# Geochemistry of Soil Solution and Canal Waters in Plinthosols under Irrigation by Flooding

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Plinthosols occur in humid and semi-humid tropical areas of several continents. The geochemistry of Plinthosols is sensitive to changes in the hydromorphic conditions which can be modified, among other factors, by flooding irrigation. Plinthosols located in floodplains of Savannah areas of Central Brazil have been flooded by irrigation for 18 and 28 years. The irrigated crops produce rice in the wet season (October to February) and soybeans in the dry season (June to September). Irrigation water is applied through the use of canals which flood the fields for rice production and keep the water level 60 cm below the soil surface for soybean production. This study compared the geochemistry of irrigation water present in the soil solution of Plinthosols and in the canal waters. The research was conducted in areas of the irrigation project Luis Alves do Araguaia, State of Goias, Brazil (Figure 1). Water samples were studied in the field (Figure 1) for determination of physical - chemical parameters (pH, Eh, dissolved oxygen, electrical conductivity, total dissolved solids) by a multiparameter water quality meter (Hanna model HI 98194). The study was performed during the dry season at 20 sites (10 sites at the canals and 10 at the soil

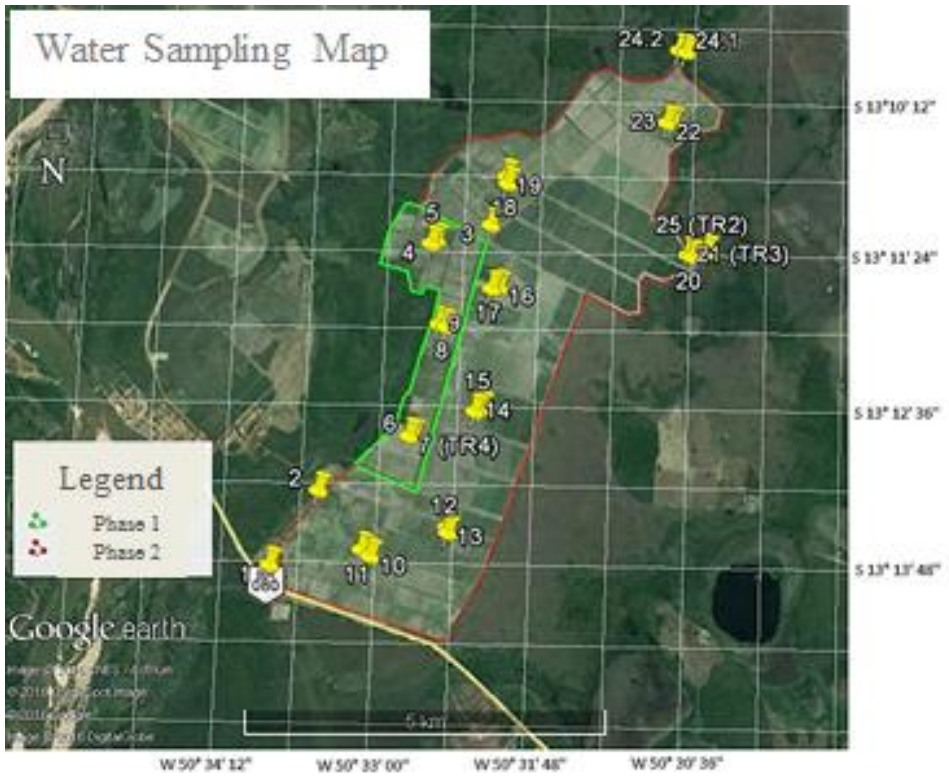


**Figure 1.** Study area. Phase 1 = 27 years of irrigation; Phase 2 = 17 years of irrigation. Yellow marks are sampling sites. Samples were collected at sites 4 to 23. Source: Google Maps, accessed on 18/01/2016.

