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Angola Future Agriculture Powerhouse In Africa And It´s Legislation For Irrigation Water

Cristina Maria Póvoa Borges[1]
Department of Chemistry, Faculty of Natural Sciences, Agostinho Neto University, Angola
Glória dos Prazeres Silva Benchimol Mohamed[2]
Department of Chemistry, Faculty of Natural Sciences, Agostinho Neto University, Angola

Abstract:
Angola is a country in Southern Africa crossed by several rivers originating from different river basins in the region. Alongside fishing and pastoralism, agriculture is one of the major productive activities promoting social development and the population´s health. Agriculture will largely depend on the climate of the region where it is practiced, the type of soil and the water used to irrigate crops. Pollutants that are discharged into irrigation water courses, or that end up there through leaching from contaminated soil, can harm plant growth and be transported to other distant regions through water courses shared between countries. Due to this situation, countries around the world establish legislation to control the quality of surface water and agricultural irrigation. This work's main objective was to analyse the legislation on water quality parameters for agricultural irrigation and compare it with the same data for Portugal. For this purpose, the main legislative decrees used were: Presidential decree 261/11 of October 6th, from Angola and decree-law nº 236/98 of August 1st, from Portugal. Taking into account that the sanitary system in Angola is deficient, the legislative system, for water analysis, should be more completed and detailed. For this reason, the analysed parameters were: organoleptic; human health, namely pathogens and chemicals; agronomic, namely toxic ions, SAR, pH, nutrients, free chlorine, among others; and physicochemical, namely BOD, COD, TDS, STS, among others. These parameters were analysed taking into account what is specified for emission limit values (ELV), maximum admission values (MAV) and maximum recommended values (MRV) by both countries. From the study carried out, it was found that Angola, in terms of irrigation water quality parameters, does not present complete data, and some of the values must be considered from the water parameter for human consumption or for superficial water in general. In terms of pathogenic parameters such as choleric vibrio, pseudomonas aeruginosa, intestinal parasite eggs, among others are not referred, but are important taking into account because of the diseases affecting the region. Related to the pesticides and organochlorine compounds, the legislation is similar to Portugal in terms of MAV for some compounds such as HCH, DDT, HCB, HCBD, among others. In terms of agronomic parameters, Angolan legislation is somehow more complete; however, values such as calcium, magnesium, potassium, nitrites and others are missing and need to be mentioned due to their importance for crops growth. Given the country's potential and the geographical characteristics of the region, Angola needs a more robust legislation in terms of water quality parameters for agricultural irrigation. A more complete legislation will help Angola to be a future agriculture powerhouse in Africa contributing for the food security of the populations.
Key Words*: Water parameters; Irrigation; Agriculture powerhouse; Legislation; Angola; Africa; Portugal.*

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I. Introduction

Around 97% of all water on the planet is found in the oceans. The remaining water, 2% is in difficult-to-access places such as underground aquifers and polar regions. The remaining 1%, only 0.36% is easily accessible in rivers and lakes and is therefore used for human consumption, industry and agriculture. [1]

Hence it is considered that fresh water is a scarce, finite asset and not always possible to recover after use.

Furthermore, the distribution of water across the planet is very uneven. Generally equatorial areas are those with the greatest abundance of precipitation, as is the case of the Zaire River Basin, responsible for 30% of the total runoff in Africa.[1]

Take into consideration the development of industry, population growth and the need for food for everyone, greater irrigation for growing products and construction of dams to generate energy are required.

Also, most of the irrigation practiced today is not the most efficient. Studies carried out indicate that only 37% of irrigation water is actually absorbed by crops; the remaining water is lost through runoff, evaporation or infiltration into the soil. And even agricultural runoff water is then of lesser value as it carries with it salts, chemicals resulting from fertilization or combating agricultural pests, among others. In other words, all this agricultural activity, if not planned in a sustainable way and with environmental preservation in mind, leads to enormous quantities of pollutants being taken to regions far from the source of contamination, endangering the lives of humans, flora, fauna, the soil, in short, the planet.[1]

Furthermore, there are several products used on a daily basis such as: cleaning products, cosmetics industry, pharmaceutical industry, automotive industry, textile industry, food industry which, due to their size and persistent properties, bio accumulative and toxic products (BTP) pass through different food chains and others, due to their persistent, mobile and toxic properties (PMT), move and contaminate regions far from the areas of application or discharge.[2]

