https://dx.doi.org/10.22161/ijaers.73.15 ISSN: 2349-6495(P) | 2456-1908(O)

Surface water Treatment for the attendance of Riverside Communities of the Brazilian Amazon

Márcio de Freitas Velasco

Master in Science and Environment – INCRA, Brazil

Abstract*— *The present study allowed to verify the efficiency of the water treatment proposed by the INCRA - National Institute of Colonization and Agrarian Reform, to the riverside communities in the Agroextractive Projects Onças Island and Arapiranga Island, in the Municipality of Barcarena, State of Pará. Of treated water and one of raw water for each island, aiming to calculate the efficiency in the treatment through the evaluation of the parameters turbidity, apparent color, residual chlorine and total coliforms. With the results obtained, the good physical quality of the water provided through the low levels of turbidity and apparent color was verified, besides the absence of microbiological contamination and low residual chlorine content, guaranteeing water free of taste and odor. The good quality of the treated water and the high efficiency of the treatment proposed for sources of surface water abstraction can be verified.

***Keywords*— Water quality. Onças Island. Arapiranga Island.**

I. INTRODUCTION

The Amazon region presents a considerable water availability, varying between 100,000 and 1,000,000 m³/hab.year depending on the State, when compared to the national average, close to 50,000 m³/hab.year. Due to this abundance, it becomes common to install water supply systems that use rivers and streams as a source of capture, a situation very common in most Amazonian municipalities [3].

The absence of basic sanitation, a recurring situation in the great majority of the riverside municipalities located in the Amazon Region, contributes annually to the deaths of thousands of people, mainly children and elderly people, with frequent outbreaks of waterborne diseases, due to the consumption of water without treatment, a situation invisible in the eyes of the great majority of the population in the great centers, because they occur in completely geographically isolated places. [2].

In general, surface water contains several components from the natural environment itself, as well as those introduced through anthropogenic activities, and the main impurities found in surface waters are dissolved solids in the ionized form, dissolved gases, dissolved organic compounds and materials in suspension, such as microorganisms and colloids, being kept in stable suspension for long periods of time, as a function of the negative charges, which provoke repulsion between these particles [13].

Such situations produce physical changes in water, visually characterized by increased turbidity, defined as the degree of reduction of the passage of light by water, and the presence of color, caused mainly by the decomposition of materials from residues of human activities. In addition, water serves as a vector for the transmission of diseases caused by bacteria, fungi and viruses [7].

There are common outbreaks of waterborne diseases in rural areas, due to the consumption of water without any previous treatment. The absence of basic sanitation contributes annually to the deaths of thousands of people, especially children and the elderly, and this situation is very common in the Amazon [2].

The Citizenship Territories Program was launched in 2008 to promote sustainable development in areas of low human development, with one of its guidelines being to guarantee access to sanitation and quality water [12].

The National Institute for Colonization and Agrarian Reform - INCRA, through its technical staff at the Regional Superintendence in Belém (SR-01), designed in 2009 a model of micro-water treatment plant - META, in order to guarantee the communities rivers within the potability standards established by current legislation. [4].

The treatment operation is based on the abstraction of water from rivers and streams of the region, to be treated and distributed individually or collectively, according to the local population density, as shown in Figures 1 and 2:

https://dx.doi.org/10.22161/ijaers.73.15 ISSN: 2349-6495(P) | 2456-1908(O)

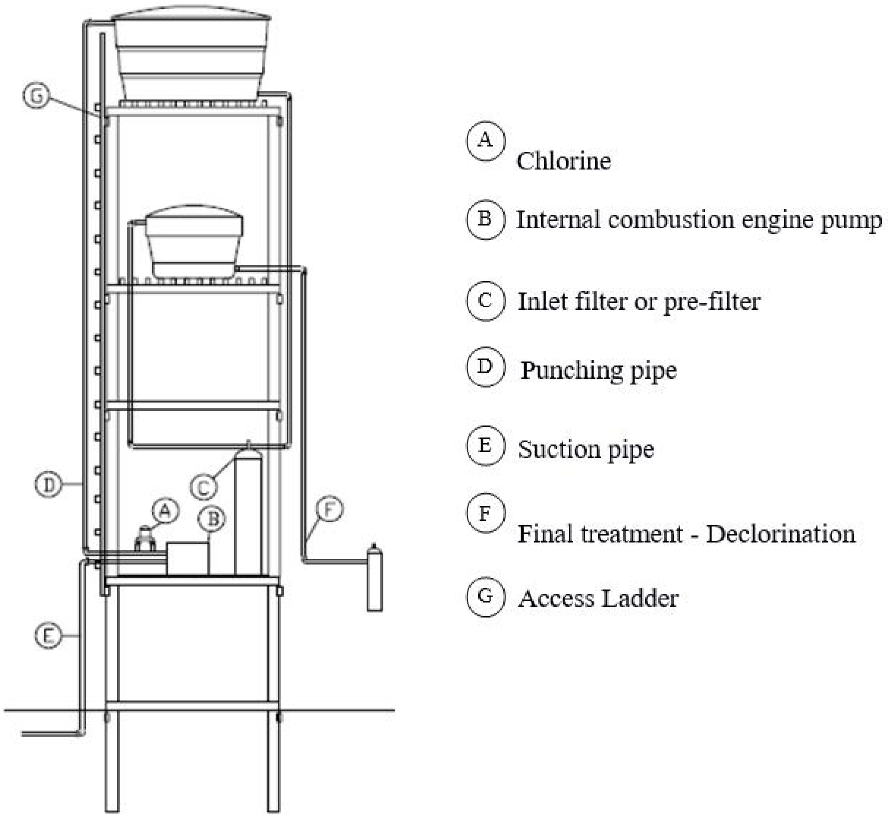

Fig.1 – Collective META Layout.

