

# WASTE WATER REUSE AS A MITIGATING FACTOR TO THE EFFECTS OF DROUGHTS IN THE STATE OF BAHIA SEMI-ARID VIABILITY STUDY<sup>1</sup>

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## Introduction

Cyclical droughts are a major cause of social distress in Brazil's semi-arid region, to which government agencies have answered with social development projects meant to achieve social growth. Within this context, wastewater reuse poses as an opportunity to boost agricultural activity in this region, supplying water and nutrients when other water sources are too depleted to supply all those needs. It is widely recognized by mainstream authors that wastewater reuse plays an important role in water resources management. Nevertheless, in Brazil, it remains an incipient and not fully regulated practice. The gap between theory and practice is analyzed in this article, considering small farmers and policy formulators' perception on the subject, in order to verify the feasibility of implementing wastewater reuse in Bahia's Semi-Arid Region as a mitigating factor to lessen the devastating effects of periodical water scarcity.

Planned water reuse is an internationally established, regulated and safe practice present on all continents intended to various purposes, including increasing the supply of drinking water, as is the case in Namibia since 1968 (ASANO practice 2002). In Israel, water reuse is a national priority (FRIEDLER, 2001). In Europe, treated wastewater can be used in agriculture irrigation among various non-potable uses, mainly in Southern countries like France, Greece, Italy, Portugal and Spain (MONTE, 2007). In the United States, water reuse is practiced in large scale and is growing around 15 % per year (USEPA, 2004). The Australian National Water Reuse Program has had significant advances in consolidating water reuse as a conservation practice (DILLON, 2004).

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It is a current trend in Europe, Israel and Australia to consider water reuse as part of water resources management either in regions where water is scarce and in highly populated areas where environmental degradation has led to water shortage. Even where there is abundance, crescent pollution levels have increased the cost of treatment, making water sources ever more expensive. Reuse is a rational option to optimize water resources and reduce wastewater treatment costs. Water reuse is a viable alternative to be considered in the early stages of water resources planning, considered as essential to sustainable development (URKIAGA *et al.*, 2008).

Social perception plays an important role in water reuse acceptance and is the most important issue, directly linked to the degree of public confidence in the institutions responsible for water management. The way projects are presented and perceived by society: better communication between the sectors involved are all critical factors that will influence public perception and project's feasibility (BAGGETT *et al.*, 2006).

Unplanned wastewater happens when socioeconomic and environmental conditions force poor population living on the outskirts of large cities, common practice in Brazil's Northeast Region, to reuse water, mainly for irrigation, without any regulation or safety consideration. Regulatory reuse framework is a necessary means to sanitize and regulate this practice that already exists. It might enable a more sustainable existence to Brazilian semiarid communities, where intermittent rivers have been degraded by continuous raw sewage discharges. The perception regarding reuse in these communities is related to how intense important the frequent droughts are to them, the way they are presented to reuse projects, and how much they trust organizations implementing the project (HESPANHOL, 2008).

This paper intends to evaluate the feasibility of implementing wastewater reuse as a mitigating action on the effects of periodical droughts in Bahia's Semi-Arid Region, considering small farmers and policy formulators views on f this practice.

## Water reuse

The intensification of urbanization processes has implicated in increased demand of water for irrigation, urban supply and dilution of wastewater, resulting in ever increasing pressures on water supplies. In this scenario water reuse might bring economic, social and environmental benefits to localities where it operates, as a sustainable alternative to traditional water sources. This practice may carry an important role as part of wastewater treatment and disposal systems, contributing to reduce pollutant loads in water bodies. (MILLER, 2006).

Water reuse recycles both water and nutrients present in reclaimed water. It is recognized that those nutrients have financial value and must be an important factor in areas with degraded soils to improve agriculture productivity. A study conducted in Jordan estimated the value of nutrients present in stabilization ponds in 75 dollars per 1.000 m<sup>3</sup> (AL-NAKSHABANDI *et al.*, 1997). Besides that, the structure formed by soil and plants are capable of removing organic matte and nutrients, acting like an efficient bio-filter to treat sewage effluents (HARUVY, 1997).

Economic efficiency can only be achieved in agricultural wastewater reuse when any other water should be more expensive than treated wastewater prevented from sewage treatment plant, and also this practice should also reduce costs to the sanitation company (WINPENNY et al., 2010).

