Identifying High Risk Areas for African Horse Sickness Epidemics in Spain.

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INTRODUCTION

African horse sickness (AHS) is one of the most important notifiable vector-borne viral diseases that affect equines. This disease causes dramatic sanitary consequences and economic losses in affected regions. Its etiological agent is AHS virus (AHSV), closely related to the bluetongue virus (BTV), which is mainly transmitted by the bite of *Culicoides* spp. One of the most important European countries in relation with the main risk factors of AHSV is Spain, since it is the second largest European country in terms of equine population and it has favorable climatic conditions for vector and for virus replication. Currently, the concern about the potential re-introduction and further spread of AHSV in Spanish and other European equidae populations has increased, as a consequence of the re-emergence of culicoides-borne diseases. Certainly, the identification of suitability areas and time periods at higher risk of AHS occurrence in Spain would allow to establish of risk-based surveillance and control programs for preventing and more rapidly control future incursions.

The aim of this study was identifying the high suitable areas for AHS epidemics in Spain. We compared the obtained results with data about the AHSV epidemic in 1987-1990 (**fig. 1**) [1]. The results will allow to prioritize strategies in high risk areas.

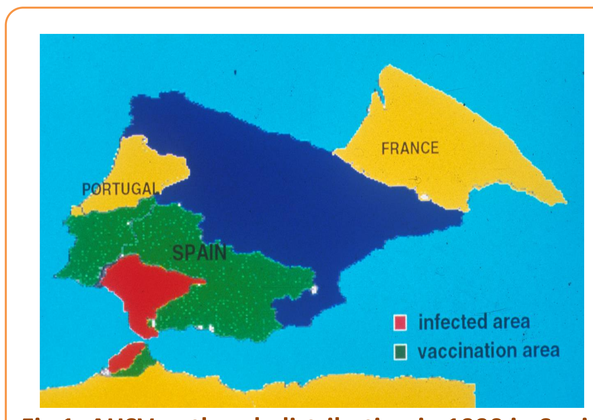
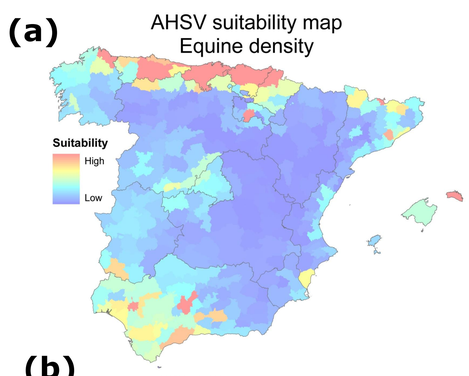


Fig 1: AHSV outbreak distribution in 1990 in Spain and Portugal (Souce: Rodriguez et al. 1992 [1])



Risk factor	Data source	Weights
Equine density	Spanish Government (INE, 2011)	0.34
Extrinsic incubation period (EIP)	Spanish National Meteorological Institute	0.36
Culicoides		0.30
- **Field data**	MAGRAMA	0.25
- **Temperature previous month**	Spanish National Meteorological Institute	0.25
- **Precipitation previous month**	Spanish National Meteorological Institute	0.25
- **NDVI previous month**	MODIS	0.25

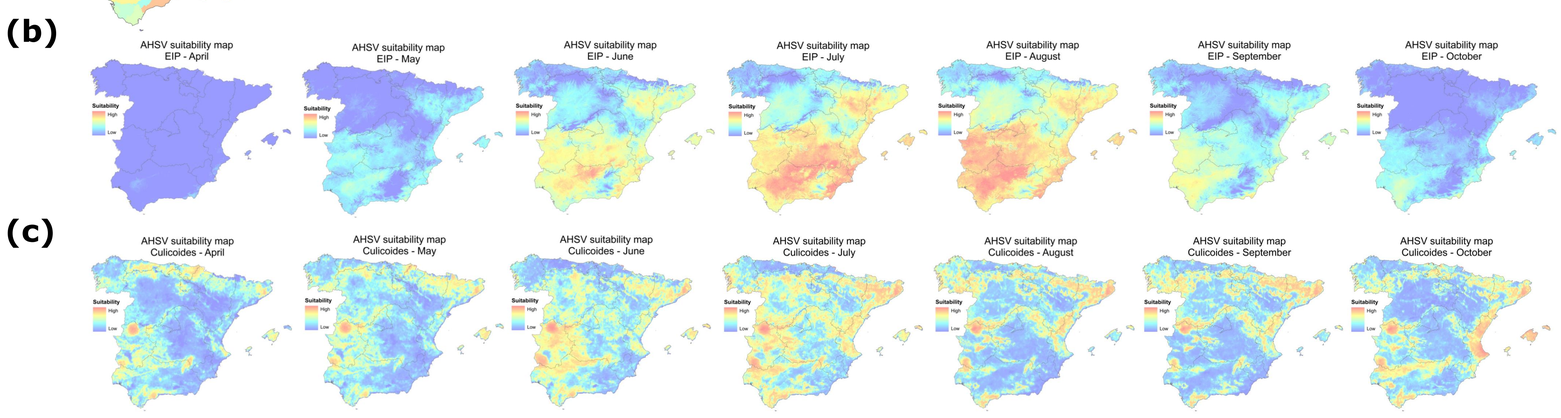


Fig 2: Map, data source and weight of AHSV risk factors in Spain: equine density (a), extrinsic incubation period (EIP) (b), culicoides (c) in the restricted period.

