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Spatial Mapping of Foot and Mouth Disease Serotypes in Karnataka using Geographical information System (GIS)

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Abstract

Foot and mouth disease (FMD) is an economically important disease affected domestic livestock. There are seven serotypes of the FMD virus reported globally. In India, serotypes O, A, C and Asia 1 are reported. The spatial distribution of different serotypes is not known. In this study, we used Geographical Information System (GIS) for mapping of different serotypes in different years for Karnataka state. We found that serotype O is the main serotype in Karnataka. The serotype distribution maps will be useful for planning FMD surveillance and disease control strategies for the state of Karnataka and can be extended to other states of India.

Key words: Geographical Information System, Spatial distribution, Foot and Mouth Disease, Serotypes of FMD, Surveillance

Foot and mouth disease (FMD), which affects animals cloven footed animals and cause economic losses. There are seven serotypes of the FMD virus (FMDV) namely: O, A, C, SAT 1, SAT 2, SAT 3, and Asia 1 [1]. Clinically, it is difficult to differentiate between FMD and other vesicular diseases such as swine vesicular disease, vesicular stomatitis, vesicular exanthema, and infection with the Seneca Valley virus.

Serotype O is the most widely studied and prevalent Foot and mouth disease (FMD) serotype worldwide [2]. It is the most common and widely distributed serotype, causing frequent outbreaks in India. Serotype O is known to be the most prevalent and widely studied serotype of FMD globally, with frequent outbreaks occurring in India, particularly in Karnataka. Despite its significance, there has been a lack of GIS-based mapping of livestock disease outbreaks in this region [3]. It affects a wide range of host species and has numerous subtypes. GIS provides a powerful tool for visualizing and analyzing spatial data, allowing for the identification of high-risk areas and the planning of intervention strategies. By incorporating serotype distribution data, we aimed to create spatial maps that can be used by disease managers and policymakers to allocate resources effectively and implement timely control measures to prevent and mitigate outbreaks [4]. Spatial mapping of livestock disease outbreaks using Geographical Information System (GIS) is very powerful tool for visualizing of outbreaks and planning for intervention strategies in high-risk areas. The spatial maps are useful for diseases managers, policy makers in allocating resources and timely control of outbreaks and prevention [5]. The use of GIS in mapping of livestock diseases has not been used in India and in Karnataka. In this study we used serotype distribution data for make spatial maps [6].

By utilizing GIS technology to map the distribution of FMD serotype O outbreaks, we can improve the allocation of resources and the implementation of control measures to reduce the impact of this devastating disease on livestock populations and agricultural economies. Our spatial maps provide valuable information for policymakers, veterinarians, and other stakeholders involved in Foot and mouth disease (FMD) control efforts, facilitating more informed decision-making and more effective disease management practices.

MATERIALS AND METHODS

Serotype data collection

Village-wise serotype data from the year 2012 to 2021 were collected from the Foot and mouth disease (FMD) Regional Centre, IAH & VB, Bengaluru, and Karnataka, India. Village-wise serotype master data was prepared, and the spatial mapping of serotype data was done using the QGIS software (3.28.0). Our study collected data on the distribution of Foot and mouth disease (FMD) serotype O outbreaks in Karnataka, including information on the affected host species and subtype variations. We then employed GIS techniques to overlay this data onto geographic maps, allowing us to visualize the spatial distribution of outbreaks across the region. By identifying hotspots of Foot and mouth disease (FMD) serotype O activity, we can better understand the epidemiology of the disease and prioritize areas for targeted intervention efforts.

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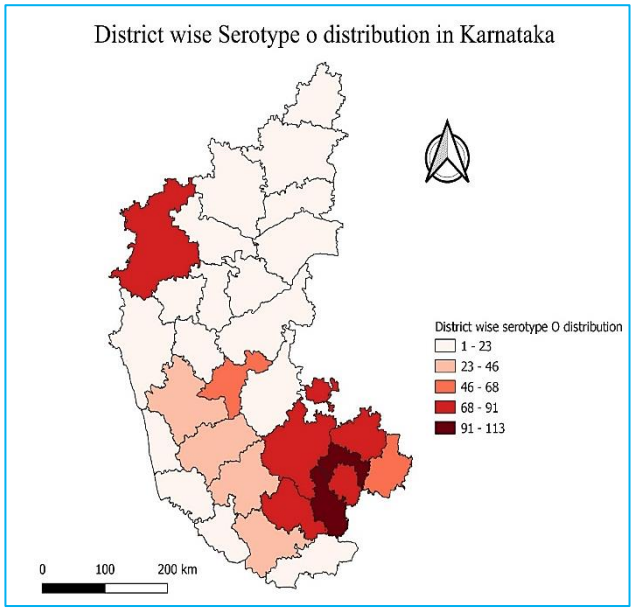