Source: Own Author

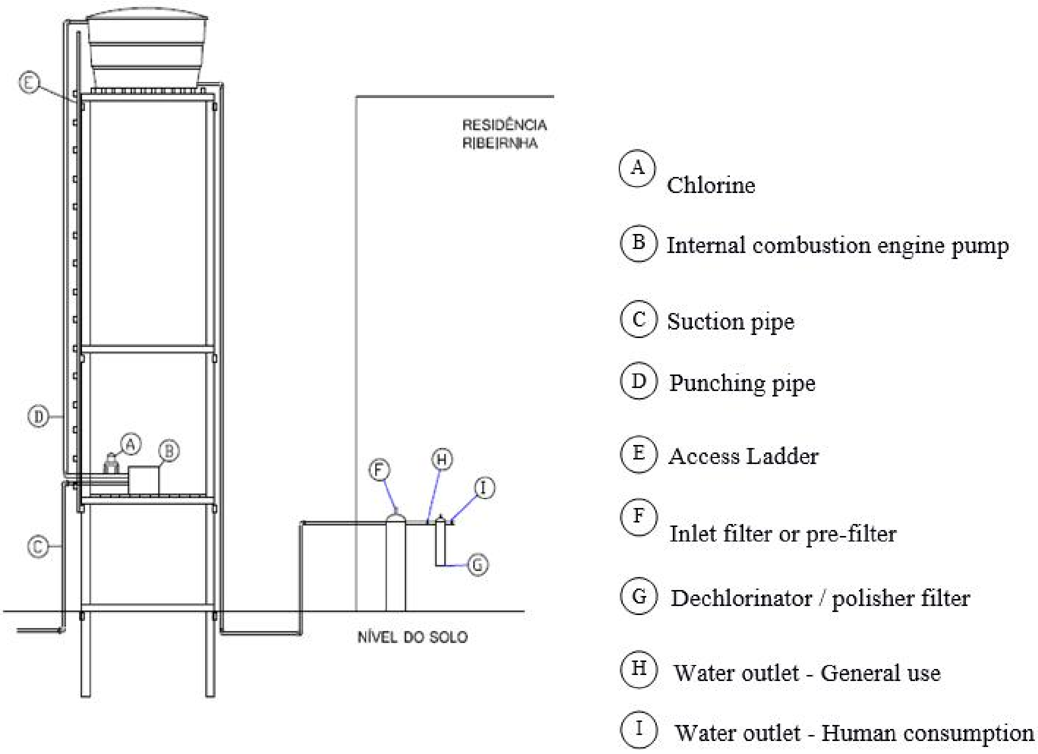

Fig.2 – Individual META Layout.

Source: Own Author

The proposed water treatment operation consists of the following steps, as shown in Figure 3:

Fig.3 – Operation flow diagram for the proposed water treatment.

Source: Own Author

The collective treatment system shown in Figure 1 basically consists of the capture of raw water directly from rivers and streams, and it is repressed to a high reservoir, installed on the top of the support structure and storage, in hardwood, with 6.40 m in height. The subsequent stage consists of chlorination and flocculation, aiming at the disinfection and clarification of the raw water, through the implantation of a chlorinator installed in the entrance barrel of the upper reservoir, in which flocculant and chlorine are added, obeying this order. Then the super-chlorinated water will fall by gravity and pass through an inlet filter, located at the base of the support structure, and later stored in an intermediate reservoir. In each residence there is installed an individual treatment center, to remove excess residual chlorine and suspended matter, guaranteeing the supply of treated water, according to the standards established by Ordinance No. 2.914, of 12/12/2011 of the Ministry of Health [8].

The individual treatment system shown in Figure 2 presents practically the same characteristics of the collective, differing in the height of the elevated reservoir, 3.00 m in height, besides the fact that super-chlorinated water falls by gravity directly to riverside residence, where an input filter is installed in series, followed by an individual treatment center, responsible for the clarification, polishing and removal of excess residual chlorine, guaranteeing the supply of treated water, in accordance with the standards established by Ordinance No. 2,914, of 12 / 12/2011 of the Ministry of Health [9].

Agroextractive Projects Onças Island and Arapiranga Island, located in the municipality of Barcarena, in the State of Pará, have several rivers and streams, which are strongly influenced by the waters of Guajará Bay, which have a high turbidity, are muddy and yellow-green coloration, a very evident situation in its tributaries, observed mainly under low tide [6].

This research aims to evaluate the efficiency of the water treatment systems proposed by INCRA through the analysis of physical-chemical and microbiological parameters in treated water samples from micro-water treatment plants installed in riverside residences in Agroextractive Projects Onças Island and Arapiranga Island, belonging to the Municipality of Barcarena, in the State of Pará, taking as a basis the water potability parameters established by the current legislation.

II. METHODOLOGY

2.1- Sampling.

Forty samples of treated water were collected in META's installed in Agro-extractive Projects belonging to the Municipality of Barcarena, distributed as follows:

- Twenty samples from collective META's installed at Agroextractive Project Ilha das Onças, where a raw water sample was collected from the common source of abstraction for all treated water samples. In this case, the Igarapé Piramanha. Sampling period: June 5 to 15, 2016.
- Twenty samples from individual META's, installed in Agroextractive Project Ilha Arapiranga, and a sample of raw water from the main source of abstraction was collected, in this case the Cutaju-mirim river. Sampling period: September 5 to 15, 2016.

The sampling plan was defined according to the location of the META's installed in the same drainage, according to the maps shown in Figures 4 and 5. Each of the sectors had twenty sampling points, plus a point for collecting raw water in the drainage. The parameters adopted to evaluate the efficiency of the proposed system are directly related to the characteristics of the surface spring used as source of gross water capture, whose turbidity and the apparent color of the water present high values, as well as the presence of total coliforms characteristic of area without basic sanitation. The presence or absence of free residual chlorine is related to the last step of the treatment, the dechlorination. The protocol adopted obeyed Portaria no. 2,914, dated 12/12/2011 of the Ministry of Health, which provides for

https://dx.doi.org/10.22161/ijaers.73.15 *ISSN: 2349-6495(P) | 2456-1908(O)*

procedures to control and monitor the quality of water for human consumption and its drinking water standard [4]. From the results obtained, the two proposed modalities were compared: individual and collective.

