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EFFECT ON PH, EC AND OM OF THE USE OF URBAN WASTEWATER IN IRRIGATION LINE IN THE PADDIES IN ALBUFERA OF VALENCIA (SPAIN)

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Abstract

This study attempts to establish the effects of urban waste water irrigation on the cultivation of rice through pH development, organic matter and electrical conductivity along an irrigation line evaluating nine plots.

The main source of water is of urban origin (sewage) that was combined with water from irrigation ditches (several sources: agricultural, urban and industrial). This study will help determine to what extent affects the soil-water-plant systems and the surrounding environment. Study results suggest through the process of analysis of the water, of agricultural soils the impact of different types of water will have on the crops and environment. The unique aspect of this study with respect to prior studies on the reuse of urban wastewater in agriculture and their effects on crops and the environment is just how to follow the linear evolution (spatial) of the chemical parameters of flooded soils for growing rice. In the analysis not only does this consider the spatial evolution but also the temporal, comparing the results obtained from samples taken before and after harvest of rice cultivation for several campaigns. The aim is to get an overview of the effects caused by these three chemical parameters in the wastewater on rice crops, waters and agricultural soils, under the conditions of the experiment, basic soils and Mediterranean conditions.

Keywords: rice, irrigation, soils, urban wastewater.

Introduction

One of the main problems of the modern cities is how to accommodate urban residual waters and the need for recycling water. In Valencia (Spain) the urban residual waters are used in part of the irrigation of agriculture.

Its a study of a rice area in the southern of Valencia city, the altitude of the area decreases to the south of Valencia, where the depression begins and is occupied by the waters of Albufera Lake. The Albufera runs parallel to the coast from north to south over a stretch of 15 km, separated only from the Mediterranean Sea by a narrow strip of sandy soil.

This study demonstrates the effects of irrigation with urban waste water within on the cultivation of rice and in the environment (Albufera Lake). The analysis of the basic soils and Mediterranean climate and altitude conditions are the key elements of this experiment.

The soils selected from paddy fields are in the same area that is usually irrigated with treated wastewater. The objective is to quantify temporal evolution of pH, organic matter and electrical conductivity through irrigation line and through the vertical infiltration, regardless of the horizontal results which has been studied in other experiments.

Materials and methods

Nine plots was choosen in the area, four of which are irrigated only with water from the issuer of the treatment plant along the same line of irrigation (plots 2, 3, 4 and 5), another with water from the lake (parcel 9), one with very poor water quality of another irrigation ditch called Favara (Plot

1), another two (plots 6 and 7) where sewage water is mixed with water from the Favara and finally the plot number 8 to receive three types of water (Favara, sewage and lagoon). The irrigation line is important for the study, as may occur or not variability from one plot to another.

In this election of the plots has been taken into account its situation along a line of irrigation, but has also been chosen plots irrigated with water similar but different to compare. The sample plots were selected randomly keeping in mind the discriminating spatial variability of soil to assess, as it sought to be sufficiently separated to detect possible changes within the parameters, although other criteria were considered as part of the controlled study: the owner, etc.

Sampled soils plots were tested before and after harvest in of three soil depths. Also water samples were taken in flooded plots and at the entrance to the ditches. Sampling was repeated during three growing seasons.

Previously washed and dried in an oven beakers 50 mL required. The vessel remained in the oven for 24 hours and after weighed. Once dry the containers were weighed, 50 grams of soil were placed in the vessels. The glasses were put down inside the stove where they remained for 24 hours. The dried soil was removed from the oven and allowed to cool in a box, this allowed moisture absorption equal to an outdoor atmosphere. Once at room temperature the vessels and samples of dry soil were weighed again.

Official guidelines and methods of analysis of soil, water and plants recommended by the *Ministerio de Agricultura* for chemical analysis were used that complemented and contrasted with other methods, such as the recommendations of the APHA (American Public Health Association) in the case of analysis water.

The measurements of pH, conductivity in soil suspension are done with deionized water with mass ratio soil: water 1:5.

For pH measurement technique was used in potentiometry with the use of pH meter. For the determination of electrical conductivity (EC) technique was used the conductivity. Previously weighed 20 g in each soil sample to which was added 50 mL of deionized distilled water and stirring for 20 minutes and steeping.

