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Geophysical research and present results at Rio Claro study area.

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Abstract

Environmental impacts related to nitrate in soil and groundwater due to human activity have been studied in many academic surveys. The major problem in nitrate contamination is it´s extension increasing the cost of remediation.

In those studies, researchers have been using various methodologies, especially direct methods of investigation such as wells, water and soil sampling and chemical analysis. Otherwise, indirect methods have the advantage of quickness, relative best prices and quality of results.

Electrical geophysical methods has been fairly used in hydrogeological studies. Especially when necessary to investigate depths, temporal and spatial variations of aquifers, preferred underground flow directions and also detection and scaling of plumes of contamination. The increase of moisture and the amount of dissolved salts cause a decrease of soil resistivity values.

On the other hand, eucalyptus are known for being an arboreal species that absorbs a significant amount of water from the unsaturated zone and, in some cases, may even influence the recharge of aquifers. In this context, the application of electric resistivity method, using the technique of handling electric, before and after the cut of a plantation grown eucalyptus, can show if the soil resistivity values change due to the presence of this plantation.

In this project, initially, we believed that after harvesting the resistivity values would decrease, since the roots of eucalyptus would no longer absorb large amounts of water, which would recharge the aquifer. The steady fall of the water level values and the calculation of water balance in the region led to the conclusion that the months during geophysical campaigns were characterized as having water deficit in the region.

Thus, the increase in values of soil resistivity could be linked to water and climatic characteristics of the region, not suffering any influence of eucalyptus. A new survey, after the rainy months (March 2014) may show differences in these results.

The use of the technique of Vertical Electric Sounding and Self Potential indicates, respectively, that the level of water presents average depth around 6.00 meters at the higher portion and the preferred direction of underground flow is to the North of the region, apparently upstream when we consider the present surface topography.

Introduction

In hydro-geological studies, geophysical methods have applicability when it´s necessary to evaluate depths, temporal and spatial fluctuations, aquifers, preferential direction of groundwater and also sizing the plumes of contamination..

Among the geophysical methods of exploration, electrical methods are increasingly being used in hydro-geological studies since they have good resolution and relatively cheap cost (Steeples,1991; Telford, 1990) .

According to Gallas (2000), the increase in the moisture content and the amount of dissolved salts cause a decrease of soil resistivity values. This condition allows the immense possibility of application of electric resistivity method in hydrogeological and environmental studies (Saraiva, 2010), where the presence of water in the saturated zone can be detected by this method, as well as the variation of moisture in unsaturated zone.

The Spontaneous Potential has its main application in the study of flow behavior of subsurface waters. SP anomalies are generated by the fluid flow, heat or underground ions. Has shown satisfactory results when necessary to locate and delineate those streams and their associated sources (Gallas, 2000).

Nowadays, few studies use these methods with the objective of comparing the influence of arborous species in the saturated zone and unsaturated aquifer system. This study main objectivity is to investigate the changes that occur in the soil resistivity values before and after the cut of a eucalyptus plantation.

Therefore, in this study, the use of these two electrical methods is of extreme importance to understand how the aquifer is behaving, compare the indirect research data with the direct research and influence tree species that absorb significant amounts of water, such as eucalyptus, engaged in saturated and unsaturated zone of an aquifer system.

Method

The study area was defined into a few options because in Brazil is not usual cultivating eucalyptus in swallow areas. Most common is to cultivate this species on the top of hills, far from rivers, springs, lakes, etc.

The area, situated near Rio Claro city (Fig. 1) is covered with sand sediments of Rio Claro Formation (Fúlfaro & Suguio, 1968) with a high permeability coefficient, providing a rapid movement in subsurface of the groundwater.