The location maps of the sampling points are shown in Figures 4 and 5, which were constructed using the GPS TrackMaker 13.8 software, used to georeference and identify the sampling points, and then finalize the map generation with the aid of the QGIS 2.4 software.

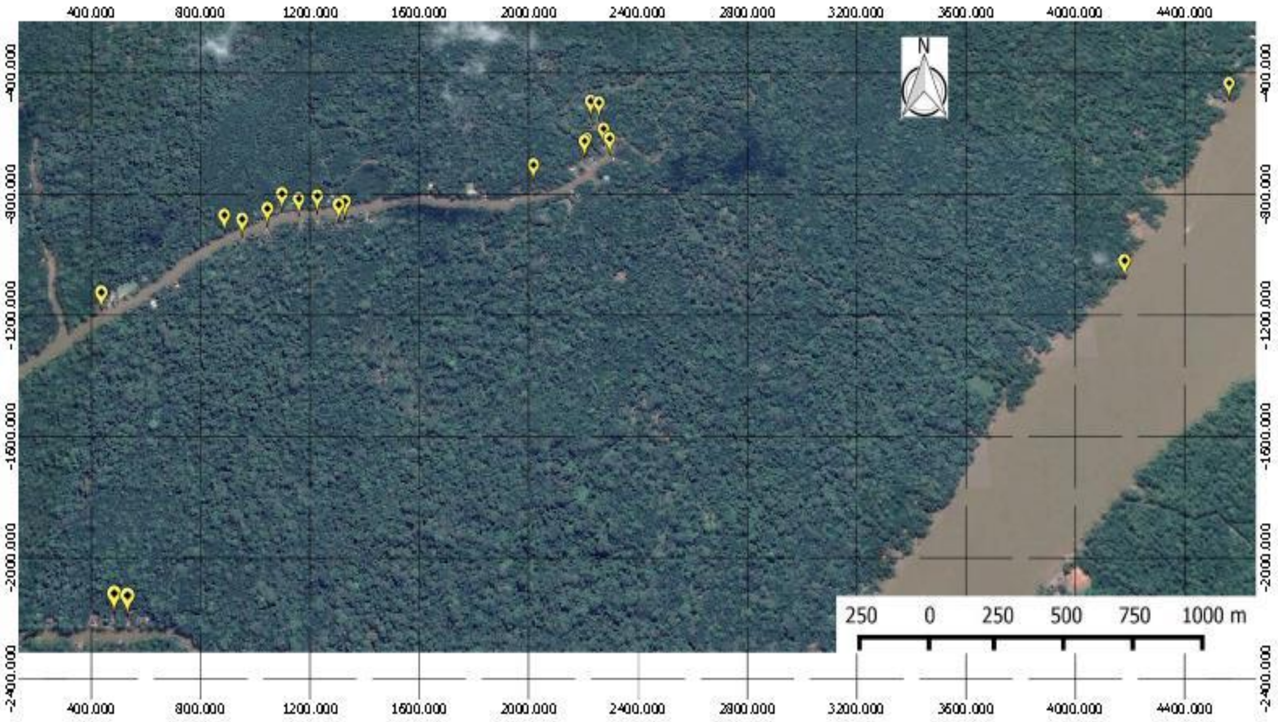

Fig.4 – META's individual sampling map (Arapiranga Island).
Source: Own Author

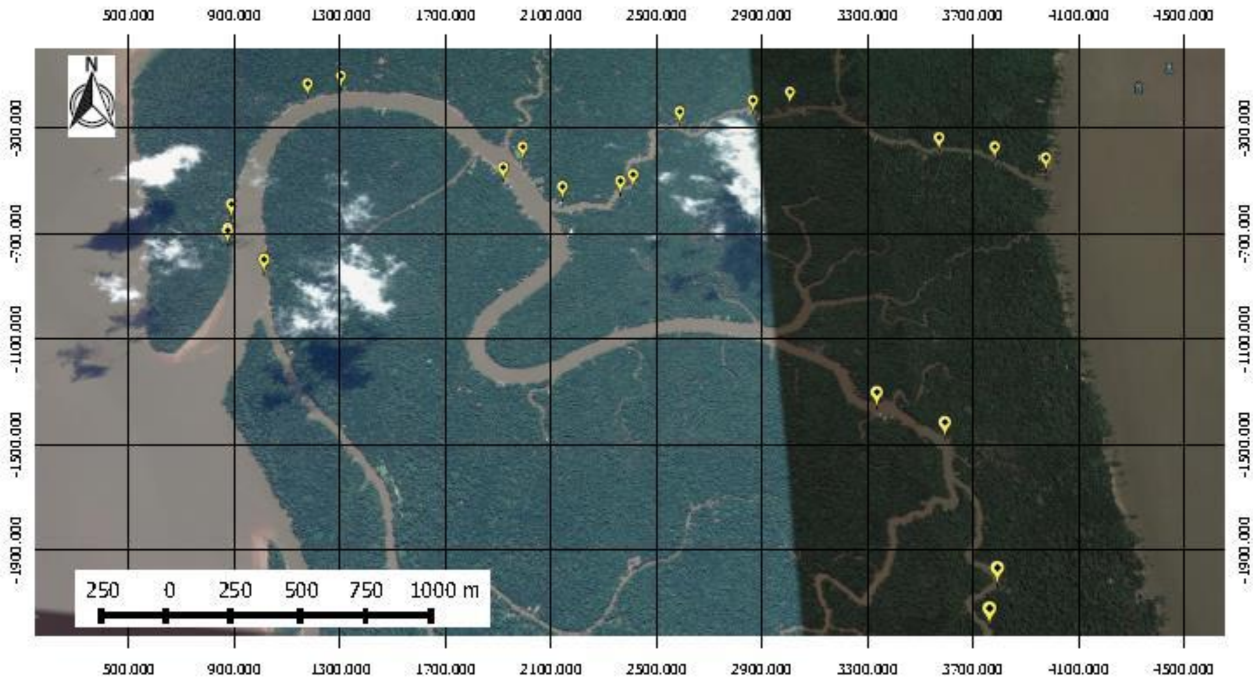

Fig.5 – META's collective sampling map (Island of Onças).
Source: Own Author

2.2- Assessment of the efficiency of the proposed water treatment.

