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The Relief and Spatial Expression of the Dams of the Rio Coreaú River Basin, Ceará, Brasil

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Abstract

The article sought to discuss and understand how the functions of the peoples (Manhoso, Várzea da Volta, Angicos and Gangorra), inserted in different relief comparisons of the Korea River Basin-CE, Water during the rainy season, and then to be Used in the dry season. In this case, the analysis of physical and chemical sensors of water and soil in order to identify how the effects on the dynamics of the natural processes caused by the human application by the use of the soil with the reflections on the water quality of the Their effects. Intrinsic functions of environmental systems as well as repercussions for a society.

Keywords: sugar, relief, chemical and chemical indicators

1. Introduction

The research proposed an integrated study of the natural and social elements from the geosystemic approach, taking as its starting point the relief in the context of a river basin. From the relief is understood the relations between the other natural elements and the expression of their use by the action of society. That said, we have the highlight of the activities developed by society generating dynamic scenarios in the landscape. The hydrographic basin of the Coreaú-CE was analyzed, emphasizing the physical characteristics of its different forms of relief and the intrinsic relations that surround them, giving a character of uniqueness to the watershed, in particular the use of the weirs and occupation of the areas (TORES e FALCÃO SOBRINHO, 2015).

In this context, we sought to discuss and understand the functions of the reservoirs (Manhoso), located in the municipality of Viçosa do Ceará, on a sedimentary plateau; the Angicos dam, located in the municipality of Coreaú and the Várzea da Volta dam, in the municipality of Moraújo, both on the sertaneja surface and, finally, the Gangorra dam, in the municipality of Granja, located in the coastal zone. It is observed that the dams in question are inserted in different geomorphological compartments, however, it retains water during the rainy season, to be used during the dry season. Factor that becomes essential due to the scarcity verified in the municipalities of the referred basin. In this case, they offer support to the population, because water is synonymous with life.

To paraphrase Coelho Netto (1998, p. 93), water constitutes one of the most important physical elements in the composition of the terrestrial landscape, interconnecting phenomena of the lower atmosphere and the lithosphere, and interfering in plant, animal and human life through interaction with the other components of your drainage environment. Among the multiple functions of the water, its function as an agent that models the land surface, controlling both the formation and the mechanical behavior of the soil and rock layers deserves to be highlighted.

2. Characterization of the Study Area

The watershed of the Coreaú is located in the north-western portion of the State of Ceará, limited geographically to the south, by the Poti-Longá and Acaraú basins, to the west the State of Piauí, to the east the basin of the Acaraú River and to the north by the Ocean Atlantic. It has a linear coast extension of approximately 130 km, represented in (figure 01). It is composed of the area drained by the Coreaú river and its tributaries, as well as sub-basins formed by the Timonha, Tapuio, Pesqueiro, Jaguarapari, Corrente Laranja, Lago Seco, Mourão, Forquilha, Poeira, Mourão and Prata rivers totaling 10,657 km² 7% of the territory of Ceará (DNOCS-1968).

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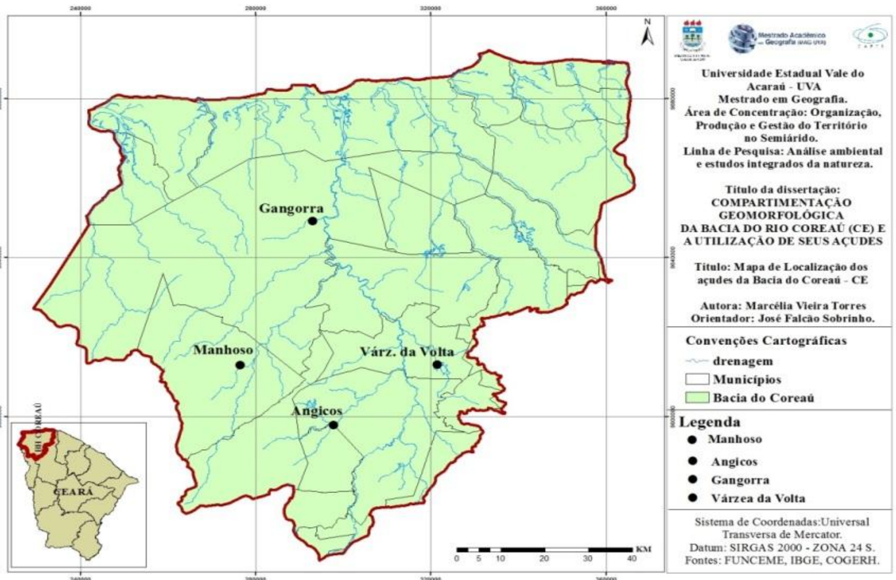
Figure 01: **Location of the dams – Coreaú Basin, Ceará, Brazil.**



Source: COGERH and Viçosa do Ceará city hall.

Highlighting the water resources, it is known that the consolidation of the water supply corresponding to such Basin includes eight of the ten main dams, that is, those that have a capacity of more than 10 million cubic meters. The reservoirs with a capacity below this value have as their main function the accumulation of water volumes that are stored after the rainy season (from February to May), to be used in the dry season (other months) of the same year. They do not, however, serve as interannual reserves, since, when consecutive dry years occur, these reservoirs do not present volumes to meet the demands (PACT OF WATERS, 2009).

The distribution of such reservoirs within the basin under analysis predominates in the sertaneja depression, explained by its greater expressiveness and by a component that contributes to coexistence with the water scarcity verified in the areas, and only three are located in pre-coastal areas. In this perspective, it becomes relevant to highlight the areas that the four reservoirs in analysis are inserted.

According to IPECE (2007), the municipality of Viçosa do Ceará, where the Manhoso dam is inserted, has an estimated population in 2014, referring to 58,332 inhabitants. It is located between the coordinates: latitude 3º 33 '44 ", and longitude 41º 05' 32". It is inserted in the Ibiapaba plateau, which comprises one of the most significant relief compartments of the territory of Ceará, the morphology is characterized by a continuous succession of valleys and tabular interflúvios, in which the edaphic differentiations bring changes in the types of agricultural occupation.

Associated with this geomorphological compartmentalization, it presents a pedological diversity, in which the Dystrophic Quartz Sands, Red-Yellow Latosol, Planosol and Argisols are highlighted. As regards its vegetation complex, it consists of Carrasco, Thorny deciduous forest, Tropical subsurface rainforest and Neotropical rainforest (IPECE, 2012). It is worth noting that the vegetation complex of the area also presents characteristics of sertaneja depression, due to being a transition area. In the surroundings of the dam, driven by human activities, it shows deforestation and exposed soil, and with action of the winds and rains carry the sediments to the bed of the dam.

Stands out, in its hydrography, the river Itacolomi, a tributary of the Coreaú river, and several small reservoirs, where only one was selected for analysis, is located 14 km from the municipality's headquarters, between coordinates Latitute 03 30 '03 "and Longitude 41 ° 00' 33, 2", in the district of Manhoso, in which it also receives this name. Its capacity is approximately 3,000,000m³ and supplies only the respective district.

The Várzea da Volta reservoir in the municipality of Moraújo, is located with greater expressiveness in an area of sertaneja depression between the coordinates: latitude 3º 28' 00" longitude: 40º 40' 50" and according to the IBGE the estimate of its population in 2014 it was 8,457 inhabitants. In relation to its natural composition, the predominant presence of Neosols Litolica soils, and attached to them, the vegetation that stands out is the Open Shrub Caatinga, Thorny Deciduous Forest and Caatinga Dense Shrub, (IPECE, 2012b).

The dam under analysis is situated on the right bank of the Coreaú River and is located 8 km from the municipality's headquarters, between the co-ordinates, latitude: 3° 30' 45 "and longitude: 40° 36' 13", contributes formally significant in terms of natural and social aspects, since it supplies the population, in addition to influencing the natural dynamics of the area. In this case, agricultural activities are factors that affect water quality, considering the limiting aspects of these practices (climate, soil depth, surface stoniness, water deficiency and erosion). Still in this perspective of analysis, we highlight the Angicos dam, which is located in the Municipality of Coreaú, and according to the IBGE, and the estimated population of this municipality in 2014 corresponded to 22,773 inhabitants. It is mostly embedded in the sertanejo depression area, between latitude 3° 32' 00" and longitude 40° 39' 24". (IPECE, 2012c). It is considered as the main reservoir of the Coreaú Basin, it supplies diverse municipalities. Perennizes a valley of 82 km (it is the most extensive perennial of the basin), between Coreaú and Uruoca. (COGERH Regional Management - Korea, 2010).