Measuring the electrical conductivity is influenced by properties of solid and liquid phases of soil and provide a direct relationship with the concentration of salts thereof (Bottraud and Rhoades, 1985).

Results and discussions

pH

In the plots and in the ditches there is an increase in pH along irrigation line, as the pH is higher in the last areas where ditches receive input from the Albufera lake.

pH values obtained correspond to most soils considered moderately basic (7.8 to 8.5). Although there are some determinations of these values that slightly exceed in soils and other results obtained from the same soil at different times return within this range.

In this study the pH not only important in itself, but also because it will depend on the degree of availability of the evidence supplied by irrigation water. For pH values obtained the nitrogen and phosphorus are fully available to the plant, as well as calcium and magnesium. However, the availability of potassium falls between 7.5 and 8.5 pH range within most of the soils studied. Most metals for this pH range is in the form of sparingly soluble salts, being soluble at acidic pH as with iron or manganese, and is therefore unlikely to find toxicity problems in plants caused by the elements trace. Zinc and molybdenum salts with these pH values increase their solubility.

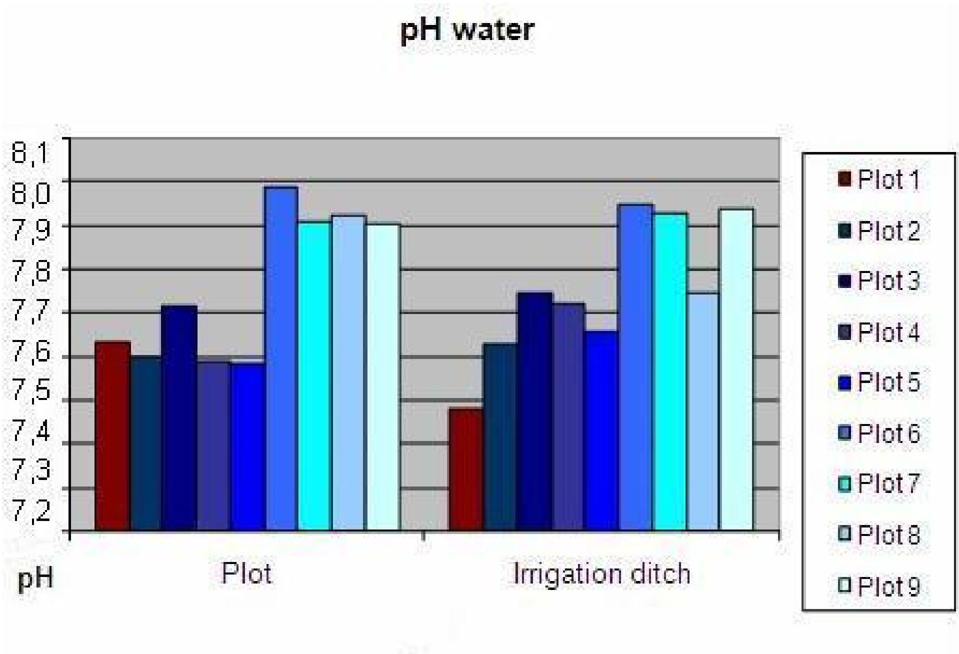

Figure 1: pH waters

The pH increases slightly within depths in most of the plots, also appears to increase slightly after harvest but this cannot establish a clear relationship as it is dependent on the time elapsed and which plots had been drained and where the samples were taken. On the other hand, does appear to show a reduction in pH as it advance along the irrigation line. The following figure displays this relationship and considers the sewage and actual distances following the route of the water to the plots.