The collected samples were analyzed in a laboratory contracted, Monitora Laboratories LTDA-ME, taking into account that the proposed water treatment follows the conventional methodologies of most of the processes adopted by water supply companies in cities spread throughout the national territory, which consists of the clarification and disinfection of raw water, and the parameters defined for the evaluation of the efficiency obeyed physical and microbiological determinants for acceptance of the final product of the operation: turbidity, through the method SMWW 22º Ed., 2130B 2012; apparent color, through the method SMWW 22º Ed., 2012 - 2120 C and total coliforms, through the method SMWW 22º Ed., 2012 - 9221 D; as well as residual free chlorine by the method SMWW 22º Ed., 2012 - 4500 Cl, since the treated water supplied will be used for human consumption [1].

The results obtained were then compared with the potability standards established in the current legislation. Subsequently, the treatment efficiency for each of the collection points was calculated. Then, the average efficiency for the individual and collective system was calculated.

In order to determine the treatment efficiency in relation to each parameter evaluated, the following relation was used:

Efficiency (%) = [(gross water value – treated water value) / • gross water value] x 100

Where:

- gross water value = before treatment;
- treated water value = after treatment, ready for human consumption.

III. RESULTS AND DISCUSSION

3.1- Collective water treatment plants.

3.1.1- EFFICIENCY IN THE REMOVAL OF TURBIDITY.

Through the results obtained, the efficiency in the removal of turbidity from the raw water in the collective META's was determined, whose results are presented in Table 1:

Table 1 – Results for efficiency in turbidity removal in the collective system - PAE Onças Island

SAMPLE	LOCALITY	COORDINATES (DATUM WGS84)			GROSS WATER TURBIDITY (uT)	POTABLE WATER TURBIDITY (uT)	EFFICIENCY OF TREATMENT (%)
		ZONE	E	N			
ON1	ONÇAS ISLAND	22M	0770562	9840785	32	0	100,00%
ON2	ONÇAS ISLAND	22M	0770435	9840590	32	0	100,00%
ON3	ONÇAS ISLAND	22M	0773899	9840776	32	0	100,00%
ON4	ONÇAS ISLAND	22M	0773191	9838580	32	0	100,00%
ON5	ONÇAS ISLAND	22M	0772813	9838788	32	0	100,00%
ON6	ONÇAS ISLAND	22M	0773331	9837671	32	0	100,00%
ON7	ONÇAS ISLAND	22M	0773246	9837443	32	0	100,00%
ON8	ONÇAS ISLAND	22M	0768912	9839803	32	2	93,75%
ON9	ONÇAS ISLAND	22M	0768624	9840046	32	1	96,88%
ON10	ONÇAS ISLAND	22M	0768605	9840259	32	0	100,00%
ON11	ONÇAS ISLAND	22M	0768935	9841418	32	2	93,75%
ON12	ONÇAS ISLAND	22M	0769171	9841499	32	1	96,88%
ON13	ONÇAS ISLAND	22M	0770855	9840410	32	2	93,75%
ON14	ONÇAS ISLAND	22M	0771254	9840458	32	0	100,00%
ON15	ONÇAS ISLAND	22M	0771342	9840517	32	0	100,00%
ON16	ONÇAS ISLAND	22M	0771681	9841120	32	2	93,75%
ON17	ONÇAS ISLAND	22M	0772220	9841235	32	0	100,00%
ON18	ONÇAS ISLAND	22M	0772497	9841321	32	1	96,88%
ON19	ONÇAS ISLAND	22M	0773519	9840865	32	0	100,00%
ON20	ONÇAS ISLAND	22M	0774228	9840675	32	0	100,00%
						AVERAGE EFFICIENCY	98,28%

Source: Own Author

https://dx.doi.org/10.22161/ijaers.73.15 ISSN: 2349-6495(P) | 2456-1908(O)

3.1.2- EFFICIENCY IN REMOVING APARENT COLOR.

Through the obtained results, the efficiency in the removal of apparent color of the raw water in the collective META's was determined, whose results are presented in Table 2:

Table 2 – Results for efficiency in apparent color removal in the collective system - PAE Onças Island

SAMPLE	LOCALITY	COORDINATES (DATUM WGS84)			GROSS WATER APPARENT COLOR (uH)	POTABLE WATER APPARENT COLOR (uH)	EFFICIENCY OF TREATMENT (%)
		ZONE	E	N			
ON1	ONÇAS ISLAND	22M	0770562	9840785	178	1,0	99,44%
ON2	ONÇAS ISLAND	22M	0770435	9840590	178	1,0	99,44%
ON3	ONÇAS ISLAND	22M	0773899	9840776	178	1,0	99,44%
ON4	ONÇAS ISLAND	22M	0773191	9838580	178	1,0	99,44%
ON5	ONÇAS ISLAND	22M	0772813	9838788	178	0	100,00%
ON6	ONÇAS ISLAND	22M	0773331	9837671	178	0	100,00%
ON7	ONÇAS ISLAND	22M	0773246	9837443	178	0	100,00%
ON8	ONÇAS ISLAND	22M	0768912	9839803	178	1,0	99,44%
ON9	ONÇAS ISLAND	22M	0768624	9840046	178	5,0	97,19%
ON10	ONÇAS ISLAND	22M	0768605	9840259	178	0	100,00%
ON11	ONÇAS ISLAND	22M	0768935	9841418	178	1,0	99,44%
ON12	ONÇAS ISLAND	22M	0769171	9841499	178	2,0	98,88%
ON13	ONÇAS ISLAND	22M	0770855	9840410	178	6,0	96,63%
ON14	ONÇAS ISLAND	22M	0771254	9840458	178	6,0	96,63%
ON15	ONÇAS ISLAND	22M	0771342	9840517	178	4,0	97,75%
ON16	ONÇAS ISLAND	22M	0771681	9841120	178	6,0	96,63%
ON17	ONÇAS ISLAND	22M	0772220	9841235	178	0	100,00%
ON18	ONÇAS ISLAND	22M	0772497	9841321	178	5,0	97,19%
ON19	ONÇAS ISLAND	22M	0773519	9840865	178	0	100,00%
ON20	ONÇAS ISLAND	22M	0774228	9840675	178	0	100,00%
						AVERAGE EFFICIENCY	98,88%

Source: Own Author

3.1.3- EFFICIENCY IN DECLORATION.