The municipality of Granja, where the Gangorra dam is inserted, is located between the coordinates, latitude 3º 07 '13" and longitude 40º 49' 34". The population estimated for 2014 according to IBGE was 53,682 inhabitants. It is located in pre-coastal areas, called the transition band between the country and coastal depression. Its physical aspects are composed of pre-littoral Glacis dissected in Tabular Interflúvios, with the presence of quartzarenic Neosols, Litolic Neosols, Planosols, and Argisols, being covered by the vegetation complex of the caatinga and pre-coastal area, (IPECE, 2012d).

The spatial expression of this dam is of great importance for the said Basin as well as for the local population. When referring to the physiognomic pattern of the vegetation, the presence of distinct characteristics, established by the action of the relief, is verified, in this case, the vegetation subperenifolia, (characterized by being a dense formation, high from 20 to 30 m), and deciduous , the latter occurring in the areas furthest from the coast, due to the greater semiarid climate, there is a greater insertion of caatinga species.

3. Methodology Adopted

The methodology used is based on the study of geosystems proposed by Bertrand (1968), when an integrated analysis of the landscape is carried out, especially in the understanding of the structure and functioning of nature and its interconnection with society. In this perspective, the author emphasizes that the relief has a significant role in the presentation of the geosystem, since it distinguishes the different landscapes besides being the support of analysis of the geofáceis and geótopos, these that present a range of details of the areas providing more veracity to study. Thus, relief can be seen as a starting point in the understanding and analysis of geosystems, since it can serve to dimension the landscape itself as an analytical instrument and the basin serves to concretize such an approach, in the case of the research making an analysis of the use of the dams in different geomorphological compartmentalization.

In order to choose these, the criterion regarding the spatial expression of the geomorphological compartmentalization (FALCAO SOBRINHO, 2006) was adopted, that is, 01 weir in the plateau area (Manhoso); 02 ponds in the sertaneja surface area (Angicos and Várzea da Volta) and 01 pond in pre - coastal areas (Gangorra). The spatial expression of the weirs can be verified in figura 02.

Figura 02: analyzed dams of the Coreaú Basin, Ceará, Brazil

Dams	Location	Conclusion year	Capacity	Municipality that serves
Manhoso	Viçosa do Ceará	2001	3.000.000m³	Manhoso
Angicos	Coreaú	1998	56.050.000 m³	Frecheirinha, Uruoca, Senador Sá, Moraújo
Várz. Da Volta	Moraújo	1919	12.500.000 m³	Moraújo e Coreaú
Gangorra	Granja	1999	62.500.000 m³	Granja

Source: COGERH and Viçosa do Ceará city hall.

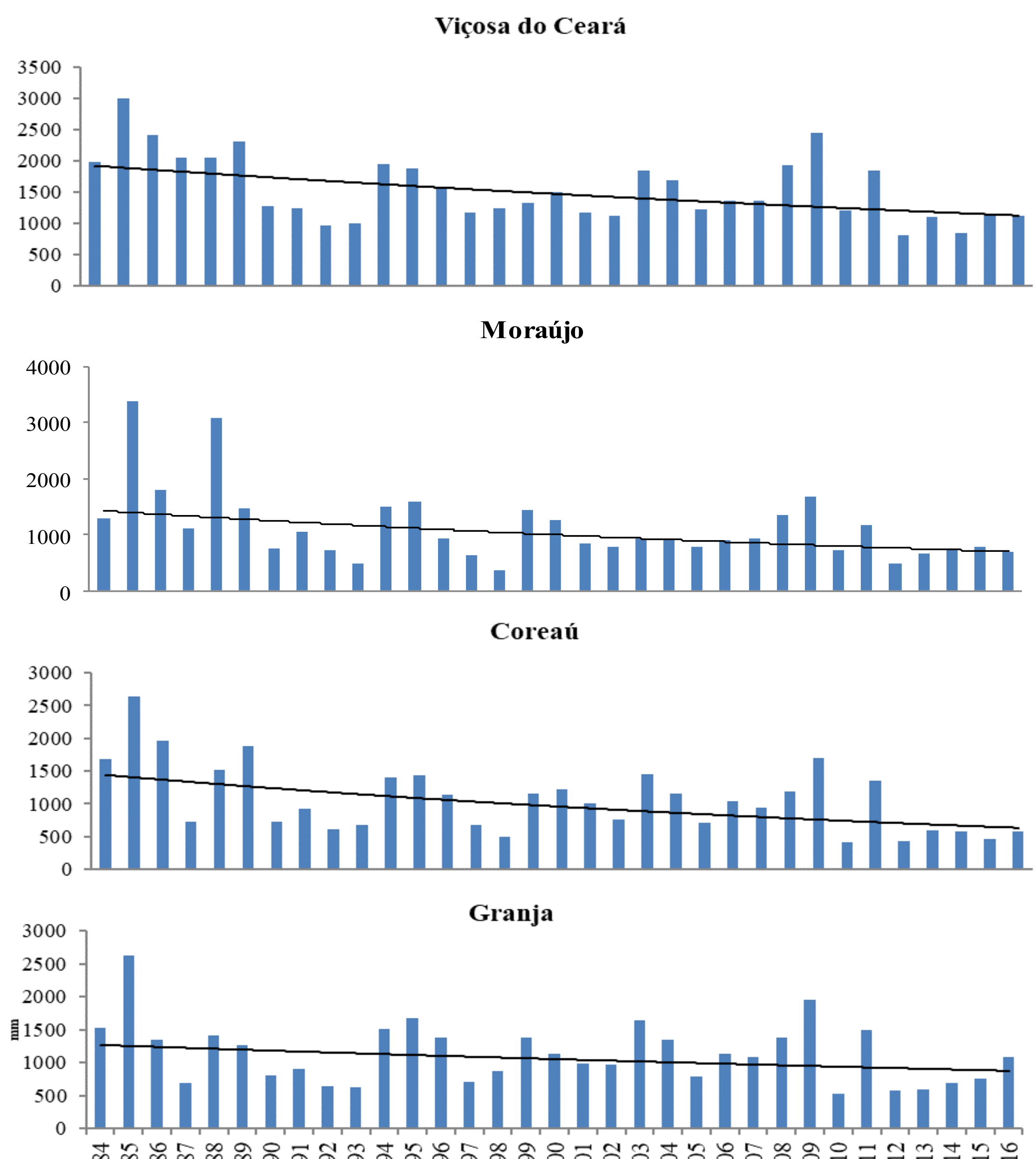
In the technical and operational procedures, physical and chemical parameters of the water and the soil were used as subsidy in order to identify the changes in the dynamics of the natural processes caused by the human action through the use of the soil with reflections in the water quality of the respective dams and consequently in society, since such dams are used for human consumption. Also, we sought to read the pluviometric indexes of the last thirty years referring to the municipalities that the reservoirs are inserted, because they contribute to their supply.

4. Results and Discussions

Thus, it is worth mentioning the importance of reading the last thirty years of rainfall indexes, provided by FUNCEME (2016), due to the rains being sources of supply of the dams, and from these data establish relations with the natural and social dynamics of the respective basin Hydrographic. It is worth mentioning the situation of the decrease of the water regime in these dams, linked to the natural aspects, through the pluviometric records referring to the last thirty years in the municipalities in which the dams are inserted, because they are sources of supply of these, besides influencing quality standards. This period was used, due to the more efficient data analysis.

When analyzing the results for rainfall indices (figure 03), it is verified that among the thirty-two years shown, more than half, have indices below 1,000 mm, a preponderant characteristic in the sertaneja area, and only eight years depict values which were observed in the years 1983, 1986, 1993, 1994, 2004, 1998, 2008 and 2012, and it should be noted that these rains happened irregularly, being concentrated between the months of January and May.

Figure 03: Annual accumulated precipitation of the Municipalities in which the dams are inserted.