Microorganisms are another problem found in water, especially wastewater, which can cause diseases such as:

• Amebiasis: is a disease caused by parasites that are eliminated with faeces which, if left near rivers, lakes, ditches, can contaminate the water causing persistent diarrhoea;

• Giardiasis and gastroenteritis: are infections of the stomach and intestine produced by viruses or bacteria found in places where there is no water treatment, sewage system, piped water or adequate disposal for waste, being responsible for the majority of deaths in children under one year of age,

• Typhoid and paratyphoid fever: are serious diseases, produced by the bacteria *Salmonella typhi* and *Paratyphi* and transmitted through contamination by faeces from hands, clothing, food and water;

• Infectious hepatitis A: which also occurs due to contamination of water by faeces;

• Cholera: is a disease caused by *Vibrio cholerae* which, after contamination, lodges in people's intestines, causing, in severe cases, diarrhoea and intense vomiting. It is also transmitted through water contaminated by the faeces and vomit of patients.

Indirectly, contaminated water is associated with the transmission of worms, such as: schistosomiasis, ascariasis, taeniasis, oxyurids and hookworm. Vectors, such as the *Aedes Egypt* mosquito that grows in water, can cause malaria, yellow fever and dengue fever in tropic regions.[2]

From the above exposed, it can be understood that this asset so precious to our planet - water - must bring together a whole set of characteristics, whether physical (colour, flavour, turbidity, temperature, pressure, presence of salts, among others), chemical (pH, alkalinity, TDS, dissolved oxygen, hardness, solvents, organic matter, calcium salts, magnesium, sodium, potassium) and biological (viruses, bacteria, algae, fish, molluscs, among others), which make it beneficial for life in Planet. Hence, countries create legislation on water quality parameters for human consumption, agricultural irrigation, use in industry, among others.

Angola, being a country with a vast set of river basins, with navigable rivers that pass through its territory and flow into other countries, needs to have legislation that properly regulates what is considered by many to be the country's true wealth.

Therefore, the present study aims to analyse the legislation for agricultural irrigation water quality parameters in Angola and compare them with the parameters considered by Portugal. Portugal was considered to this comparison because it is in another region, with another types of soils, some different crops, another sanitary conditions, among others factors, and it’s important to see the similarity of parameters on analyse contributing for food security.

II. Material And Methods

The methodology for carrying out and understanding the analysis was contextualize: water network of southern African countries, Angola's water network, types of soil in Angola that may influence water quality, the agricultural practice zones and the type of crops. After verifying the extent of those aspects, the current Angolan legislation for water irrigation was analysed and compared with data from Portugal in order to verify whether it takes into account parameters recommended for the development of crops, food security and consequently the sustainable development of the region.

Water network of Southern African countries

Southern Africa is one of the regions on the planet where there is a shortage of water, mainly due to high levels of evaporation and low rainfall, but also due to the fact that water sources are often far from demand centres and their transportation requires high costs.

Despite this, the large rivers flow between countries and sometimes are considered borders between states (Fig.1). Hence, the sharing of water between consumers from different countries must be equitable, beneficial and in a portion environmentally sustainable that allows the development of these societies. When this sharing does not occur or there are forms of pollution that pass from one state to another, regional and international conflicts can occur.

Figure nº 1 - International River Basins in the Southern Africa [3]

Angola's water network

Angola is a country in the western region of southern Africa, with an area of 1.246,700 km^2, has a vast superficial water capacity where deep rivers suitable for navigation stand out and are sometimes interspersed with a variety of rapids and waterfalls. It forms 5 retention systems, namely: the Atlantic Ocean (the rivers Kwanza, Cunene, Chiloango, M´Brifge, Queve and others); the Congo River (Cuango, Cuilo, Cassai with their tributaries on the left bank); the Zambezi River (Lungue-Bungo, Luanguinga and others) with around 20.00km2 of flooded plain; the Kalahari receiving basin (Kuito, Cubango and others) and the Etosha receiving basin (Cuvelai). [4] Thus, the main rivers total more than 10,000 km in length, not counting the small streams [5,6]