In the chlorination operation carried out in the initial stage 2.5 mg / l of active chlorine is added to the disinfection of the raw water, and the dechlorination is carried out in the final stage of the process, thus generating the data shown in Table 3, proving the efficiency in this stage of treatment:

Table 3 – Results for dechlorination efficiency in the collective system – PAE Onças Island

SAMPLE	LOCALITY	COORDINATES (DATUM WGS84)			GROSS WATER CHLORINE (mg/l)	POTABLE WATER CHLORINE (mg/l)	EFFICIENCY OF TREATMENT (%)
		ZONE	E	N			
ON1	ONÇAS ISLAND	22M	0770562	9840785	2,5	0	100,00%
ON2	ONÇAS ISLAND	22M	0770435	9840590	2,5	0,01	99,60%
ON3	ONÇAS ISLAND	22M	0773899	9840776	2,5	0	100,00%
ON4	ONÇAS ISLAND	22M	0773191	9838580	2,5	0	100,00%
ON5	ONÇAS ISLAND	22M	0772813	9838788	2,5	0	100,00%
ON6	ONÇAS ISLAND	22M	0773331	9837671	2,5	0	100,00%
ON7	ONÇAS ISLAND	22M	0773246	9837443	2,5	0	100,00%
ON8	ONÇAS ISLAND	22M	0768912	9839803	2,5	0	100,00%
ON9	ONÇAS ISLAND	22M	0768624	9840046	2,5	0	100,00%
ON10	ONÇAS ISLAND	22M	0768605	9840259	2,5	0	100,00%
ON11	ONÇAS ISLAND	22M	0768935	9841418	2,5	0	100,00%
ON12	ONÇAS ISLAND	22M	0769171	9841499	2,5	0	100,00%
ON13	ONÇAS ISLAND	22M	0770855	9840410	2,5	0	100,00%
ON14	ONÇAS ISLAND	22M	0771254	9840458	2,5	0	100,00%
ON15	ONÇAS ISLAND	22M	0771342	9840517	2,5	0	100,00%
ON16	ONÇAS ISLAND	22M	0771681	9841120	2,5	0	100,00%
ON17	ONÇAS ISLAND	22M	0772220	9841235	2,5	0	100,00%
ON18	ONÇAS ISLAND	22M	0772497	9841321	2,5	0	100,00%
ON19	ONÇAS ISLAND	22M	0773519	9840865	2,5	0	100,00%
ON20	ONÇAS ISLAND	22M	0774228	9840675	2,5	0	100,00%
						AVERAGE EFFICIENCY	99,98%

Source: Own Author

3.1.4- EFFICIENCY IN THE DISINFECTION OF GROSS WATER.

In the chlorination operation carried out in the initial stage 2.5 mg / l of active chlorine is added to disinfect the raw water, thus generating the data shown in Table 4, proving the efficiency in this treatment step:

Table 4 – Results for the efficiency of disinfection of raw water in the collective system – PAE Onças Island

SAMPLE	LOCALITY	COORDINATES (DATUM WGS84)			GROSS WATER TOTAL COLIFORMS (P-A/100 ml)	POTABLE WATER TOTAL COLIFORMS (P-A/100 ml)	EFFICIENCY OF TREATMENT (%)
		ZONE	E	N			
ON1	ONÇAS ISLAND	22M	0770562	9840785	PRESENCE	ABSENCE	100,00%
ON2	ONÇAS ISLAND	22M	0770435	9840590	PRESENCE	ABSENCE	100,00%
ON3	ONÇAS ISLAND	22M	0773899	9840776	PRESENCE	ABSENCE	100,00%
ON4	ONÇAS ISLAND	22M	0773191	9838580	PRESENCE	ABSENCE	100,00%
ON5	ONÇAS ISLAND	22M	0772813	9838788	PRESENCE	ABSENCE	100,00%
ON6	ONÇAS ISLAND	22M	0773331	9837671	PRESENCE	ABSENCE	100,00%
ON7	ONÇAS ISLAND	22M	0773246	9837443	PRESENCE	ABSENCE	100,00%
ON8	ONÇAS ISLAND	22M	0768912	9839803	PRESENCE	ABSENCE	100,00%
ON9	ONÇAS ISLAND	22M	0768624	9840046	PRESENCE	ABSENCE	100,00%
ON10	ONÇAS ISLAND	22M	0768605	9840259	PRESENCE	ABSENCE	100,00%
ON11	ONÇAS ISLAND	22M	0768935	9841418	PRESENCE	ABSENCE	100,00%
ON12	ONÇAS ISLAND	22M	0769171	9841499	PRESENCE	ABSENCE	100,00%
ON13	ONÇAS ISLAND	22M	0770855	9840410	PRESENCE	ABSENCE	100,00%
ON14	ONÇAS ISLAND	22M	0771254	9840458	PRESENCE	ABSENCE	100,00%
ON15	ONÇAS ISLAND	22M	0771342	9840517	PRESENCE	ABSENCE	100,00%
ON16	ONÇAS ISLAND	22M	0771681	9841120	PRESENCE	ABSENCE	100,00%
ON17	ONÇAS ISLAND	22M	0772220	9841235	PRESENCE	ABSENCE	100,00%
ON18	ONÇAS ISLAND	22M	0772497	9841321	PRESENCE	ABSENCE	100,00%
ON19	ONÇAS ISLAND	22M	0773519	9840865	PRESENCE	ABSENCE	100,00%
ON20	ONÇAS ISLAND	22M	0774228	9840675	PRESENCE	ABSENCE	100,00%

Source: Own Author

3.2- Micro-individual water treatment plant.