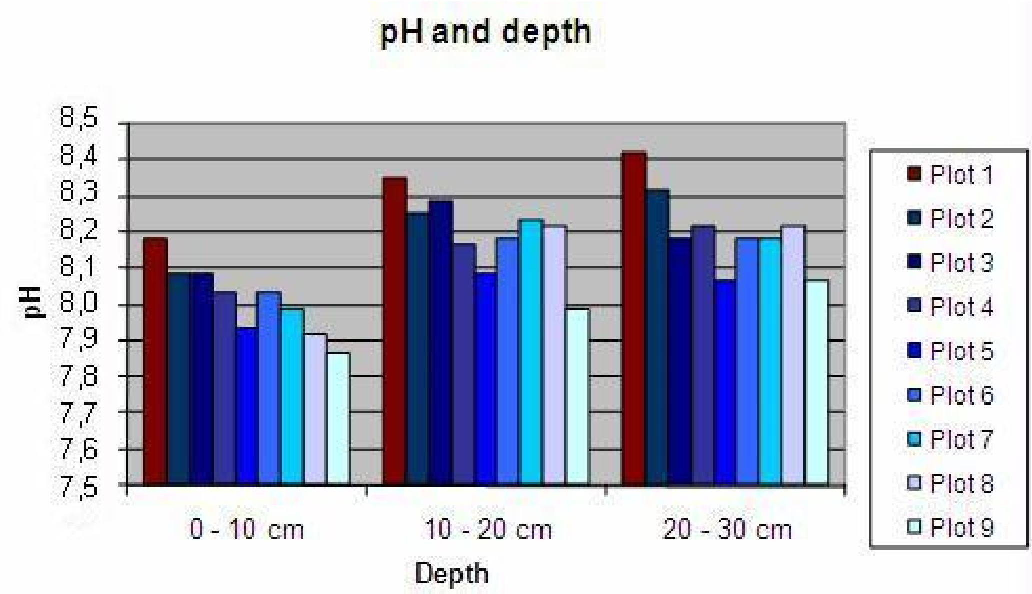

Figure 2: pH soils and depth

As shown in the picture there is a clear relationship between pH and the distance to the treatment plant along the irrigation line. Once mixed with water from other sources in plot 6 (from the red line) it seems that the pH increases again, but you can not make a conclusive statement until the results are compared from different sampling points of each plot.