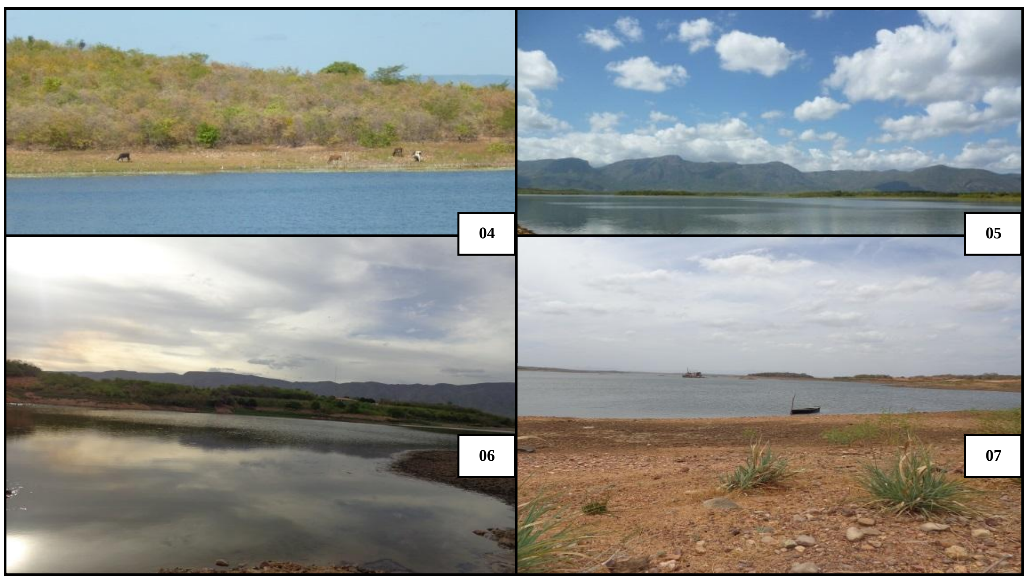


The trend lines express the pluviometric decrease in all the areas observed, mainly in the areas of sertaneja depression. It is worth noting that in all of the municipalities analyzed, the year 1985 had the highest rainfall, being more than 2,500 mm and in the last five years, there was a noticeable decrease in their indices when compared to previous years. Factor that directly influences agriculture, since in such areas such practices depend on the amount of rainfall and the period during which they occur, as well as on fishing activity, a fact observed in conversations with local farmers, where "lack of rains makes the physiognomy of landscapes lifeless."

In this perspective, these pluviometry characteristics attribute multiple roles in the salinization process, acting as a transporter and concentrator as it leaches the soil and transports the salts to the nearest weir, acting as a diluent when the volume of water bodies increases and reducing so the concentration of salts in them.

Also in this approach, evaporation has a relevant performance in the salinization process as a facilitating agent, since it contributes to the extraction of the salts found in the soil by the exudation process and as a concentrator, as it withdraws only the water from the dams, thus increasing the concentration of salts (SUASSUNA, 1996).

Figure 04: **Angicos Dam Figure 05**: **Várzea da Volta Dam**
Figure 06: **Manhoso Dam Figure 07**: **Gangorra Dam**



Source: TORRES, Marcélia Vieira, 2015

The reservoirs remodel and create new landscapes in the Brazilian Northeast from the introduction of large bodies of water, contribute significantly to the development of the areas they cover. They are used for various purposes, often for multiple uses. In this case, water is used to supply human, animal, irrigation and industry, tourism and leisure, among others. However, they also have disadvantages, since their construction generates a fragmentation of the landscape that existed before (Figures 04 to 07).

According to Audry (1990), the large dams, due to their water volumes, have greater inertia and less amplitude of seasonal salinity variation. On the contrary, small and medium dams, these in analyzes, present generally very low inertia, in these types are observed excessive amplitudes of the seasonal variation of salinity, low in the period of the floods and high in the period of drought, making the seasonality an important factor in the decision on the possibility and the way of managing the use of its waters. It should be noted that in the dry season, when demand increases, water quality is more compromised.

According to Cavalcante (2003), the geomorphological forms existing in the sertaneja depression, ridges, rock outcrops, dry slopes and clusters of inselbergs, water mirrors were spread. Also, where the topography of some features was higher than the maximum level of the weir, these were replaced by lacustrine island landscapes. In this context, the use and occupation of the soil for the most diverse types of activities brings a new configuration to the areas.

The recent development of these landscapes is closely linked to the demand for water, climate change and land use because they act intensively in economic development, therefore, the proper management of water resources is a fundamental component of environmental policy. Driven by the natural characteristics of the semiarid one of the viable solutions found to face this problem was the construction of dams that could supply the lack of water during the dry season. But the big problem was the lack of investments in the care of these, because the combination of natural and anthropic factors interfere in the characteristics and properties of the water, attributing them specific character in each place. Sometimes this interference modifies the physico-chemical and biological properties and may compromise potability when it comes to water intended, in particular, for public water supply. According to Resolution CONAMA-357/05, in a river basin, the quality of the water resources destined to human consumption depends, in most cases, on the land use systems on the slopes, associated to the erosive processes that surround the areas of production and capture of Water. As a rule, fresh water is distributed in classes, according to their quality and destination, ie the water quality can be evaluated by specific parameters.

"Inadequate soil management, both in rural areas and in urban areas, is the main cause of degradation (...). These areas are, therefore, more susceptible to degradation than those with great demographic pressure, but which take into account the risks of nature (...). Natural conditions themselves can, along with inadequate management, accelerate degradation. " (CUNHA and GUERRA, 2011, p.345).

In order to reinforce, Carvalho and Morais (2013) say that for an analysis of land uses and coverage, they characterize the vegetation and other natural constituents that cover the soil, and identify the existing human activities in the occupied areas, as well as identifying the pressure that has been occurring in vulnerable areas and with that can create strategies to mitigate the damages caused. "Knowing how the landscape elements (function, structure and dynamics) are related and structured is a crucial tool for the characterization of the soil cover, as well as the types of anthropic uses that interfere in these systems, to identify and interpret the different uses and types of coverage of a region, besides contributing to the studies of the surrounding landscape, is the means by which we can understand its spatio-temporal dynamics. " (CARVALHO AND MORAIS, 2013).

From these approaches, it is understood that the dynamics that involve space and time, can define the evolution of the landscape and the modifications they suffer, be influenced by natural factors that assiduously act in the modeling of relief, hydrography, vegetation, among others, or in human action that is an agent that constantly changes the landscape. These alterations may not be perceived in a short space of time and may even be considered as apparently static, but when comparing the landscape in a temporal evolution will be identified the changes occurred in the landscape.

Taking into account that several problems caused by sediments and that their production and transportation are directly related to the topographies of the areas of the Korea Basin. We chose this spatial cut as a work unit, that is, four dams in different relief areas, associating their uses with the activities developed in their surroundings, since they exert influence on the structure, dynamics and quality of such dams. In this case, from the point of view of the superficial erosive processes or fluvial channel, two physical parameters of water analysis are affected in a more specific way, that is, the color and turbidity, due to being visibly observed.

Thus, the production of sediments is closely related to the composition, use, management and transportation of the soil. Sediments are of great importance in environmental impact studies and therefore represent their capacity to accumulate species of microorganisms and chemical elements that are associated with the suspended material, being transported in dissolved form, or sometimes colloidal. Such context serves as justification for the development of this work, to investigate and verify the relationship of physical aspects, land use, the influence of the relief on the situation and water quality of the highlighted reservoirs.

It is important to emphasize the human influence exerted on the relief, because through productive activity, which portrays its action in nature, geological and geomorphological effects have been promoted, which are diversified throughout the temporal process. Being characterized by the modified landscapes, which, influence, in intense impacts to the geological geomorphological stratum. In this perspective, it is known that geomorphological compartmentalization reveals an endogenous and exogenous specific process, such as a hydrographic basin, which is in constant modifications due to a permanent exchange of matter and energy between the configurations of its dynamic system, which interact with the different natural components, gathering them in an intense and immediate way in all their extension.

Thus generating transformations in the morphic, climatic, vegetal, pedological and geological structures in the area of its comprehensiveness. These factors, evidenced in the vicinity of the dams, as well as, the human interferences, these, driven by the geomorphological compartmentalization that are inserted.

4.1. Results of the Physical and Chemical Parameters of Water in the Reservoirs

Water quality is related to human action in water resources with the availability of water, and its study is of great relevance for the evaluation of the possibilities of use. Thus, Tundisi (1999) reinforces that changes in the quality, distribution and quantity of water can threaten the survival of living beings. And with certain analyzes we can classify the suitability of water, especially for human consumption. Therefore, it is understood that the water regime and the production of sediments occur as a function of the actions associated with natural conditions and human activities, that is, the physical characteristics (relief, geology, soil and climate). erosion, while the socioeconomic interferences are due to the use and occupation of the soil (CUNHA, 2001). In this case, to investigate the level of water eutrophication, Carlson (1977) related the parameters: total phosphorus, inorganic phosphate and chlorophyll, with modifications for tropical systems. This relationship generated an index called the Trophic State Index (EIT), shown in figure 08.