3.2.1- EFFICIENCY IN THE REMOVAL OF TURBIDITY.

Through the obtained results, the efficiency in the removal of turbidity of the raw water was determined in the individual META's, whose results are presented in Table 5:

Table 5 – Results for efficiency in turbidity removal in the individual system – PAE Arapiranga Island

SAMPLE	LOCALITY	COORDINATES (DATUM WGS84)			GROSS WATER TURBIDITY (uT)	POTABLE WATER TURBIDITY (uT)	EFFICIENCY OF TREATMENT (%)
		ZONE	E	N			
AR1	ARAPIRANGA ISLAND	22M	0769920	9847573	25	0	100,00%
AR2	ARAPIRANGA ISLAND	22M	0769524	9847056	25	0	100,00%
AR3	ARAPIRANGA ISLAND	22M	0767156	9846277	25	0	100,00%
AR4	ARAPIRANGA ISLAND	22M	0767186	9846273	25	0	100,00%
AR5	ARAPIRANGA ISLAND	22M	0768187	9847503	25	0	100,00%
AR6	ARAPIRANGA ISLAND	22M	0768164	9847508	25	0	100,00%
AR7	ARAPIRANGA ISLAND	22M	0768201	9847423	25	0	100,00%
AR8	ARAPIRANGA ISLAND	22M	0768218	9847394	25	0	100,00%
AR9	ARAPIRANGA ISLAND	22M	0768156	9847393	25	0	100,00%
AR10	ARAPIRANGA ISLAND	22M	0768151	9847386	25	0	100,00%
AR11	ARAPIRANGA ISLAND	22M	0767535	9847208	25	0	100,00%
AR12	ARAPIRANGA ISLAND	22M	0767277	9847157	25	0	100,00%
AR13	ARAPIRANGA ISLAND	22M	0767229	9847168	25	0	100,00%
AR14	ARAPIRANGA ISLAND	22M	0766962	9846960	25	0	100,00%
AR15	ARAPIRANGA ISLAND	22M	0767337	9847187	25	0	100,00%
AR16	ARAPIRANGA ISLAND	22M	0767461	9847223	25	0	100,00%
AR17	ARAPIRANGA ISLAND	22M	0768018	9847315	25	0	100,00%
AR18	ARAPIRANGA ISLAND	22M	0767414	9847215	25	0	100,00%
AR19	ARAPIRANGA ISLAND	22M	0767520	9847199	25	0	100,00%
AR20	ARAPIRANGA ISLAND	22M	0767368	9847229	25	0	100,00%
						AVERAGE EFFICIENCY	100,00%

Source: Own Author

3.2.2- EFFICIENCY IN REMOVING APARENT COLOR.

The efficiency of the removal of apparent color from the raw water in the individual system was determined by the results obtained. The results are presented in Table 6:

https://dx.doi.org/10.22161/ijaers.73.15 ISSN: 2349-6495(P) | 2456-1908(O)

Table 6 – Results for efficiency in apparent color removal in the individual system - PAE Arapiranga Island.

SAMPLE	LOCALITY	COORDINATES (DATUM WGS84)			GROSS WATER APPARENT COLOR (uH)	POTABLE WATER APPARENT COLOR (uH)	EFFICIENCY OF TREATMENT (%)
		ZONE	E	N			
AR1	ARAPIRANGA ISLAND	22M	0769920	9847573	146	0	100,00%
AR2	ARAPIRANGA ISLAND	22M	0769524	9847056	146	0	100,00%
AR3	ARAPIRANGA ISLAND	22M	0767156	9846277	146	0	100,00%
AR4	ARAPIRANGA ISLAND	22M	0767186	9846273	146	0	100,00%
AR5	ARAPIRANGA ISLAND	22M	0768187	9847503	146	0	100,00%
AR6	ARAPIRANGA ISLAND	22M	0768164	9847508	146	0	100,00%
AR7	ARAPIRANGA ISLAND	22M	0768201	9847423	146	0	100,00%
AR8	ARAPIRANGA ISLAND	22M	0768218	9847394	146	0	100,00%
AR9	ARAPIRANGA ISLAND	22M	0768156	9847393	146	0	100,00%
AR10	ARAPIRANGA ISLAND	22M	0768151	9847386	146	0	100,00%
AR11	ARAPIRANGA ISLAND	22M	0767535	9847208	146	0	100,00%
AR12	ARAPIRANGA ISLAND	22M	0767277	9847157	146	0	100,00%
AR13	ARAPIRANGA ISLAND	22M	0767229	9847168	146	0	100,00%
AR14	ARAPIRANGA ISLAND	22M	0766962	9846960	146	0	100,00%
AR15	ARAPIRANGA ISLAND	22M	0767337	9847187	146	0	100,00%
AR16	ARAPIRANGA ISLAND	22M	0767461	9847223	146	0	100,00%
AR17	ARAPIRANGA ISLAND	22M	0768018	9847315	146	0	100,00%
AR18	ARAPIRANGA ISLAND	22M	0767414	9847215	146	0	100,00%
AR19	ARAPIRANGA ISLAND	22M	0767520	9847199	146	0	100,00%
AR20	ARAPIRANGA ISLAND	22M	0767368	9847229	146	0	100,00%
						AVERAGE EFFICIENCY	100,00%

Source: Own Author

3.2.3- EFFICIENCY IN DECHLORINATION.

