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Preliminary Analysis Of Agricultural Irrigation Water Quality In Commune Of Cambamba I (Talatona)

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Abstract:
Water is a vital resource for the existence of living organisms and its use for domestic, industrial, agricultural production, among others, can lead to its deterioration, affecting ecosystems and the potability necessary for human consumption. The present work had as main objective: to evaluate, preliminarily, the quality parameters of the agricultural irrigation water of the Cambamba I commune (Talatona). The Cambamba River, with a hydrographic basin of 250 Km ^{2}, with a peak flow of 700 m^3/s, crosses the city of Luanda in a section of 12 km passing through several residential areas including the Cambamba I district. The district of Cambamba I has a very diverse population. There are merchants, teachers, doctors, bankers, but also farmers who grow various agricultural products, especially vegetables, in their homes or on uninhabited land. Most of these products are then sold in the municipality and in the city of Luanda. The parameters were determined using techniques such as conductimetry, spectroscopy, gravimetry, volumetrics, among others. The variables under analysis were: pH, turbidity, EC, calcium, magnesium, nitrates, nitrites, sulphates, phosphates, chlorides, COD, hydrocarbons and total alkalinity. The analysed parameters, pH and calcium are within the value recommended by legislation and may contribute to the occurrence of reactions and growth of cultures; EC and chloride ion are also within acceptable values. The values of nitrates, nitrites and sulphates are far below the recommended values, with little significant effect on soil fertilization and crop development. The values of magnesium, phosphates, turbidity and chemical demand for oxygen are far above what is allowed, which may lead to phytotoxicity, reduction in the quality and quantity of crops. Faecal coliforms, hydrocarbons and high total alkalinity were also detected, which could result from the fact that wastewater from urban sewage is discharged into the river. This irrigation water has no sufficient quality for the growth of plantations, and may constitute a serious risk to the food security of those who use it, as well as contributing to the phenomenon of eutrophication.

Key Word: *Cambamba I, water quality, agricultural irrigation.*

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I. INTRODUCTION

The water crisis in Africa in general and in Angola, in particular, has tended to worsen in recent decades, with reduced values being observed in reservoirs of different locations, with industries and urbanization being the main consumers and causes of its pollution.

The use of this resource is so important that the 2030 Agenda, its sixth objective is "*to guarantee the sustainable management and availability of drinking water and basic sanitation for all*", and recommends the improvement of water quality indicators, thus reducing the pollution by minimizing the release of hazardous chemicals and materials, reducing the proportion of untreated wastewater and increasing recycling and reuse, with the help of Water Treatment Stations (WTSs) and Waste Water Treatment Plants (WWTPs) globally[1].

Also in Angola, the sustainable management of water resources is taken into account. However, in the last three years and due to the covid-19 pandemic, several sanitary fences at provinces and international borders were decreed (Presidential Decree No. 81/20, of March 25)[2]. There was a decrease in commercial activity, loss of jobs and consequent worsening of populations life. Due to this, several families had to resort to different types of support to guarantee their survival. The practice of urban and peri-urban agriculture has intensified, which allows the cultivation of essential products for nutrition in low-income families and the fight against hunger and poverty. This is the case of Cambamba I commune, belonging to the municipality of Talatona, located in Luanda, in the geographical position 8º53´51´´S13º13´12´´E.

The Municipality of Talatona is among the most populous municipalities in the city of Luanda, parallel to the municipalities of Kilamba Kiaxi, Cacuaco and Belas. It is about 17 km from the centre of the capital, with an infrastructure basically made up of towers for residential and commercial use, in addition to horizontal condominiums[3].

According to the 2018 population projections, prepared by the National Institute of Statistics (NIS), the municipality of Talatona has a population of approximately 500,000 inhabitants[4].

In the 1990s, this area was considered a farming area for peasants migrating from southern Angola. Once a neighbourhood in the municipality of Belas, it became urbanized in the following decade, but it was only from 2002 onwards that its population effectively stabilized[3].