Figure 08: Parameter (Trophic State)

Trophic State	IET
Oligotrophic	< 44
Mesotrophic	44 – 54
Eutrophic	54 – 74
Hypereutrophic	>74

Source: ***Limnologia Fluvial*, Brigante e Espíndola, 2003.**

Based on these parameters, according to the data provided by COGERH (2014), the waters of the Várzea da Volta dam belong to the Mesotrophic state, that is, water bodies with intermediate productivity, with possible implications for water quality, but at acceptable levels in most cases. The Angicos water dam, according to the "Water Quality System: Trophic State", made available by COGERH (2015), presented a Mesotrophic state in 2014, and in February 2015 it was changed to the Hypereutrophic state. This refers to water bodies significantly affected by high concentrations of organic matter and nutrients, with a marked impairment in their uses, and may even be associated with episodes of algal blooms and fish mortality and cause undesirable consequences on the livestock activities in the riverside regions.

Regarding the Gangorra reservoir, it is in the Eutrophic state, that is, it refers to bodies of water with high productivity in relation to the natural conditions, of low transparency, generally affected by human activities, in which there are undesirable changes in quality water and interference in its multiple uses. (CETESB, 2002).

In this perspective, figures 09 to 12 show the results of the physical and chemical parameters of the waters of the referred dams in the periods of drought and rainy, comparing with the standards established by CONAMA (20/1986, 357/2005 and 430/2011) , in order to understand the changes existing in these periods, as well as the interferences exerted by human action. The respective dam for not being monitored by COGERH was carried out only two collections, one during the dry season and the other during the rainy season, in order to show the differences that exist at each moment.

Figure 09: Water analysis of the Manhoso reservoir.

Manhoso Dam			
Parameters	**Agost/2013**	**Jan/2015**	**CONAMA Resolution 20/1986; 357/2005 e 430/2011**
Chlorides	165	47,3	**250mg/L**
Iron	*	0,2	**250 mg/L**
Total solids	*	142	**500mg/L**
Sulfates	*	5,7	**250mg/L**
pH Lab.	8,11	7,4	**6 a 9**
Turbidity	13	4,9	≤100 **NTU**
Color	100	30	**until 75 mg Pt/**
OD	*	*	≥5
BOD	*	*	**≤5**
Nitrogen	*	*	*
Phosphor	*	*	**≤0,1**
Alc. Bicarb	72	79,6	*
Calcium	*	*	*
C. Élét. Lab	*	**219**	*

Depth: 3 cm Drt: Drought R: Rainy *Absence of data.

Source: TORRES, Marcélia Vieira, 2013 e 2015.

Regarding the color (Pt-Co) of the water Lima (2008) states that it comes from the organic matter and a change in its coloration coming from sewers, a fact that influenced the result of the Várzea da Volta dam, which presented a value) and the Manhoso (100), values higher than those established by CONAMA, (figures 09 and 10), which can be attributed to the existence of numerous sediments, of many nearby residences, thus generating a large accumulation of garbage around the dam, lacking in this case, a care with the environment.

Still in this sense, the parameter phosphorus, in 2014, presented a value above that stipulated by CONAMA. They appear in natural waters through discharges of sanitary sewers. Organic matter contained in feces and powdered detergents used in large quantities are the main source. In addition, some industrial effluents, such as fertilizers, pesticides, chemicals in general, canned foods, slaughterhouses, refrigerators and dairy products, present excessive phosphorus. In addition to water drained in agricultural and urban areas may also cause the excessive presence of this parameter in natural waters.

Figure 10: Water analysis of the Várzea da Volta reservoir.

Açude Várzea da Volta					
Parameters	**Fev/2013**	**Mai/2013**	**Mai/15**	**Ago/15**	**CONAMA Resolution 20/1986; 357/2005 e 430/2011**
Chlorides	126,82	101,9	60,56	56,38	**250mg/L**
Iron	0,86	0,21	1,15	0,58	**250 mg/L**
Total solids	471,33	478,5	202	246,5	**500mg/L**
Sulfates	81,11	77,4	37,68	35,98	**250mg/L**
pH Lab.	8,57	9,07	7,18	7,65	**6 a 9**
Turbidity	78,7	75,35	3,59	1,91	≤100 **NTU**
Color	70	30	100	40	**até 75 mg Pt/**
OD	*	*	5,22	6,69	≥5
BOD	-1	4,4	*	*	**≤5**
Nitrogen	1,114	6,448	2,68	1,45	*
Phosphor	0,055	0,129	0,067	0,028	**≤0,1**
Alc. Bicarb.	*	*	*	*	*
Calcium	35,3	14,8	22,50	*	*
C. Elét. Lab.	0,49	*	0,35	*	*

Depth: 3 cm Drt: Drought R: Rainy *Absence of data.

Source: COGERH: 2013 e 2015. Organized by TORRES, Marcélia Vieira.

The concentration of dissolved oxygen in the water table (Figure 11) was the dissolved oxygen content, which is expressed as the amount dissolved in the medium and its concentration is subject to daily and seasonal variations influenced by the temperature of the photosynthetic activity, the water turbulence and the water flow (PALMA-SILVA, 1999). It is associated with the presence of suspended solids and biodegradable organic substances such as household sewage and certain industrial wastes (MATHEUS et al., 1995).

In this discussion, the Biochemical Oxygen Demand (BOD) of a water is the amount of oxygen required to oxidize organic matter by aerobic microbial decomposition to a stable inorganic form. The largest increases in the parameter in focus are caused by mainly organic evictions in water resources.

In this case, a high content of organic matter can induce the complete depletion of oxygen in the water, causing the disappearance of fish and other forms of aquatic life. Moreover, they indicate an increase of the microflora present interfering in the balance of aquatic life, produce flavors and odors besides obstructing the sand filters used in water treatment plants.

Following the parameters, Alkalinity, for Libânio (2005) may be due to the pH, and serves to measure the capacity of the water to neutralize the acids, because it is according to their content that the dosage of the chemicals used is established. And Chlorides are related to the high evaporation index, from the short rainy season, to the dissolution of salts and releases of domestic and industrial sewage, factors that exist in the areas.

Figure 11: Water analysis of the Gangorra reservoir.

Açude Gangorra									
Parameters	**Fev/2013**	**Mai/2013**	**Fev/2014**	**Mai/2014**	**Agost/2014**	**Fev/15**	**Mai/15**	**Ago/15**	**Resolução CONAMA 357/2005 e 20/1986)**
Chlorides	39,81	117,99	115,23	97,7	115,23	163,35	92,38	99,7	**250mg/L**
Iron	0,15	0,16	-0,2	0,2	-0,2	0,27		0,26	**250 mg/L**
Total solids	189,75	197	259,5	250,5	259,5	365	190,5	246,5	**500mg/L**
Sulfates	-8	19,06	*	10,47	*	5,47	21,05	21,03	**250mg/L**
pH Lab.	7,73	7,87	7,05	7,35	7,05	7,68	7,28	7,15	**6 a 9**
Turbidity	14,83	2,76	7,01	9,39	7,01	10,8	5,42	1,74	≤100 **NTU**
Color	10	5	25	30	25	30	40	30	**até 75 mg Pt/**
OD	*	*	*	*	*	7,36	6,56	4,37	≥5
BOD	2	-1	1,3	*	2	*	*	*	**≤5**
Nitrogen	*	1,884	*	0,71	2,19	2,110	0,190	1,010	*****
Phosphor	0,017	0,018	0,034	0,075	0,041	0,083	0,033	0,039	**≤0,1**
Alc. Bicarb.	57,2	47,3	32,13	21,45	32,13	35,39	15,97	24,42	*****
Calcium	13,42	10,58	3,2	5,54	3,2	5,83	3,75	6,33	*****
C. Elét. Lab.	0,27	0,26	0,398	*	0,398	0,58	0,34	0,32	*****
Depth: 3 cm Drt: Drought R: Rainy ***Absence of data.									

Source: COGERH: 2013 a 2015. Organized by TORRES, Marcélia Vieira

According to Lima (2008), the total solids (mg / L), the Sulphates (mg / L) and the Total Iron (mg / L) are found in water derived from the lithological characteristics, through ions water and the salinity of the medium, through erosive processes and sediment transport, occurring mainly in the rainy season, where it can be observed the increase of the values of these parameters, also caused by the discharge of sewage and the use of the soils with agricultural purposes.

According to Macêdo (2004), water turbidity is caused by the dispersion of light rays due to the presence of suspended particles (clays, silts or sources of pollution), which modify the lighting conditions of the waters, influencing in photosynthesis, in the growth of aquatic plants, and ultimately affecting consumption. This parameter, which only the Várzea da Volta dam, exceeded the maximum value established.

Figure 12: Water analysis of the Angicos reservoir.