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profile). Piezometers were installed into the Plinthosols' profiles to allow measurements of soil solution physical-chemical parameters at a 60 cm depth. Measurements were performed after a 24 hr equilibrium time. In the canal waters, measurements were performed by immersing the instrument into the water.

Results showed Eh values were lower for the canal waters compared to the soil solution and, as expected, pH values were higher for the canal waters (Table 1). Dissolved oxygen was about 30% lower for the soil solution. These results clearly indicate differences in the geochemistry of the irrigation water from the canals compared to the field soil solution water.

**Table 1.** Physical-chemical parameters data for two water sources.

| **Canal Water** | | | | | | **Soil Solution** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Site** | **pH** | **Eh (mV)** | **DO (%)** | **EC (µS/cm)** | **TDS (ppm)** | **Site** | **pH** | **Eh (mV)** | **DO (%)** | **EC (µS/cm)** | **TDS (ppm)** |
| P4 | 7.5 | -57.5 | 6.0 | 43 | 22 | P5 | 6.3 | 42.3 | 3.1 | 38 | 19 |
| P6 | 7.7 | -56.1 | 4.7 | 41 | 21 | P7 | 7.2 | 8.2 | 2.3 | 44 | 22 |
| P8 | 7.8 | -52.4 | 7.8 | 43 | 21 | P9 | 6.7 | 75.8 | 7.1 | 26 | 13 |
| P10 | 7.3 | -37.5 | 2.8 | 40 | 20 | P11 | 6.0 | 71.1 | 2.4 | 29 | 15 |
| P12 | 7.3 | -53.8 | 2.5 | 37 | 18 | P13 | 6.7 | 5.5 | 2.6 | 27 | 14 |
| P14 | 8.0 | -81.2 | 3.8 | 37 | 18 | P15 | 6.2 | 56.5 | 3.5 | 34 | 17 |
| P16 | 7.4 | -30.2 | 5.6 | 36 | 18 | P17 | 6.5 | 81.9 | 4.9 | 51 | 25 |
| P18 | 8.0 | -91.6 | 6.0 | 41 | 20 | P19 | 6.3 | 17.1 | 3.4 | 140 | 70 |
| P20 | 7.3 | -70.3 | 13.4 | 35 | 17 | P21 | 6.3 | -31.0 | 6.4 | 62 | 31 |
| P22 | 6.9 | -33.5 | 14.3 | 36 | 18 | P23 | 5.8 | 67.8 | 7.2 | 23 | 11 |
| **Avg** | **7.5** | **-56.4** | **6.7** | **38.9** | **19.3** | **Avg** | **6.4** | **39.5** | **4.3** | **47.4** | **23.7** |
| **SE** | **0.03** | **1.50** | **0.31** | **0.27** | **0.15** | **SE** | **0.03** | **3.17** | **0.17** | **2.22** | **1.10** |

Notes: Eh=redox potential; DO=dissolved oxygen; EC=electrical conductivity; TDS=total dissolved solids; Avg=average; SE=standard error.

It is likely that Eh and pH values were buffered by iron (hydr)oxides at the soil solution as the Plinthosols present a plinthic horizon at the 60 cm depth. Iron-rich minerals controlled reducing reactions and kept the Eh value around 6 mV. Strongly reducing conditions were achieved for the canal waters possibly because iron (hydr)oxides were not present in significant amounts in the water so other redox sensitive compounds controlled the reducing conditions. Surprisingly, dissolved oxygen was higher for the canal waters. We expected low concentrations of dissolved oxygen in the canal waters because Eh values were below the range for oxygen reduction, which is above 300 mV (McBride, 1994). It is still not clear why dissolved oxygen showed this behavior, however the presence of living aquatic organisms may have had an effect on dissolved oxygen concentrations in the canal waters.

In conclusion, the geochemistry of irrigation water in the canals and soil solution were different. This may influence geochemical transfer between Plinthosols and canal waters.

## References

McBride, M.B. 1994. Environmental Chemistry of Soils. Oxford University Press, New York, NY. 406 pp.