## Social perception of wastewater reuse

Consumers' willingness to accept products cultivated with treated wastewater is essential for this practice to be successful. There are many factors that might trigger people's rejection on wastewater reuse, among which: lack of adequate information about risks associated with the practice; technical difficulties for the implementation of routine epidemiological studies; inadequate management of social aspects related to the practice; non-existent convergence of interest and information among scientists and policymakers (environmental, health and water resources); and the absence of tested protocols, at regional level, to implement reuse projects (Salgot, 2008).

To avoid rejection, there are some key aspects that should be taken into account in society's attitude toward reuse: perceptions regarding the quality of services and products offered by sanitation agencies; perception of risk (other than the actual risk); degree of confidence on the local health authority. Building public confidence is a fundamental issue, that should include planning a fair participation process with communication channels that operate requesting, receiving and offering society's and the authorities' demands in a clear and honest way (HÜRLIMANN et al., 2008).

When there is an acute water shortage, people tend to be more receptive towards wastewater reuse, regardless of cultural issues. In this context, perception of benefits resulting from the implementation of such projects is clearer, facilitating their social acceptance. Public opposition is usually related to attitudes, beliefs, prejudice, and lack of knowledge, fear and mistrust, often justified by poor results of previous sanitation programs implemented in other economic, social or political situation.

## The semiarid region in Bahia

Brazilian semiarid region is characterized by its climate, vegetation, soil and popular culture. Low, erratic rainfall (less than 800 mm per year) result in frequent droughts, which poses as its most striking feature, having strong impact on the region. Regional geology is quite varied, but the crystalline rock shield, that covers most of its territory, determines the low productivity and high salinization of aquifers, with strong influence in regional waters. Environmental conditions, associated with poverty, social inequality and poor economic performance, define this region (SUDENE, 2011). Its hydrography is dominated by intermittent water streams that flow during short periods after incidence of rain. Only a few rivers such as the São Francisco Pardo, Contas, Paraguaçu e Itapicuru get to be perennial, standing up to the dry months (SEI, 2011).

The state of Bahia has 265 its municipalities out of a total of 417 in the semi-arid region. In area it covers 391 km<sup>2</sup>, or 2/3 of the state's area, which comprises 564.733,177,

containing a population of 7 million people, of which 53% live in urban areas (IBGE, 2010). Rebouças (1999) argues that the «the cyclical drought is more of a cultural myth than a reality» and, so, poverty in this region is not a result only of the water shortage. This statement is based on the fact that the Brazilian semiarid region is one of the wettest in the world, and thus the lack of water being only one element which «requires greater commitment and greater rationality in the management of natural resources» (REBOUÇAS 1999 , p. 128). Meanwhile, this regional ecosystem, called “caatinga”, has been traditionally undervalued and continuously modified and cleared contributing to the worsening of the seasonal droughts, resulting in agricultural low productivity due to soil degradation.

Water scarcity and the lack of development policies addressing regional features properly have had a negative impact on quality of life and has made large number of people to leave this region. To reverse this process, it is necessary to improve water availability by saving the best quality fresh water to human and animal supply, and reserving lower quality water, such as brackish water or treated wastewater for irrigation.

Current public policies designed to mitigate social problems and boost semi-arid region economy have favored Irrigated fruit production, such as those around the municipality of Juazeiro. Those projects have attempted to integrate the semi-arid region to globalized markets, which have favored the occupation of the *Caatinga* by agricultural production arrangements not well suited to this ecosystems, promoting soil degradation and over-exploitation of scarce water resources. Large irrigation projects have been the main State promoted policy for social economic growth, while maintaining traditional “drought relief” policies, mainly the construction of very large dams and water transfer projects, like the São Francisco River’s Transposition. Large and middle property owners have always been the main public served by these programs, while most of the population is left excluded from the process, leading to the exodus of the poor from the countries to the big cities, where family networks are weakened and traditional values as social solidarity tend to disappear (DUROUSSET and COHEN, 2000).

