

# Regional agricultural production statistics for 160 years using the geographic information system and the spatial analytical technique

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## Abstract

In this study, we created a continuous quantitative series that discriminate Portuguese annual production values at the district level, for about 160 years using a GIS-based spatial analytical technique. For the first time, it was obtained a series of annual production for eleven products: wheat, maize, rye, barley, oats, rice, wine, olive oil, potatoes, beans and grain. In spite of the limitations, the clarity and expressiveness of the spatial representation were observed, which allowed understanding the general characteristics of the distribution of the production and the relative densities, facilitating the reading of the data that gather information of the agricultural production for about 160 years (between 1850-2009).

*Keywords:* Agricultural statistics data, Areal interpolation, GIS, Spatial analysis, Time series.

## 1 Introduction

In the “Agriculture in Portugal: food, development and sustainability (1870-2010)” project the research team searched for agricultural statistics data in the Portuguese public regional archives, such as the National Archives of Torre do Tombo (formerly known as the General Archive of the Kingdom, which is more than 600 years old) and the Arquivos Distritais (the Arquivos Distritais [district archives] of Portugal have the mission of preserving and valuing the archival heritage of historical interest). However, the fragmentation and discontinuity of quantitative sources on regional agricultural production in Portugal place limits on the construction of historical databases with different levels of disaggregation. Mainly, because the agricultural statistics data have been collected and published using different administrative units. As such, in this paper we describe how Geographic Information System (GIS) based spatial analytical technique, namely the areal interpolation, was used to address this problem.

In addition, we also explore how can we visualize this long-term agricultural statistic data, which express the temporal evolution of regional agricultural production in Portugal. Finally, the general characteristics of the distribution of Portuguese production are analysed.

## 2 Portuguese agricultural statistical data

The archival research made able to construct a continuous statistical database at the district level (Figure 1) for the

decades between 1850 and 1989. Nevertheless, data from 1990 to 2005, made available by the Agricultural Statistics, were collected at the level of the agrarian regions (AR) (this are statistical regions with regard to agriculture, consisting of seven units in the territory of the Continent). From 2006 onwards, due to a common standard within the European Economic Community, the Statistics Portugal (INE) begins to collect data at the level of the Territorial Units Nomenclature (NUTS).

### 2.1 Areal weighting approach

To (dis)aggregate the information, it was necessary to use GIS to understand the area differences between the administrative units. Firstly, the production values at the AR level were converted to the NUTS II level. In this phase, the applied approach is a traditional aggregation of data to NUTS II level. Although several authors mention a number of problems associated with this approach, e.g., Gregory (2002), due to the form of the modifiable areal unit problem (Openshaw, 1984), we still applied it because officially, the formation of the AR started from the NUTS III aggregation, and the NUTS III aggregation forms the NUTS II level (Figure 2). As such, the administrative unit areas do not differ between the different administrative levels. Therefore, we obtained the values of agricultural production for the period from 1990 to 2009 at NUTS II level. Secondly, the new values at NUTS II level were converted to the district level. In this phase, we considered the last known production values at the district level (1989) and using the areal weighting method, the production values of each district that belongs to each NUTS II were

estimated using the coefficient of annual growth production ( $a^1$ ):

$$a^1 = t \text{ production} / t-1 \text{ production}$$

where  $t$  production corresponds to the first known production value at NUTS II level (1990) and  $t-1$  production corresponds to the last known production value at district level (1989) weighted by the proportion of the area contained inside the NUTS II (Figure 3). For instance, to estimate the production in 1990 at the district level, the production in 1989 (at the district level) is multiplied by the annual growth production coefficient. In this way, the evolution of production in each district is given by production annual growth of the NUTS II where the district mainly belongs to (Figure 4). The cases in which this approach is more crucial are the districts of Aveiro, Guarda, Viseu, Lisbon, Santarém and Setúbal, since their areas are divided by different NUTS II. An alternative would be to use growth rates weighted by the proportion of the area of each district in the different NUTS II in which the district is “more present”.

### 2.2 Spatial representation

Through the normalization of the production values using min-max values of total annual production, all production years were mapped. Figure 5 shows an example of one of the created maps. With this map, we can understand the importance of Beja district in the total Portuguese wheat production.