Angicos Dam									
Parameters	**Fev/2013**	**Mai/2013**	**Fev/2014**	**Mai/2014**	**Agost/2014**	**Fev/15**	**Mai/15**	**Ago/15**	**CONAMA Resolution 20/1986; 357/2005 e 430/2011**
Chlorides	70,59	67,1	79,68	67,1	87,4	121,56	10,2	124,84	**250mg/L**
Iron	-0,01	-0,2	-0,01	-0,2	-0,2	0,1	0,1	0,21	**250 mg/L**
Total solids	212,75	194	226,5	194	230,5	337,5	269,5	319,5	**500mg/L**
Sulfates	16,04	9,84	21,67	9,84	7,84	27,74	28,37	23,91	**250mg/L**
pH Lab.	8,09	8,03	8,14	8,03	7,89	9,05	8,01	8,84	**6 a 9**
Turbidity	4,15	3,19	0,74	3,19	5,07	9,08	6,13	19,7	≤100 **NTU**
Color	15	40	5	40	30	30	30	30	**até 75 mg Pt/**
OD	*	*	*	*	*	9,63	7,8	8	**≥5**
BOD	-1	2,3	*	*	*	*	*	*	**≤5**
Nitrogen	0,172	0,761	0,036	1,4	1,46	1,590	0,300	2,11	*
Phosphor	-0,01	-0,013	0,672	0,023	0,026	0,042	0,026	0,083	**≤0,1**
Alc. Bicarb.	0	-8,95	0	-8,95	-8,95	53,09	47,90	42,18	*
Calcium	25,4	15,04	16,93	15,04	13,6	16,63	13,33	13,46	*
C. Elét. Lab.	0,31	*	*	*	0,383	0,48	0,43	0,5	*
Depth : 3 a 4 cm	Drt: Drought			R: Rainy				*Absence of data.	

Source: COGERH: 2013 a 2015. Organized by TORRES, Marcélia Vieira.

And the last parameter analyzed is Conductivity (μS / cm), characterized by the presence of ions dissolved in the water. It can be said that it is the capacity of water to conduct electric current and is therefore one of the most used ways to determine its level of salinity. In CONAMA's Resolution 357/05 and Ordinance 518/04 of the Ministry of Health, there is no citation of a limit value for this indicator, although, lately, it has gained importance in the evaluation of surface water quality.

4.2. Results of Soil Physical and Chemical Parameters Near the Main Reservoirs

The physical and chemical analyzes of the soil make it possible to identify and evaluate the available quantities of the essential elements so that this component can aid in the development of agricultural activities as well as in the dynamics of nature. According to Fernandes Santiago (1983), at first, the soil consists of mineral particles of different sizes (particle sizes) and their texture corresponds to the relative proportion of these fractions, that is, how much sand, silt and clay they have.

To emphasize, LEPSCH (2002) says that when the unit mineral constituents of the small clods are separated, the formation of a set of individual particles that are in natural conditions, acting interconnected, varying in size is verified. According to EMBRAPA (1997), the soil texture corresponds to the relative proportion of the different particle sizes in a given soil mass, such as sand, silt and clay fractions, at the point of adherence to soil preparation and planting implements.

In this case the physical (granulometric) analysis of the soil aims to quantify the proportion of the solid constituents in sand, silt and clay. This distinction makes possible the knowledge of the potential of use and management of the soil in the area, such as the availability of water for vegetation, erosion risk and mechanization potential, among others.

And with respect to the chemical analysis has the objective of providing information about the nutrients present in the same and their availability to be absorbed by the roots of the plants. In this case, a fertile soil needs calcium, magnesium, potassium, phosphorus, organic matter, light acidity, high capacity to retain nutrients and without the presence of sodium and aluminum, the latter causes root death, so there can be no free aluminum in soil, observed at pH above 5.0. It will appear when the soil is very acidic, with pH less than 5.0, most observed value in Granja (near the Seawater pond, figure 19).

Figure 13: soil chemical analysis (close to the Manhoso reservoir)

Areas: 1, 2, 3	**Depth**	**P**	**K**	**Na**	**Ca**	**Ca+Mg**	**Al**	**H+Al**	**CE**	**Carbon**	**PH**
1	0 – 5 cm	1	0,1	0,04	3,10	5,40	0,05	2,45	0,13	35,8	6,01
2	0 – 5 cm	0	0,15	0,35	7,80	12,20	0,05	2,45	1,58	19	5,82
3	0 – 5 cm	0	0,1	0,04	3,50	5,80	0,05	1,70	0,18	35,6	6,19
1	5 – 10 cm	1	0,1	0,04	3,50	5,70	0,05	1,75	0,11	33,2	6,63
2	5 – 10 cm	2	0,23	0,04	3,30	5,70	0,0	2,00	0,14	33	6,64
3	5 – 10 cm	0	0,08	0,04	3,10	5,10	0,05	2,05	0,12	33,2	6,48
1	10 – 15 cm	1	0,05	0,13	6,20	8,50	0,0	1,85	0,27	24,4	6,32
2	10 – 15 cm	0	0,15	0,09	6,20	8,20	0,05	3,00	0,29	18,2	6,26
3	10 – 15 cm	1	0,03	0,13	6,00	8,50	0,05	2,70	0,29	28	6,25
1	15 – 20 cm	0	0,1	0,22	5,20	8,5	0,05	2,75	0,72	18,2	5,51
2	15 – 20 cm	1	0,1	0,17	5,10	7,90	0,05	3,15	0,7	20,4	5,65
3	15 – 20 cm	1	0,1	0,17	5,90	8,90	0,05	1,70	0,68	20	5,66
1	20 – 25 cm	1	0,1	0,04	3,40	5,30	0,05	2,65	0,12	35	6,08
2	20 – 25 cm	1	0,13	0,30	7,50	11,00	0,0	2,45	1,36	20,2	5,87
3	20 – 25 cm	0	0,13	0,26	7,10	11,70	0,0	2,40	1,16	19,4	5,73
1	25 – 30 cm	0	0,05	0,26	2,30	3,5	0,0	1,35	1,14	32,4	5,5
2	25 – 30 cm	1	0,03	0,04	0,90	1,70	0,10	1,90	1,06	36,8	4,91
3	25 – 30 cm	0	0,05	0,13	1,80	2,50	0,05	2,15	0,74	34,8	5,04

Area 1: with vegetation ; **Area 2**used in subsistence farming ; **Area 3**: without vegetation

Source: IFCE, 2015. Organized by TORRES, Marcélia Vieira.

The acronym "pH" indicates potential of hydrogen and defines acidity or alkalinity of the soil. There is a pH range between 6 and 7 where essential nutrients and micronutrients are more easily absorbed by the roots. In this range they are available to be absorbed. As for the result of the soil analysis indicates pH = 5 (acid soil), the essential elements to the plants (nitrogen, phosphorus and potassium) are unavailable, that is, the plant can not feed on them because of pH. To clarify, Rossa (2006a) points out that it is as if the acid soils formed a barrier to the absorption of essential nutrients by the plant.

In this context, soils can be naturally acidic due to their own poverty in the bases of the source material or due to formation processes that favor the removal of basic elements such as K, Ca, Mg, Na (LOPES AND COLS., 1991). In this logic, it is necessary to emphasize the importance of the sum of bases (SB), which refers to the total amount of the bases and is composed of calcium, magnesium and potassium. It serves to indicate if the soil has nutrients available to the plant.

Figure 14: soil physical analysis (close to the Manhoso reservoir)

Areas: 1, 2, 3	**Depth**	**Coarse sand (g/Kg)**	**Thin sand (g/Kg)**	**Silte (g/Kg)**	**Clay (g/Kg)**	**Textural Classification**	**SUM**	% sands	% clay	% silte
1	0 – 5 cm	291	189	319	200	Franco	1000	48,1	20,0	31,9
2	0 – 5 cm	415	264	208	113	Franco Arenoso	1000	67,9	11,3	20,8
3	0 – 5 cm	406	246	211	137	Franco Arenoso	1000	65,2	13,7	21,1
1	5 – 10 cm	255	190	368	188	Franco	1000	44,4	18,8	36,8
2	5 – 10 cm	377	275	230	118	Franco Arenoso	1000	65,2	11,8	23,0
3	5 – 10 cm	394	274	216	116	Franco Arenoso	1000	66,8	11,6	21,6
1	10 – 15 cm	386	196	240	178	Franco Arenoso	1000	58,2	17,8	24,0
2	10 – 15 cm	446	250	210	94	Franco Arenoso	1000	69,6	9,4	21,0
3	10 – 15 cm	407	275	209	109	Franco Arenoso	1000	68,2	10,9	20,9
1	15 – 20 cm	411	279	226	84	Franco Arenoso	1000	69,0	8,4	22,6
2	15 – 20 cm	517	373	95	14	Areia	1000	89,0	1,4	9,5
3	15 – 20 cm	537	365	86	12	Areia	1000	90,2	1,2	8,6
1	20 – 25 cm	509	213	213	64	Franco Arenoso	1000	72,3	6,4	21,3
2	20 – 25 cm	604	314	68	15	Areia	1000	91,7	1,5	6,8
3	20 – 25 cm	488	367	127	18	Areia Franca	1000	85,5	1,8	12,7
1	25 – 30 cm	471	266	211	53	Franco Arenoso	1000	73,7	5,3	21,1
2	25 – 30 cm	584	343	63	9	Areia	1000	92,8	0,9	6,3
3	25 – 30 cm	562	368	61	10	Areia	1000	92,9	1,0	6,1

Area 1: with vegetation; **Area 2**: used in subsistence farming ; **Area 3**: without vegetation

Source : IFCE, 2015. Organizada por TORRES, Marcélia Vieira.