Soil types in Angola

Angola is characterized by a wide variety of soils. Among them, sandy soils (psammitic) stand out in more than 53% of the country and include: Namibe, coastal areas north of Sumbe and the Kalahari basin, which extends 2500km in length and 1500km in width to the northern Congo basin. This area is mainly composed by quartz grains, with no mineral nutrients and little accumulation of organic material. Therefore, they have low water retention and fertility. The waters that circulate through these regions are quite pure. [7]

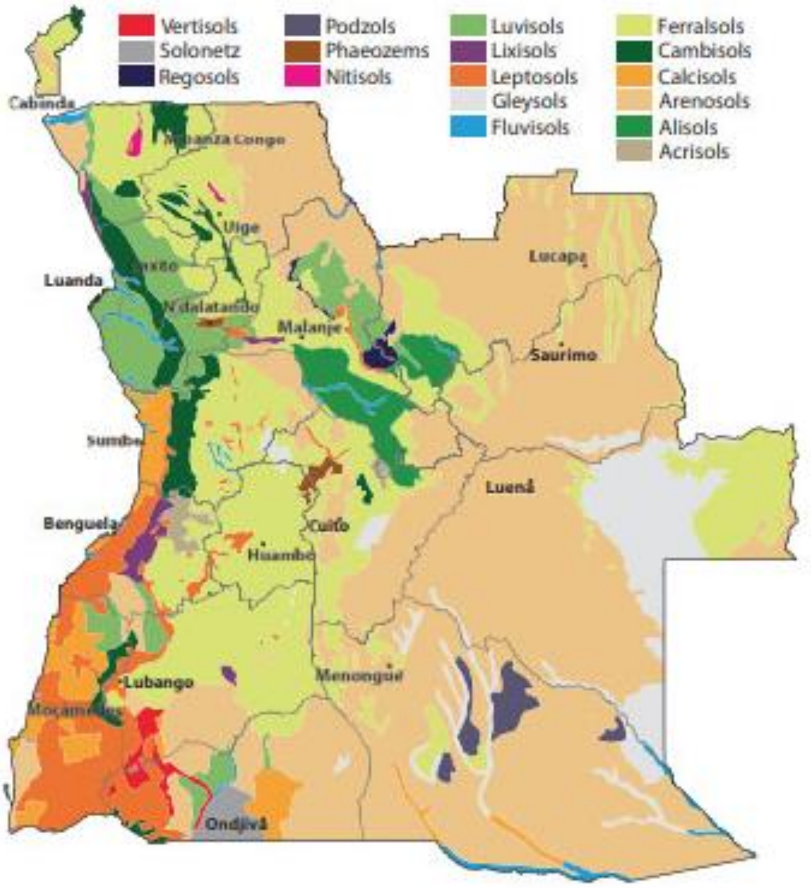

Figure nº 3 – Soils type of Angola [6]

Ferralsols, reddish in color due to the oxidation of iron and aluminum, can also be found in the western half of Angola. These soils are derived from gneisses, granites, schists, limestones and quartzites and occupy 23% of the territory. These are soils with little water retention capacity that, in times of greater rainfall, can be easily leached and thus have low fertility due to the loss of organic material and mineral nutrients. [8.9]

Another type of soil that can be found are resolols (lithosols), very characteristic in southwestern Angola, where gravel plains and rocky hills predominate. They occupy an area of 6% of the territory. There are also limestone, limestone and luvisol soils that are mostly fertile for a variety of crops; alluvial soils (fluvisols) with high organic content and good water retention; hydromorphic soils (gleysol clays) that are typically acidic and typical of flooded plains.

Taking into account the aspects previously seen (hydrographic network common to Southern African countries, and existing soil types), it can be said that the analysis of water quality parameters, whether physical, chemical or biological, must be carried out regularly and according to the purpose for which they are intended: consumption, recreation, agriculture, industry, among others. And these parameters must be legislated and, to a certain extent, be common to several countries. [10.11]

National agricultural regions

Due to the existing river basins, their exploitation and the existing soil types, Angola is a country with great agricultural potential. The Ministry of Agriculture illustrated five major agricultural regions in Angola (figure no.2). [12]