### 3 Discussion and Conclusion

In this study, statistical data collected by the INE since 1990, using different administrative units, was converted to the district level. For the first time, disaggregated series for the main agricultural Portuguese products (e.g., wheat, corn, rye...) from 1850 to 2009, were obtained. With this series, a characterization of the regional production of cereal and vegetables can be undertaken. In addition, having this information we were now able to analyse the cyclical oscillations of production, which had unequal durations and intensities, in the various regions of the country.

### References

Agriculture in Portugal, 1870-2010 (2015) (FCT-PTDC/HIS-HIS/122589/2010).

Gregory, I. N. (2002). The accuracy of areal interpolation techniques: standardising 19th and 20th century census data to allow long-term comparisons. *Computers, Environment and Urban Systems*, 26(4), 293–314.

Openshaw, S. (1984). *The Modifiable Areal Unit Problem, Concepts and Techniques in Modern Geography* (No. 38). Norwich: CT: Geo Books.

Figure 1: Districts of Portugal



Figure 2: Administrative units of AR, NUTS III, and NUTS II

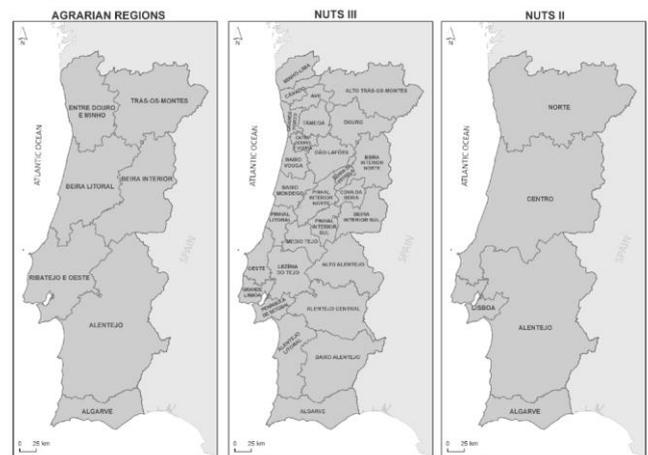


Figure 3: Districts VS NUTS II



Figure 4: Estimation of wheat production in 1990 for the districts in which their areas are inside NUTS II Norte.

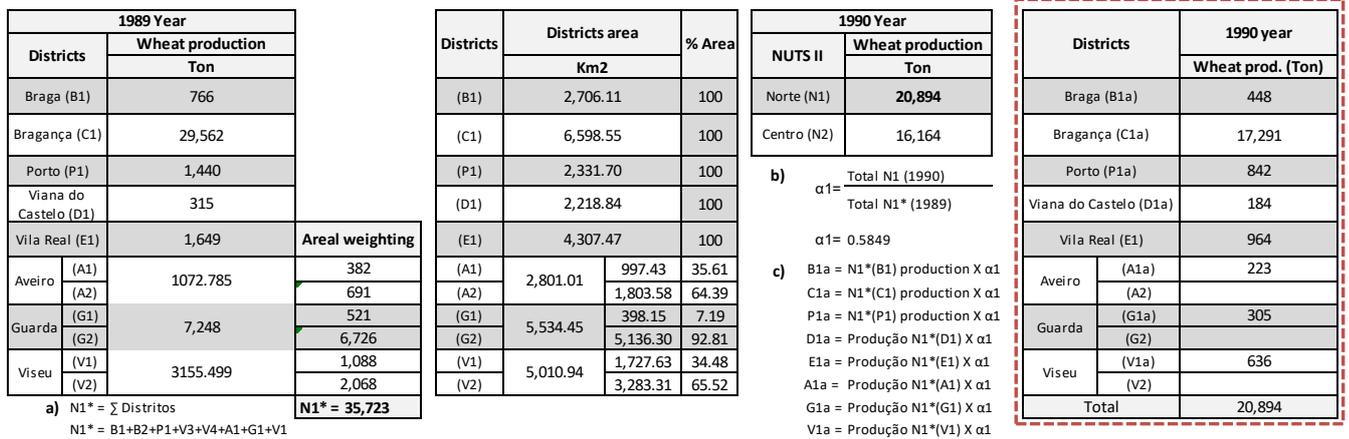


Figure 5: Wheat production (1850-2009). Production values normalized using min-max values of total annual production.

