Use of geographic information systems technology in the epidemiological surveillance of African swine fever

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Summary

Geographic information systems (GIS) proved to be a very useful during the last two outbreaks of African swine fever in Sardinia and enabled comprehensive the implementation and organisation of the epidemic surveillance system. The knowledge of the precise location of the centre of infection made it possible to characterise all centres of infection and led to the mapping of possible routes of origin and spread of the virus from one case to another. GIS provided valuable and essential information to determine areas that required restrictions and offered an effective model of synergy between epidemiological data and legislative requirements during the epidemic.

Keywords

African swine fever, Animal, Disease, Epidemic, Geographic information system, Management, Sardinia.

Utilizzo della tecnologia GIS nella sorveglianza epidemiologica della peste suina africana

Riassunto

Nel corso delle ultime due ondate epidemiche della Peste suina africana in Sardegna, l'impiego del sistema GIS è stato di indubbia utilità per una completa implementazione ed organizzazione del sistema di sorveglianza epidemiologica. La conoscenza della esatta localizzazione dei focolai del territorio ha infatti consentito da un lato di caratterizzare ogni focolaio, tracciando le possibili vie di origine e di diffusione del virus da ogni caso e, dall'altro ha fornito informazioni essenziali per la definizione delle aree da sottoporre a restrizione, fornendo un efficace modello di sinergia fra i dati di natura epidemiologica e i provvedimenti di carattere legislativo, modello determinante per la gestione del fenomeno epidemico.

Parole chiave

Gestione, Malattie epidemiche, Peste suina africana, Sardegna, Sistema informativo geografico.

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Introduction

African swine fever (ASF) is an endemic disease in areas of Sardinia where several risk factors coexist, such as the presence of wild boar and illegal metapopulations of feral pigs (2). Actions to eradicate ASF since 1993 and precautions taken to avoid disease spread during epidemics have modified pig breeding developments in the entire region (1). These activities have also had serious repercussions on national and international trade. In the 2004 and 2005 increased incidence of ASF was witnessed, even in previously unaffected areas that had not been considered at risk. Geographic information systems (GIS) technology was used to identify the location of outbreaks and the extent of disease spread, using land-use maps.

Materials and methods

Sardinia is one of the largest islands of the Mediterranean, with a surface area of 24 090 km^2. Pig breeding system is a parallel activity in agricultural management and there are approximately 248 000 pigs in a total of 17 700 herds on the island, distributed as follows: 90.34 % are backyard farms, 2.78 % are free-range farms, 5.06 % are confined farms and only 1.80 % are intensive units. For our study, we used the software GIS MapInfo® Professional 7.8 SCP with the aid of land-use maps processed from Corine Land Cover 2003 developed by Geostudi snc.

Discussion

During the last two African swine fever epidemics in Sardinia that occurred in 2004 and 2005, a GIS (Mapinfo®) was used and was integrated with a database containing epidemiological data and essential base maps (municipal boundaries, hydrographic features, roads, railways, land use, etc.), to identify possible sources of infection from wild or domestic animals reared in free or semi-free range conditions (3). In particular, the land-use map (Corine Land Cover 2003, *Regione Autonoma della Sardegna*, developed by Geostudi snc) was used for a context analysis of infected areas, identified unequivocally by geo-referencing. This method indicated immediately whether land-use types existed in the vicinity of the infected area that provided suitable habitats for populations of wild or free-range pigs (Fig. 1). Two zones are demarcated around every outbreak where