In the chlorination operation carried out in the initial stage, 2.5 mg / l of active chlorine is added to the disinfection of the raw water, and the dechlorination is carried out in the final stage of the process, thus generating the data shown in Table 7, proving the efficiency in this step of treatment:

https://dx.doi.org/10.22161/ijaers.73.15 *ISSN: 2349-6495(P) | 2456-1908(O)*

Table 7 – Results for dechlorination efficiency in the individual system - PAE Arapiranga Island

SAMPLE	LOCALITY	COORDINATES (DATUM WGS84)			GROSS WATER CHLORINE (mg/l)	POTABLE WATER CHLORINE (mg/l)	EFFICIENCY OF TREATMENT (%)
		ZONE	E	N			
AR1	ARAPIRANGA ISLAND	22M	0769920	9847573	2,5	0	100,00%
AR2	ARAPIRANGA ISLAND	22M	0769524	9847056	2,5	0	100,00%
AR3	ARAPIRANGA ISLAND	22M	0767156	9846277	2,5	0	100,00%
AR4	ARAPIRANGA ISLAND	22M	0767186	9846273	2,5	0	100,00%
AR5	ARAPIRANGA ISLAND	22M	0768187	9847503	2,5	0	100,00%
AR6	ARAPIRANGA ISLAND	22M	0768164	9847508	2,5	0	100,00%
AR7	ARAPIRANGA ISLAND	22M	0768201	9847423	2,5	0	100,00%
AR8	ARAPIRANGA ISLAND	22M	0768218	9847394	2,5	0	100,00%
AR9	ARAPIRANGA ISLAND	22M	0768156	9847393	2,5	0	100,00%
AR10	ARAPIRANGA ISLAND	22M	0768151	9847386	2,5	0	100,00%
AR11	ARAPIRANGA ISLAND	22M	0767535	9847208	2,5	0	100,00%
AR12	ARAPIRANGA ISLAND	22M	0767277	9847157	2,5	0	100,00%
AR13	ARAPIRANGA ISLAND	22M	0767229	9847168	2,5	0	100,00%
AR14	ARAPIRANGA ISLAND	22M	0766962	9846960	2,5	0	100,00%
AR15	ARAPIRANGA ISLAND	22M	0767337	9847187	2,5	0	100,00%
AR16	ARAPIRANGA ISLAND	22M	0767461	9847223	2,5	0	100,00%
AR17	ARAPIRANGA ISLAND	22M	0768018	9847315	2,5	0	100,00%
AR18	ARAPIRANGA ISLAND	22M	0767414	9847215	2,5	0	100,00%
AR19	ARAPIRANGA ISLAND	22M	0767520	9847199	2,5	0	100,00%
AR20	ARAPIRANGA ISLAND	22M	0767368	9847229	2,5	0	100,00%
						AVERAGE EFFICIENCY	100,00%

Source: Own Author

3.2.4- EFFICIENCY IN THE DISINFECTION OF GROSS WATER.

In the chlorination operation carried out in the initial stage 2.5 mg / l of active chlorine is added to disinfect the raw water, thus generating the data shown in Table 8, proving the efficiency in this treatment step:

Table 8 – Results for efficiency of raw water disinfection in the individual system - PAE Arapiranga Island

SAMPLE	LOCALITY	COORDINATES (DATUM WGS84)			GROSS WATER TOTAL COLIFORMS (P-A/100 ml)	POTABLE WATER TOTAL COLIFORMS (P-A/100 ml)	EFFICIENCY OF TREATMENT (%)
		ZONE	E	N			
AR1	ARAPIRANGA ISLAND	22M	0769920	9847573	PRESENCE	ABSENCE	100,00%
AR2	ARAPIRANGA ISLAND	22M	0769524	9847056	PRESENCE	ABSENCE	100,00%
AR3	ARAPIRANGA ISLAND	22M	0767156	9846277	PRESENCE	ABSENCE	100,00%
AR4	ARAPIRANGA ISLAND	22M	0767186	9846273	PRESENCE	ABSENCE	100,00%
AR5	ARAPIRANGA ISLAND	22M	0768187	9847503	PRESENCE	ABSENCE	100,00%
AR6	ARAPIRANGA ISLAND	22M	0768164	9847508	PRESENCE	ABSENCE	100,00%
AR7	ARAPIRANGA ISLAND	22M	0768201	9847423	PRESENCE	ABSENCE	100,00%
AR8	ARAPIRANGA ISLAND	22M	0768218	9847394	PRESENCE	ABSENCE	100,00%
AR9	ARAPIRANGA ISLAND	22M	0768156	9847393	PRESENCE	ABSENCE	100,00%
AR10	ARAPIRANGA ISLAND	22M	0768151	9847386	PRESENCE	ABSENCE	100,00%
AR11	ARAPIRANGA ISLAND	22M	0767535	9847208	PRESENCE	ABSENCE	100,00%
AR12	ARAPIRANGA ISLAND	22M	0767277	9847157	PRESENCE	ABSENCE	100,00%
AR13	ARAPIRANGA ISLAND	22M	0767229	9847168	PRESENCE	ABSENCE	100,00%
AR14	ARAPIRANGA ISLAND	22M	0766962	9846960	PRESENCE	ABSENCE	100,00%
AR15	ARAPIRANGA ISLAND	22M	0767337	9847187	PRESENCE	ABSENCE	100,00%
AR16	ARAPIRANGA ISLAND	22M	0767461	9847223	PRESENCE	ABSENCE	100,00%
AR17	ARAPIRANGA ISLAND	22M	0768018	9847315	PRESENCE	ABSENCE	100,00%
AR18	ARAPIRANGA ISLAND	22M	0767414	9847215	PRESENCE	ABSENCE	100,00%
AR19	ARAPIRANGA ISLAND	22M	0767520	9847199	PRESENCE	ABSENCE	100,00%
AR20	ARAPIRANGA ISLAND	22M	0767368	9847229	PRESENCE	ABSENCE	100,00%

Source: Own Author

The results showed that both systems present high efficiency for each parameter evaluated.

The collective system showed slightly lower efficiency for the parameters apparent color and turbidity in some samples. This situation may be related to factors such as operating time, reservation volume, among others [13].