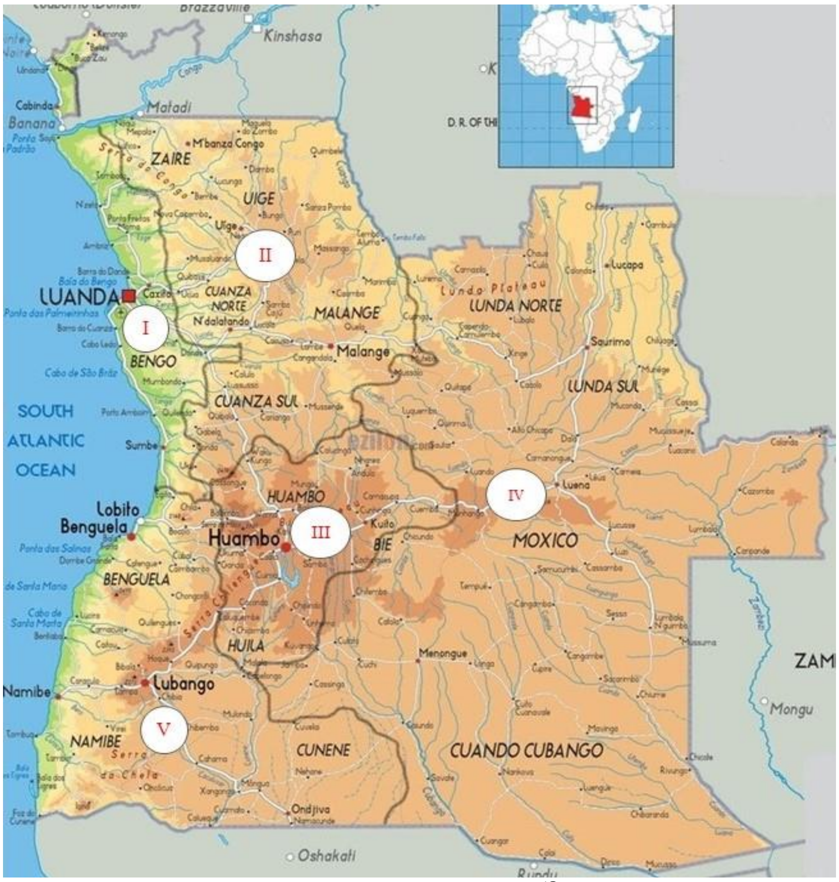

Figure nº 2 – Large agricultural regions of Angola [13] (adaptation by the authors)

Firstly, two Regions (I and II) are distinguished in the North with rainfed agriculture and use of the alluvial strips of the main rivers and whose crops are cassava, corn, beans and sweet potatoes. Next comes Region III, the well-known Central Plateau, where despite corn being of great importance in the population's diet, potatoes, beans and vegetables are also grown. Region IV comprises the eastern part of the country, where agriculture is mainly for self-consumption, with a widespread predominance of cassava, but also with a tradition of cereal cultivation. Finally, Region V to the south, which includes part of the province of Huíla and practically all of Cunene, with a predominance of cereal cultivation. [12]

These agricultural plantations depend fundamentally on water, as it represents up to 90% of the physical composition of the plants, therefore, it is extremely important that the water used has good quality and in compliance with the regulated parameters, in order to maintain the quality of cultivated products and, consequently, the food security for populations.

Angolan and Portuguese legislation for water quality parameters

Water Resources Management in Angola is defined based on a set of legislative diplomas which highlights:

a) Law No. 6/02 of June 21, Water Law

This law defines the general principles of the legal regime inherent to the use of water resources (Water Law, 2002), establishing rules for the use and use of water with a view to integrated management, the development of water resources and their protection and conservation , and powers to State institutions in defining general policy and its development (Presidential Decree nº 82/14 of 21 April). [14]

b) Presidential Decree No. 261/11 of October 6

This decree regulates Water Quality, establishing standards and criteria with the purpose of protecting the aquatic environment and improving water quality, depending on its main uses. The same legal diploma applies to inland, surface and underground waters, as well as waters for aquaculture, livestock farming, agricultural irrigation and spas. Furthermore, it also regulates the standards for controlling wastewater discharges into national aquatic bodies and into the soil, aiming to preserve the quality of the aquatic environment and protect public health (Presidential Decree nº 261/11). [15]

c) Presidential Decree No. 83/14, of April 22;

