Understanding ASF dynamic in South Africa: from spatio-temporal analysis at national level to fine special network analysis.

Etter E.M.C a, b, c, Mushagaluza Ciza Ac, Mapendere C.d, Fergusson J.W.Hd, Jori F.a, b, Penrith M.L. e

a CIRAD, UMR Animal, Santé, Territoires, Risque et Ecosystèmes (ASTRE), Montpellier, France

b ASTRE, Univ Montpellier, CIRAD, INRA, Montpellier, France

c Department of Production Animal Studies, Faculty of Veterinary Sciences, University of Pretoria, South Africa.

d Centre for Environmental Studies, Department of Geography, Geoinformatics and Meteorology, University of Pretoria

e Department of Veterinary Tropical Diseases, University of Pretoria, South Africa

Since the first probable ASF outbreak occurred in the Koedoesrand Ward in 1926, South Africa has experienced many other outbreaks that can be divided temporally into 2 time periods; the period before the development of the OIE disease database and the period after. More than 143 outbreaks of swine fever were reported during the first period but not all were clearly defined as classical swine fever (CSF) or ASF. Since the development of the OIE disease database (1993), 72 outbreaks directly involving 2968 cases mainly in smallholder pig farms were reported. Outbreaks occurred mainly in Northern provinces part of the control zone defined in 1935. Since 2012, outbreaks tended to be more likely to occur in the free zone.

In order to better understand the context in which African Swine Fever (ASF) outbreaks occurred in South Africa we described temporal, spatial distribution of reported ASF outbreaks in South Africa and examined spatio-temporal structure of ASF outbreak clusters in South Africa. Multi-Distance Spatial Cluster Analysis was used to assess the spatial clustering using ArcGIS 10.6, spatiotemporal clusters analyses were carried out using the R package splancs and scanning was utilised to identify spatiotemporal clusters of the disease using SaTScan. A specific focus was the particular zone of Northern Kwa-Zulu Natal (NKZN) bordering Mozambique and Eswatini (formerly Swaziland) defined by the zoning policy as a control zone. A spatialized social network analysis was used in order to assess the relevance of this zoning as no ASF outbreak was ever reported. Pig movement patterns were analysed using Social Network analysis (SNA) in R software. This network was georeferenced and a map of pig movements was produced. In the second phase farms, origins and destinations were grouped by villages and the villages represented the nodes of the network while directed arcs referred again to pig movement. Sociograms or link graphs were drawn using the igraph package in R.

At national level ASF outbreaks exhibit statistically significant clustering while the interaction between time and space have shown qualitatively a negative space-time interaction that was significant at month scale (p=0.003) but not significant at year scale (p= 0.577). Different spatial and temporal clusters (2 up to 5 clusters) associated to high-rate ASF outbreaks were detected, always including municipalities located in both control and free zones (p<0.001). Thus, surveillance strategies should be applied not only to the control zone but rather in all areas identified as high risk areas.

Our study provided evidence of an extensive pig network connecting all villages in the rural control area in NKZN. The SNA revealed that pigs are not only bought and sold within these closely linked villages but stock is brought from as far as 500km within South Africa and from Mozambique where ASF is endemic and regularly reported. In terms of sale, pig transactions occurred beyond the ASF control zone without any official permits. Despite the absence or very low prevalence of the diseases, proximity with endemic countries in addition to lack of such records of pig movements place the zone at an increased risk of introduction and spread of ASF and therefore confirmed the relevance of the current zoning policy. Understanding the social networks that drive observed movements enable the state veterinarian to implement effective interventions in case of an outbreak or for prevention sensitisation. Such sensitisation in addition to a real enforcement of the law (pigs kept in pens, animals and animal movements records) would allow countries such as South Africa to protect their investments by practicing disease control and surveillance i.e. their zoning policy. In addition, further studies should be implemented in order to evaluate the presence of ASF sylvatic cycle in transboundary protected areas, in order to finalize the assessment of the status of this zoning policy.