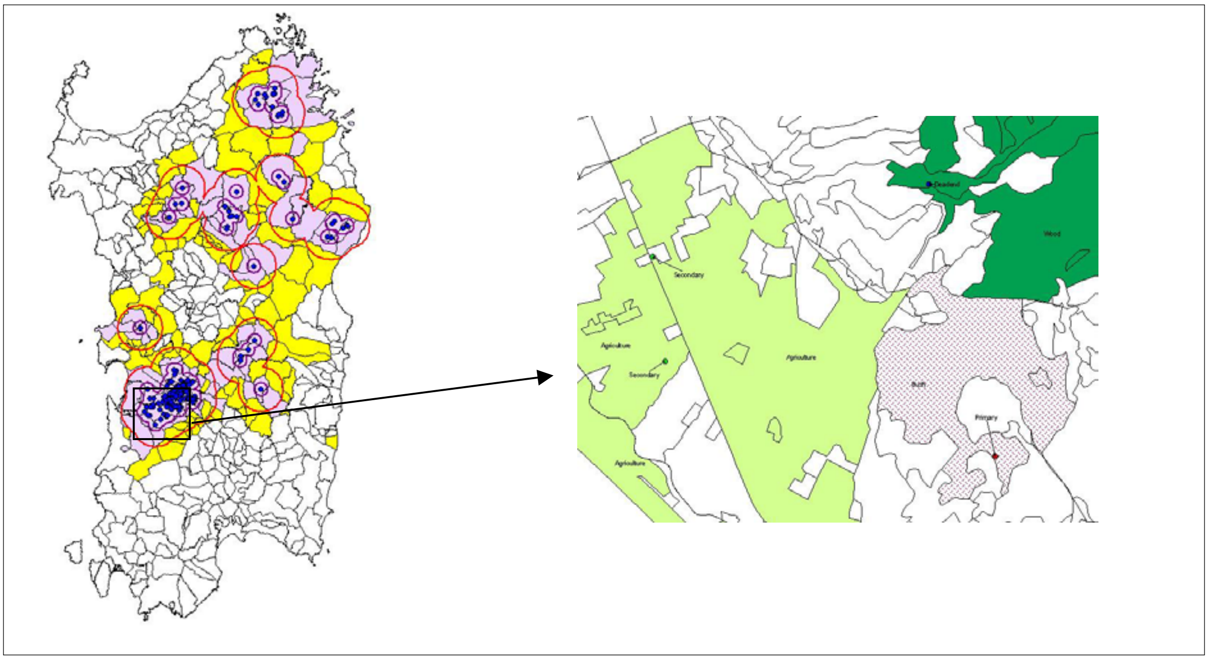

Figure 1
Land-use types in infected areas

restrictive measures were introduced. Figure 1 shows the location of several outbreaks across the territory. We were able to obtain information on the epidemic in the region that was particularly useful in the interpretation of the date of onset and spread of the disease into hitherto unaffected areas. The location of the infected areas can be visualised immediately and useful information obtained for an accurate analysis of temporal and spatial epidemiology as well as for effective planning of epidemiological surveillance programmes by means of context analysis (roads, presence of natural barriers, such as rivers, lakes, rock barriers, urban and industrial areas, etc.). In this way, potential escape routes through which the disease can spread to farms situated outside the infected area can be identified immediately (movement of livestock vehicles, equipment, animals).

Results

Using GIS technology we were able to classify the 2005 incidents into primary (where the epidemic started) and secondary outbreaks (Table I) (4). The primary outbreaks were those in which the disease occurred without any epidemiological signs. The secondary outbreaks are those that were epidemiologically correlated with the primary outbreaks which were the source of infection and which triggered a long series of epidemiological correlations. Another category of secondary outbreaks was included but was considered to be 'dead-end' category, in that no other outbreaks could be correlated thereto (Fig. 2). Figure 2 illustrates how the secondary outbreaks are correlated with the primary outbreaks. The difference between secondary outbreaks and the so-called 'dead-end' secondary outbreaks is that the former are correlated with primary and some other secondary outbreaks, while the 'dead-end'

Table I
Classification of outbreaks

Local sanitary unit	No. of primary outbreaks in 2005	No. of secondary outbreaks in 2005	Total 2005
1 Sassari	3	14	17
2 Olbia	1	13	14
3 Nuoro	7	7	14
5 Oristano	3	150	158
Total Sardinia	14	184	198