This decree defines the regime for carrying out public water supply and wastewater sanitation activities. Applicable to public water supply and wastewater sanitation systems, with the necessary adaptations, to private water supply and wastewater sanitation systems, in relation to the licensing of the activity, the technical requirements of the respective installations and their safety, to complementarity of systems, the quality of drinking water and wastewater treatment standards and compliance with public health and environmental standards. [16]

In the case of Portugal, the legislation on water quality parameters is presented in:

d) Decree-Law 236/98, of August 1st (Portugal)

The decree establishes standards criteria and objectives with the purpose of protecting the aquatic environment and improving the quality of waters depending on their main uses, defining the requirements to be observed when using them for the following purposes: water for human consumption, water to support water agricultural life, bathing water and irrigation water, as well as wastewater discharge standards into soil and water.[17]

III. Results

Talking on water reuse for agricultural irrigation, it´s talking about three broad categories of parameters: parameters related to human health, agronomic parameters and physical-chemical parameters. Each of these is subdivided into other parameters as shown in figure nº 4:

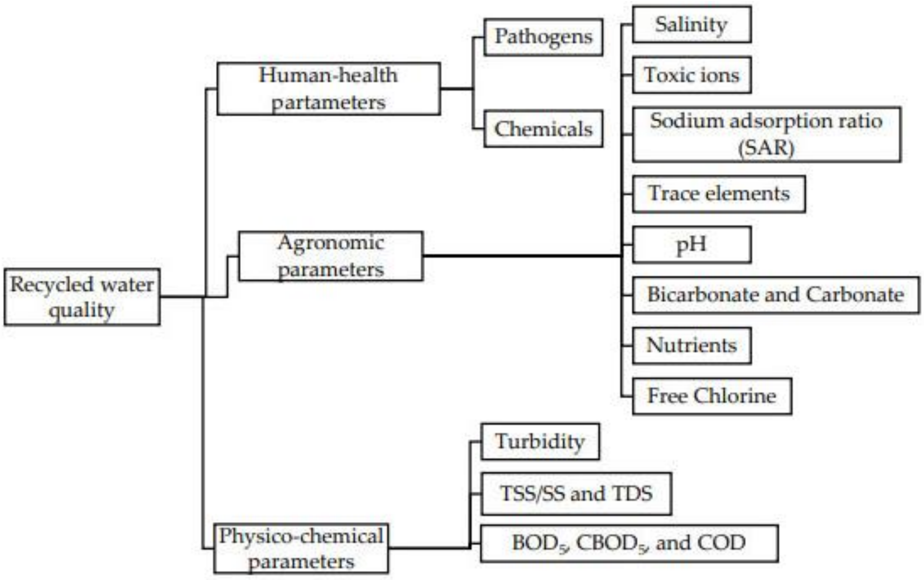

Figure nº 4 – Agricultural water quality parameters [18]

Taking these parameters into account, an analysis of the regulations for Angola was carried out, compared to Portuguese legislation, and the results are presented below.

By Presidential Decree No. 261/11 of October 6, for Angola, the regulation on water quality (Chapter I, Article 1, point 2) establishes that the same should be applied to inland, surface and underground water, as well as water for agriculture, livestock, agricultural irrigation and bathing. In Article 2, point 3, it explains what is meant by irrigation water as surface or underground water or even waste water that aims to satisfy or complement the water needs of agricultural or forestry crops. In the same article, point 33 defines the **Emission Limit Value (ELV)** as the mass, expressed in specific units for each parameter, the concentration or level of an emission of a given substance that must not be exceeded during one or more determined periods time for an installation to discharge into the aquatic environment and onto the ground. These values can be set for certain groups, families or categories of substances. The maximum quantity can also be expressed in units of mass of the pollutant per unit of the characteristic element of the polluting activity. Point 34 defines the **Maximum Allowable Value (MAV),** as the quality standard value that must not be exceeded. And point 35 defines the **Maximum Recommended Value (MRV),** which is the quality standard value that, preferably, should be respected, or not exceeded. [15, 17]

Thus, the recommended water quality parameters for irrigation are: [16,17]

1. **Organoleptic Parameters**: in relation to these parameters, the ELV to the smell determines that it should not be detectable in a 1:20 dilution; the colour should not be visible in a 1:20 dilution, making no reference to either the flavour or the turbidity.

