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GEOGRAPHIC CLUSTERS OF FOOT-AND-MOUTH DISEASE (FMD)

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Geographical maps are often used to show epidemiological information about foot-and-mouth disease (FMD) occurrence. The number of outbreaks, affected herds rates, level of occurrence and other indicators have been placed within appropriate sub-areas of the geographic map (quadrants, municipalities, departments). Thus some indicators are compared and color shadings are used to depict the epidemiological situation and this was pointed out in areas with similar FMD behavior.

The geographical pattern of a disease is usually graphically displayed on a map, but the visual study, however, is not an objective procedure for cluster seeking. In many situations furthermore we have a mass of data related to several variables, and then we are led to ask: how many groups are there? and, where should the division be placed?

In recent years, several mathematic-statistical techniques have been suggested for cluster seeking. The essential concern of these techniques is to find groupings of "n" areas; in our example these areas are 18 departments of the República Oriental del Uruguay, except Montevideo (Fig. 1); in such a way the areas within group or clusters (geographic aggregations) are similar than the areas between clusters. In many of the numerical clustering methods, the clusters are determined by iterative seeking, taking into account the geographical contiguity of the areas that are closer together according to some epidemiological metric character, in this case the FMD level of occurrence.

The procedure applied in this work is one in which "n" areas are grouped into initially undefined number of clusters through a nested sequence of clustering. For FMD occurrence regionalization (Fig. 1) the statistical clustering scheme takes in account an association measurement between every pair of the "n" areas, the difference (d) or Euclidean distance:

$$d\ (A, B) = \left[\sum_{i=1}^{k} (X_{i.A} - X_{i.B})^2 \right]^{1/2} \quad \text{where}$$

A and B are two areas, and "i" is one of the "k" metric possibles characters.

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Using the statistic "d" between each pair of areas, one may derive a "n x n distance matrix", beginning a sequential process for constructing the hierarchical clustering. In each stage of clustering the respective "distance matrix" must be elaborated.

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1					
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The former spatial grouping is a process in which every cluster obtained at any stage is a merger of clusters at previous stages. It is possible to perceive the two extremes of clustering, e.g. "n" clusters with one area per cluster (weak clustering) and a single cluster with all "n" areas (strong clustering), and also a monotonically increase of taxonomical degree as one goes from one clustering level to another.

By scanning the elements of the distance matrix, at any stage, we identify smallest inter-area distance; at any stage in this process it may occur that more than one inter-area distance may correspond to the smallest value in the distance matrix. Thus, clusters are formed until an adequate number of spatial clusters is reached (Fig. 2).

The geographical clustering might be described as a fundamental devise of epidemiology used in trying to explain the causative mechanism of the diseases behavior. In this work we are applying this procedure to the FMD regionalization.

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Figure 1. Level of Occurrence of FMD. 1972-79. Uruguay.

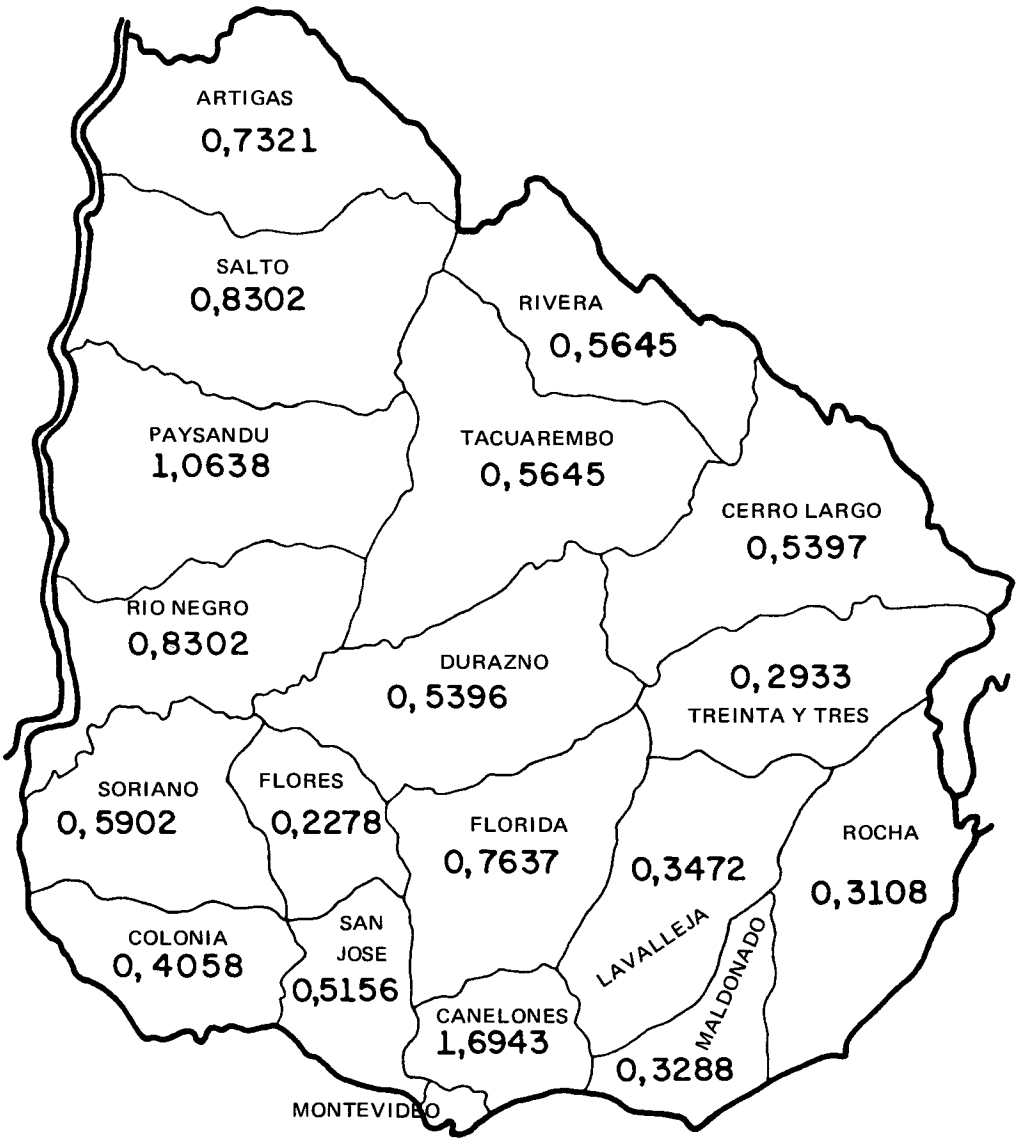

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Figure 2. Geographic Clusters of FMD Occurrence. Uruguay.