Within the commune of Cambamba I, the Cambamba river flows with a hydrographic basin of 250 km^2 and a peak flow of 700 m^3/s, in a section of 12 km that crosses the city of Luanda to its mouth. The Cambamba river basin covers the municipalities of Viana, Luanda, Cazenga, Belas and Talatona. It comprises the drainage ditches of Senado da Câmara, Cariango, Camama, Golfe and Talatona. The latter refers to the study area that begins in Camama, in the vicinity of the Jorge Sebastião condominium and goes to Talatona, and another begins in Gamek, passes through Nova Vida, through Talatona, ending in the Atlantic Ocean. It ends up being a reservoir for retaining solid waste and other forms of residual liquid discharges from the surrounding residential areas[3].

Often, due to the lack of rainfall, the practice of irrigation is essential to ensure agricultural production. In the case of this commune, farmers resort to water from the drainage ditch of the Cambamba river for this practice.

Bearing in mind that bibliographic data on agricultural practices in this locality are scarce and that agricultural products for human consumption must follow practices that guarantee food safety, the quality parameters of that irrigation water are one of the factors that must be taken into account. Hence, carrying out this research work with a view to answering the following concerns: has the water used in agricultural irrigation in the Cambamba I neighbourhood acceptable quality or, can its characteristics constitute a danger to the health of the populations?

The general objective of this work is to preliminarily evaluate the quality parameters of agricultural irrigation water in the neighbourhood of Cambamba I (Talatona). To this end, it is intended to identify the ways of handling agricultural irrigation water in the Cambamba I neighbourhood; characterize parameters of that water and compare these values with values foreseen in the national and international legislation of some countries.

II. MATERIAL AND METHODS

The study area is next the Nova Vida project, and Xyami Shoping (figure 1), where several inhabitants carry out various activities: preparing land for cultivation, collecting and selling agricultural products, washing vehicles among others.

In the image above it can be seen that the area is essentially residential, however, there is a green area around the retention ditch of the Cambamba river where the peasants of the area take advantage of it to carry out agriculture and whose waters are essentially the result of rainfall and urban runoff.

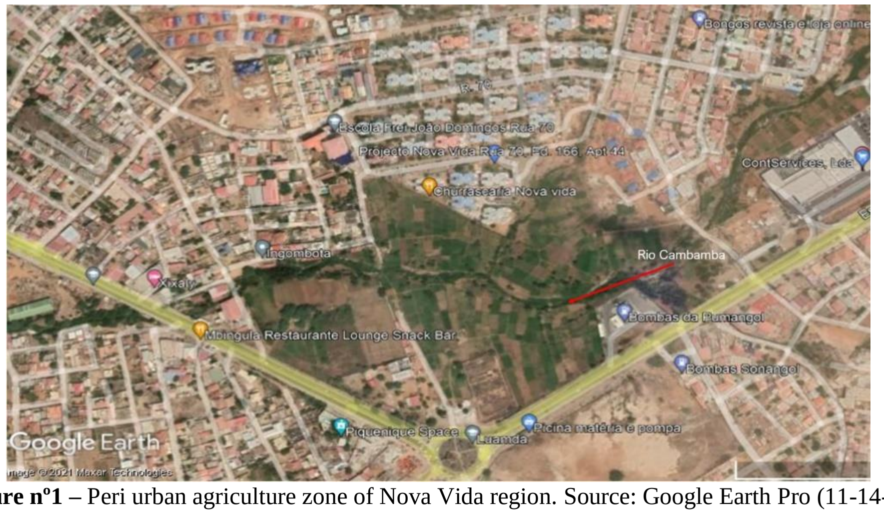
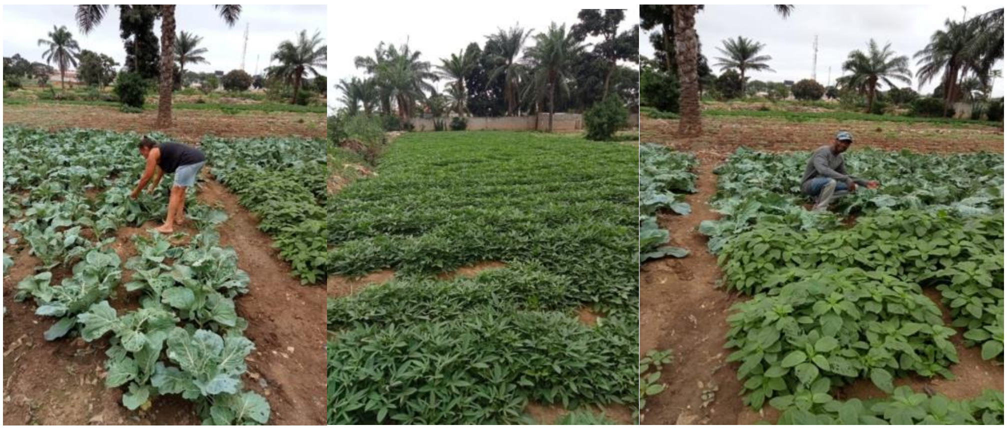


