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Spatial analysis of rabies cases in foxes in Hungary between 1990 and 2001: a preliminary report

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Abstract. In this paper we present the methodology and some preliminary results of the spatial analysis of rabies positive fox cases diagnosed in Hungary between 1990 and 2001. A database has been built based on the data provided by the Animal Health and Food Control Department of the Ministry of Agriculture, of all registered positive cases, specifying the date, location and affected species. We have developed a Geographical Information System for the spatial analysis. The aim of the study is to analyse the spatial patterns of subsequent rabies cases. Beyond the well-documented seasonality of the cases we want to find out whether they show regular spatial patterns and if yes what is their nature. Another important question is whether clustering of data can be observed and how stable or reoccurring these clusters are at a given location or area. The results might be important in a later stage of the eradication campaign when a strategy for the maintenance of large, rabies free areas should be developed.

1. Introduction

As a zoonosis and an incurable disease, Rabies has always been given due respect both in human and veterinary medicine. Most rabies cases in Hungary are still diagnosed in red foxes (*Vulpes vulpes*). This is in accordance with the European situation and it confirms the role of the red fox as the reservoir and primary perpetrator of the disease. Administrative boundaries pose no barrier to the disease, however they represent artificial division lines that may hinder the meaningful study of rabies epidemiology. This recognition also led to the extension of the scale of this study and establishing connections with a similar study that is under way in Austria [1].

Our primary aim was to build an up-to-date, GIS-based epidemiological database that enables us to study the epidemiology of rabies and to test different epidemiological models with the latest data available. We processed the rabies cases diagnosed in foxes between 1990 and 2001 and we tried to find regularities, patterns in the spatial epidemiology of the disease. This method and the findings of our study may be applicable in the reassessment and cost-effective organisation of the rabies eradication campaign [2]. Further benefits may be gained by acquiring data for the definition of high-risk areas [3].

The studied time interval is particularly interesting because the oral immunisation campaign of foxes against rabies was extended to a significant proportion of the country in 1996 and a marked reduction of rabies cases was achieved subsequently.

In a previous study we applied a similar GIS-based approach for spatial analysis of Aujeszky's disease of swine in Csongrád County [4].

2. Materials and methods

2.1. Data

Data were collected from the rabies case registry of the Animal Health and Food Control Department of the Ministry of Agriculture. Data were provided in different formats so we needed different processing techniques. A database management software (Rabidib) was developed for the digitalisation of the hand written records of the 1990-1993 period. The 1994, 2000 and 2001 records were provided in a Microsoft Word document file and they could be directly imported into the database. The 1995-1997 records were provided as printouts so we digitalized them using the Microsoft Office XP Professional Edition Microsoft Office Document Scanning software and imported the recognised text into the database. The database had to be unified after the data entry process because the settlement registry code system differed before and after 1993. The next task was to connect the database of rabies cases with the GIS database. The resulting database contains the data of all documented rabies cases for the 1990-2001 period, i.e., 6624 entries, including the location and date of the occurrence as well as the affected species. Cases are linked to the location of the nearest settlement on a digital map.

2.2. Software

Both the Rabidib database management software and the RabiGIS integrated GIS database management software were developed with Visual Basic 6.0 Professional Edition. The database was developed using the Microsoft Office XP Professional Edition Microsoft Access software. We used MSDE 1.0 through ADO as a database motor. RabiGIS uses Mapinfo MapX 4.51 for processing operations on a 1:100.000 vector-graphic map of Hungary.

2.3. Spatial and statistical analysis

The study model has been designed to check each individual rabies record for the presence of a possible source case within a defined movement range and within a 60 day latency period limit. If such a case is found, the two location points are connected and the direction and speed of spreading are calculated. The cumulative directions of the linked cases are compared to the population dynamics data of the same period.

We also want to find the "spontaneously" emerging rabies cases in rabies free areas occurring beyond the longest latency period and the average fox movement range. If no source case can be associated with a specific case, it is selected for further investigation as a potential new source of an outbreak.

All results are to be interpreted and further analysed in the context of various epidemiological models.

3. Preliminary results

The study is in the explorative phase after data entering and cleaning. At the moment, some summary statistics have been computed and some summary maps are made, without any in-depth analysis. We plan to focus on the following study questions. (1) Finding potential infection paths, that is, successive cases within reasonable distance in space and time. (2) Developing/comparing methods to quantify space-time clustering in cases, in order to identify stable and/or moving clusters. (3) Measuring the speed of propagation. (4) Testing various epidemiological models with the data. (5) Linking the data to some related background models, e.g. population dynamics, meteorology, etc.

Figure 1 illustrates that the incidence intensity varies between different areas of the country. We must apply and/or develop statistical methods for the analysis of this visual observation, since some spatial and temporal patterns cannot be illustrated on this map. The observed incidence intensities may be related to the

- true infection intensity in foxes,
- infection intensity in other species,
- fox population density,
- observability in the given geographic area.

Further statistical analysis should be applied to separate these factors and account for their contribution to the observed incidence pattern.

Figure 1: The cumulative picture of the rabies cases diagnosed in foxes between 1990-01-01 and 2001-12-31 in Hungary.

Figure 2 shows that the number of rabies cases is in correlation with the population dynamics and some behavioural aspects of the fox population. The realisation of the presence of such patterns can help us plan the eradication process.

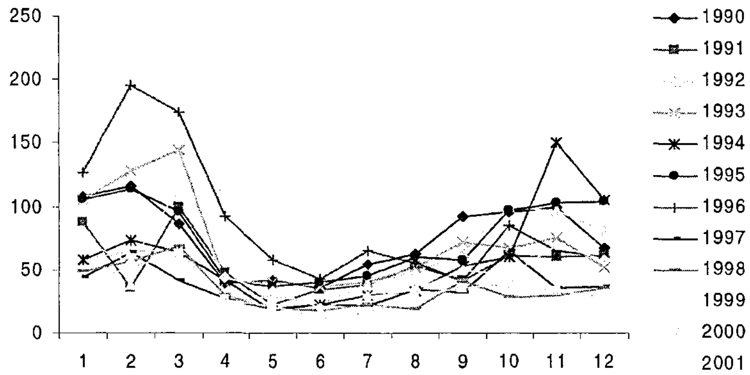

Figure 2: Numbers of fox rabies cases diagnosed each month.

4. Discussion

The scope of this work is limited to the processing of fox rabies cases. However, the spread of rabies can be facilitated by most free ranging and those animals that are likely to transmit the disease by biting. As a next step, the study should be extended to the rabies cases registered in other carnivores (dogs, cats, badgers, etc.).

We consider the applied methodology to be suitable for building epidemiological databases and for analysing their spatial characteristics. It is also applicable for the epidemiological analysis of other infectious diseases.

The potential results obtained from this study might be important in a later stage of the eradication campaign when a strategy for the maintenance of large, rabies free areas should be developed. They can help set priorities for the treatment of specific areas and define cost effective and functional barrier- and intervention-vaccination areas.

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