

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

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ABSTRACT: The present work concerns to the study of the public water supply system, actual situation in Castelo Branco, Portugal. The Castelo Branco geographical area is about 1439.94 Km² with a 500000 people population being an inner region of the country with big problems of water supply during the summer months.

The purpose of this work is to develop a methodological procedure as a working tool to the management optimisation of the water supply system taking in consideration: the groundwater supply; the system management and the captured water volumes control.

The definition of a groundwater hydraulic potential in a major fractured hydrogeology field, in which the water is conditioned by the presence of extended altered formations and it's mobility conditioned by the intense fracture density is the goal of the propose work. The working data is available in a few Portuguese water institutions, and summarizes to 2002, the groundwater volumetric supplies, hydrological basin type, planning regions, geology, litology and served population. To the groundwater productivity estimated cartography was adopted a set of statistics and geostatistics methodologies like Ordinary Kriging, using a preliminary variographic data analysis that allowed the inference of the preferential underground flow.

KEYWORDS: groundwater productivity, geostatistics methodologies, Ordinary Kriging.

1. 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.

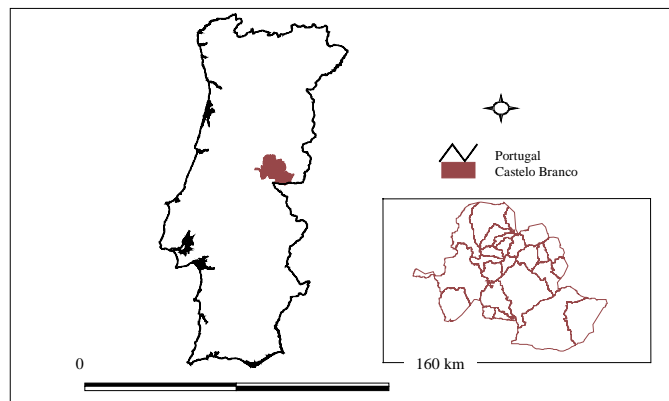


Fig. 1 – Localization of the area Castelo Branco

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.

2. 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 Massise, Central Iberia Zone*. In its 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 hidrogeological potential is the Rañas of *Beira Baixa deposit* (*Fig. 3*).

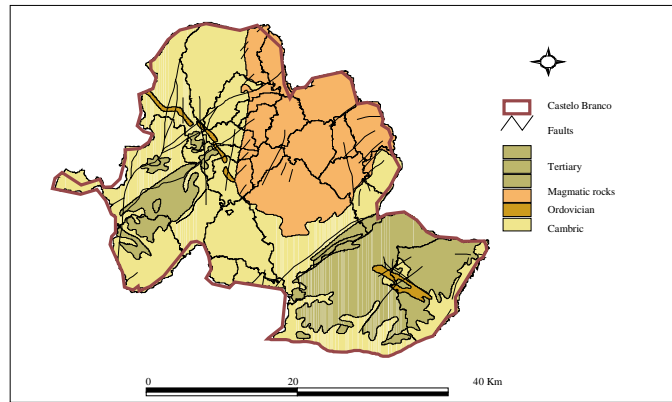


Fig. 2 – Geology in the area of Castelo Branco

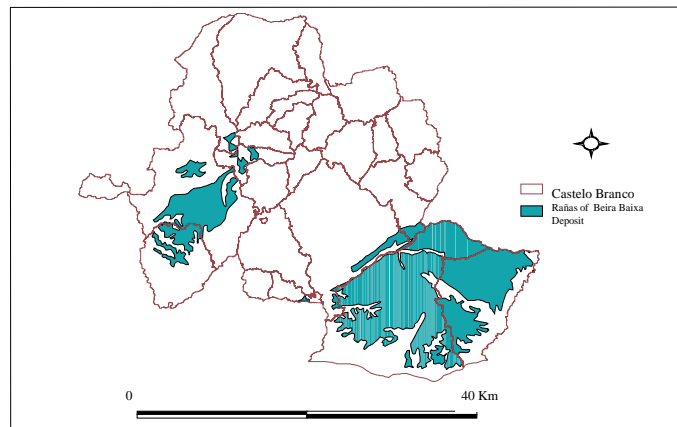


Fig. 3 – Hidrogeological Systems in Castelo Branco

2.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.

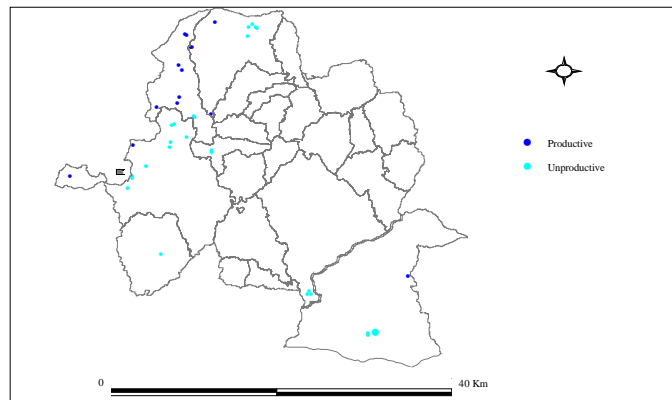


Fig. 4 – Localization of the Underground Water Productive and Unproductive Captations in Castelo Branco

The *Multiple Correspondences Analysis (MCA)* was used as a synthesis methodology of the previous selected information (Pereira, 1990). In *Tab. 1* is represented the considered variables and its classes codification (*andad software*).