Regarding the carbon in soils is not homogeneous, that is, it consists of a wide variation of chemical components that differ in their intrinsic rates of decomposition and the degree to which they can be stabilized in the interactions with mineral surfaces or inclusion in aggregates. Determines the content of organic material and assists in the availability of nutrients.

In the present study, the soil moisture content of the semi-arid soils is similar to that of the other semi-arid soils (Fig. The contents of 0 to 10 low, 11 to 20 medium, 21 to 40 high and above 40 very high. This is an element of low soil mobility. The way phosphorus is present in the soil depends on the pH, in neutral and alkaline soils it is in the form of calcium phosphates of low solubility. Moraes (1993) reports that the accumulation of phosphorus on the surface comes from the decomposition of plant residues and the decrease of the fixation due to its low contact with the inorganic nutrients of the soil.

Figure 15: soil chemical analysis (near Várzea da Volta reservoir)

Areas: 1, 2 ,3	Depth	P	K	Na	Ca	Ca+Mg	Al	H+Al	CE	Carbon	PH
1	0 – 5 cm	2	0,13	0,04	4,80	7,20	0,05	6,10	0,42	31,6	5,66
2	0 – 5 cm	5	0,26	2,17	7,80	9,90	0,05	3,05	3,16	28,2	5,73
3	0 – 5 cm	9	0,28	2,78	7,80	10,10	0,05	1,80	3,63	29,2	5,88
1	5 – 10 cm	2	0,10	0,04	4,90	6,60	0,05	2,90	0,21	31,2	5,65
2	5 – 10 cm	2	0,21	1,61	7,20	9,10	0,05	1,85	3,00	26,6	5,17
3	5 – 10 cm	2	0,18	0,87	6,30	7,0	0,05	2,25	2,28	28,4	5,35
1	10 – 15 cm	3	0,10	0,04	5,30	6,90	0,05	3,75	0,28	31,2	6,11
2	10 – 15 cm	3	0,10	0,74	3,90	5,0	0,05	1,35	2,19	33,6	5,55
3	10 – 15 cm	2	0,1	0,52	2,80	3,80	0,0	1,50	1,93	34,8	5,45
1	15 – 20 cm	2	0,21	0,09	5,20	6,70	0,05	2,20	0,32	31,8	5,85
2	15 – 20 cm	4	0,13	0,39	3,80	5,30	0,05	2,20	2,21	26,4	5,63
3	15 – 20 cm	3	0,1	0,43	5,00	5,30	0,05	3,20	2,24	27	5,47
1	20 – 25 cm	2	0,15	0,04	5,10	6,10	0,05	3,00	0,25	33,4	5,75
2	20 – 25 cm	10	0,03	0,26	3,10	4,30	0,05	2,80	1,88	33	5,41
3	20 – 25 cm	7	0,08	0,57	3,70	5,10	0,05	1,65	2,67	33,8	5,62
1	25 – 30 cm	7	0,1	0,04	5,20	7,00	0,05	3,20	0,29	32,4	5,70
2	25 – 30 cm	1	0,1	0,26	2,40	3,40	0,10	1,50	1,33	36,8	4,51
3	25 – 30 cm	2	0,23	0,26	2,30	3,30	0,15	2,25	1,14	37,2	4,52

Area 1: with vegetation; **Area 2**: used in subsistence farming ; **Area 3**: without vegetation

Source: IFCE, 2015. Organizada por TORRES, Marcélia Vieira.

It is verified in figure 13 that the values of Ph decrease with depths, that is to say, in the analyzes (25-30 cm) presented the lowest indexes, in this case evidences the expressive acidity of the soil, making nutrient availability difficult for the development of the vegetation cover. According to Rossa (2006b), soils ideal for cultivation should have a pH between 6.0 and 6.5. However, this range can be extended from 5.5 to 6.8 and in the case of products grown in the areas, such as beans, 5.5 to 6.5; the corn, 5.5 to 7.0 are in accordance with the stipulated values for such practices. It is known that over the years and with the annual development of these activities, the nutrients required for an estimated productivity tend to decrease, and these are carried to the beds of the dams causing changes in water quality.

Also observed in the parameters Ca; Ca + Mg (aid in the development of the vegetative complex and its quantity varies according to the needs of each crop) and the higher Al rates, which, to leach the soil, according to the depth this element is infiltrating. With respect to Ca, its content from 0 to 15 is considered low, from 16 to 40 average and above this is high, thus, in the analyzes all were framed in the low content. It can be observed that clay and silt present approximate values in sand near the Manhoso reservoir, although the sand is prioritized. Therefore, the definition of sandy loam, and it is worth mentioning, the decrease of clay with depths.

In this sense, it was also verified that in the area that exists agricultural crops present the highest values of potassium and decrease in depth of the profiles. What is justified by Melo et al. (2008) due to its easy leaching, due to its monovalence, therefore presenting weaker bonds than calcium and magnesium. The variation of this element should be between 0 and 1.15 is low, 1.18 2.30 average; 2.33 to 4.60 high; and higher very high.

Figure 16: physical soil analysis (near the Várzea da Volta reservoir)

Areas: 1, 2, 3	**Depth**	**Coarse sand (g/Kg)**	**Thin sand (g/Kg)**	**Silte (g/Kg)**	**Clay (g/Kg)**	**Textural Classification**	**SUM**	% sands	% clay	% silte
1	0 – 5 cm	284	90	292	334	Loamy loam	1000	37,4	33,4	29,2
2	0 – 5 cm	313	80	261	346	Loamy loam	1000	39,3	34,6	26,1
3	0 – 5 cm	238	82	299	380	Loamy loam	1000	32,0	38,0	29,9
1	5 – 10 cm	115	98	374	413	Clay	1000	21,3	41,3	37,4
2	5 – 10 cm	166	168	405	260	Loamy	1000	33,4	26,0	40,5
3	5 – 10 cm	145	154	408	293	Loamy loam	1000	30,0	29,3	40,8
1	10 – 15 cm	221	131	290	358	Loamy loam	1000	35,2	35,8	29,0
2	10 – 15 cm	326	220	240	215	loamy-loamy loam	1000	54,6	21,5	24,0
3	10 – 15 cm	267	165	265	303	Loamy loam	1000	43,2	30,3	26,5
1	15 – 20 cm	573	206	121	100	Loamy loam	1000	78,0	10,0	12,1
2	15 – 20 cm	473	306	157	65	Free sand	1000	77,8	6,5	15,7
3	15 – 20 cm	551	256	138	55	Sandy loam	1000	80,7	5,5	13,8
1	20 – 25 cm	485	227	159	130	Sandy loam	1000	71,2	13,0	15,9
2	20 – 25 cm	474	273	165	89	Sandy loam	1000	74,7	8,9	16,5
3	20 – 25 cm	480	283	172	65	Sandy loam	1000	76,3	6,5	17,2
1	25 – 30 cm	451	208	183	158	Sandy loam	1000	65,9	15,8	18,3
2	25 – 30 cm	409	267	206	117	Sandy loam	1000	67,6	11,7	20,6
3	25 – 30 cm	412	277	200	111	Sandy loam	1000	68,9	11,1	20,0

Area 1: with vegetation; **Area 2**: used in subsistence farming ; **Area 3**: without vegetation

Source: IFCE, 2015. Organized by TORRES, Marcélia Vieira.

In relation to the physical analysis, the sand, clay and silt quantification, and its classification, that is to say, in sandy and sandy loam soils (soils close to the Manhoso and Gangorra dams), predominates sand properties, when it comprises at least 70% of the material by weight (soils with less than 15% clay). Characteristics of the clay fraction predominate in clayey, sandy-clayey and clay-silty soils.

According to the definition of Franco refers to a mixture with properties almost in equal proportions of particles of sand, silt and clay. Thus, clay fraction properties are used to classify soils with values as small as 20% clay, while soils to be classified as sandy or silty must have at least 40 or 45% of these fractions, respectively. In this case, most soils are classified as certain type of free soil, meaning they tend to have an ideal composition. Therefore, a soil in which particles of sand predominate is classified as sandy loam. Similarly, loamy-silty, loamy-loamy-silty, loamy-loamy and loamy-loamy loam can occur.

