Preliminary Study of Avian Influenza A Infection Using Remote Sensing and GIS Techniques

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Abstract. The outbreak of Avian Influenza A (H5N1) infection has spread across all over the world from East-South Asia to Russia, Greece, Romania and Turkey. It will be important to find the transmission route and determine the environmental factor that affect the prevalence of avian influenza A virus. Based on the environmental parameters derived from remote sensing (RS) measurements and the avian influenza A (H5N1) infection case data in China during January 23, 2004 to February 24, 2004, the correlations between the outbreak of H5N1 avian influenza and the environmental parameters of the infected area, such as land surface temperature, was conducted using the spatial analysis abilities of GIS. The statistically significant association between the land use or land cover and outbreak of avian influenza A infection was found, i.e. about 86.4% of the 44 cases are in the cropland. Besides, by the buffering analysis, it is estimated that the vicinity at 50 km or so to main railways plays a key role in the spatial distribution of avian influenza A infection. Finally, we draw preliminary conclusion that the infection often outbreak in a certain range of land surface temperature etc probably due to in part the H5N1 virus implications.

1 Introduction

The avian influenza A infection has outbroken in poultry and wild birds around the world, killing thousands of poultry, which has already aroused much attention from nearly all the people. According to WHO latest information, the human cases have amounted to 118 infected, included 61 dead since December 1997 [2]. As for as avian influenza A is concerned, we only know that the virus, particularly the high pathogenic

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H5N1 strain, can easily mutate to transmit to human directly, if appropriate condition is satisfied. However, from the perspective of epidemiology and effectively control, the transmission, the origin, the ecosystem of the outbreak and spatial pattern of avian influenza A infection outperform above-mentioned factors, which is particularly in the interests of many environmental epidemiologist.

Geographic Information Systems (GIS) and remote sensing (RS) technologies are being used increasingly to study the spatial and temporal patterns of infectious diseases (Brooker and Michael, 2000), which show great potential to serve as: (1) an effective data capture, mapping and analysis tool for the development of spatial epidemiological diseases; (2) an environment for modeling the spatial distribution of infection accounting for the RS derived parameters and climate measures; and (3) a focal tool in infection control given their abilities to better define the endemic area and predict precisely the risk of the population exposed to some infections.

In this paper, the data and methods used in the study were introduced in Section 2. The analysis of data was conducted in Section 3. Finally, we gave the preliminary conclusions.

2 Data and Methods

2.1 Pre-processing of Infection Case Data

The first avian influenza outbreak in the Guangxi Zhuang autonomous region in Southwestern China on January 23, 2004. From then on till February 24, 2004, there were other 43 cases in total of avian influenza A infection across China, which were all high pathogenic i.e. H5N1 strain virus. It is very uncommon in China for so many cases in such short time. We chose the case data during the period as the objective of our study concerning the statistical implications. Accounting for the time lags between report of suspected case and determining of case, the time of case outbreak was determined on the day of report of suspected case, which is better in line with the true situation of avian influenza A infection. The spatial coordinate of avian influenza A infection was centred at the county level. The spatial resolution of the analysis was based on the 1km x 1km pixel.

2.2 Preparation of Land Use/ Land Cover Data

Due to the little change of land use/land cover, we chose the MODIS land cover product (MOD12Q1) of 2001 in China, which identifies 17 classes of land cover including 11 natural vegetation classes, 3 developed land classes (1 class of which is a mosaic with natural vegetation), 1 permanent snow or ice class, 1 barren or sparsely vegetated class, and 1 water class.

2.3 Land Surface Temperature Measurement

We chose MODIS thermal infrared bands 1B data to derive land surface temperature using the split-window technique [3]. In order to reduce the random error, we derived the mean temperature of the infected area by averaging the measures of neighbouring 8 cells (1km x 1km).

3 Analysis

Buffering is a process of identifying objects within a specified distance of a reference object. A simple environmental example would be to create a buffer around the strip. In regarding to the avian influenza, Buffer could be used to assess potential risks to the affected avian population. In this case, we built a buffer around the main railway of China (Figure 1) on both sides by 50 kilometres away the main railway of China. Based on the buffer analysis, there are 43 cases (97.8%) in the buffer area, which suggests that some strong association between the railway and the outbreak of avian influenza A infection exits.

From the mean land surface temperature derived from MODIS data, we got a plot of temperature range in 44 cases of avian influenza A infection in China, from which we found that about 66% (29/44) of avian influenza cases outbreak in the range of (7^0C, 13^0C), other 34% in the range of (–13^0C – 7^0C) and (17^0C -27^0C). It is very important for us to effectively prevent and control the avian influenza for temperature varies in the (7^0C – 13^0C) range in the autumn and spring in most part of China. So we should take any measures to strengthened monitoring of the avian influenza prevalence in the season when temperature varies in that range.

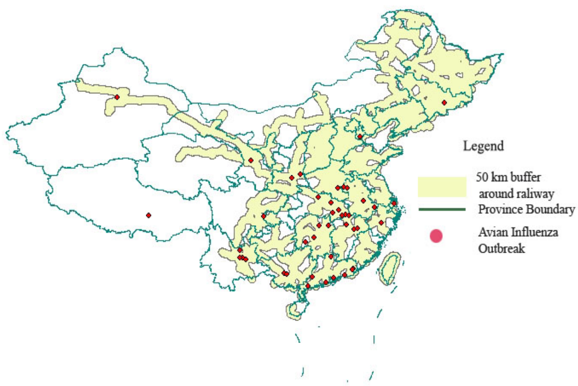

Fig. 1. The 50 km buffer map around main railway network of China, which is overlaid with avian influenza A infections cases of the period between January 23- February 24, 2004

Land cover type is very popular in the environmental epidemiology, especially for vector-borne infection disease, because the vector habitat usually prefers some specific land cover type to other types. Meanwhile, there are great evidences of avian influenza transmitted from migratory birds, which often fly through some specific routes. Therefore, when we tried to find the environmental factor influencing the outbreak of avian influenza A infection, we incorporated the land cover type into our research. Through overlay analysis of case data and land cover data, we find that there are 28 cases (64%) outbreak in cropland.

4 Conclusion

Besides the land cover type, we also got some association between mean land surface temperature and avian influenza, from the perspective of cluster in the specific range of mean land surface temperature in the area affected by avian influenza A infection.

This can be implicated that avian influenza A (i.e. H5N1) virus often adapts to some range of temperature, which is in line with the high frequency of avian influenza in winter and spring when the land surface temperature in most of China accords to the range calculated in our study. However, accounting for the avian influenza prevalence in May 2005, a plenty of migratory birds died of H5N1 strain avian influenza in Qinghai Lake, and the prevalence in the southeast Asia, where the land surface temperature often lies out of the range we got in the study. In the study, strong association as well between railway and avian influenza A infection holds true. This can be explained by the fact that in China, the transportation by railway of poultry products is the key way besides the highway for most poultry managers. In this study, we only investigated the correlation between railway and avian influenza A infection.

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