Variable Type	Variable	Number of Classes	Classes
Quantitative	Population (inhabitants)	3	[0;3565.67] [3565.67;7131.34] [7131.34;10697]
	Volume(m ³)	3	[0;144405.2] [144405.2;288810.4] [288810.4;43215.6]
Qualitative	Hidrologycal basin	3	—
	Planning Region	2	—
		—	—
	Litology	3	—
Geology	5	—	

Tab. 1 –Classes used in Multiple Correspondence Analysis

The three first axes explain 74.57 % of the variable variability - axle 1-32.64%; axle 2 - 23.26%; axle 3 -18.68%.

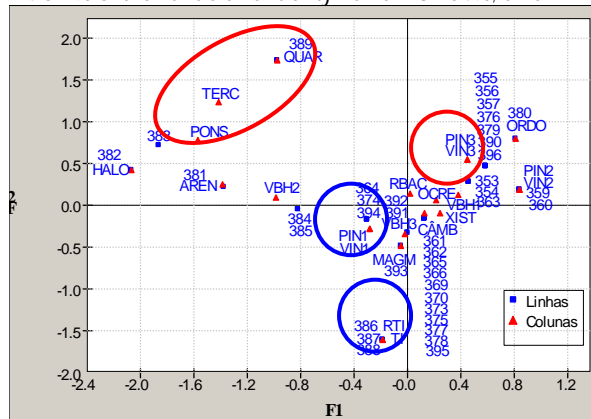


Fig. 5 – Axes of Multiple Correspondence Analysis

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).

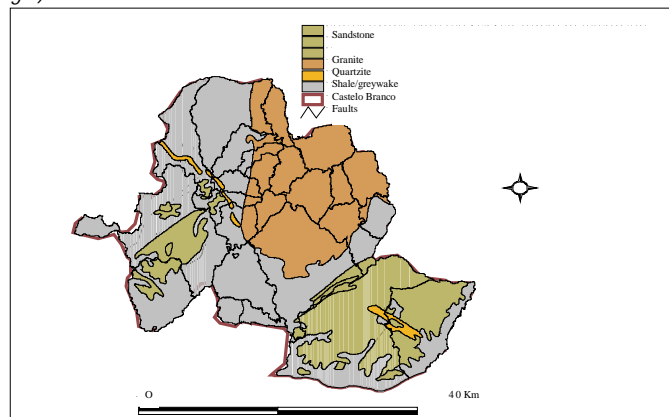


Fig. 6 – Localization of the Underground Water Captations with the type of Litology

3. 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*.

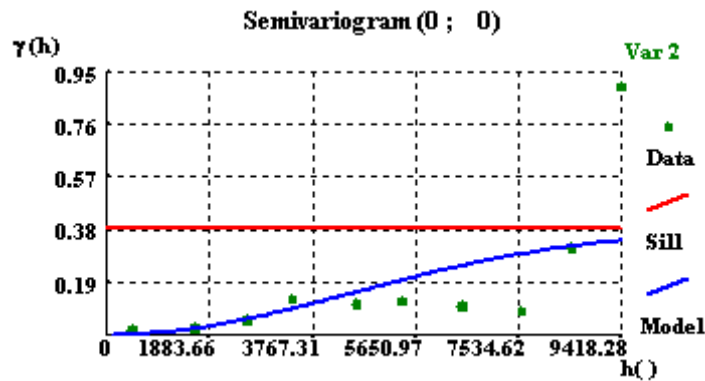


Fig. 7 – Omnidirecional Variogram ajusted with Gaussian Model

The Ordinary Kriging was applied to the determination of an estimated cartography (*Fig.8*).

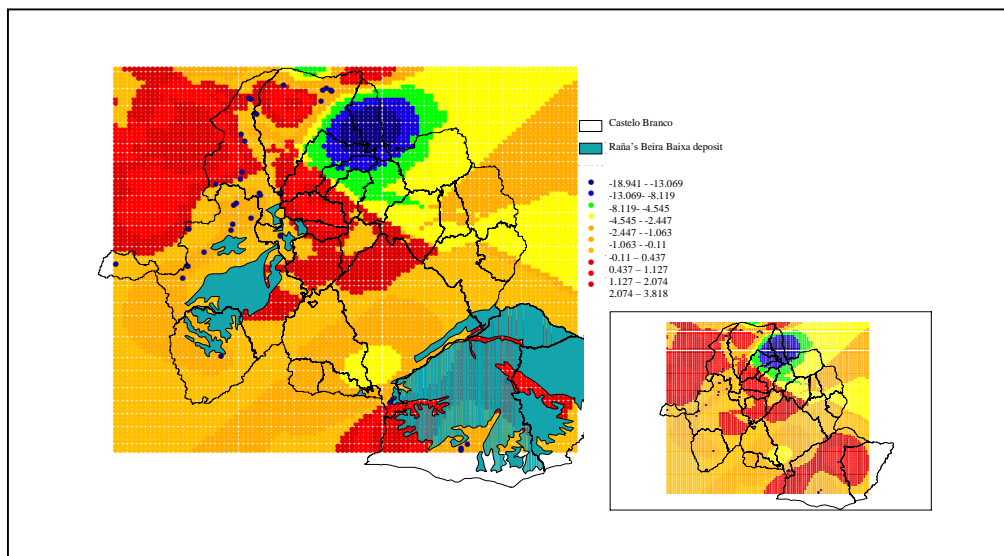


Fig. 8 – Estimated values to the MCA axle 2

4. Conclusions

The greater groundwater productivity concerns to the hidrogeological 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.

References

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