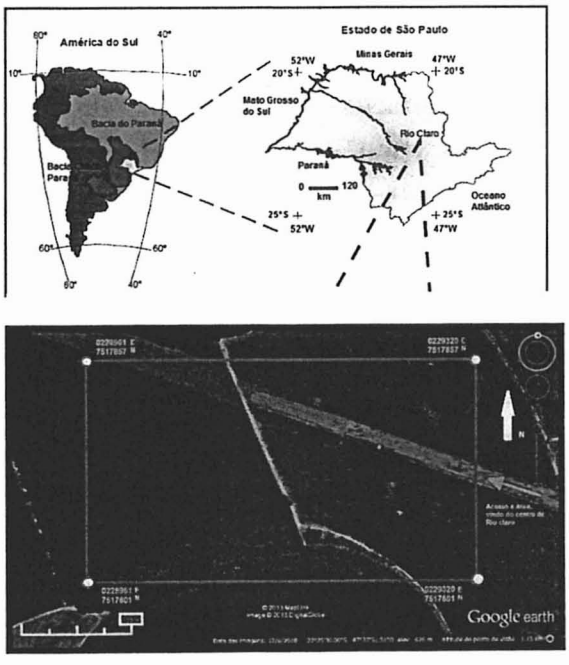

Figure 1 - Location of the area. Adensohn (2013).

The geophysical survey includes six electrical imaging profiles done in July and September of 2013, respectively before and after the eucalyptus harvesting. The survey included also nine vertical electrical soundings (VES) which indicated the water table depth and helped the results interpretation of the electrical imaging and a self-potential survey (SP) also done. Figure 2 shows the location of the electrical imaging lines and VES.

Electrical imaging were performed using dipole-dipole array and electrode spacing of 5m to profiles 1, 2 and 3 and 2,5m to profiles 4, 5 and 6 due to available space. This arrangement allowed to investigate10 levels resulting in 915 data for each section.

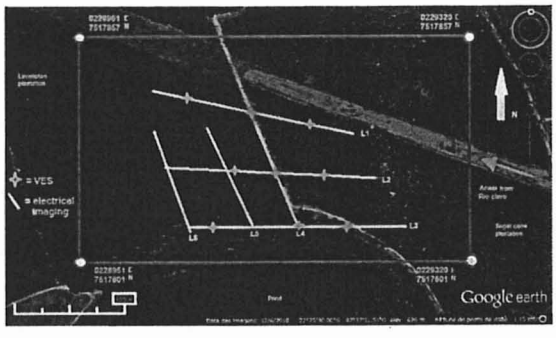

Figure 2 - Location geophysical survey.

VES survey was performed using ab/2 (maximum distance between electrodes) from 50m to 80m investigating more than 20m deep in some cases (Figure 3).

SP was done using a fixed base and taking measures each 10 meters along the same lines 1, 2 and 3 used

to electrical imaging.

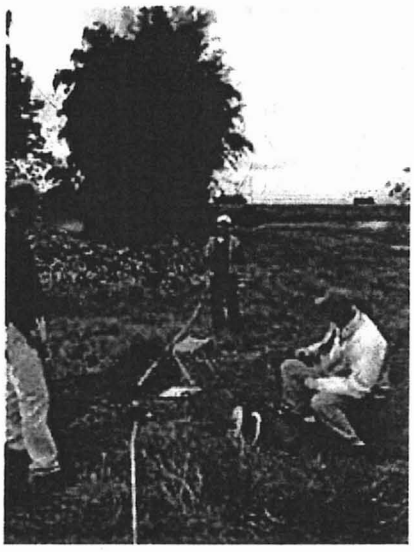

Figure 3 – VES-9 survey.

Results

The roots of eucalyptus trees absorb greater quantities of water from the unsaturated zone, since most of its roots can be found in this portion. Thus, when active in this area, may be responsible for preventing the recharge of the aquifer if the quantity of rain is not greater than the demand of the trees.

With the eucalyptus harvesting we expected that the campaign held in September detected smaller resistivity values in surface levels with the increasing of soil moisture and allowing, to some extent, the recharge of the aquifer.