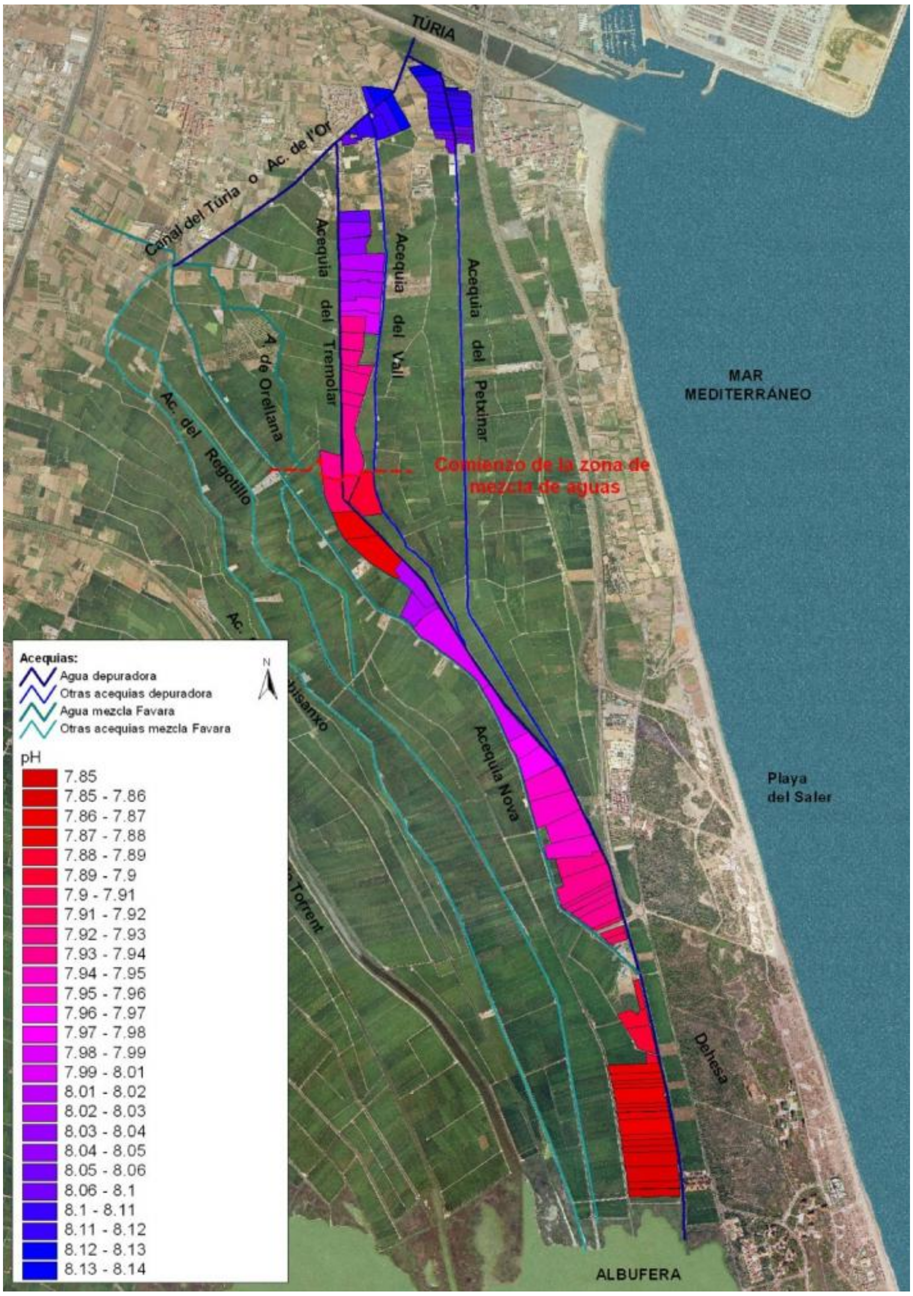

Figure 3: pH evolution along the irrigation line

Electrical Conductivity

The electrical conductivity of the water increases along the irrigation line, in the ditches and in plots, especially from the where the waters mingle with others from diverse origins, with a peak in the plot 7.

In soil electrical conductivity was taken from the aqueous extract. As shown in the table where mean soils are increasing saline rich as in the waters along the irrigation line (with electrical conductivities of 0.5 to 2.1 dS/m). These conductivity values that are provided below are considered within tolerable salinities in soil for rice cultivation and well below toxic levels. As Perason and Bernstein point to the variety "Caloro" in the United States in are considered acceptable levels 2 dS/m and toxic from the 4 dS/m, tolerating higher levels in other phases. Furthermore, from the results it appears that there is a relationship between salinity and crop cycle time which has soil analysis.

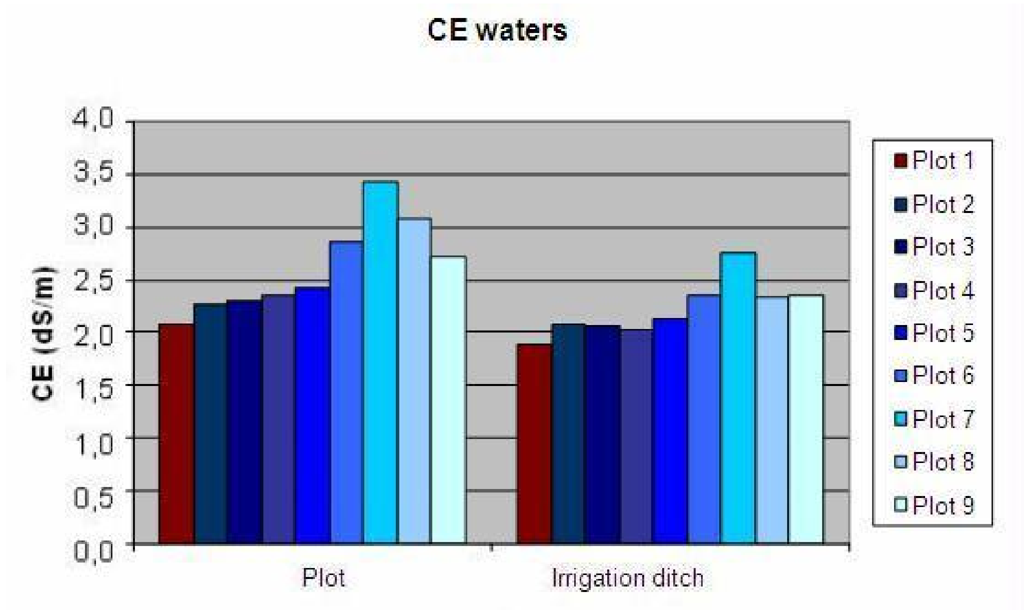

Figure 4: Electrical conductivity of waters (dS/m)

Seen that salinity decreases after harvest significantly, the more surface the sample is taken and it appears to be due to the absorption of salt by the crop roots as salinity variations are less pronounced when depth exceeds the zone of influence of the roots.