It is verified in figure 16, that the values of PH mostly vary between 5 and as it had already been verified in the sly heath, this parameter presents decrease in its value with the depths (25-30 cm). Also observed in the parameters Ca; Ca + Mg and higher Al indexes.

Significant indices of silt and clay in the samples (0 to 15 cm) are evident in this table, a fact attributed to the direct product of the weathering of crystalline rocks, and the low action of the water in the chemical weathering of these (SANTOS et al., 2009), and the effects of the water deficit on the soil surface.

Figure 17: soil chemical analysis (near the Angicos reservoir)

Areas: 1, 2, 3	Depth	P	K	Na	Ca	Ca+Mg	Al	H+Al	CE	Carbon	PH
1	0 – 5 cm	2	0,18	0,35	6,50	17,45	0,05	2,00	0,13	33,60	6,95
2	0 – 5 cm	1	0,18	0,30	6,95	16,30	0,0	2,15	0,29	33,6	7,20
3	0 – 5 cm	1	0,15	0,22	4,65	13,25	0,0	2,15	0,11	34	6,65
1	5 – 10 cm	0	0,13	0,09	2,30	9,70	0,05	3,0	0,1	32	6,31
2	5 – 10 cm	0	0,13	0,09	2,35	9,20	0,05	3,15	0,07	33,2	6,13
3	5 – 10 cm	0	0,13	0,09	2,55	9,70	0,05	2,60	0,09	33	6,15
1	10 – 15 cm	0	0,10	0,09	2,60	9,40	0,05	3,05	0,09	30,6	5,80
2	10 – 15 cm	0	0,10	0,13	2,40	8,80	0,05	3,05	0,1	34	5,67
3	10 – 15 cm	0	0,18	0,13	2,60	10,90	0,10	2,65	0,09	32,6	5,59
1	15 – 20 cm	0	0,05	0,09	5,60	9,10	0,40	3,20	0,09	32,8	5,39
2	15 – 20 cm	0	0,05	0,04	6,10	5,60	0,40	3,80	0,16	32,6	4,92
3	15 – 20 cm	0	0,05	0,09	3,0	5,20	0,30	3,30	0,11	34,8	4,87
1	20 – 25 cm	0	0,05	0,13	2,10	7,20	0,05	3,15	0,04	35,8	5,73
2	20 – 25 cm	1	0,05	0,09	1,40	6,0	0,05	2,80	0,04	36,2	5,86
3	20 – 25 cm	0	0,05	0,09	2,0	6,40	0,05	2,95	0,04	36,6	5,93
1	25 – 30 cm	0	0,05	0,09	3,00	16,00	0,20	3,40	0,97	36,6	5,42
2	25 – 30 cm	0	0,05	0,04	2,50	14,00	0,10	2,60	0,64	37,2	5,48
3	25 – 30 cm	1	0,1	0,09	2,70	13,90	0,10	1,80	0,88	37,6	5,47
Area 1: with vegetation; **Area 2**: used in subsistence farming ; **Area 3**: without vegetation											

Source: IFCE, 2015. Organized by TORRES, Marcélia Vieira.

In the area, the soils predominate the lithoolic Neosols, these, constituted by little thick organic material, with insufficient manifestation of the diagnostic attributes that characterize the different processes of soil formation, either due to the greater resistance of the source material or the other factors of (weather, relief or weather) that can prevent or limit soil evolution.

They present characteristics originating from the material of origin, being defined by (EMBRAPA, 2006) as little evolved soils and without the presence of diagnostic horizon. Further, they may reveal high (eutrophic) or low (dystrophic) base saturation, acidity and high levels of aluminum and sodium. They range from shallow soils to deep and from low to high permeability.

As shown in figure 16, an elevation of the EC, a fact designated to the accumulation of salts in the soil, is also influenced by the internal drainage efficiency of the profile and the water cycles, either by irrigation or by rainfall (SOUZA et al., 2007). The tendency for salinization of soils in the semi-arid region is common due to climatic factors, drainage deficiency, source material and inadequate irrigation.

Figure 18: soil physical analysis (near the Angicos reservoir)

Areas: 1, 2, 3	Depth	Coarse sand (g/Kg)	Thin sand (g/Kg)	Silte (g/Kg)	Clay (g/Kg)	Textural Classification	SUM	% sands	% clay	% silte
1	0 – 5 cm	515	154	241	91	Sandy loam	1000	66,8	9,1	24,1
2	0 – 5 cm	497	159	251	92	Sandy loam	1000	65,6	9,2	25,1
3	0 – 5 cm	529	157	218	96	Sandy loam	1000	68,6	9,6	21,8
1	5 – 10 cm	344	194	303	159	Sandy loam	1000	53,8	15,9	30,3
2	5 – 10 cm	335	204	299	163	Sandy loam	1000	53,8	16,3	29,9
3	5 – 10 cm	321	200	311	167	Sandy loam	1000	52,1	16,7	31,1
1	10 – 15 cm	284	90	292	334	Loamy loam	1000	37,4	33,4	29,2
2	10 – 15 cm	313	80	261	346	Loamy loam	1000	39,3	34,6	26,1
3	10 – 15 cm	238	82	299	380	Loamy loam	1000	32,0	38,0	29,9
1	15 – 20 cm	115	98	374	413	Clay	1000	21,3	41,3	37,4
2	15 – 20 cm	166	168	405	260	Loamy	1000	33,4	26,0	40,5
3	15 – 20 cm	145	154	408	293	Loamy loam	1000	30,0	29,3	40,8
1	20 – 25 cm	221	131	290	358	Loamy loam	1000	35,2	35,8	29,0
2	20 – 25 cm	326	220	240	215	Sandy loam-loam	1000	54,6	21,5	24,0
3	20 – 25 cm	267	165	265	303	Loamy loam	1000	43,2	30,3	26,5
1	25 – 30 cm	161	12	502	325	Loamy-clay-silty	1000	17,3	32,5	50,2
2	25 – 30 cm	194	111	361	334	Loamy loam	1000	30,5	33,4	36,1
3	25 – 30 cm	153	133	376	337	Loamy loam	1000	28,7	33,7	37,6

Area 1: with vegetation; **Area 2**: used in subsistence farming ; **Area 3**: without vegetation
Source: IFCE, 2015. Organized by TORRES; Marcélia Vieira.

In addition, inadequate soil and plant management practices, such as burning, deforestation, soil erosion and gravel extraction, and extensive ranching contribute to a marked reduction in organic matter content and, consequently, N content in soils (FARIA et al., 2010). Also, in the analysis, on the parameter Aluminum, its content increases as the PH index decreases, ie, the values of pH close to neutrality contributed to the unavailability of aluminum observed at depths (0 to 05 cm).

It is worth mentioning that this area presents flat relief, which favors the higher energy of the water providing the highest concentration of the clay content in depth, evidenced in the samples.

According to the analyzes (figure 18) and the classification of the soils, made by Embrapa, the area predominates the Argisols. These are mineral soils with differentiation between horizons, recognized by the increase, sometimes in clay content in depth. They can be sandy, of medium texture or clayey in the more superficial horizon. And they have a stronger color (yellowish, brownish or reddish), greater cohesion and greater plasticity and stickiness in depth, due to the higher clay content.

