Airborne Electromagnetic Data as External Variable to Predict Groundwater Electrical Conductivity in the Crystalline Domain of Irauçuba Region - Ceará, Brazil

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ABSTRACT

Comparison of geostatistic models to predict groundwater electrical conductivity utilizing high high resolution airborne EM data and water electrical electrical conductivity from wells in a region comprised by paragneisses and migmatites in the the semi-arid of Northeast Brazil.

BACKGROUND:

Helicopter Electromagnetic-HEM and water electrical conductivity-EC measurements reflect the the capacity of material to conduct electric current. current.

OBJECTIVE:

Predict groundwater electrical conductivity using using two different geostatistical methods.

Help the government drilling programs.

METHODS:

Non-stationary kriging and stochastic simulation in simulation in ISATIS software. The HEM data was was used as an external drift variable into the modeling to highlight the variability of groundwater groundwater electrical conductivity.

RESULTS:

Measurements in new drilled wells were compared compared with predictive maps and placed very very close to the expected values or within the standard deviation range, although it did not work work for dug wells.

The central region is expected to have low groundwater electrical conductivity.

CONCLUSIONS:

Stochastic simulation worked better than kriging. kriging.

Differences in unit scales of water and HEM data did data did not hinder a qualitative interpretation of of groundwater EC variability.

Related to the map products, there is great influence influence of HEM data in (edge regions) without without conditioning points, so interpretations should be taken carefuly. However, where there are are wells, a better integration of the two variables variables delineated conductive regions more realistically.

Collaborative work among CPRM, USGS, UNICAMP and UnB.

Airborne and ground data acquired during the Northeastern Brazil Groundwater Project, between the Geological Geological Surveys of Brazil and Canada. 2000 – 2004 http://PROASNE.net

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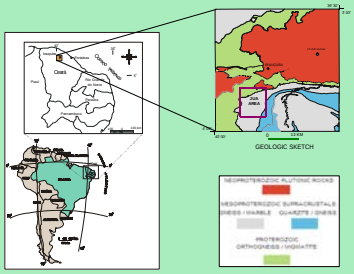
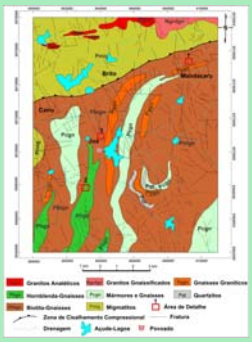
The Study Area

CLIMATE: semi-arid to sub-humid.
annual rain fall: 550 - 1.200 mm (22 - 48 in)
annual temperature: 24 - 30 C (80 – 92 ºF)

WATER SUPPLY: low productive drilled wells usually brackish, need of dessalinitors.



Geologic map of Juá Area

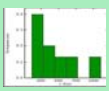


METHODS

Juá Water electrical Conductivity Data

- November, 2000 campaign for **modeling** 20 wells, 15 with water EC measurements

# Map	Well	Depth (m)	Q (m3/h)	EC (mS/m)	Situation	Rock
1	45	7.00		234	Operational	Paragneis
2	46	60.00		200	Non Operational	Marble/gneiss
3	47			-	Abandoned	Marble/gneiss
4	48			-	Abandoned	Marble/gneiss
5	50	60.00	1.10	415	Operational	Paragneis
6	51	60.00	4.50	558.2	Operational	Paragneis
7	53	60.00	1.20	203	Abandoned	Paragneis
8	54	72.00	0.70	-	Abandoned	Paragneis
9	65	48.00	6.00	274.4	Not Instaled	Paragneis
10	66	54.00	6.00	603	Operational	Paragneis
11	67	42.00	6.00	117	Operational	Paragneis
12	72	60.00	0.70	1104.1	Operational	Paragneis
13	74	56.00		768.4	Operational	Marble/gneiss
14	105			-	Non Operational	Paragneis
15	106	60.00		-	Non Operational	Paragneis
16	195	60.00	0.10	750	Not Instaled	Paragneis
17	196	75.00	0.38	150	Not Instaled	Paragneis
18	221	60.00	0.03	260	Not Instaled	Marble/gneiss
19	222	78.00	1.25	360	Not Instaled	Paragneis
20	223	72	-	1050	Not Instaled	Gneiss