It can be said that the soils analyzed do not generally have short term salinity problems. Given its texture and electrical conductivity, the values of sodium extracted show that some may involve having a slightly characteristics of saline.

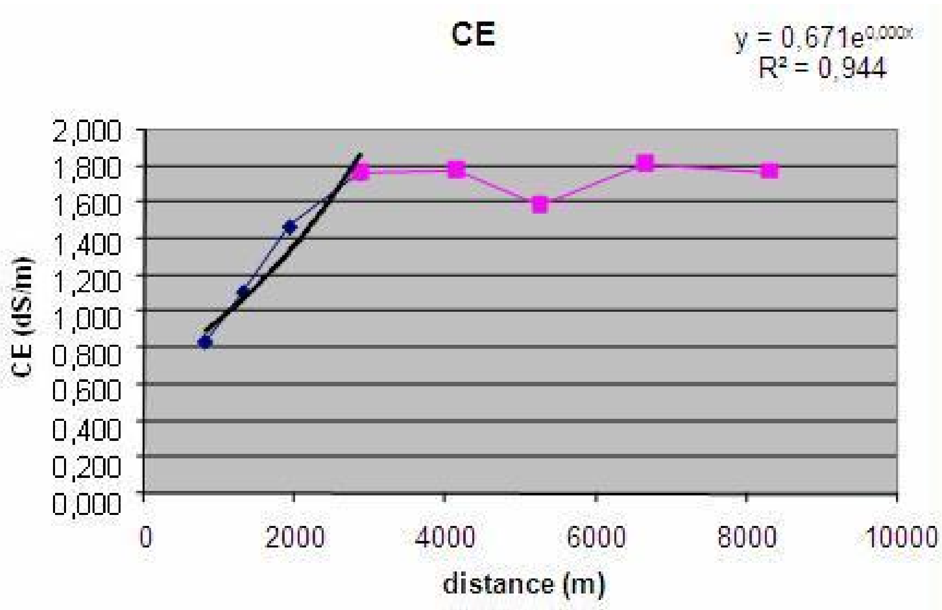

Figure 5: Electrical conductivity of soils based on the distance to the treatment plant (from plot 2 to 9)

If we relate the average conductivity in the 10 cm soil surface with distance from the treatment plant to the plot is obtained in the first four plots (with water from the treatment plant) electrical conductivity increases progressively as the distance does it then stabilized from plot 6 in which the waters of the plot are mixed with (a variant of other) waters of poor quality. (If an attempted adjustment), the four plots receiving sewage water conductivity as a function of the distance to an exponential curve is obtained $y=0.671e^{0.0004x}$. This setting has an $R^2=0.9447$ which is quite acceptable, where "y" is the electrical conductivity in dS/m and "x" is the distance in meters. In view of the results of soil and water appears predominantly horizontal drag salts laundering vertically.

