Spatial Epidemiology Of Animal Rift Valley Fever In Yemen, 2000-2001

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Abstract

Rift valley fever (RVF) is an arthropod borne disease produced by a *Bunyavirus* belonging to the genus *Phlebovirus*. Several species of *Aedes* and *Culex* are the vectors of this virus that affects sheep, goats, buffalos, cattle, camels and human beings. The human disease is well known, especially during periods of intense epizootic activity. The initial description of the disease dates back to 1930. Until 2000, this disease was only described in Africa, and then outbreaks were also declared in the Kingdom of Saudi Arabia (2000-2001 and 2004) and in Yemen (2000-2001). Animal and human cases were recorded. This work presents a retrospective summary of the data collected on animal RVF cases during this epidemic in Yemen. Results from several RVF surveys were gathered from the Yemeni vet services and FAO experts. Geographical data (topographic maps and data freely available on internet) were used for the location of outbreaks. After cleaning checking and standardisation of location names, all data were introduced into a GIS database. The spatial distribution of outbreaks was then studied at two scales: national level and local scale in the Wadi Mawr area (Tihama plain, Western coast of Yemen).

Introduction

On September 10th 2000, the Yemeni vet. Services noticed the first signs of the RVF in Kidf Abo Harbah Village in Wadi Mawr (district of Az Zuhrah, in the North-West of Yemen) when a calf died followed by abortion in cattle. Mortalities of lambs and calves were observed on September 12th 2000, followed by some abortions in sheep in Mahel Abed in the same valley. The peak of epizootic was reported to be September 21th 2000 (Alqadasi, pers comm.). This work presents the different steps of data collection and a preliminary analysis of the data collected on animal RVF during this epidemic. Hypothesis and limits of this study are discussed.

Material and Methods

The epidemiological database used was collected from September 23th 2000 to February 3rd 2001 by the vet services, central veterinary laboratory and national epidemiology unit. A case was defined as a village with at least one death or one abortion in either cattle, sheep, goat or camel during the period. Among the different wadis (valleys) located in the Tihama, Wadi Mawr (mainly in the district of Az Zuhrah of the Hodeidah governorate) was the most infected. Then, in this preliminary study, it was decided to focus on the region of Wadi Mawr (exactly within 30km from the town of Bajilah, Lat 15.65°N, Long 43.10°E). Because of the lack of census of farms and/or animals, locations of villages were extracted from 1:50 000 scale paper maps scanned and georeferenced in UTM 38, datum WGS1972 projection (Source Yemen Survey Authority, Sana'a). Point locations and names of all built-up areas, villages or hamlets were then obtained. These names were compared to the one available in the epidemiological database.

The link between heavy rainfall and the occurrence of RVF outbreaks has been pointed out by several authors (Linthicum, 1987). Rainfall data time series of the Western part of Yemen were provided by the Tihama Development Authority of the Hodeidah governorate. Altitudes were derived from a Digital Elevation Model provided by USGS (Shuttle Radar Topography Mission) freely available on a FTP site (ftp://e0mss21u.ecs.nasa.gov). A **vegetation index** derived from satellite images (Normalized Difference Vegetation Index, NDVI) was used as surrogate

information for moisture and vegetation amount. Ten days synthesis NDVI images of 1km resolution were freely downloaded from Internet (http://free.vgt.vito.be/, (source Spot Vegetation imagery, CNES copyright) for August to October 2000, around the period of emergence.

Results

At the national level, out of more than 2000 investigations of RVF suspicions, 90% were located inside the governorates of the Tihama coastal plain: Hodeidah, Haja, Saadah, Al Mahweet, Dhamar (sorted by descending magnitude of number of clinical cases). **In the study area**, out of 612 villages or hamlets located and identified in the study area, 11.5% reported either abortion or death of animals (Figure 1). Most of the infected villages have been found in the vicinity of the Wadi Mawr main canal in low altitude areas (<300m).
The effect of the dam constructed on the Wadi Mawr can be seen in August on NDVI images. Location of the infected villages seems more correlated with NDVI in September than NDVI in August (lot of villages in areas with low NDVI) or October (lot of villages free from the disease in areas with high NDVI (Figure 2)). High NDVI values associated with altitude (higher than 300m) seem to be negatively correlated with the appearance of clinical cases.
Areas with moisture around Bajilah increase from August to September but there is no difference between 1999 and 2000. This is consistent with the analysis of rainfall data. Precipitations in the Wadi Mawr area in 2000 were not exceptional in comparison with a time series beginning in the seventies (data not shown).