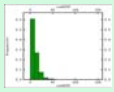
Histogram for Water EC 2000 data

- November, 2005 campaign **test of the models -** New 5 drilled drilled wells and 3 dug wells

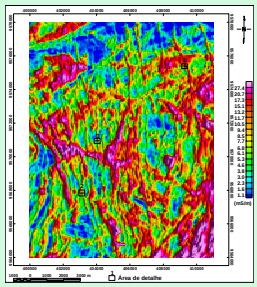
Well number	RM_1 (new)	UB_1 (new)	UB_4 (new)	J_1 (not used)	SL_4 (not used)	SP_4 (not used)	CD_1c (not used)	CB_1c (not used)	RM_1c (not used)	SP_2 (used in simulation)
Type / Situation	Drilled / Deactivated	Drilled / not installed	Drilled / not installed	Drilled / not installed	Drilled / not installed	Drilled / not installed	Dug / manual pump	Dug / manual pump	Dug / manual pump	Drilled / dug windmill
EC mS/m	184.0	858.0	810.0	290.0	321.0	151.2	261.0	231.0	140.4	219.0
Yield m ³/h	1 (aprox.)	0.3	<0.3	< 0.3	< 0.3	< 0.5	-	-	-	< 0.5

Airborne Electromagnetic Data

- 4,500 Hz frequency



Histogram and map of HEM data (mS/m)

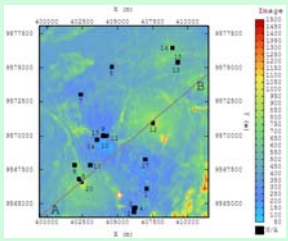


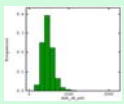
GEOSTATISTICAL APPROACHES

EXTERNAL VARIABLE CONCEPT

Variables acquired by different ways but reflecting the the same phenomena (physically related in nature), and and broadly distributed at the same spatial domain. domain.

Groundwater Electrical Conductivity by Non Stationary Kriging



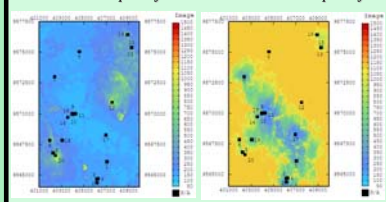


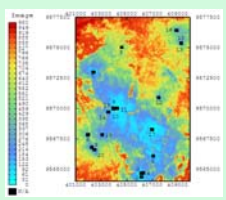
Map and Histogram for Non Stationary Kriging

Groundwater Electrical Conductivity by Stochastic Simulation (Non Stationary analysis)

Scenarios for 100 simulations

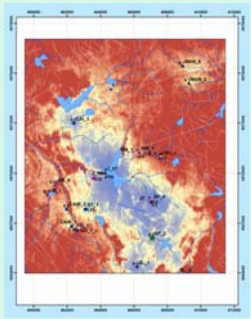
25 % Iso-frequency 90 % Iso-frequency



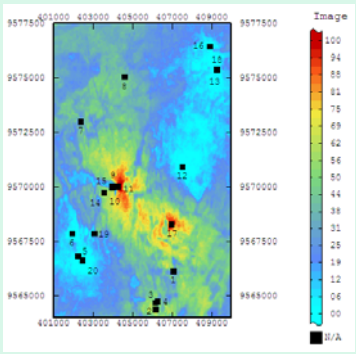


Variability Analysis for 100 simulations Standard Deviation

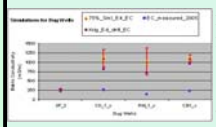
75% Iso-frequency map for of 100 simulations



Probability map for groundwater EC lower than 200 mS/m for 100 simulations



EVALUATION OF THE MODELS



Not suitable for dug wells
Poor correlation
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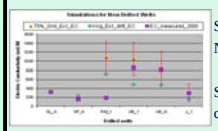
Surface water does not affect the model



Suitable for drilled wells
New and non-operational
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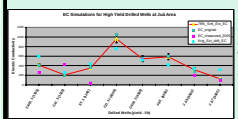
Smaller variability over conditioning wells



Not suitable for 8 high yield wells
poor correlation
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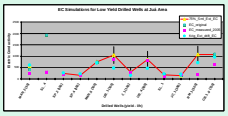
Smaller Std Dvt



Slightly better correlation with 11 low yield wells
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Greater Std Dvt