Appropriate development solutions for the semiarid region should consider the fulfillment of a set of requirements regarding well-being and quality of life, which should go beyond definition used in Human Development Index - HDI UN, that fails to qualify development and does not deal with important issues related to citizenship (OLIVEIRA, 2001). That author also points out that “the first substantive dimension of local development should be the effective citizen participation in local government, in what should resemble the Greek “*agora*”, since representative democratic system has been unable to overcome the gap between government and people”.

## Methodology

The adopted methodology has as a core feature the narrow gap between researcher and the tough reality of the semiarid region, creating conditions for an unhindered relationship between subject and object of knowledge, due to the subjective dimension

of the object. The survey was conducted with two population groups: farmers in Santo Antonio district of São Domingo, Bahia, and formulators of water policy, i.e., professionals working in private and governmental institutions that manage water resources or sanitation. Semi-structured interviews and closed questionnaires were applied to farmers, while only semi-structured interviews were conducted with the second group. Thus, it was possible to perform a statistical study of the first group of respondents which allowed a quantitative as well as qualitative approach.

Open semi-structured Interviews were conducted with 35 small farmers, in a first round. After a thorough analysis of these results, a closed questionnaire was elaborated and applied to other 105 farmers. Both groups of individuals chosen randomly in the district. This sample had error margin of 4.4%.

The reason for this methodological approach of data collection through semi-structured interview, was that it favored the intersubjective relationship between the researcher and the respondents, allowing better understanding of the results. Its goal is to capture the personal perception of the interviewee on the subject of interest of the study, in this case, the agricultural reuse of treated sewage.

Regarding wastewater reuse perception, the goal was to define research indicators, and identify the circumstances they occur, quantifying the level of acceptance or rejection this practice might cause. Interviews conducted with farmers sought farmer's direct perception about water reuse: benefits, costs, perceived risks, different attitudes. We wanted to identify how they perceived risks, advantages and disadvantages and their main reasons for accepting or rejecting reuse.

The population of small farmers in the district of Santo Antonio region in São Domingos, is representative of the "Identity Territory of Sisal", selected due to its proximity to water reuse projects, as well as for its typical characteristics of the semi-arid, both in physical and social, cultural and economic aspects.

Interviews conducted with policymakers were performed using different tools. In some cases, respondents chose to answer the interviews via email, while with the interviews were answered in person. This situation was not a desirable one, but was imposed by the interviewees themselves. In some cases, the respondents, after a personal pre-interview, did not agree to record the interviews (no explanation provided), sending the responses later by email.

The group of water policy formulators was formed by members of Bahia State Council on Water Resources (CONERH), consisting of water resources users on the following sectors: irrigators, watershed committee members, industries, sanitation agencies, health, education, Government and Civil Society. Thus, ensuring that most stakeholders relevant to the topic agricultural wastewater reuse in the semiarid was represented.

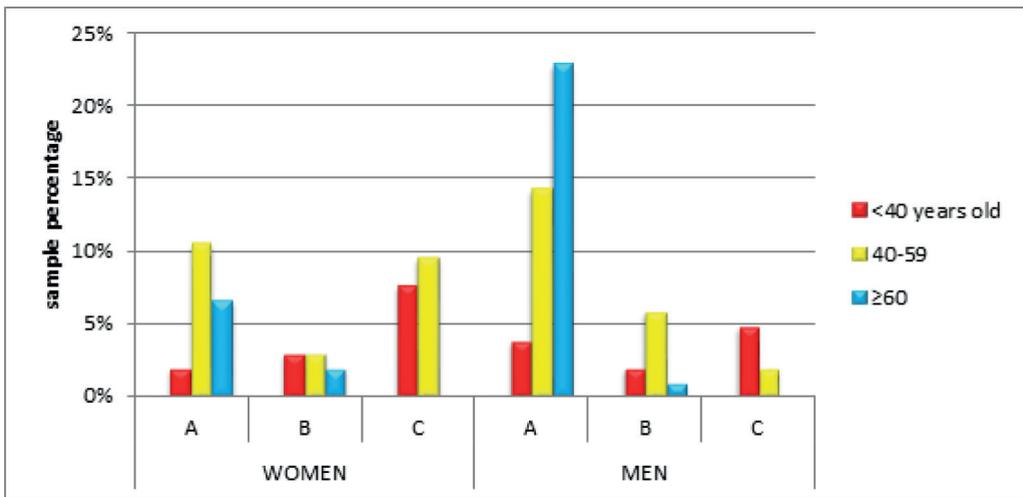
## Results

While wastewater reuse of water has posed as an internationally recognized practice, it has not yet been implemented in the array of usual measures adopted to mitigate the consequences of water shortage, as a practice capable of maintaining agricultural activities

during droughts. The obtained responses to questionnaires and interviews indicate the level of acceptance or rejection of reuse and how it is manifested.