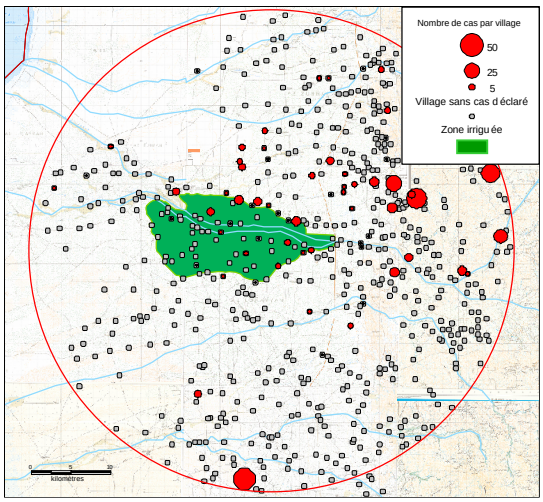

Figure 1: Number of RVF cases in the villages located within 30 km around to Bajilah town

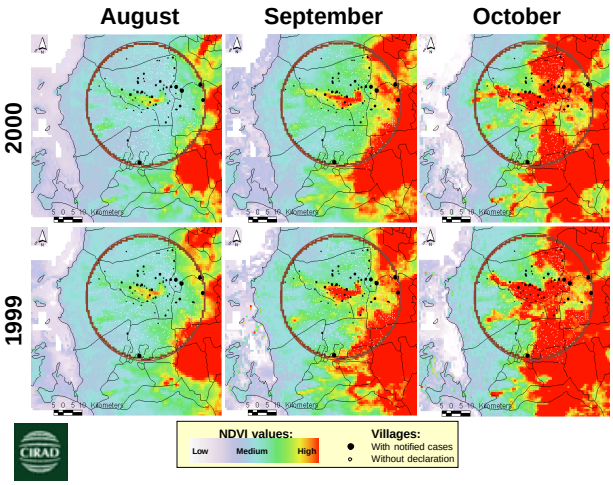

Figure 2: Analysis of NDVI in 1999 and 2000 in the humid zone around Bajilah

Discussion

Rift Valley Fever occurred for the first time in Yemen and in the Arab Peninsula in 2000. At the beginning, human cases were then confounded with malaria and surveillance was enhanced during the epidemic. Data are then probably biased as some premises were not investigated and as the suspicions based on clinical symptoms were not systematically confirmed by laboratory tests. The extension of the infection is nevertheless in agreement with transversal serological surveys that have been implemented later (data not shown).
The total animal susceptible population in the infected districts was not available. Analysis had to be performed at the village level. Only 70 infected places were identified. This is mainly due to the lack of standardisation of Arab location names in the database and to the time elapsed between the edition of the paper maps used (last revision in 1985 in majority) and the disease

(2000-2001). It is assumed that the location of new settlements in the area has no link with the risk of contracting the disease.
During the last twenty years, many irrigation schemes have been developed in this area of Yemen. Two scenarios can be drawn to explain the emergence of RVF in 2000 in Yemen. According to some experts, the virus could have been introduced as early as 1997, corresponding to previous circulation of RVF in the Horn of Africa (Miller et al 2002). Following this hypothesis, local factors would have determined the emergence of clinical cases in 2000. The other hypothesis is that RVF virus was introduced in 2000 and then spread quickly. The analysis of rainfall data and NDVI images seems to show that no special events preceded the occurrence of the disease. This is in favour of a recent introduction of RVF in the Arabic peninsula. To draw more detailed conclusions, local agricultural practices (irrigation, husbandry) and animal movements (trade flows, transhumance) favouring the multiplication of the vector and the contact host/vector need to be studied at various scales.

Conclusion

NDVI has been proposed to be used for early warning systems of RVF infection (Linthicum et al 1999). In Yemen, the correlation of this index with the infection seems to be influenced at least by the altitude or by the slope (*i.e.* effect of temperature and breeding sites flush). Studies of the landscape and entomological surveys in the areas with high NDVI or other indices like PVI or SATVI (Vonder 1998) should be performed. To better understand the spread of the disease, quality of data should be improved. Data about infection rather than the clinical cases, about the movement of the animals and the contact with infected insects should be collected. Apart from this research topic, the standardisation of data should be improved in the surveillance of RVF.

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