2.**Human health parameters**:

2.1 **pathogens**: With the exception of data for human consumption water, the legislation does not make reference for irrigation waters to parameters such as total and faecal coliforms, faecal streptococci, salmonella, total germs, sulphite-reducing clostridia, choleric vibrio, *Escherichia coli*, *Pseudomonas aeruginosa*, or eggs of intestinal parasites.

2.2. **chemical agents**: the legislation for agricultural irrigation waters makes reference to some pesticide and organochlorine compounds data as presented in table nº 1. The same data are also referred in Portuguese legislation; however, both legislation without observations about the damage they can cause on human health.

Table nº1: MAV for some pesticides

Pesticides	Unities	MAV	Observations
Total Pesticides	mg/l	2,5	
Pesticide by individualized substance	mg/l	0,5	
Polychlorinated biphenyls (PCB)	mg/l	20	Contamination occurs through the disposal of electrical equipment or the incineration of industrial waste, giving rise to furans and dioxins that can be absorbed through the lungs, skin, ingestion of contaminated food and water. They can cause cancer, problems with the reproductive and immune systems, among others. [19]
Hexachlorocyclohexane (HCH) ([5])	mg/l	([1]) 20 ([2]) 100 ([3]) 50	It is a persistent organic pollutant (POP). It can be bioaccumulated causing toxic effects on the reproductive, immune and nervous systems. [20]
Carbon tetrachloride	mg/l	12	Carbon tetrachloride mainly affects the central nervous system (CNS), heart, liver and kidneys. [21]
DDT ([5]): Isomer p-p'DDT Total	mg/l mg/l	10 25	It acts mainly on the central nervous and reproductive system. [22]
Pentachlorophenol ([5])	mg/l	2	Exposure to pentachlorophenol affects the immune, cardiovascular, respiratory, gastrointestinal and reproductive systems, among others. [23]
Aldrin, dieldrin, endrin and isodrin ([5])	mg/lg/l	([4]) 30	It can cause headache, dizziness, nausea, vomiting, muscle tremors and convulsions [24]
Hexachlorobenzene (HCB) ([5])	mg/l	0,03	It is a fungicide whose contamination can occur through ingestion of contaminated food, causing liver damage, interfering with the production of haemoglobin, in the nervous system, among others. [25]
Hexachlorobutadiene (HCBD) ([5])	mg/l	0,1	It is a persistent organic pollutant mainly affecting the kidneys [26]
Chloroform	mg/l	12	It can cause changes in motor activity, affects the respiratory and digestive systems and has carcinogenic activity. [27]

* Table adapted by the authors. (1) Applicable to estuary, marine and territorial waters. (2) Applicable to surface fresh waters affected by discharges. (3) Applicable to surface fresh waters not affected by discharges. (4) In total, for the four substances, with a maximum of 5 mg/l for endrin. (5) The concentration of hexachlorocyclohexane, DDT, pentachlorophenol, dieldrin and/or dieldrin and/or endrin and/isodrin and hexachlorobenzene and hexachlorobutadiene in the sediments and/or molluscs and/or crustaceans and/or fish should not increase significantly over time.

3. **Agronomic parameters**: Regarding these parameters, some MAV and ELV data are legislated to Angola. The MRV data, presenting on table nº 2, belongs to Portuguese legislation with the respective implications on agricultural crops.

Table No. 2: MAV, ELV, MRV of agronomic parameters and agricultural implications[16,17]

Parameter	Units	MAV	ELV	MRV	Observations
Aluminium	Al mg/l		10	5	Risk of unproductivity in soils with pH‹5.5. In soils with pH›7 the risk of toxicity is eliminated by precipitating aluminium.
Total Arsenic	As mg/l	0,1	1,0	0,10	Toxicity varies depending on the crops, ranging between 12 mg/l for Sudan grass and 0.05 mg/l for rice.
Ammoniacal Nitrogen	NH_4 mg/l	1	10		
Kjeldahl Nitrogen	N mg/l	2			
Total Nitrogen	N mg/l		15		

