Public water supply system analysis in the region of Castelo Branco (Portugal) – geostatistical methodologies to the groundwater productivity estimation

Ana Cristina Ribeiro Fonseca*, Luís Filipe Tavares Ribeiro**, Maria Teresa Durães Albuquerque***
*Escola Superior de Tecnologia do Instituto Politécnico de Castelo Branco, Avenida do Empresário 6000 Castelo Branco, Portugal, anafonseca.ipcb.pt, 00351967714301,
** Instituto Superior Técnico, Universidade Técnica de Lisboa, Lisboa, Portugal
***Escola Superior de Tecnologia do Instituto Politécnico de Castelo Branco, Castelo Branco, Portugal

Introduction

Castelo Branco is a town located in the inner central part of Portugal (*Fig.1*). Is about 1.439,94 km2, distributed by 25 administrative sections. The public water supplying system has an approach extension of 500 km, enclosing a population of 50 000 inhabitants.
Fig. 1 – Localization of the area Castelo Branco
The serious problems of water supplying, during the summer months, shows that the exclusive supplying through superficial water captations, is not sufficient to make face to this problem.
Nowadays, the consumers of Castelo Branco, are supplied by two superficial water captations (a total of 1952240 m3 of water per year to 26742 inhabitants) and by 39 underground water (42681,6 m3 per year allowing supplying 1067 inhabitants).
In this work is presented a study concerning the underground potentials modelling, establishing a methodology to an optimised management of the water supply system.

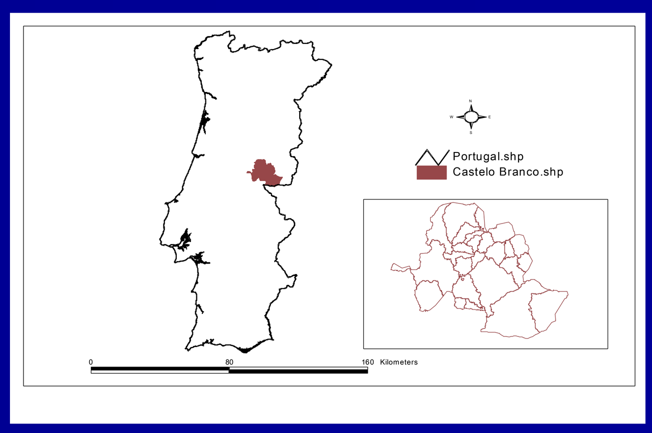

Fig. 1 – Localization of the area Castelo Branco

Geology and Hydrogeology

Three morph-structural units characterize the Portuguese hydrological basin of the Tejo river: the *Ancient Massive*, the *Occidental border* and the *Tertiary basin of the Tejo river*. In the *Ancient Massive* two geotectonics sub units are identified: the *Central Iberia Zone* and the *Ossa Morena Zone*.
The studied area is located in the *Ancient Massive*, *Central Iberia Zone*. In is litological constitution there are essentially, eruptive and metamorphic Pre-Cambrian and Palaeozoic old rocks, Tertiary arkoses, sandstone and calcareous rocks, Holocene alluviums, and the Ordovician quartzite (*Fig.2*). The most important hidrogeologycal potential is the Rañas of *Beira Baixa deposit* (*Fig. 3*).

