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Concepts and classification for water reuse in Brazil by different destinations

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ABSTRACT : *The aim of this paper was to conceptualize water reuse based on different destinations, taking into account the quality required for water security. A systematic review of the Brazilian literature was carried out through bibliographical research focused on the themes: reuse water, wastewater use, gray water reuse, water reuse legislation. An updated classification on the types of reused water was proposed and the need for regulation at national level was noted, however considering the different types of reuse and destinations. Futhermore, depending on the source, different destinations may be given for water reuse, taking into account the risks to the present or persistent contaminant or pollutant after the producer treatment.*
KEYWORDS *water reuse, reuse types, reuse water legislation.*

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I. INTRODUCTION

The Brazilian National Water Resources Politics aims to ensure the present and future generations the necessary availability of water, in quality standards appropriate to respective uses; rational and integrated use of water resources for sustainable development; preservation and defense against critical hydrological events of natural origin or arising from the inappropriate use of natural resources [1].

Water is an essential right to life [2], thefore it is a priority issue for public health. The Brazilian Constitution of 1988 [3], in Article 225, argues the preserving and conserving water in quality and quantity is to protect the right to health, in addition, establishes the right of all to a balanced environment and a healthy quality of life, as well as as the public duty to act in this matter. However, the scenario of chemical pollution and biological contamination in water resources is increasing, reaffirming water as a finite natural resource. These actions limit the availability of water for human consumption, becoming reuse of water or the term "reuse water", the "current future", one of the main strategies for sustainable development in water management to ensure environmental balance and access to water for all in the future.

Indirect and unplanned reuse of water has been carried out by many municipalities and localities, where an upstream region discharges sewage into the environment due to poor sanitation, the untreated sewage follows, and water from the water resource is captured downstream. unintentionally and uncontrolled dilution in environmental water, and water is collected for treatment and drinking destination [4].

In Brazil there are few municipalities and states that had regulatory aspects regarding reuse water. In the federal constitution is writed that is a public duty ensure adequate and satisfactory legislation aimed at reducing or preventing health risks and to intervene in health problems against the environment given the set of health surveillance actions [3].

This paper aims to formulate the concept of reuse water in Brazil considered different destinations, to propose an updated classification of reused water types and to reinforce the need for national regulation.

II. METHODOLOGY

A systematic review study of the Brazilian literature was developed, and national bibliographic research focused on the themes: reuse water, wastewater use, gray water reuse, reuse water legislation. The bibliographic survey was conducted by consulting three electronic databases: Scientific Electronic Library Online (SciELO), Web of Science and Scopus, with no published year interval. The laws and regulations were consulted by the Google database.

Comparative analyzes were made through concepts, patterns and conceptions presented in the documents and articles, and was described the most cited.

III. RESULT AND DISCUSSION

Reuse water was defined as the reused of water from treated sewage [5,6]. Sanitary sewage is the liquid discharge consisting of domestic and industrial sewage discharged into public networks [7]. Domestic sewage comes mainly from public and commercial residences and buildings which contain toilets, laundries and kitchens [7, 8]. These authors divide the classification into black water and gray water. Black water is effluent from toilets, basically containing faeces, urine and toilet paper or from faeces and urine separating devices, having in its composition large amounts of faecal matter and toilet paper. On the other hand, it has a high organic load and the presence of largely sedimentable suspended solids in high quantity [3]. The gray waters are those effluent from washbasins, showers, tanks and washing machines and dishes [4]. Industrial sewage is waste resulting from industrial processes, depending on the type of industry it has very specific characteristics, being necessary to study each type of waste separately [7]. Although the general concept when describing water reuse seems to lead to the understanding which all the different origins can become the same type of reuse water (**Figure 1**). Ideally, depending on the source, different destinations may be given for water reuse, taking into account the risks to the type (s) of contaminant or pollutant present or persistent after the producer treatment.

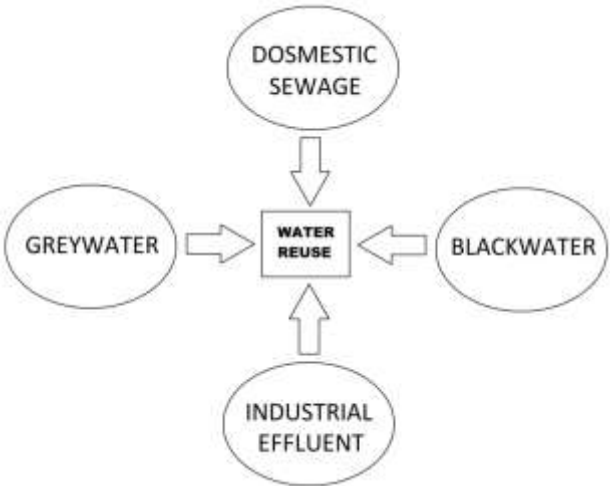

Fig.1. Different sources of water reuse production.

Thus the reuse water always come from different type of sanitary sewage, whether from black water, gray water or industrial sewage. Therefore, it was subjected to treatment steps in the Sewage Treatment Stations (STS) and was subjected to a treatment step in the process of transformation into reuse water by somehow.

In the few legislations in Brazil found on the subject, at the municipal and state levels is described that the use of rainwater is a type of reuse water [11-18]. However, rainwater had not been used in anthropogenic processes. Although it is enviroment recycled water and can be a very important tool for water resource management, but should not be confused with reuse water. Therefore, after it going through the natural hydrological cycle this water will have its first use [19] become necessary to update the concept in the regulatory aspects. According to the Brazilian federal constitution is a public duty to ensure adequate and satisfactory legislation aimed reducing or preventing health risks and to intervene in health problems arising from the environment, taking into account the set of sanitary surveillance actions [3].