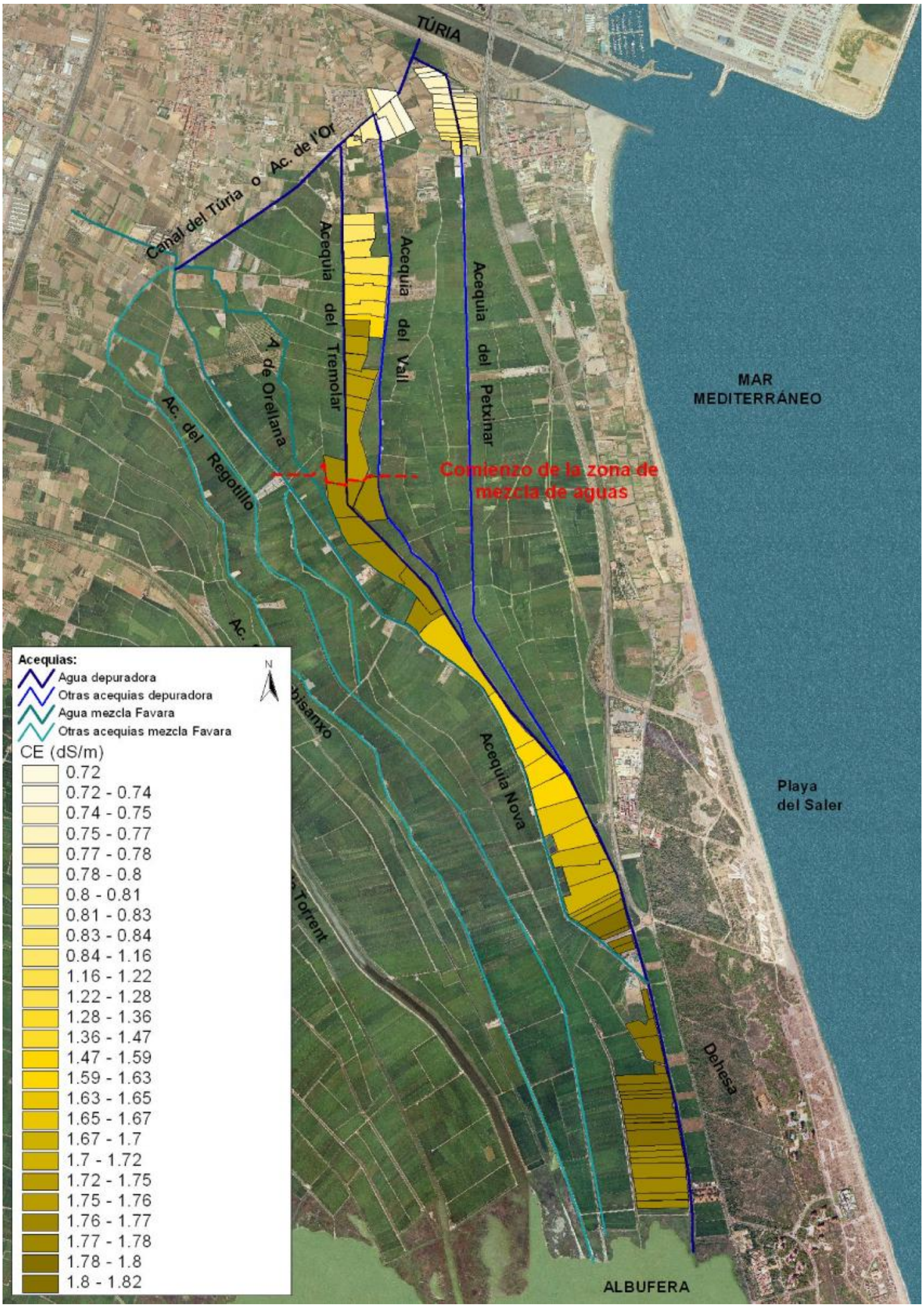

Figure 6: CE evolution along the irrigation line

Organic Matter

The results of the organic matter in the soil at the surface 30 cm along the three years of study show fields with a high organic content (of between 2.5 and 7.2%). As expected and as with the electrical conductivity, is a decrease in the percentage of organic matter with depth. Results show that matter content increases after the crop cycle organic, suggesting that the contributions are higher for this crop residues to soil losses representing consumption by plants and natural mineralization.