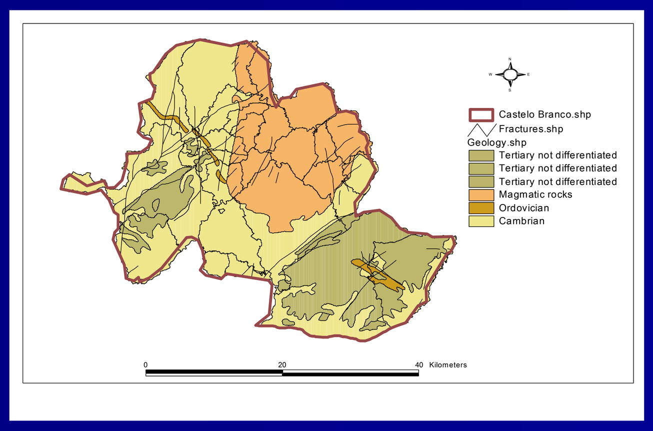

Fig. 2 – Geology in the area of Castelo Branco

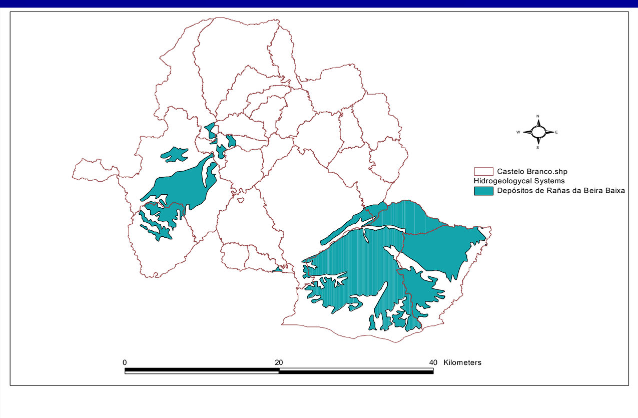

Fig. 3 – Hidrogeologycal Systems in Castelo Branco

Exploratory Data Analysis - Multiple Correspondence Analyses

The variables used, to the groundwater productivity characterization were: the population dimension and groundwater volumes (during 2002), hydrological basin typology, administrative unit typology, Litological classes and Geological classes. In *Fig.4* are located considered the water captations. The ***Multiple Correspondences Analysis*** (***MCA***) was used as a synthesis methodology of the previous selected information *(Pereira, 1990).* The three first axles explain 74.57 % of the variable variability - axle 1-32.64%; axle 2 - 23.26%; axle 3 -18.68%.
Fig. 5 – Axes of Multiple Correspondence Analysis
The high, groundwater volumes values (VIN3) and population (PIN3) are explained by axle 2 (positive direction), and directly correlated to the quartzite litology (QUAR). The low groundwater volumes values are directly correlated with shale and graywacke *(Fig.5).*

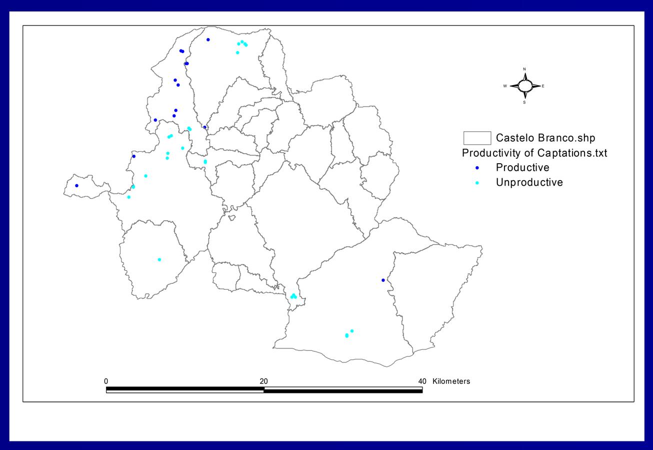

Fig. 4 – Localization of the Underground Water Productive and Unproductive Captations in Castelo Branco