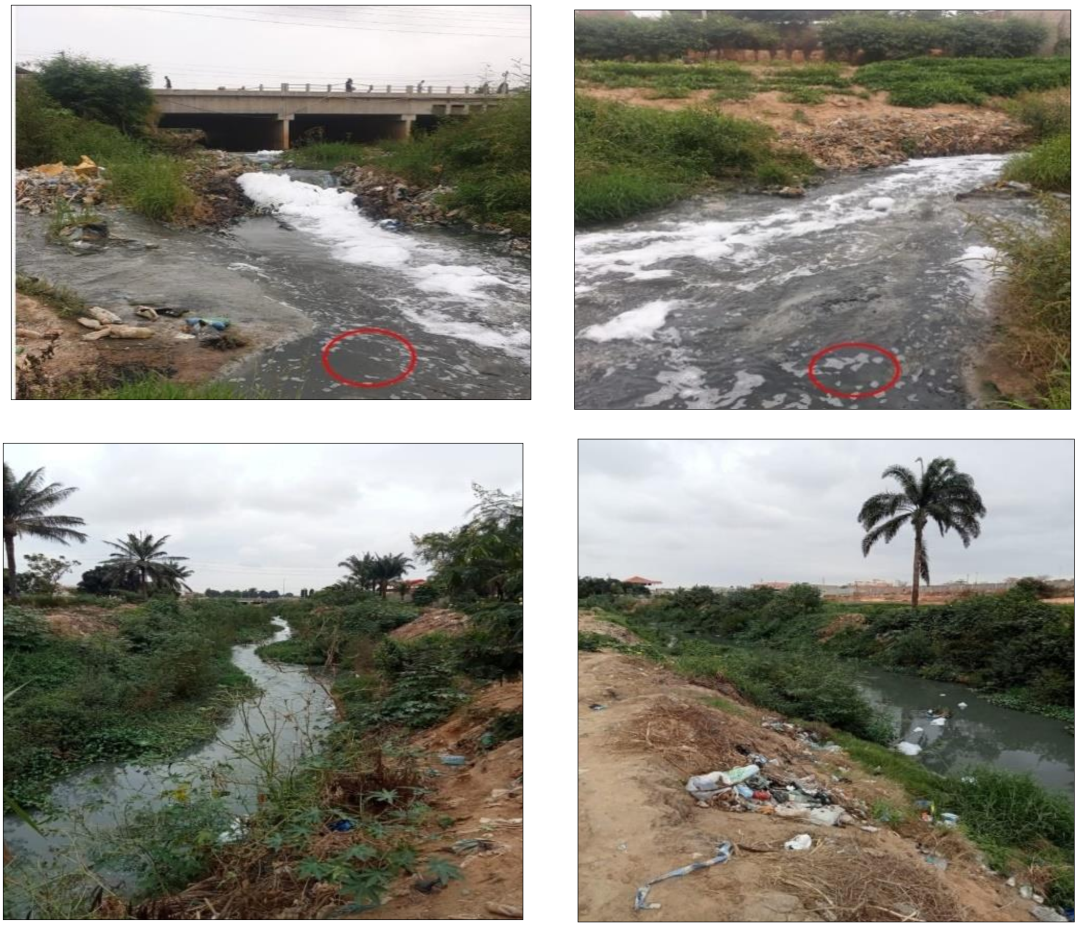
Figure nº1 – Peri urban agriculture zone of Nova Vida region. Source: Google Earth Pro (11-14-21)