Fig 1 Map of serotype O distribution in Karnataka state

RESULTS AND DISCUSSION

The maximum number of FMD outbreaks (n=448) was observed in 2013. In Karnataka, serotype O is more prevalent compared to all other serotypes. In Karnataka, all 31 districts have reported FMDV serotype O. Bangalore rural district has reported the highest number of outbreaks followed by Ramanagara, Belgaum, Tumkur, Bangalore Urban, Mandya, Chikkaballapura, Kolar, Davangere, Shivamogga, Chikkamagaluru, Hassan, Mysuru, Gadag, Dakshina Kannada, Koppal, Haveri, Bagalkot, Uttara Kannada, Chitradurga, Raichur, Chamarajanagara, Gulbarga, Dharwad, Udupi, Bidar, Bellary, Bijapur, Kodagu, and Vijayanarag reported very less number of FMD outbreaks.

The map shows the distribution of Serotype O in Karnataka state. Year wise serotypes distribution from 2012 to 2021 map is shown in (Fig 2-6). Serotype O was reported maximum in the year 2013 followed by 2021, 2018 and 2017. In this study, we collated data on serotype distribution in Karnataka state of India. The spatial distribution of serotypes was prepared using GIS (Geographical Information System). Overall, serotype O was predominantly distributed across districts of Karnataka with the year 2013 reporting maximum outbreaks.

In one study, ELISA and multiplex PCR was used to type the serotypes and found that serotype O and Asia 1 were responsible for the outbreaks [7].

It has spread in East Asian countries which include Hong Kong, South Korea, North Korea, Japan, Mongolia, Eastern Russia, Taiwan and China [8-12]. It is also reported from South East Asia countries including Myanmar, Malaysia, Vietnam, and Thailand [13-17], Southern Asian countries such as Iran, Iraq, Afghanistan, and Pakistan [10], [18-19], Western Asian countries such as Turkey, Jordan and Israel [19]. In Indian subcontinent the serotype O was found in India, Sri Lanka, Bhutan, Bangladesh and Nepal [20-29]. Serotype O is reported from Karnataka from many districts [30].