However, what we observed was increased resistivity in all lines, especially in the areas of eucalyptus planting, which can be attributed to the low rainfall in the period between the campaigns, insufficient to modify substantially the local condition

A example with the results for L2 and L4 are shown on Figure 4 and 5.

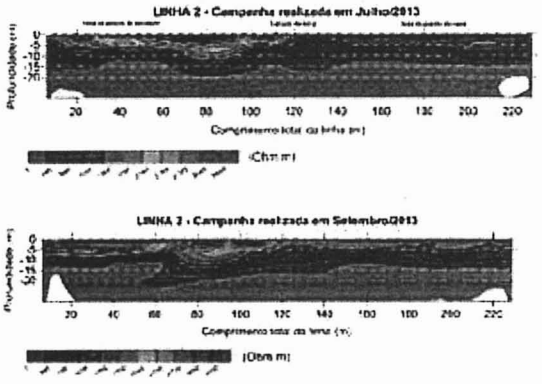

Figure 4 – Eletrical Imaging for L2.

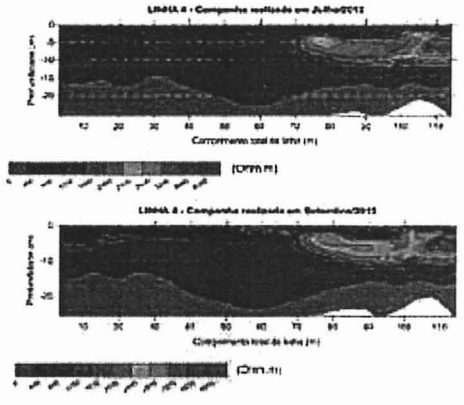

Figure 5 – Eletrical Imaging for L4.

VES indicated with good precision the water level and it were made to check these results along the lines for electrical imaging the area. As a example (Figure 6) VES 10 indicates water level at 5,24m and a direct

measurement at monitoring well "O" show water level at 5,5m.

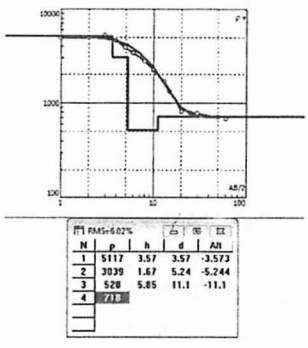

Figure 6 – VES 10 curve, next to monitoring well "O" and table with results.

Finally, SP survey (Figure 7) indicate that, in this aquifer system, the pond is influential in the aquifer recharge and not the opposite as expected, since the local topography decreases towards the lagoon, in this case, South. This result agrees with the measures carried out in monitoring wells in the area over the last two years.

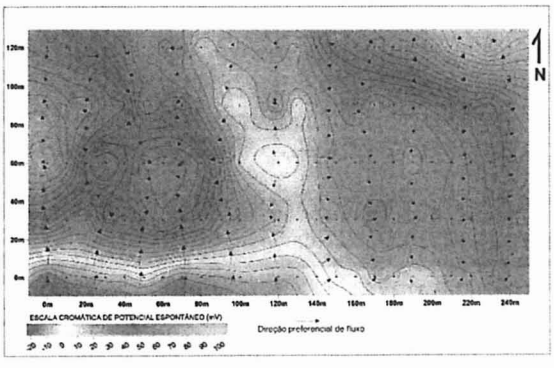

Figure 7 – Result map of SP survey with water flow interpolated directions.

Conclusions

A dry season, longer than expected, could have changed the results. The increase of resistivity instead of its decrease could be referenced to the hydric balance calculated in Adehnson (2013) with few rain after March of 2013 and hydric deficit from June to November of this year.

SP survey proves that the water flow is from SW to NE or next to S to N what agrees with the measures carried out in monitoring wells in the area over the last two years.

A new survey that will be done at the end of March/2014 and it may show the increase of conductivity relationship to the expected water level elevation.

Continuing the project, we expect new surveys each three months until the end of 2014 to determinate a possible hydrogeological pattern with eucalyptus presence with the roots grow again.

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