A total of 105 farmers were surveyed (representing 79.5% of the population of 132 farmers of St. Anthony), of which 62 are men and 43 women. Most of the population is above 30 years old, with only three representatives in the range of 25 to 29 years and none under 25 years old. There are indications of low education levels, with most of farmers having attending school for less than eight years, not going pass middle school. It can be noticed that women tend to have better education levels than men, and also that education levels increase as age decreases, as can be seen in Chart 1.

**Chart 1: Farmers – educational levels by age and gender**



Sendo:

- A Elementary
- B Middle school
- C High school

In Santo Antonio district, farmers work their own or their family's land, in most cases, land that had been owned by the family for generations. Almost all (96%) has exercised this activity since the end of childhood. The farms size range from small lots to midsize properties. São Domingos is inserted in a the Identity Territory of Sisal, characterized by the cultivation of sisalana agave. But, in recent years, this activity has been decaying, being the third most important economic activity for local farmers. Temporary crops of corn, beans, cassava and cactus pads (for fodder), and also livestock production, including dairy have been replacing the sisal. Small farmers growing interest in milk production poses as a surprising discovery, since this type of farming requires and consumes lots of water and fodder. It is also unexpected to realize that small cattle like goat and sheep, more adjusted to this climate, has not generated the expected response.

The first information gathered by the survey was of generic demographic and social economic nature, then followed the specific questions on small farmers' perception about wastewater reuse. The goal was to probe whether wastewater reuse in agriculture would be perceived as an opportunity to enhance access to water and, thus better harvests, or not. The initial response indicates that farmers might be receptive to new technologies that would increase water supply and mitigate some of the local environmental problems, such as lack of sanitation and river pollution, considered the implications of the practice of reuse. That kind of response shows the kind of community's perception on risk, concern and sense of opportunity this practice would incite. Community's perception on this matter showed to be closely linked to how they relate to the environment and also how they view new technologies, considering fear of the unknown and of losing control of their familiar practices (FADUL and SANTOS, 2008).

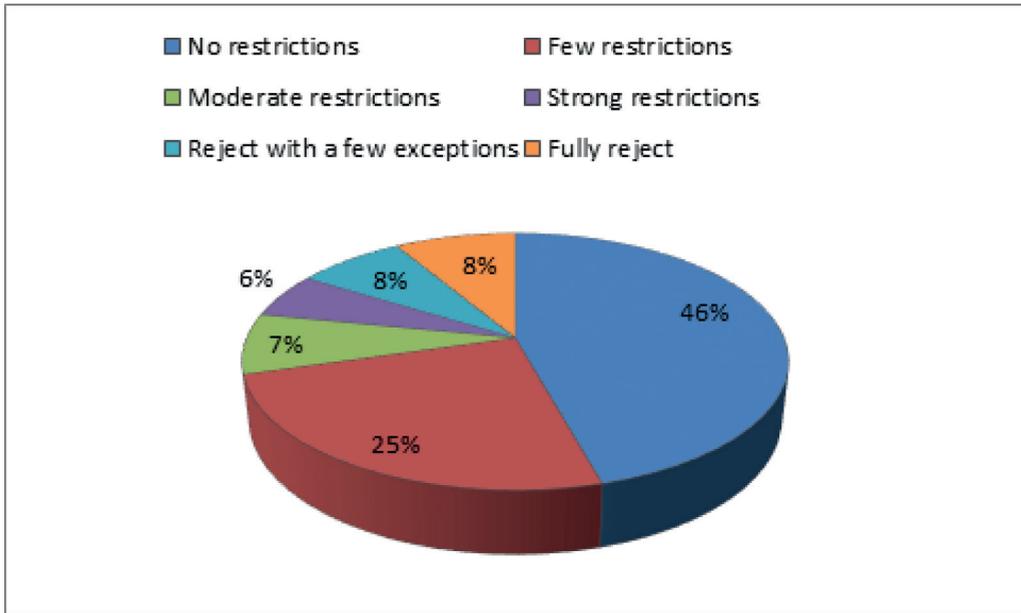
The total number of negative responses regarding the statements "Reuse can ensure access to water during droughts" and "reuse can contribute to increased agricultural production" was 10% and 8% respectively. Analyzing the gender and age group, it was noticed a greater resistance among women, increasing with age, reaching a percentage of 44% of negative responses among women over 60 years old. Among young women, the rejection towards reuse tends to be lower than among young men. The response from a member of the group is representative of the views of those who oppose the reuse, for her [...] it happens that the residue stays on the soil, and the dirty stuff on the water stays...we cannot use it. It is not natural (farmer interviewee n. 21, female, 60+ years old).