Barium	Ba mg/l			1,0	
Beryllium	Be mg/l			0,5	
Boron	B mg/l			0,3	For fine-textured soils and in short periods, a maximum concentration of 2 mg/l is recommended.
Total Cadmium	Cd mg/l	0,01	2,0	0,01	Toxic to beans, beetroot and turnips in concentrations of around 0.1 mg/l in nutrient solutions. More restrictive limits are recommended, as this ion accumulates in plants and soil, potentially harming humans.
Total Lead	Pb mg/l	0,05	1,0	5	Very high concentrations can inhibit cell development in cultures.
Total Cyanides	CN mg/l	0,05	0,5		
Chlorides	Cl mg/l	250		70	For tobacco cultivation, a concentration of less than 20 mg/l is recommended, and should not exceed 70 mg/l.
Free residual chlorine	Cl_2 mg/l		0,5		
Total residual chlorine	Cl_2 mg/l		1,0		
Chlorophenols	µg/l	100			
Cobalt	Co mg/l			0,05	Toxic in nutrient solutions for tomato crops in the order of 0.1 mg/l. It tends to be inactive in neutral or alkaline soils.
Total copper	Cu mg/l	0,1	1,0	0,20	Toxic in nutrient solutions with concentrations between 0.1 mg/l and 1 mg/l for various crops.
Electrical Conductivity	dS/m			1	Much depends on the resistance of crops to salinity, as well as the climate, irrigation method and soil texture.
Hexavalent Chromium	Cr (VI) mg/l		0,1		
Total Chromium	Cr mg/l	0,05	2,0	0,10	As its toxic effect is unknown, more restrictive limits are recommended.
Tin	Sn mg/l			2,0	
Phenols	C_6H_5OH mg/l		0,5		
Total Iron	Fe mg/l	1	2,0	5,0	Non-toxic in well-aerated soils, but can contribute to soil acidification, making phosphorus and molybdenum unavailable.
Fluorine	F mg/l			1,0	Inactivated in neutral and alkaline soils.
Total Phosphorus	P mg/l		0,5 – 3*		
Polynuclear Aromatic Hydrocarbons	µg/l	100			
Lithium	Li mg/l			2,5	Tolerated by most crops at concentrations greater than 5 mg/l; mobile on the ground. Toxic to citrus fruits at low concentrations (‹0.075 mg/l).
Total Manganese	Mn mg/l		2,0	0,20	Toxic for a certain number of crops from a few tenths to a few mg/l, but normally only in acidic soils.
Total Mercury	Hg mg/l	0,001	0,05		
Molybdenum	Mo mg/l			0,005	It is non-toxic in normal concentrations. In soils rich in free molybdenum, forage can, however, cause toxicity in animals.
Total Nickel	Ni mg/l	0,05	2,0	0,5	Toxic for a certain number of crops between 0.5 mg/l and 1 mg/l; reduced toxicity for neutral or alkaline pH.
Nitrates	NO_3 mg/l		50	50	High concentrations can affect the production and quality of sensitive crops. In the plot's fertilization plan, it is important to account for the nitrogen conveyed by the irrigation water.
DO	% saturação	50			
pH	Sorensen Scale	5,9 – 9,0	6,0 – 9,0	6,5-8,4	
Selenium	Se mg/l			0,02	Toxic to crops at concentrations of around 0.025 mg/l. In soils with a relatively high content of absorbed selenium, forage can cause toxicity in animals.
SAR	meq/l			8	It depends on the salinity of the water, soil characteristics and the type of crop to be irrigated.

Anionic Surfactant Substances	µg/l	0,5			
Sulfates	SO4 mg/l	250	2000	575	
Sulfites	SO3 mg/l		1,0		
Sulphides	S mg/l		1,0		
Vanadium	V mg/l			0,10	Toxic to several crops in relatively low concentrations.
Total Zinc	Zn mg/l	0,5		2,0	Toxic to various crops over a wide range, reduced toxicity at pH›6 and fine-textured or organic soils.

* **DO**: Dissolved Oxygen; **SAR**: Sodium Adsorption Ratio.

4. **Physicochemical parameters**: in relation to these parameters, some data relating to MAV and ELV are legislated to Angola; MRV data, also presented in table no. 3, belongs to Portuguese legislation with the respective implications on agricultural crops.