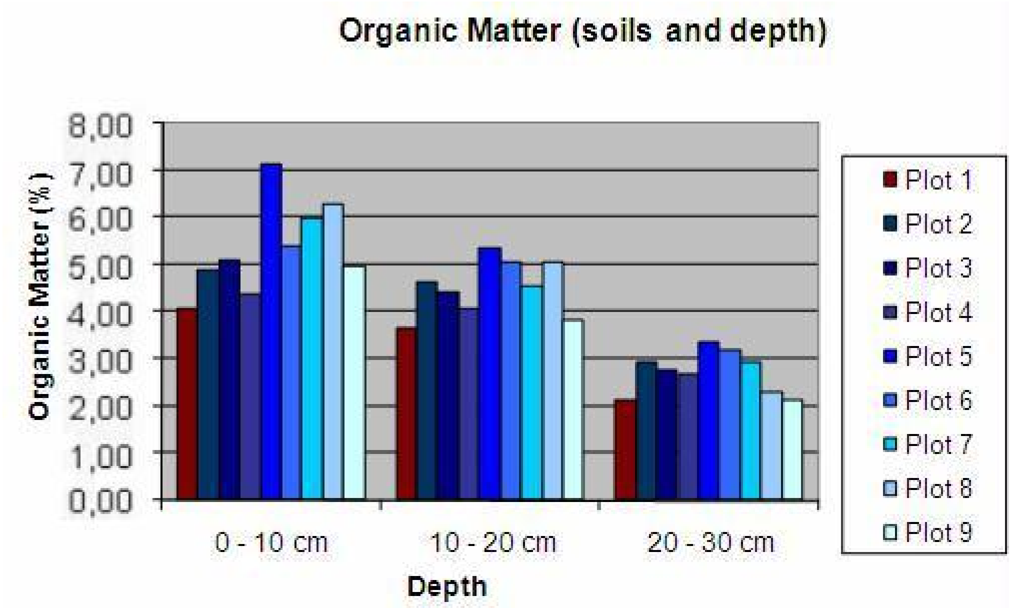

Figure 7: Organic matter percentage in the plots in each of the three depths.

An increase in the organic content by mixing the water of the first water plots from other sources that have not been cleaned, along the irrigation line there is no relationship to organic matter, increasing and decreasing without any apparent correspondence, although in each plot keeps decreasing with depth. This can be seen when rendering the percentage organic matter taking into account the actual distance of the canals that irrigate the treatment plant.

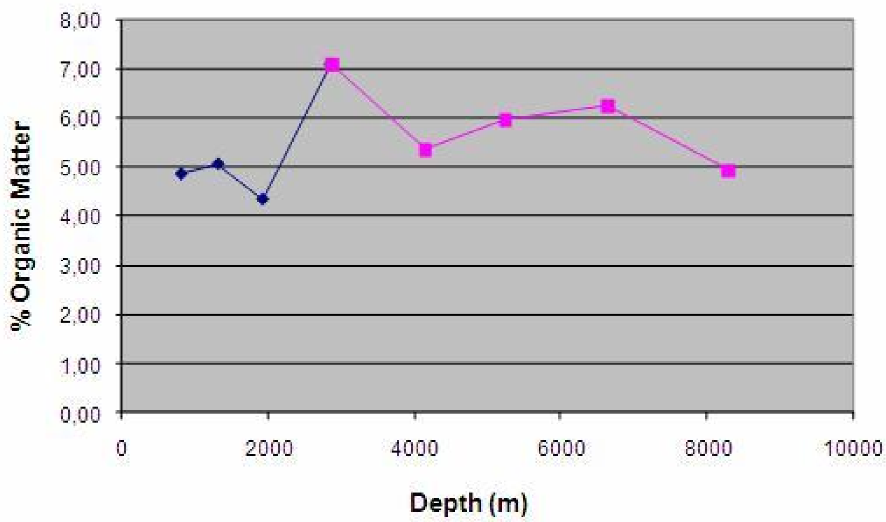

Figure 8: Organic matter percentage of based on the distance to the purifier plant exit