On the other hand, a significant number of farmers, who are favorable to wastewater reuse, clearly perceive the opportunity of increased water supply to the maintenance of their crops, but also the environmental advantages. Through analysis of obtained answers, a categorization on restrictions to the practice of wastewater reuse was obtained (Table 1). The intensity of personal restriction to the practice is shown on Chart 2.

**Table 1: Degrees of rejection to wastewater reuse**

<b>Category</b>	<b>Number of negative answers</b>
No restrictions	0
Few restrictions	1
Moderate restrictions	2
Strong restrictions	3
Reject with a few exceptions	4
Fully reject	5

Chart 2: Level of rejection to wastewater reuse among farmers



Risk perception was assessed in regard to the main issues identified in the literature and to those identified during interviews: environmental risks, health risks, commercial risks (difficulty of marketing products irrigated with reclaimed water) and the “yuk” or disgust factor, as it was described in literature. The health concern seems to be the most significant issue in risk perception, followed by the commercial risk and closely by the most subjective “yuk” factor.

Water resources policy formulators agree to the importance of an open deep discussion among scientists, government, water users and civil society for an adequate wastewater regulation plan. It is common sense the need to define roles within government branches in order to promote reuse. Policy operator interviewees from water management agencies state that they cannot be responsible for this kind of practice, since it is not the role of their companies or agencies to do so. The same thing, was stated by the representatives of the agricultural sector, being thus clear that it is necessary a decisive governmental action to assign responsibilities accordingly.

An interviewee from the water supply sector stated that present legislation is not clear concerning professional responsibilities on the matter, making it very risky for an engineer to take responsibility on a project of this nature, as they could easily be sued for malpractice in case of public health problems. Another issue related to the legislation, pointed out by the sanitation company representative, is that current legislation on this matter is too restrictive in regard to quality standards, therefore posing as an obstacle to its implementation. A civil society representative, otherwise, states that:

Quality standards should be established by those treating and buying reclaimed water. Current legislation is an impeditive to wastewater reuse implementation. If the treated wastewater supplier gives truthful information on the effluent quality, it should be the farmers' job to correctly and safely apply it (water resources operator interviewee nr. 14)

Water resource operators nr. 2 and nr. 3, representatives from PETROBRÁS and Urban Development Department, believe reuse to be an economically viable alternative, as a new water source, that might carry some advantages to the semiarid region. Other interviewees, representatives of Engineering Counsel, Department of Agriculture, Federation of Rural Producers and Sanitation Company believe that the costs of reuse would be high, hindering the implementation of this practice, the following points being raised:

I believe that costs are high in present scenario, taking into account that the cost of water is relatively low. However, if we consider the polluter pays principle, in the future, the charges imposed by watershed agencies and environmental protection laws might make it more cost effective to implement reuse and distribute these along the productive chain. Perhaps, at first, it would be more interesting for the producer, to seek more efficient irrigation methods reducing the consumed volume of water, as its cost tends to grow (Water resources operator interviewee nr. 4 - Civil Society).

Opinions tend to converge regarding benefits, especially concerning wastewater reuse in the semi-arid: recognizing it as an opportunity to enhance usage of water and the nutrients existing in sewage in irrigation of agricultural fields and soil remediation. (Water resources operator interviewee nr.3, Urban Development Department).