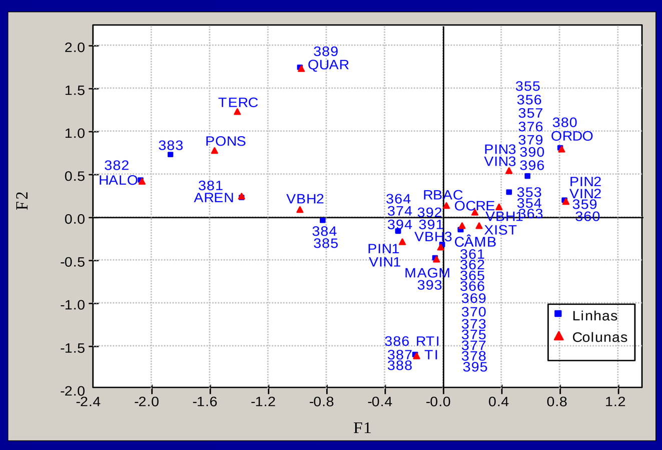

Fig. 5 – Axes of Multiple Correspondence Analysis

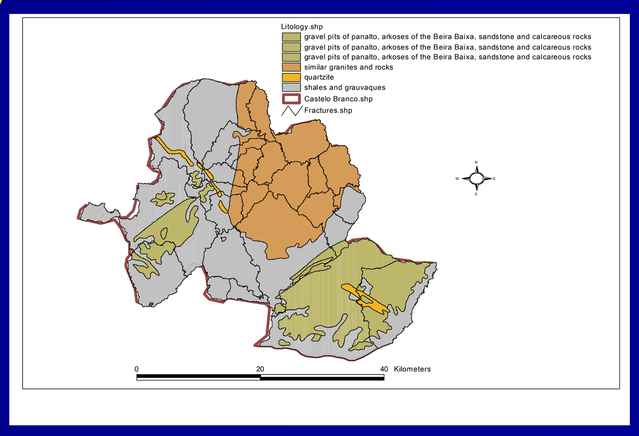

Fig. 6 – Localization of the Underground Water Captations with the type of Litolog

Geostatistical Analysis

Geostatistics methodologies were applied to the structural study of the new synthesis variable and its estimated values mapping (*geoms software*). The second ***MCA*** axel was selected because it explains the most significant volume values, being the synthesis of all the significant attributes to groundwater productivity characterization.
For the structural study of the new variable the respective variogram was calculated (*Soares, 2000*). There weren't evidences of anisotropy and it was adopted the omnidirectional variogram. A gaussian theoretical model was adjusted with the parameters represented in *Fig.7*.
Fig. 7 – Omnidirecional Variogram ajusted with Gaussian Model
The Ordinary Kriging was applied to the determination of an estimated cartography (*Fig.8*).
Fig. 8 – Estimated values to the MCA axle 2

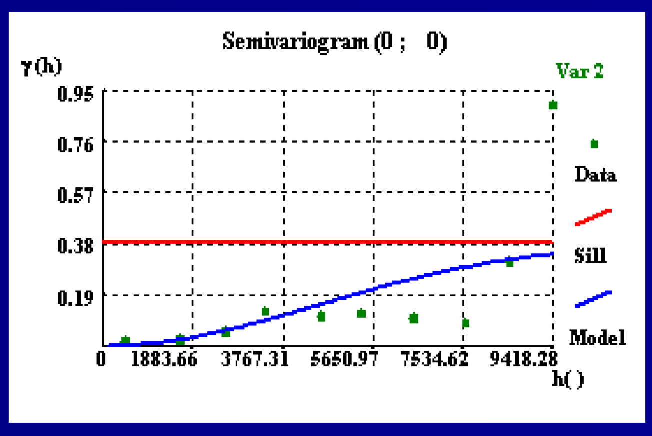

Fig. 7 – Omnidirecional Variogram ajusted with Gaussian Model

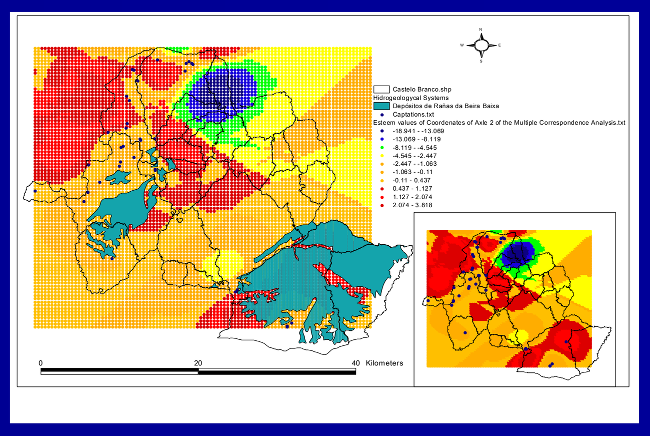

Fig. 8 – Estimated values to the MCA axle 2

Conclusions

The greater groundwater productivity concerns to the hidrogeologycal system *Deposit de Rañas da Beira Baixa* and to the Ponsul basin. Mostly, associated to quartzite litology.
The lower values of groundwater productivity concern to the sub-basin of the international Tejo River and mostly associated to shale litology.

Referencies

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