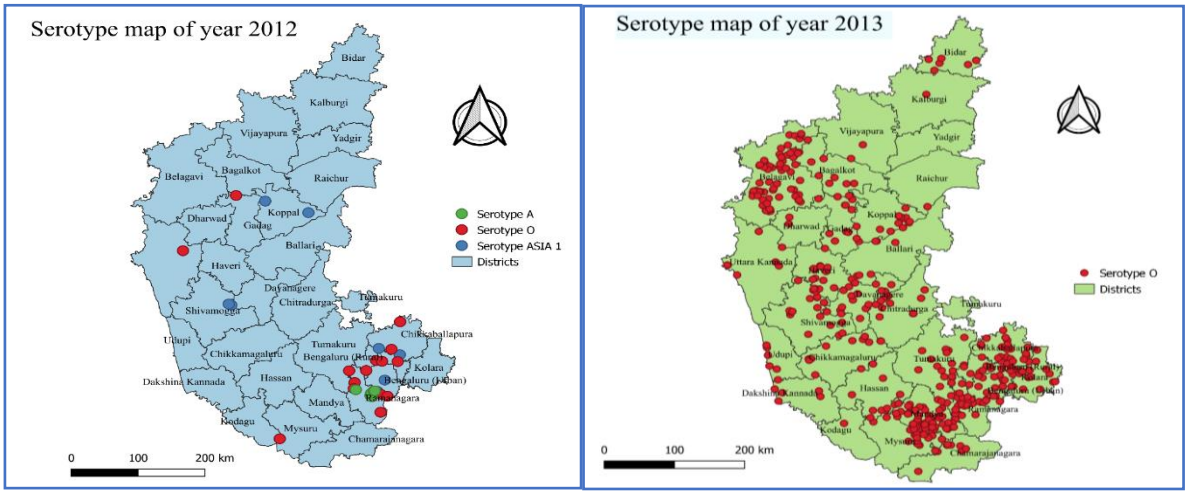

Fig 2 Serotype maps for the years 2012 and 2013

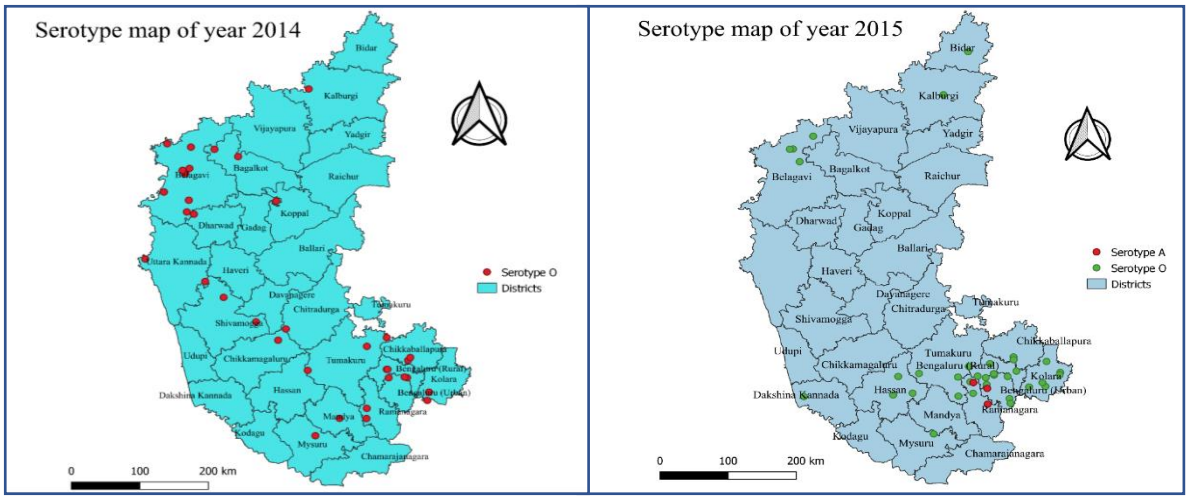

Fig 3 Serotype maps for the years 2014 and 2015

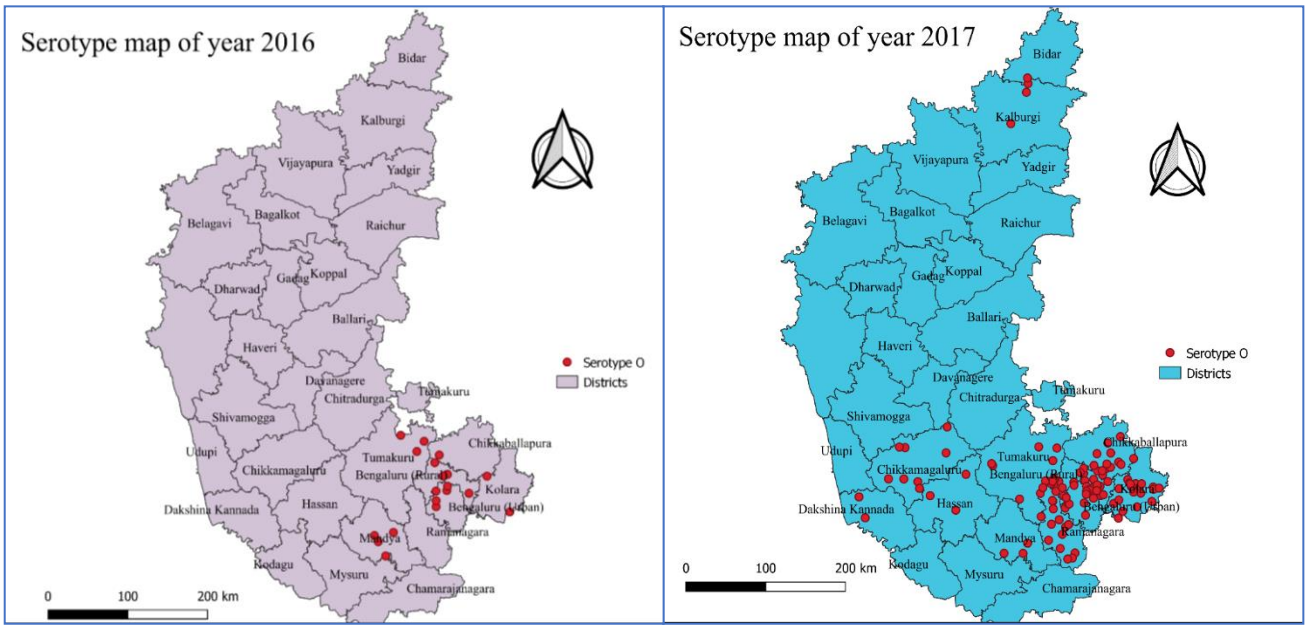

Fig 4 Serotype maps for the years 2016 and 2017

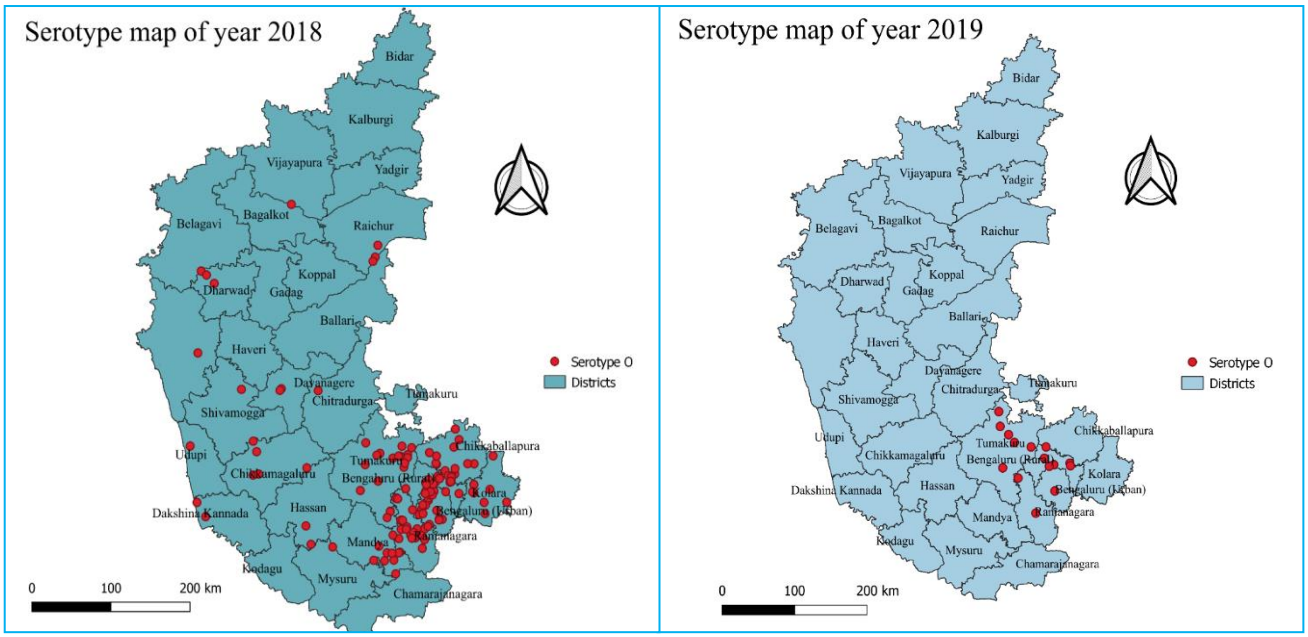

Fig 5 Serotype maps for the years 2018 and 2019

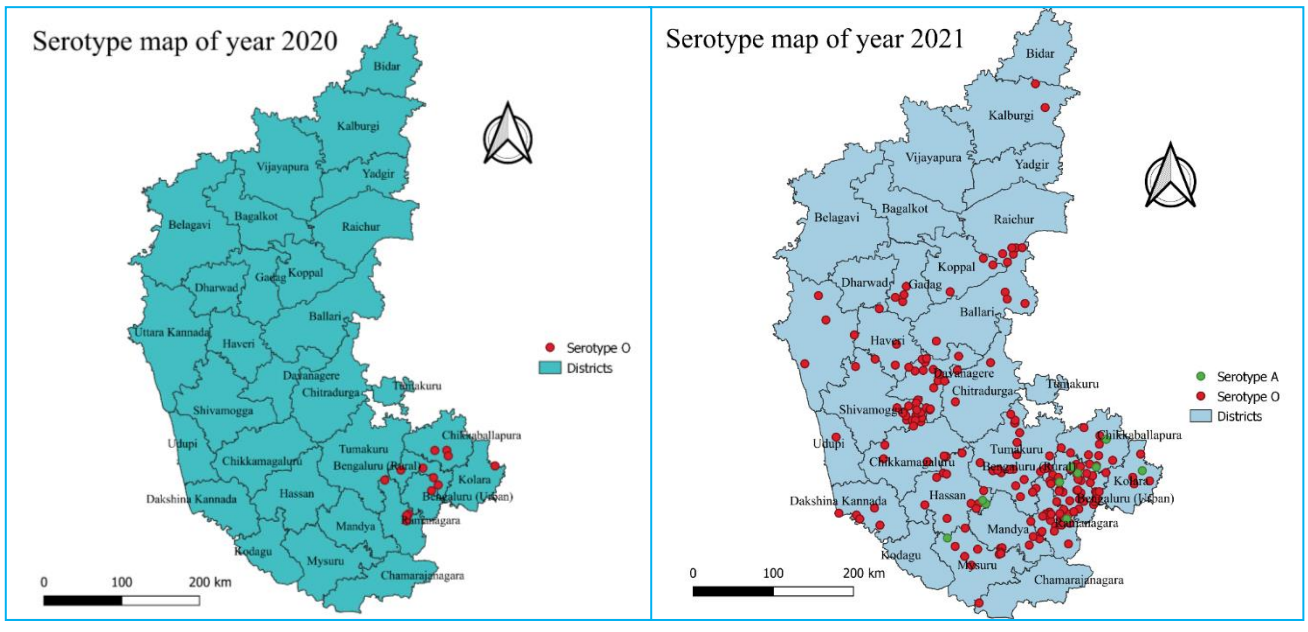

Fig 6 Serotype maps for the years 2020 and 2021

The Serotype A distribution is less prevalent compared to Serotype O. Serotype O and A have the widest global distribution and have been responsible for outbreaks in Europe, America, Asia and Africa. it was noticed in East Asia, South East Asia, Indian subcontinent, Southern Asia, Arabian Peninsula, Western Asia, Central Asia, North Africa [31]. Asia 1 serotype is primarily found in the Indian subcontinent, it has also been sporadically reported