In terms of environmental risks, respondents pointed out the risks regarding soil, plants and landscape degradation according to reuse regulation and management, requiring constant monitoring and planning. To Water resources operator interviewee nr. 2, industry representative, technical and supervisory monitoring is needed. The following respondents, who agree, add:

There is a tangible risk of soil degradation, either for inadequate irrigation technics, or poorly executed agricultural practices (Water resources operator interviewee nr.4, Civil Society).

Water resources operators associate wastewater reuse risks with improper management. There are two major groups at health risk when reclaimed water is used in agriculture: the workers who will deal with irrigation and the group of consumers of goods produced with this water. Bearing in mind the economic, environmental, socio-cultural and political-institutional dimensions, several positive or negative indicators associated with the acceptance or rejection of reuse were identified. Surprisingly, one of the reasons cited by Water resources operators 1, 6 and 9 refers to the notion that there is an

abundance of water, making reuse unnecessary and redundant. Cultural, educational and political issues are some of the most cited factors.

Environmental risks are associated with potential soil degradation due to contamination, salinization and structural changes. The contamination might occur due to the presence of pathogens (parasites, bacteria and viruses); chemicals, drugs, and heavy metals present in sewage. Proper monitoring of the effluent and its interaction with the soil-plant system may guarantee the requested safety. The risk of soil salinization requires careful irrigation management.

## Discussion

Both groups interviewed tend to declare a positive interest at first, while negative perceptions emerged during the course of the interview, when risks and more subtly aspects regarding reuse surfaced. From the point of view of small farmers, opportunities for improvement of access to water, or just the ability to participate in new projects representing living conditions enhancement are, in principle, welcome. Water policy operators, on their side, perceive reuse as an opportunity to advance in water management. To this group it is undesirable to be openly against the idea of water reuse. Thus, the reasons that have hindered the implementation of reuse do not appear in the foreground speech, despite bearing a significant weight. The comparative analysis of indicators provides a reading of perceptions noted in both groups.

Considering obtained results, the two groups of actors perceive agricultural reuse as a new resource, and as an opportunity of access to water that would be available even during drought periods. This could result in a potential increase in agricultural production of crops with lower water quality requirement.

Reuse is also seen as a practice that might contribute to environmental improvements. Environmental advantages are recognized by both groups, by decreasing pressure on the water sources, reducing pollution and conserving water for more important uses, especially in semiarid watersheds.

Reuses costs are mainly associated to the deployment of a new technology, the evaluation of impacts on treatment and fertilization costs, either positive or negative, is of great importance. Water policy formulators agree that, since the adoption of new technologies may eventually mean the need for new investments, particularly monitoring microbiological quality of effluent and agricultural products. On the other hand, they fail to agree on costs allocation, opinions being split about who should be charged with the costs for sewage treatment: those receiving the treated effluent, or the sanitation company, that may reduce costs of treatment by supplying the farmers with the effluent. Moreover, the possibility of reducing the costs of fertilization with the use of recycled water is perceived positively by some of the water policy formulators.

Health risks represent a very important aspect for both groups of actors, being a relevant issue to influence their perception on water reuse. However, the literature has shown that health risks are manageable, depending on the level of knowledge of the population, technical training and appropriate management of water reuse. Subjective

and cultural factors also depend on the correct population approach, as well as the elucidation of processes, benefits and risks involved in this practice

## Conclusions

Taking in consideration all the data gathered with both groups of actors, it can be observed that agricultural water reuse pose as an attractive idea, as it presents itself as an opportunity to benefit society and the environment, but of low viability for not being competitive with other practices, incurring in new risks and requiring a new way to manage water resources and sanitation, resulting in changes of political and institutional order. Therefore, wastewater reuse needs to be perceived as a necessity by farmers and water policy formulators in order to be inserted in public policy actions.

Small farmers perception on treated wastewater reuse in agriculture showed peculiar characteristics associated with current socioeconomic situation in the studied region (Sisal Territory of Identity). Noteworthy is the small number of young people among the respondents, unlike the demographic characteristics observed in the municipality, despite the high demographic representativeness of the sample. This fact can be justified by the low attractiveness agricultural activities have to young people, which leads them to pursue other activities with regular remuneration in the service sector or in the municipal public service. The fact is that a significant number of farmers in Santo Antônio keep other economic activities besides agriculture to complement income. The difficulty of maintaining agricultural activity as a single income in the semiarid region has direct impact on the lack of interest in agricultural reuse.