At the beginning of the research, a survey of the conditions on the ground was carried out. The empirical method of inquiry was used, carrying out random open interviews and questionnaires in a total of 45, of which 15 were for farmers, 15 for residents and 15 for traders, all of them aged 18 years old or over and both genres. This target audience was selected because many of them are producers and consumers of agricultural products grown there (Figures 2, 3 and 4).



Figures 2, 3 and 4 – Agricultural study area with producer and consumer (source: by the authors)

The followed action was collecting water samples from the river basin of the Cambamba river (fig. 5, 6, 7 and 8) in glass flasks, with the analyses carried out by the laboratories of the Química Verde Company and ISPTEC Institute. The methods used for analysis were: titration, of the Most Probable Number (multiple tube technique), thermometry, electrometry, nephelometry, Mohr, gravimetry and molecular absorption spectrometry.



Figures 5,6,7 and 8: Sample collection area on the Cambamba river (source: by the authors)

III. RESULTS

The main problems related to the infrastructure of the Cambamba river basin in the sub-urban environment are mainly related to the lack of sewage treatment, because large part of the region under study releases effluents with toxic and polluting residues into the river.

The farmers in the region are the ones who does not benefit from basic sanitation such as: drinking water supply, sanitary sewage, urban cleaning and drainage, management of rainwater and solid waste. Because of this situation, there are several diseases affecting them such as diarrhoea, malaria and typhoid fever.

Agricultural activity in the study area is moderate; the water is withdrawn through a system of motor pumps and hoses near the river. This agricultural activity is carried out exclusively by the aid of manual tools such as: machetes, hoes, shovels, among other means. The products obtained here are cabbage (*Brassica Carinata*), jimboa (*Amaranthus* spp), Kizaca (*Maniote Esculenta*), Use (*Hibiscus Sabdariffa*) and sweet potato (*Ipomoea Batatas* (L) Lam)[5]. These products are then distributed in markets adjacent to the neighbourhood.

From the analyses carried out on the agricultural irrigation waters of the study area, the obtained results are presented below, in table nº 1, and are compared to values in the legislation of countries such as Angola[6] - Presidential Decree n.º 261/11 of October 6th, Portugal[7] - Decree-Law nº 236/98 of August 1st, Brazil[8] - CONAMA Resolution nº 357/05 of May 17th and the international food organization FAO[9].

Table no 1: Agricultural irrigation water quality parameters for Cambamba I and regulated values for Angola, Portugal, Brazil and FAO.

Nº	Parameters analyzed	Unity	Results	Presidential Decree nº 261/11, 6 of October ANGOLA	Decree-Law nº 236/98, 1 of August PORTUGAL	CONAMA Resolution nº 357/05, 17 of May BRAZIL	FAO_{uma}
01	Hydrogen potential (pH)	Scale of Sorensen	7,63	5,0 – 9,0	6,5 – 8,4	6,0 – 9,0	6,5 – 8,4
02	Turbidity	NTU	49,9	---	---	40	---
03	Electrical Conductivity	µS/cm	1908	---	1000	---	3000
04	Cálcium	mg/L Ca	51,302	---	---	---	0 – 400
05	Magnésium	mg/L Mg	60,682	---	---	---	0 – 60
06	Nitrates	mg/L NO_3	0,002	1	50	10,0	0 – 10
07	Nitrites	mg/L NO_2	0,094	1	---	1,0	---
08	Sulphates	mg/L SO_4	0,076	250	575	250	0 – 960
09	Phosfates	mg/L P_2O_3	3,017	1	---	0,020	---
10	Chlorides	mg/L Cl	156,2	250	70	250	0 – 1065
11	Chemical Oxigene Demand (COD)	mgO_2/L	1280	150	---	---	---
12	Faecal Coliformes	MPN/100ml	1800	---	100	---	---
13	Total Hidrocarbons	mg/L	1686	---	---	---	---
14	Total Alcalinity	mg/L	312,32	---	---	---	---

IV. DISCUSSION

The criteria for water quality in a region can never be absolute, as the soil, the drainage, and the management of anthropic activities influence its suitability. Organic, inorganic and microbial pollutants in wastewater produce harmful effects on soil, crops and humans.