Figure 18: soil chemical analysis (near the Gangorra reservoir)

Areas: 1, 2 ,3	Depth	P	K	Na	Ca	Ca+Mg	Al	H+Al	CE	Carbon	PH
1	0 – 5 cm	0	0,13	0,13	1,80	2,90	0,10	4,25	0,19	19,8	5,16
2	0 – 5 cm	0	0,05	0,26	10,10	5,0	0,05	1,95	0,4	36,6	5,57
3	0 – 5 cm	1	0,05	0,26	2,80	5,0	0,05	1,75	0,44	36,2	5,87
1	5 – 10 cm	0	0,13	0,09	1,70	2,90	0,15	4,50	0,18	20,6	5,19
2	5 – 10 cm	0	0,05	0,17	4,40	4,60	0,05	3,10	0,28	35	5,22
3	5 – 10 cm	0	0,03	0,17	2,80	4,70	0,05	1,90	0,33	36,8	6,24
1	10 – 15 cm	0	0,13	0,09	1,50	2,90	0,15	4,70	0,25	23,2	5,17
2	10 – 15 cm	1	0,05	0,17	3,50	5,60	0,15	3,95	0,30	34,2	5,05
3	10 – 15 cm	0	0,05	0,17	5,00	5,40	0,10	2,85	0,26	35,8	5,16
1	15 – 20 cm	0	0,05	0,09	1,10	2,30	0,30	4,55	0,13	35,8	4,37
2	15 – 20 cm	0	0,03	0,1	5,90	5,30	0,10	3,75	0,22	36	5,53
3	15 – 20 cm	0	0,03	0,1	8,90	5,80	0,10	4,25	0,16	35,2	5,34
1	20 – 25 cm	0	0,03	0,0	1,50	2,40	0,45	3,65	0,85	36	4,38
2	20 – 25 cm	0	0,03	0,1	3,40	5,40	0,05	3,80	0,14	34	5,61
3	20 – 25 cm	0	0,03	0,1	7,9	5,90	0,05	4,10	0,17	33	5,45
1	25 – 30 cm	0	0,08	0,09	1,40	3,20	0,10	3,60	0,15	29,4	4,70
2	25 – 30 cm	0	0,03	0,22	2,30	5,90	0,05	3,50	0,16	35,6	5,58
3	25 – 30 cm	0	0,03	0,09	2,80	5,90	0,05	3,35	0,3	34	6,08

Area 1: with vegetation; **Area 2**: used in subsistence farming ; **Area 3**: without vegetation

Source: IFCE, 2015. Organizada por TORRES, Marcélia Vieira.

It is worth noting that Ph in the soils around the Manhoso and Angicos reservoirs stand out, with the areas with the best results. As a rule, it is verified that the values of the parameters Ph, C; Ca and Ca + Mg are higher in areas with vegetation, thus emphasizing the importance of organic material in the soil.

Also in this approach, in the acid soils, the fixation of the phosphorus (P) by the iron (Fe) and by the aluminum (Al) forming insoluble compounds not suitable for the plants. Brazilian soils, in general, are very acidic. In an acid soil, the levels of Ca, Mg and K are low, factors identified in most analyzes. As for alkaline soils (pH> 7.0), only one sample (close to the Angicos reservoir) shows a deficiency in the availability of phosphorus because of the formation of calcium phosphate that is insoluble and unusable for the plants. In these soils, there is an increase in the levels of Ca, Mg and K, but a deficiency of micronutrients.

The availability of nutrients are influenced by soil pH. Nitrogen (N) is best utilized by the plant in soil with pH above 5.5, a value observed in most analyzes. Maximum availability occurs in the soil pH range of 6 to 6.5 and then decreases. Phosphorus (P2O5) has better plant availability at pH 6 to 6.5. Potassium (K2O) is best utilized at soil pH greater than 5.5.

Figure 19: **soil physical analysis (near the Gangorra reservoir)**

Areas: 1, 2, 3	Depth	Coarse sand (g/Kg)	Thin sand (g/Kg)	Silte (g/Kg)	Clay (g/Kg)	Textural Classification	SUM	% sands	% clay	% silte
1	0 – 5 cm	573	206	121	100	Sandy loam	1000	78,0	10,0	12,1
2	0 – 5 cm	473	306	157	65	Free sand	1000	77,8	6,5	15,7
3	0 – 5 cm	551	256	138	55	Sandy loam	1000	80,7	5,5	13,8
1	5 – 10 cm	485	227	159	130	Sandy loam	1000	71,2	13,0	15,9
2	5 – 10 cm	474	273	165	89	Sandy loam	1000	74,7	8,9	16,5
3	5 – 10 cm	480	283	172	65	Sandy loam	1000	76,3	6,5	17,2
1	10 – 15 cm	451	208	183	158	Sandy loam	1000	65,9	15,8	18,3
2	10 – 15 cm	409	267	206	117	Sandy loam	1000	67,6	11,7	20,6
3	10 – 15 cm	412	277	200	111	Sandy loam	1000	68,9	11,1	20,0
1	15 – 20 cm	291	189	319	200	Loamy	1000	48,1	20,0	31,9
2	15 – 20 cm	415	264	208	113	Sandy loam	1000	67,9	11,3	20,8
3	15 – 20 cm	406	246	211	137	Sandy loam	1000	65,2	13,7	21,1
1	20 – 25 cm	255	190	368	188	Loamy	1000	44,4	18,8	36,8
2	20 – 25 cm	377	275	230	118	Sandy loam	1000	65,2	11,8	23,0
3	20 – 25 cm	394	274	216	116	Sandy loam	1000	66,8	11,6	21,6
1	25 – 30 cm	386	196	240	178	Sandy loam	1000	58,2	17,8	24,0
2	25 – 30 cm	446	250	210	94	Sandy loam	1000	69,6	9,4	21,0
3	25 – 30 cm	407	275	209	109	Sandy loam	1000	68,2	10,9	20,9

Area 1: with vegetation; **Area 2**: used in subsistence farming ; **Area 3**: without vegetation

Source: IFCE, 2015. Organized by TORRES, Marcélia Vieira.

It is worth emphasizing that the texture influences the water absorption and the infiltration process and the occurrence and growth of different plant species and the movement of water and solutes are directly related to the physical properties of the soil, which also exert a great influence on the soil degradation by the erosive process. During long periods of time, pedological processes such as erosion, deposition, and weathering can alter the texture of different soil horizons. Management practices do not usually change the textual class of a soil. The texture can only be altered by mixing other soil types with different textual classes. In the area according to the results of the table stand out the sandy soils, these, have a better drainage structure than the clayey ones.

5. Final Considerations

In this case, to understand the dynamics of land use and occupation in the municipalities of Viçosa, Granja, Coreaú and Moraújo, it was sought to understand how the activities - which are practiced in these areas - configure the geographic space itself, since land use is understood as form, by which, space is occupied by man. In this way, it was verified that in the analyzed dams the relation established by the inhabitants is influenced by the geomorphological compartmentalization in which they are inserted, that is to say, in the sertaneja depression is perceptible a strong incidence of erosive processes caused by the inappropriate use and undue occupation of the area in the vicinity of the water environment), motivated by the semiarid conditions, that is to say, a relation of dependence of this water environment, since, they make use of them for the supply, and as aid in the sustenance, through the fishing.

Another factor verified was the significant occurrence of migrations, in particular, in the sertaneja depression that directly affects the generation of environmental problems (deforestation, wastes and others). Due to the fact that a relationship of "belonging" with the reservoir is not established, these aspects are poorly identified in the other areas, thus reflecting changes in the parameters analyzed.

Regarding the morphological characteristics of the studied soil profiles, they reflect the conditions of the source material and the landscape. As can be seen, the variations in granulometry and the different sediment deposition conditions that are conditioned to the relief and the oscillations of the watercourse - are being transported and altered by undue action, through traditional management practices.

Thus, through analyzes that identify the actuation, dynamics and alteration of the natural elements, it was possible to have the notion of the degree of actuation and imbalances provoked by a certain pattern of occupation. In this perspective, the inadequate management of the soils, in particular agriculture and livestock, which are predominant in the analyzed areas, may be directly responsible for the transformations occurring in the landscape. It can be emphasized that agriculture is the most hostile form of land use. When practiced, improperly and abusively, it causes deterioration and / or environmental degradation.

In a more detailed way, from the physical and chemical analyzes of water, changes in the patterns caused by human action, as a result of the devastation of ciliary forest, litter on the banks and beds of the reservoirs were verified in the Várzea da Volta dam (altering the coloring of the water and consequently its quality). Thus, it can be observed that the functionalities of environmental systems are affected each day by the changes imposed by human actions with repercussions in society.

A clear example is the silting, because there is the presence of agricultural crops in the raised areas directed to the flat ones, from which it causes surface runoff generated by the rains, and also, modifications in the fauna and flora of the water body. Committing, therefore, the infrastructure of these dams giving rise to several negative impacts on the water, especially, in the reduction of the accumulated volume, and, consequently, in the flow of them. This, therefore, increases the values of turbidity, damages to biodiversity through the drag and ground of microorganisms - that serves as food for fish.

In this case, an evaluation of the variables of water quality is relevant to the understanding of the interaction of ecosystems with the aquatic environment of the environmental impacts, in order to search for viable solutions for these. The development of precise and safe methodologies, especially with regard to the sampling procedure, are increasingly required in order to contribute to the achievement of these objectives. Therefore, the study of the operation, monitoring and care of reservoirs is relevant in this scenario because it directly influences the guarantee of service to the demand, mainly for future generations.

In the highlighted areas, it was evident that soil use and occupation processes induce, as a consequence, the progressive degradation of the soil and the loss of productivity. This is due to the natural fragility that the areas under the influence of this climate regime are prone to low and irregular annual rainfall indexes, high rates of evapotranspiration, shallow soils and high concentration of salts, among other factors.

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