Table nº 3: MAV, ELV, MRV of physicochemical parameters and agricultural implications

Physicochemical Parameters	Units	MAV	ELV	MRV	Observations
BOD (20ºC)	mg/l O_2	5	40		
COD	mg/l O_2		150		
TDS				640	Much depends on the resistance of crops to salinity, as well as the climate, irrigation method and soil texture.
STS	mg/l		60	60	High concentrations may cause soil clogging and silting in irrigation networks, as well as blockages in drip and sprinkler irrigation systems, and in the latter system, water may cause deposits on leaves and fruits.

BOD: Biological Oxygen Demand; **COD**: Chemical Oxygen Demand; **TDS**: Total Dissolved Solids; **STS**: Soluble Total Solids.

IV. Discussion

After analysing the data collected for the different parameters of agricultural irrigation water in Angolan legislation, it was found that organoleptic parameters such as taste and turbidity do not have regulated values, but they should, because Angola has a deficient sanitary system, and the existence of these factors may mean decomposing organic matter, hydrocarbons, formation of ammonia gases, pathogens on the surface of particulates and, by this way, causing illnesses in users of products irrigated by these waters and consumed raw. [28]

That´s why it is important to have robust legislation on pathogens parameters. Each passing day new variants appear and can compromise the health of farmers, populations living around, consumers, among others. The values of pathogens are not specified in Angola legislation for agricultural irrigation waters, only for human consumption waters and related to: total coliforms, faecal coliforms, faecal streptococcus, salmonellas and total germs. Some pathogens are not specified, such as choleric vibrio, pseudomonas aeruginosa, intestinal parasite eggs and they are a concern for organizations and states around the world. [15,16] It should be noted that there are other parasitic infections such as *E. Colie*, intestinal nematodes, thermotolerant coliforms, enterocytes, among others, not legislated as well.

Regarding to chemical agents that endanger human health and can be found in agricultural irrigation waters, such as pesticides, persistent organic pollutants, organochlorine compounds among others, Angola has very limited legislation. Taking into account that every passing day, more products are being synthesized for different purposes and the resistance of agricultural pests and other pathogenic organisms to pesticides is increasing, it is necessary to systematically update the data of this type of agents, which must be made with specifications regarding the toxicity and harmfulness of the aforementioned chemicals. [29]

Regarding agronomic parameters, Angolan legislation is a little more complete, however does not reference parameters such as magnesium, which, with a value slightly higher than permitted, could cause phytotoxicity problems if the upward trend persists[30], calcium, which in excess can cause nutritional imbalances and growth reduction of crops [30, 31] or excess of potassium that prevents the absorption of calcium and magnesium [30,31], we can jeopardize the environmental sustainability of ecosystems as these nutrients interfere with soil productivity and the quality and yield of agricultural crops.

Related to physicochemical parameters, Angolan legislation does not make reference to Total Organic Compounds (TOCs). This parameter is extremely important to assess the quality of water and the absence or absence of organic compounds, from the simplest to the most complex, and, therefore, to get an idea of whether the irrigation water used is free from contamination from sewage discharges, among others.[28,30]

V. Conclusion

With the completion of this study, it can be concluded that the proposed objective was achieved.

From the maps consulted, it was possible to verify that waters pass through Angola from a whole set of river basins common to countries in Southern Africa; it has a wide variety of soil types that can interfere in the quality of water and are made up of five large agricultural regions.

Due to the intense human activity that is taking place in Angola, such as agriculture, fishing, industry, mining, logging oil, among others, it is necessary to have a strong legislation in terms of waters pollution. Particularly regarding to water pollution, Angola presents legislation that allows integrated management of water resources (Law no. 6/02 of June 21, Water Law), their protection, conservation, control of supply and sanitation activities (Presidential Decree no. 83/14, of April 22), as well as defining quality parameters for different purposes and with waters of different types (Presidential Decree no. 261/11 of October 6).

On the legislation consulted for water quality parameters in agricultural irrigation, Angola presents legislation that sometimes is unclear, incomplete (for parameters and parameters categories) not updated in terms of data on chemical and biological parameters.

Currently, Angola needs to diversify its economy, combat poverty, develop food security and the health of its populations. Therefore, through its National Institute of Public Health, must update all the aforementioned data sets and monitoring on a regular basis pollutant emission that jeopardize the quality of irrigation waters.

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