The growth and development of plants fundamentally depend on the continuous flow of mineral salts, indispensable for the performance of the main metabolic functions of cells in plants, hence the need to carry out, permanently, analyses of waters and soils where they develop[3].

From the analyses on agricultural irrigation waters in the Cambamba I region, a series of parameters were observed at 25ºC, which are related to each other and described below:

The pH obtained is within the range value recommended for agricultural irrigation (6.5-8.4), which according to WHO, FAO and legislation consulted, corresponds to the standard accepted value for irrigation water. Values below these can cause corrosion of the irrigation systems and above them cause alkalinity that despite the legislation consulted does not establish precise values for alkalinity in water, it is always related to the possible presence of bicarbonate, carbonate and hydroxide ions that can cause clogging of irrigation devices and because of calcium and magnesium to form insoluble minerals that are less available for plant nutrition[10].

Calcium, as is knowing, is a macronutrient that makes up the cell wall of plants, contributes to the germination of grains and its lack causes reduced crops growing. Magnesium, on the other hand, is responsible for the chlorophyll molecule, participates in the metabolic processes of amino acid and protein formation and phosphorus absorption, without which there is reduced growth, inhibition of flowering, leaf necrosis and fruit degeneration. From the verified values for these two elements, it was verified that calcium is within the allowed values, being able to help the growth of the cultures; Magnesium with a value slightly higher than the permitted value may cause phytotoxicity problems if the upward trend persists[10,11,17].

Water turbidity is an organoleptic characteristic due to colloids in suspension (clay, finely divided organic and inorganic matter, microscopic organisms and algae). In the study area it was verified the existence of discharges from domestic activities, detergents resulting from washing vehicles, among others. According to the WHO and FAO, the turbidity value should vary between 1 NTU for treated water and 5 NTU in the distribution network. To have a high value in the study region, there is a risk that the irrigation water will be, on the one hand, contaminated by faecal coliforms and, on the other hand, causes high electrical conductivity that will make the water unavailable to form the solution of ions necessary for the nutrition of different crops. High electrical conductivity means less water available for plants even if the soil appears wet (physiological drought)[12].

The electrical conductivity is above the maximum value recommended for some countries; however, it is within the allowed value for FAO. Even so, associated with other factors such as pH and turbidity, it can cause wilted plants, with changes in the structure, thickness and colour of the leaves[11].

Chloride is an ion that is easily found in irrigation water. It is an essential element for plants but in very low amounts and it can participate in several of its processes such as photosynthesis. According to the most of legislation consulted, the value verified in the region is within the recommended limit but, even so, it could become toxic for more sensitive crops, such as the bean crop (*Phaseolus vulgaris*), onion (*Allium fistulosum* L.), carrot (*Daucus carota*), lettuce (*Lactuca sativa*) and potato (*Solanum tuberosum*). When deposited on the leaves, it can cause injuries and gastrointestinal problems if consumed raw[10].

The Chemical Oxygen Demand (COD), it was found to have a high value in relation to that allowed by legislation, which may be due to the fact that the study area, is close to the release of domestic and industrial sewage, high proliferation of aquatic plants and algae (which lead to the phenomenon of eutrophication) amount of oxidizable compounds, nitrogen resulting from decomposing of organic matter, sulphur and phosphorus, originating from detergents as well as hydrocarbons resulting from car washes. All these compounds and the reactions in which they participate make this water poor in oxygen. Oxygen-poor water does not favour the growth of cultures since it does not allow ionic dissociation, soil aeration, growth of aerobic microorganisms, among other aspects necessary for agriculture[13,16].