Collective systems were installed on Onças Island in the year 2014, with a longer operating time, a fact that generates the need for system maintenance. The higher reservoir volume, 2,000 liters, requires a greater amount of reagent and a longer reaction time to achieve maximum efficiency in the treatment of raw water.

The individual system has a lower volume of reservation, 500 liters, which requires less reagents, as well as a shorter reaction time, besides having a lower installation cost. Another important fact is that individual systems were installed in the year 2016.

Since the proposed treatment is equivalent in both cases, both in the collective and individual systems, we can verify that the pre-chlorination, flocculation, filtration and dechlorination / polishing operations present high efficiency in the clarification and disinfection of raw water coming from and sources of surface abstraction, widely used by riverine populations [9].

It is worth highlighting the fact that the reagents used in the proposed treatment are easy to acquire and of proven efficiency [10].

IV. CONCLUSIONS

The two varieties of the water treatment system proposed by INCRA evaluated are distinguished subtly as to the efficiency level for turbidity and apparent color parameters, but both present maximum efficiency in the disinfection of raw water. The dechlorination and the polishing of the treated water in the final stage of the process guarantees a final product with appreciable organoleptic properties for the human consumption, being this very important characteristic for its acceptance by the main interested ones, the riverside ones.

It was evidenced the need for a stronger monitoring of the units already installed in order to ensure maximum efficiency in the process of obtaining treated water within the standards of potability required by current legislation.

In general, the water provided by the micro-water treatment plants designed by INCRA, used for domestic consumption in the riverside communities living in PAE Onças Island and PAE Arapiranga Island presents good physical quality evidenced by the low levels of turbidity and apparent color, both in the individual and in the collective mode.

The absence of microbiological contamination evidenced in the results can contribute to the reduction in the cases of waterborne diseases, so common in the rural environment. The low levels of residual chlorine ensure water free of taste and odor, which, most of the time, causes distrust in consumption by the riverside, which has the organoleptic parameter of mineral water.

REFERENCES

[1] BRITTO, Fábio Brandão et al. Monitoramento e modelagem da qualidade da água e agrotóxicos em corpos hídricos no Baixo São Francisco sergipano. 2015.

[2] DA SILVA, Eunice Ferreira; NACHORNIK, Valdomiro Lourenço. Ação Cívico-Social (ACiSo): A experiência de estudantes universitários participantes do Projeto Rondon na Ilha do Marajó, Estado do Pará. Revista ELO–Diálogos em Extensão, v. 4, n. 1, 2015.

[3] GOULDING, M.; BARTHEM, R.; FERREIRA, E. 2003. The Smithsonianatlas of the Amazon. Princeton Editorial Associate, Inc. Hong Kong. 253 pp.

[4] INCRA, 2015. RELATÓRIO DE GESTÃO DO EXERCÍCIO DE 2014. Disponível em http://www.incra.gov.br/tree/info/file/8868. Acesso em 30 Set. 2016.

[5] MINISTÉRIO DA SAÚDE. Portaria nº 2.914, de 12 de dezembro de 2011. Disponível em http://bvsms.saude.gov.br/bvs/saudelegis/gm/2011/prt2914_12_12_2011.html. Acesso em 30 Set. 2016.

[6] MOURA, Elyana Melo. MAPEAMENTO DO HALO DE DISPERSÃO FORMADO POR EFLUENTES INDUSTRIAIS LANÇADOS NA BAÍA DO GUAJARÁ NO TRECHO COMPREENDIDO ENTRE O BAIRRO DE VAL-DE-CÃES E O DISTRITO DE ICOARACI. Programa de Pós-graduação em Geologia e Geoquímica. Universidade Federal do Pará, Centro de Geociências, Belém-PA, 2007.

[7] PAVANELLI, Gerson. Eficiência de diferentes tipos de coagulantes na coagulação, floculação e sedimentação de água com cor ou turbidez elevada. 2001. Tese de Doutorado. Universidade de São Paulo.

[8] PORTAL DOS CONVÊNIOS, 2013. Convênio nº 791882/2013. Disponível em https://www.convenios.gov.br/siconv/ConsultarProposta/ResultadoDaConsultaDeConvenioSelecionarConvenio.do?idConvenio=374402&destino=. Acesso em 30 Set. 2016.

[9] PORTAL DOS CONVÊNIOS, 2014. Convênio nº 802393/2014. Disponível em https://www.convenios.gov.br/siconv/ConsultarProposta/ResultadoDaConsultaDeConvenioSelecionarConvenio.do?idConvenio=411743&destino=. Acesso em 30 Set. 2016.

[10] RÔLA, Anoar Kayali Koubeissi et al. AVALIAÇÃO DA EFICIÊNCIA DE COAGULANTES COMERCIAIS PARA APLICAÇÃO EM SISTEMAS DE TRATAMENTO DE ÁGUA. Journal JCEC/REQ2, v. 2, n. 3, p. 014-033, 2016.

[11] SOUZA, APC; SOUZA, EAM; PEREIRA, N. C. ANÁLISE DA UTILIZAÇÃO DO COAGULANTE POLICLORETO DE ALUMÍNIO (PAC) NA REMOÇÃO DA COR, TURBIDEZ E DQO DE EFLUENTE DE LAVANDERIA TEXTIL. Blucher Chemical Engineering Proceedings, v. 1, n. 2, p. 9566-9572, 2015.

[12] VISÚ, Gilson Carlos et al. O programa territórios da cidadania: uma análise a partir do cone sul de Mato Grosso do Sul. Observatorio de la Economía Latinoamericana, n. 203, 2014.

[13] VELASCO, Márcio de Freitas. Obtenção de um floculante vegetal catiônico a partir de taninos extraídos dos resíduos sólidos da produção de açaí no estado do Pará. Dissertação (Mestrado) – Universidade Federal do Pará, Instituto de Ciências Exatas e Naturais, Programa de Pós-Graduação em Ciências e Meio Ambiente, Belém, 2017.