

Georgia has a warm climate, which is favourable for the spread of Anthrax and high intensity. The higher the relief height, the lower the temperature, and the lower the Anthrax spread and intensity. In some places, for example, on the Greater Caucasus Range, the Caucasus watershed ridges, or the Lesser Caucasus, there are no manifestations of Anthrax.

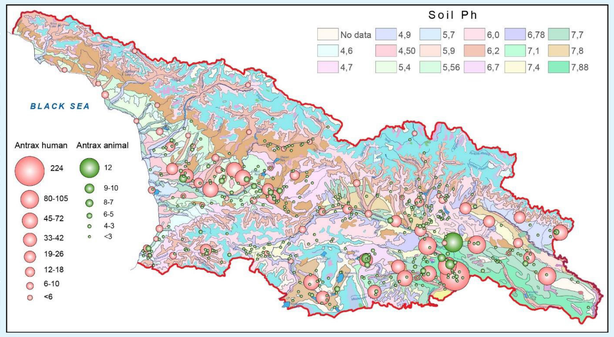

Figure 4

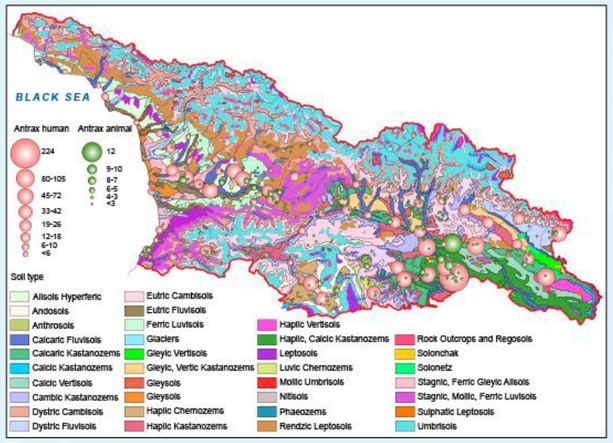

Figure 5

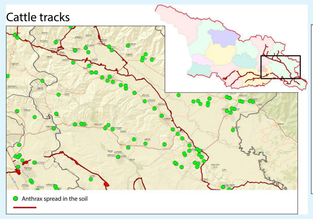

Figure 6

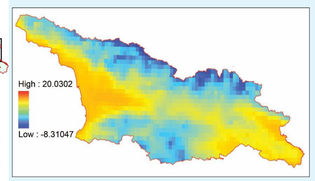

Figure 7

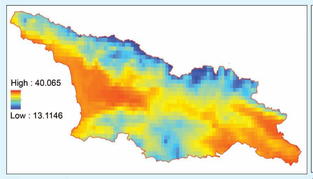

Figure 8

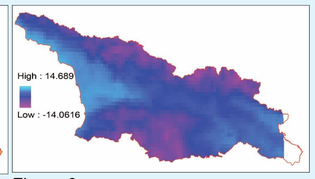

Figure 9

Conclusion

- During high temperatures, the spread of Anthrax is intense in the plains. The risk of Anthrax spread decreases with increasing altitude. Irrigation with untreated water also contributes to the spread of Anthrax, in which the bacillus enters the upper layers of the soil and is transferred to pastures;
- The spread of Anthrax spores is also facilitated by the ways of transporting livestock, during which the animals spread the Anthrax bacilli or leave these bacteria in the soil for hundreds of years.
- Soil types and their chemical composition have been related to the preservation of the Anthrax bacillus for centuries.

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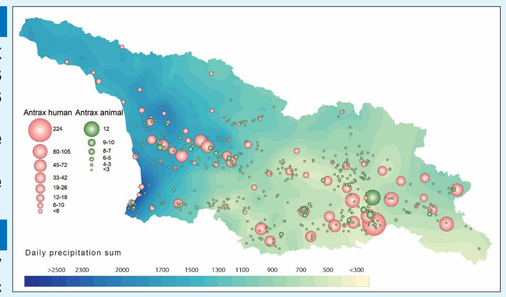

Figure 10

PHOTOGRAPHY ENCURAGED