The only Brazilian national regulation found was that of the Brazilian Association of Technical Standards - NBR 13.969 / 97 [20], which defines reuse water in processes such as:

(i) Local reuse: sewage of essentially domestic or similar characteristics, treated sewage shall be reused for purposes requiring non-potable but sanitary safe water quality. The type of reuse can range from simple recirculation of rinse water from the washer, with or without treatment to toilets, to high-level removal of car wash pollutants;
(ii) Domestic wastewater: from domestic bathing, cooking and floor washing. In that case, it would be from gray water;
(iii) Unplanned indirect reuse of water: occurs when water used for some human activity is discharged into the environment and reused downstream in its diluted form unintentionally and uncontrolled. Walking to the point of capture for the new user, it is subject to the natural actions of the hydrological cycle (dilution, self-purification);

(iv) Planned indirect water reuse: occurs when effluents, after being treated, are discharged in a planned manner into surface or groundwater bodies to be used downstream in a controlled manner to meet any beneficial use;
(v) Planned direct water reuse: occurs when effluents, after being treated, are sent directly from their discharge point to the reuse site, not being discharged into the environment. This is the case with the highest occurrence, intended for use in industry or irrigation.

This regulation, NBR 13.969 / 97 [20], provides a classification according to use and details quality parameters, which are not in full agreement with the current legislation on bathing (CONAMA Resolution No. 274/2001) [21] and with Ordinance No. 5 [22], which provides for potability. In addition, there is no relationship of parameter values that applies to all classes that consider health risks for bathing and potability. It describes the following parameters by class:

(vi) Class 1 - Car washes and other uses that require direct user contact with water, with possible aspiration of aerosols by the operator including fountains. Indicated parameters: Turbidity, Fecal coliform, Total dissolved solids, pH and Residual chlorine;
(vii) Class 2 - Washing of floors, sidewalks and garden irrigation, maintenance of lakes and canals for landscape purposes, except fountains. Indicated parameters: Turbidity, fecal coliform and chlorine;
(viii) Class 3 - Reuse of toilet flush. Indicated parameters: Turbidity and fecal coliform;
(ix) Class 4 - Reuse in orchards, cereals, fodder, pasture for cattle and other crops by surface runoff or spot irrigation. Indicated parameters: fecal coliform and dissolved oxygen.

In the state of Ceará legislation, Law No. 16,033 of June 20, 2016 [18], a classification for reuse water was described as follows:

- Internal reuse: internal use of water reuse from activities carried out in the enterprise itself;
- External reuse: use of treated effluents from stations managed by sanitation service providers or third parties, whose characteristics allow their use.

In the article 24, paragraph 3, of the Federal Constitution, it is described that as there is no federal law on general rules, States must exercise full legislative competence to meet their peculiarities. Thus, in the absence of national regulations, some states have developed state laws to ensure the use of reuse water for urban, agricultural and industrial purposes. Only 7 of the 26 brazilian states presented in their laws and regulations references on concepts, uses and applications of reuse water, they were: Rio de Janeiro (Law No. 7424/2016, Law No. 7599 24/2017), Espírito Santo (Law No. 10,487 / 2016), São Paulo (Law No. 16174/2015, Law No. 16,160 / 2015), Ceará (Law No. 16,033 / 2016), Bahia (Resolution No. 75/2010), Paraná (Law No. 11,552 / 2012) and Rio Grande do Sul (Law No. 6616/2006). On the other hand, these laws bring considerations about the use of rainwater as reuse water applications, which configures no guaranties for the process of technological treatment of this resource and nor does it fit with the definition of this type of matrix in scientific studies.

Based on the result found in the analysis of state laws and regulations only states of the Bahia (Resolution No. 75/2010) [11] and Paraná (Law No. 11522/2012) [17] considered parameters of reuse water quality. The legislation of the state of Ceará (Law nº 16.033 / 2016) [18] does not bring any notes on quality parameters, but it describes responsability for its Secretariat of the Environment and the State Superintendent of Environment to oversee the quality of reuse water.

At national level, there is no specific wastewater legislation that includes concepts, classifications and quality standards which ensure the reuse water for different destinations, with safety necessary for humans, animals and the environment.

Resolution no. 54/2005 of the National Council of Environment (CONAMA) delegates to the specific guidelines, criteria and parameters for the reuse modalities, defined in the items which will be established by the competent organs. Whichever, there is no mention of the competent bodies to make specifc regulation. The bill No. 54 of presented in the year 2016, provided for water supply from alternative sources, reused water. However, it did not cited any quality assessment parameters, and so far has not become national law.

Therefore, it is necessary to consider the creation of specific legislation for the different reuse systems to avoid risks to human and environmental health. Reuse water quality parameters should take into account the origin and destination of each type of reused water (**Figure 2**):

• Local or internal reuse - for new developments (building reuse systems) from gray water;
• External reuse - from water reuse treatment plants (WWTP);
• Industrial reuse - internal reuse of reused water from industrial activities of the enterprise itself or from external reuse.

Fig. 2. Relations considered for reused water.

In addition to the different types of use and quality parameters associated with the use of reused water, the law on the subject should contain or encourage discussion about the possibility of using reused water for potable purposes. Despite being controversial use and there is currently no safety for such use, provision should be made for use in critical cases.

IV. CONCLUSION

The classification for reused water should be made according to its origin, respecting the particularities of the water treatment. The quality parameters evaluated should take into consideration whether there is primary or secondary contact, regardless of origin, type, classification as it should not pose a risk to the handler. If there is primary contact in handling should be more restrictive, if there is no contact should still ensure quality not to endanger the environment.

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