Nitrates and nitrites can be found in irrigation water as a product of biological decomposition, due to the action of bacteria, the presence of nitrogenous detergents, among others. The values of nitrates and nitrites analysed in the water under study are far below the values recommended by legislation. They are nutrients that stimulate crop growth and have the same effect as nitrate in fertilizers, where high levels of nitrate can be beneficial during the early growth stage, but can cause yield loss during the later flowering and fruiting stages. In this case, its low value may mean that farmers will have to use fertilizers[12,13].

The influence of phosphates on crops is mainly related to energy transfer in cells. In addition, it is one of the components of nucleotides, cellular DNA and RNA. Plants with a deficiency on this macronutrient usually have leaves with a purplish pigmentation and necrosis of the leaf tissues, which results in lower productivity of the agricultural crop. In the case of the water under study, the observed value is above the value allowed by legislation. It is a good nutrient for a certain growth of agricultural crops, but, in excess, it causes lasting damage, mainly to the soil, where it causes the death of many microorganisms essential for the favourable growth of cultures[10].

Sulphates in irrigation water have benefits in soil fertility reflected in crop growth as they influence the respiration process, vitamin and protein synthesis, resistance to cold and oxidative stress. According to the consulted legislation, the value obtained in the study is low and may be considered insufficient for agricultural practice in that region[10].

According to the authors Jeong, Kim and Jang, as well as the legislation consulted, the use of this water is inappropriate for agricultural irrigation due not only to the high number of suspended particles, as previously mentioned, which can carry with it a high number of faecal coliforms (as verified), which may cause diseases such as those mentioned in a survey applied to populations. According to the same authors, the risks to human health are more alarming for foods consumed raw; foods under a cooking process at high temperatures, reduce the risk of disease[12].

Despite the consulted legislation not establishing precise values for total hydrocarbons, they appeared maybe because of the activities verified in the area, such as car washes, car repairs, movement with fuel by the population, supplying irrigation motor pumps, among others. Many of these compounds have low solubility in water in order of the ppm or ppb. However, even these low concentrations can endanger human health (cancer) and ecosystems; cause a decrease in oxygen in the water because microorganisms present in the environment can degrade hydrocarbons converting them into CO_2 and H_2O. The amount of oxygen to carry out this biodegradation is high, therefore very quickly the oxygen dissolved in water is consumed. Also, in the present case it may, over time, make the soils unproductive[14,15].

Finally, it should be noted that the water under analysis had an unpleasant smell (cesspit) which could be due to decomposing of organic matter, formation of ammonia gases, hydrocarbons, microorganisms, among others. According to the authors Jeong, Kim and Jang, water for agricultural irrigation should not have an unpleasant smell, as this could constitute a serious case of public health and the long-term use of wastewater for irrigation would cause physical deterioration of the soil[12,14].

V. CONCLUSION AND RECOMMENDATIONS

The present investigation was concluded with all proposed objectives accomplished.

The agricultural region of Cambamba I is an important area in the city of Luanda that contributes to the existence of another green space, can improved the nutrition for the population and being a source of income for the farmers who work there.

The farmers interviewed were mostly men from the province of Benguela, living next to the fields and dedicated themselves full time to growing vegetables.

Many of the analysed parameters are in the range of allowed values. However, in combination with others can cause problems for health of populations, soil fertility and growth of crops.

Based on the consultations carried out, this could be the first kind of work in the Cambamba I region. Because of it, it is recommended: permanent monitoring of agricultural irrigation water for reasons of public health and food safety; creation of a WWTP to collect water from human settlements in the region and reuse it for agricultural irrigation; maintenance of this agricultural area, under the conditions mentioned above, as it can constitute a green area for oxygenation in an area that is already a little poor in terms of vegetation cover and extensive urban planning and a point of healthy food for its populations; implement public awareness programs on the consequences of using wastewater without proper treatment to irrigate crops.

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