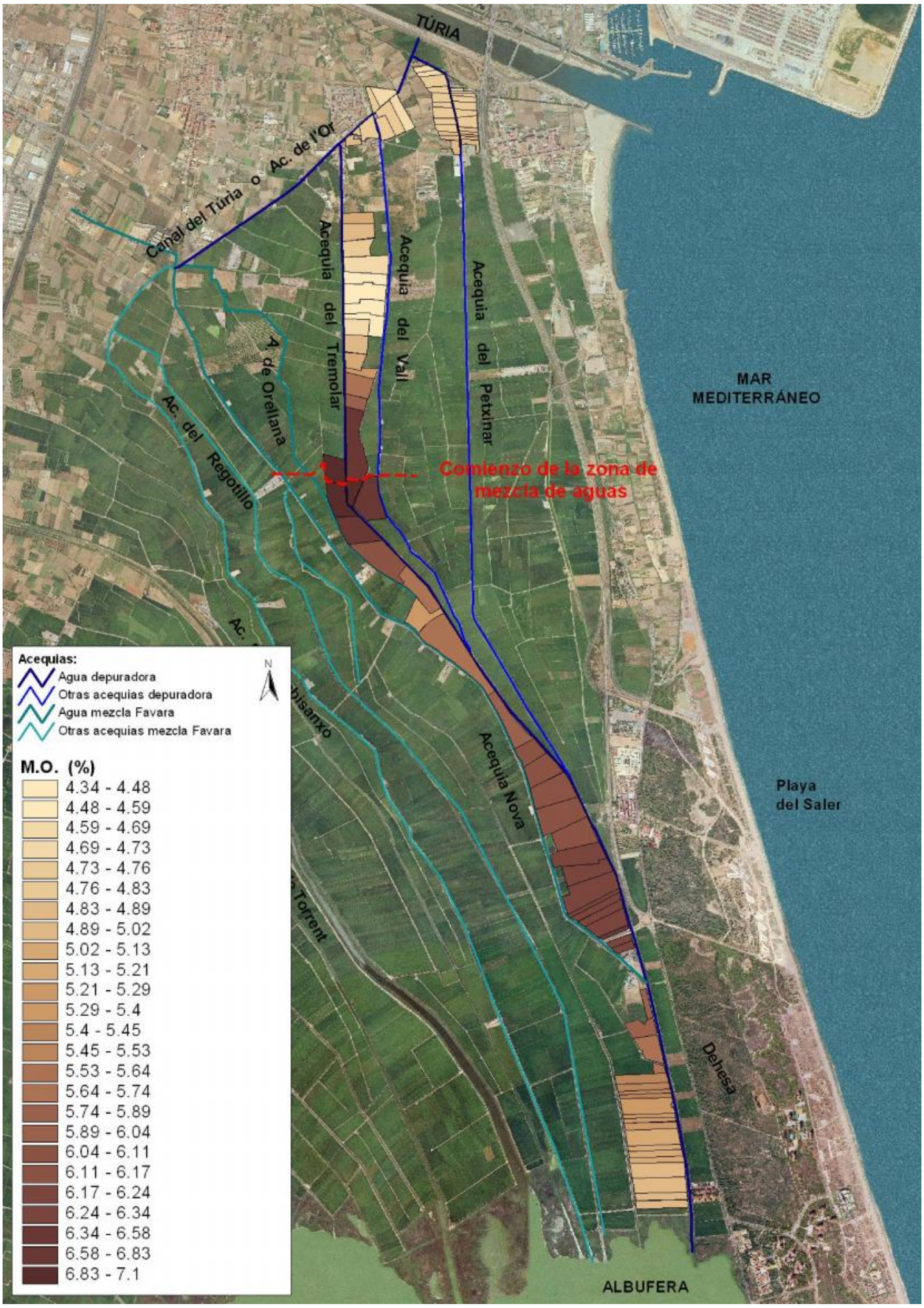

Figure 9: Organic matter evolution along the irrigation line

Conclusions

Irrigation with sewage waters appears to slightly reduce soil pH, soils are still within normal values in the area, calcareous soils with a pH between 7.5 and 8.5. At these pH's many of the heavy metals present in these soils receiving reused water are poorly soluble salt forms. A significant reduction in pH could lead to the absence of immobilizing heavy metals in soils with a consequent increase of the concentration in the soil solution and its incorporation into the plant.

In parallel studies confirms the premise that the rice acts somewhat as a decontaminator of elements that decrease the concentration of nutrients and heavy metals in the solution of residual water irrigated soils, however, the fact that water recycles from one plot to another there is an increase in salinity along the irrigation line that involves two effects: a cumulative one plot to another and another by washing in the latest plots with the drag of solutes with soil water flooding long, it causes a salt leaching despite the low permeability soil. Still, the electrical conductivity values of soils are within the normal ranges for rice cultivation.

Sewage waters carry a large amount of dissolved salts, organic matter, nitrogen and phosphorus. The organic matter content together with high levels of phosphorus involve increased microorganisms generally that are detrimental to the crop as it is located in flooded conditions with little aerated water. These waters aren’t unsuitable for irrigation, unlike present an agronomic quality than the water from other sources that carry the various canals to the rice fields of the park.

To be reused for irrigation waters discharged at the end of the process the Albufera, not only implies a better use of water resources, but also on certain parameters of toxicity levels are lower than if vertiese directly. Since the purification capacity of the soil-crop, without losing sight of the crop as a scavenger of soluble salts, organic matter and other nutrients, you might think that tertiary treatment would not be necessary as long as the water previously passed by the crop and go directly to the lake or other sensitive areas.

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