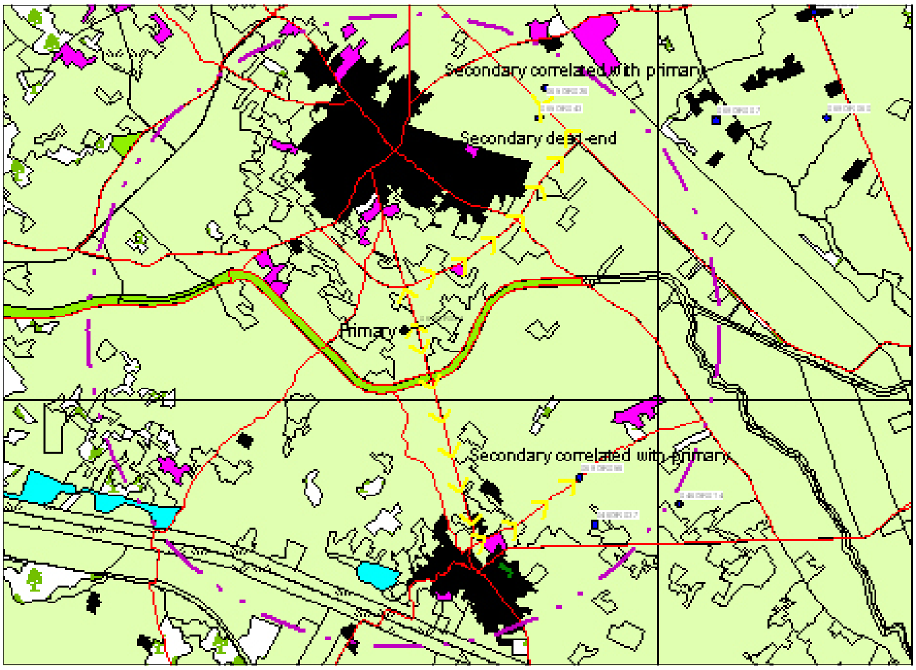

Figure 2
Secondary outbreaks: correlations and dead-end outbreaks

outbreaks are not correlated with any other secondary outbreak. An accurate picture of the distribution of the infected areas throughout the region enabled an accurate definition of the boundaries of those zones in which restrictive measures were to be introduced. Based on land-use type and landforms, the method used indicates, on the one hand, the presence of any natural barriers that were likely to impede disease spread and, on the other hand, those areas in which greater vigilance should be exercised. We observed, for example, that cases detected in a particular area that had been identified through the combined use of GIS and the land-use map, occurred chiefly in woodlands or Mediterranean bush where it is difficult to separate the animals from wild pigs or from other pig herds (Fig. 3). The domestic and wild pigs in this area can be considered as belonging to metapopulations that are not in direct contact with the surrounding areas (5).

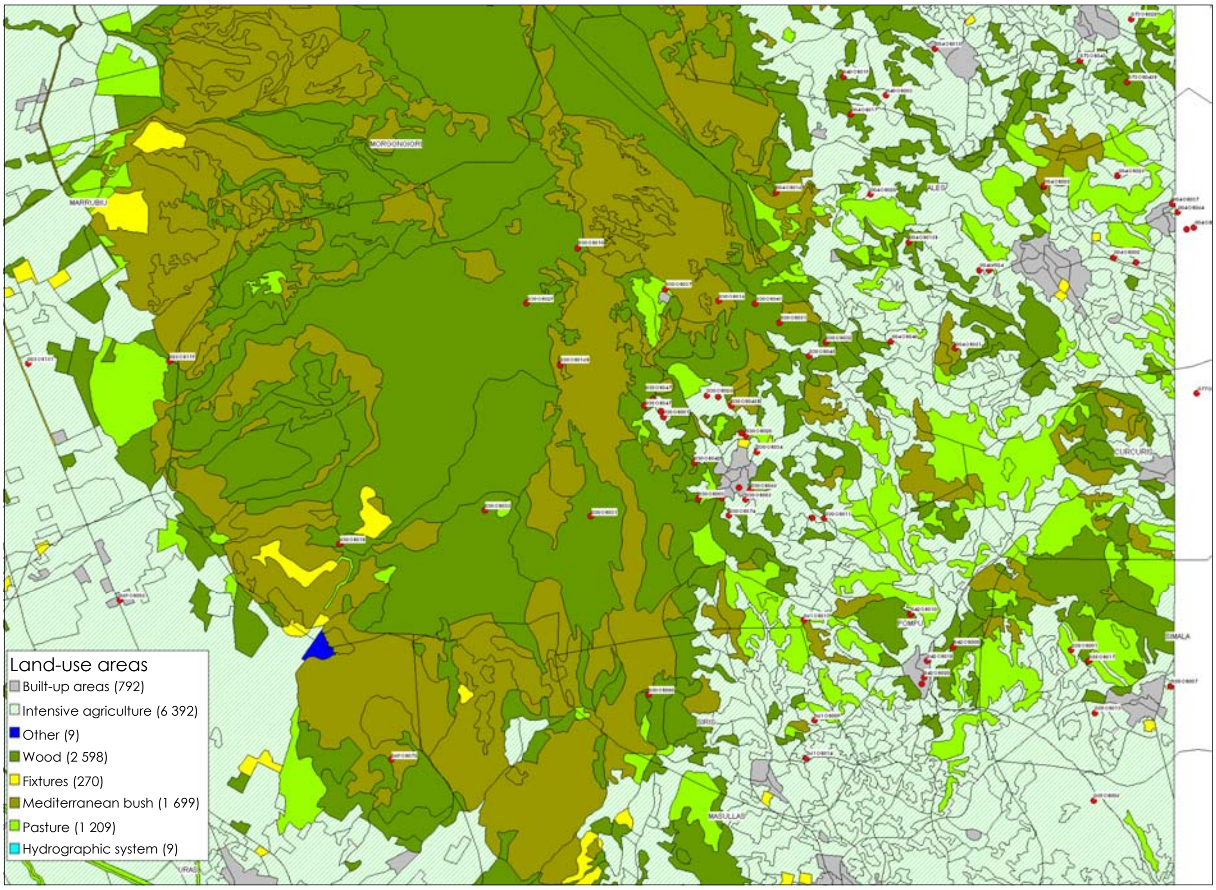

Figure 3
Outbreaks coordinates and land-use map

Conclusion

This study highlighted the increasing value of GIS as an essential tool that should be used to offer a better understanding of health issues and to provide relevant data to facilitate the management of epidemics.

Acknowledgements

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