in countries to the west and east of this region. Periodically, the serotype has spread into the Middle East and occasionally reached Europe. However, it has not been reported from Africa or the Americas [32-35]. The Asia 1 serotype was first detected in samples collected in India in 1951 through 1952 [36] and later in Pakistan in 1954 [37]. The Asia 1 serotype was reported from West Bengal state of India [38]. The Asia1 serotype was also observed in Karnataka during the year 2012 [30]. It was first detected in **e**arly 1920s in Europe and mainly affected pigs and cattle with less infection. However, in 2004, four small outbreaks of serotype C were detected in the Amazon region [39]. The last report of Serotype C was noticed in Ethiopia during 2005 [40]. In India there were no reports of Asia 1 since 1996 [38]. Only sub-Saharan Africa is affected by the SAT 1-3 serotypes.

CONCLUSION

Analysis of Foot and Mouth disease serotype data in Karnataka for the period of 2012-2021 was carried out and revealed that the serotype O is the main serotype in the state. We found that 97% of the outbreaks occurred with serotype O. The yearly trends of Foot and mouth disease (FMD) shown that the year 2013 was noticed maximum number of outbreaks and least number of outbreaks in the year 2020 (n=13). Bengaluru rural and Ramanagar districts reported maximum serotype O outbreaks and needs targeted surveillance and studies to identify factors responsible for variation in the distribution of outbreaks in other districts. The GIS maps will be helpful for policy makers to visualize the spatial distribution of FMD outbreaks due to different serotypes and plan for intervention strategies for effective prevention and control of disease in Karnataka state.

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