MATERIAL AND METHODS

The identification of high suitable areas for AHS in Spain was performed by using a multicriteria decision framework based on "weighted overlay" using geographical information systems (GIS) (software ArcGIS 9.2). This study consisted of the identification and spatial mapping of risk factors related to AHS spread [*i.e.* extrinsic incubation period (EIP), equine density and vector distribution] (**fig. 2**). These maps received a specific importance or "weight" and were combined to create the AHS suitability maps.

The estimation of Culicoides distribution in Spain was based on Culicoides captures together with environmental variables associated with its distribution and abundance. In addition, given the high seasonality of activity and abundance of *Culicoides* spp. in Spain (*i.e.* from April to October) [2], the study was restricted to this period.

RESULTS

This epidemiological tool has allowed to obtain a suitability map for the whole risk period (**fig. 3**), as well as one map for each month (**fig. 4**). These maps allow to identify the high risk areas and times period for AHSV epidemic.

The most suitable areas for AHS development in Spain were located in South-West (SW), Balearic Islands (BI) and North-Center (NC) of Spain (**fig. 4**). The SW region corresponded with the historical distribution of AHS and BTV outbreaks, which are related with *C. immicola* distribution [1, 2, 3]. Similarly, BI is a region historically related mainly with the same *Culicoides* sp. and BTV outbreaks [2, 3]. However, NC suitable regions overlapped mainly with *C. obsoletus* distribution, which is the vector responsible for the spread of BTV in Northern of Europe [2, 3]. It is important to highlight that each area has a different and characteristic equine production (SW and BI – horse selection and competition; NC – equine meat production), hence one outbreak would have a different economic repercussion.

July and August were highlighted as the most suitable months for AHS occurrence. The months in the risk period with the lowest risk were April. This result has a strong relation with the climatic conditions required by virus and vector.

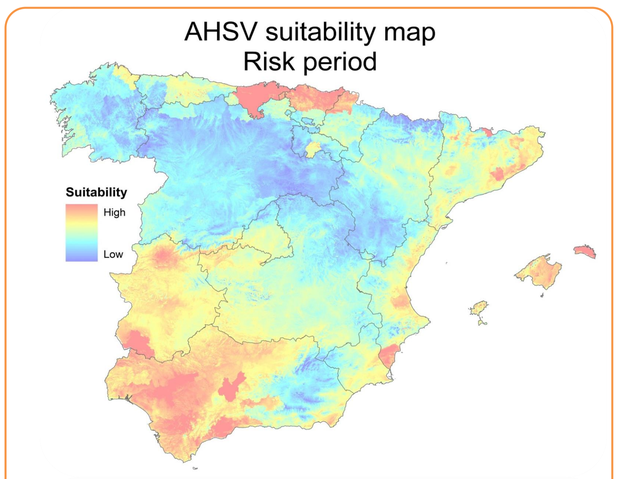


Fig 3: Map of AHS suitability distribution in Spain in the risk period (from April to October).

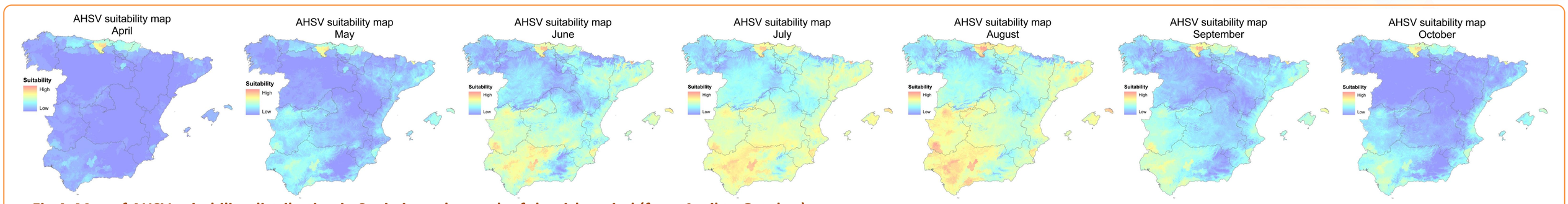


Fig 4: Map of AHSV suitability distribution in Spain in each month of the risk period (from April to October).

DISCUSSION AND CONCLUSION

The method used here has allowed to identify and to map the highest suitable areas and time periods for AHS epidemics in Spain. Having into account that the equine sector in Spain is very important with animals of high economic and genetic value and the devastating socio-economical consequences of the historic outbreaks of AHSV serotype 4 in 1987-1990 reported into Spain (**fig. 1**), these results may be useful by the official veterinary services to support risk-based surveillance and control strategies which, ultimately, are intended to more cost-effectively prevent and control potential incursions of AHS in Spain.

However, these epidemiological method has an important subjectivity associated with selection and "weights" of each risk factors. Thus, the risk factors were selected by an extensive literature review, although, the "weight" could be improved by expert opinion elicitation. Impact of changes in weights should therefore be further evaluated using sensitivity analysis.

These AHS epidemiological results allow to improve the equine disease control and prevention programs which ultimately aims to reduce the sanitary and economic consequences associated to potential incursions of AHS in the country.

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