The health risk is the main concern of farmers and policy makers who consider that worker's and consumer's health risk should be reduced to the maximum. However, there are differences in opinion between farmers and policy formulators about the safety criteria to be adopted, being the latter more cautious than the first. The State Resolution on Water Reuse reflects WHO recommendations, which has embraced very strict criteria in terms of effluent quality applied in agriculture, that are also applied by most countries practicing planned water reuse.

Environmental, social, economic and political-institutional factors tend to be opinion generators to various stakeholders on water reuse. The environmental factor determines the necessity for reuse implementation, since water scarcity and soil degradation pose as the trigger that transform sewage effluent from waste into resource, in social perception. Reuse has been successful in situations where there is shortage of water, but also where agricultural production has high value. The implementation of planned systems requires public sector effort in articulating inter farmers' interests in overcoming cultural barriers and investing time and resources in new technology.

Reuse has generated enough interest, either among farmers or amid policy makers, in order to pursue their development and deployment. To be effective, this practice should be integrated with other technologies suitable for the semiarid, that associate water management, sanitation and agricultural production in order to promote better social and economic conditions in rural semiarid, such as ecological sanitation, dams and

underground tanks for rainwater utilization. These actions, as any other, depend for their success, in continuous studies, technological development, intervention and monitoring, with a permanent presence in the semiarid region of the state, in all its spheres.

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**Abstract:** This paper intends to evaluate the feasibility of implementing wastewater reuse as a mitigating factor of the effects of periodical droughts in Bahia's Semi-Arid Region, considering small farmers and policy formulators views on f this practice. The research site was a small municipality of Bahia's semi-arid, São Domingos. The methodology consisted of semi-structured interviews and questionnaires. The obtained results partially confirmed the initial hypothesis, indicating that cultural based perceptions are an important factor: being either the spontaneous repulsive response or the belief that this practice poses a health risk. But the results also point these as obstacles that can be conquered. The research indicated that Economic factors were the most difficult problems to overcome. Nevertheless, the social importance of family agriculture to this region justifies the efforts to build the necessary institutional infra-structure to accomplish the implementation of a wastewater reuse policy.

**Keywords:** Water resources policy; Social perception; Sanitation.

**Resumo:** Este artigo tem o objetivo de avaliar a viabilidade de implantação do reúso agrícola de água como elemento mitigador dos efeitos da seca no semiárido baiano, analisando as razões para a implementação de políticas de reúso de água sob o ponto de vista de agricultores e de formuladores de política de recursos hídricos. A pesquisa foi localizada em São Domingos, município da região semiárida da Bahia e a metodologia consistiu na realização de entrevistas semiestruturadas e aplicação de questionários fechados. Os resultados indicam que a questão cultural se constitui em obstáculo importante, seja pelo sentimento de repulsa, ou pela crença de que a prática pode trazer riscos à saúde, entretanto, os principais fatores que dificultam a implantação de reúso são de ordem econômica, destacando-se o pouco valor da produção agrícola na referida região.

**Palavras-Chave:** Política de recursos hídricos; Percepção social; saneamento.

**Resumen:** Este artículo tiene como objetivo evaluar la factibilidad de implementar la reutilización agrícola de aguas como un factor de mitigación de la sequía en la región semiárida de Bahía, el análisis de las razones de la aplicación de las políticas de reutilización de agua desde el punto de vista de un grupo de agricultores y de formuladores de políticas de recursos hídricos. La investigación es localizada en São Domingo, municipio de la región semiárida de Bahía. La metodología fue fundamentada en entrevistas semiestructuradas e cuestionarios. Los resultados indican que la cuestión cultural es un obstáculo importante, sea por el sentimiento espontáneo de rechazo, o la creencia de que el proceso adoptado puede traer riesgos para la salud. Todavía los principales factores que dificultan su aplicación son de orden económico. Sin embargo, la importancia social de la agricultura de esta región justifica la construcción del marco institucional adecuado para esta tarea.

**Palabras clave:** Política de recursos hídricos; Percepción social; Saneamiento.

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