

An Assessment of Undergraduates' Perception on Water Resources Management in Pernambuco's Semiarid Region

Uma Avaliação da Percepção de Estudantes Universitários sobre a Gestão de Recursos Hídricos no Semiárido de Pernambuco

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Abstract: *The aim of this paper was to explore undergraduates' perception on water resources management in Pernambuco's semiarid region, located in the northeastern part of Brazil. The discussion addressed here is mainly focused on water scarcity, water waste and effluent reuse policies. A basic qualitative research was undertaken. The research corpus was composed by undergraduate students of the Academic Centre of Agreste at the Federal University of*

Pernambuco. The data collection was carried on by semi-structured interviews with the students, which were submitted to qualitative analysis. The findings are suggestive that: (i) the inefficient and ineffective water resources management is more severe than the small amount of water that impinges such a semiarid region; (ii) undergraduates are unaware about the range of alternatives to reduce water waste; and, lastly, (iii) they understand the benefits concerning the effluent reuse processes, however, it is necessary to make people aware that the system needs financial investments and security, which will increase the social commitment to suggest sustainable solutions. These findings unveiled the need for this university to promote more educational efforts — whether trainings, or courses, or modules, or policies —, aiming to increase the levels of their awareness on such this subject, so as to decrease water waste in this region.

Keywords: *Water Resource Management; Water Shortage; Water Waste; Effluent Reuse; Brazilian Semiarid Region; Public Policies.*

Resumo: *O objetivo deste artigo foi explorar a opinião das pessoas sobre gestão de recursos hídricos na região semiárida do Nordeste do Brasil, especificamente no estado de Pernambuco. A discussão abordada aqui é focada principalmente nas políticas de escassez de água, desperdício de água e reutilização de efluentes. Uma pesquisa qualitativa básica foi realizada. O corpus da pesquisa foi composto por informações cedidas por estudantes de graduação do Centro Acadêmico de Agreste/Universidade Federal de Pernambuco. A coleta de dados foi realizada por meio de entrevistas semiestruturadas com os sujeitos, as quais foram submetidas à análise qualitativa. Os resultados sugerem que: (i) a gestão ineficiente e ineficaz dos recursos hídricos é mais severa do que a pequena quantidade de água que afeta uma região semiárida; (ii) os indivíduos desconhecem a variedade de alternativas para reduzir o desperdício de água; e, por fim, (iii) eles entendem os benefícios dos processos de reutilização de efluentes, no entanto é necessário conscientizar as pessoas de que o sistema precisa de investimentos financeiros e segurança, o que aumentará o compromisso social para se sugerir soluções sustentáveis.*

Palavras-chave: *Gestão de Recursos Hídricos; Escassez de Água; Desperdício de Água; Reuso de Efluentes; Região Semiárida do Brasil; Políticas Públicas.*

1. Introduction

Water resources management (WRM) refers to a set of legal, institutional, administrative, technical and social organization policies, which aims to regulate and define the use and preservation of hydric resources¹ so as to ensure their sustainability (Garjulli, 2003). According to the Garjulli (2003), WRM demands considerable changes in people's behaviour in order to work effectively. In Brazil, the creation of the National Water Resources Policy — shortly abbreviated as PNRH —, set forth by law nº 9.433 of 1997 (Brasil, 1997), represented a pivotal improvement in the river basins management. This policy is grounded on three main pillars: participation, decentralization and integration. In particular, participation takes place through river basin committees comprised by government representatives, market associations and non-governmental organizations (Porto & Porto, 2008).

The river basins management is a serious environmental policy concern in the Brazilian northern semiarid region, wherein the issue of water scarcity is the most acute. Indeed, both physical and climatic conditions in this region demand from authorities a greater commitment and rationality in the WRM. In conjunction with this, Rebouças (2003, p. 128) states that: the most lacking aspect in such a semiarid region “[...] is not water [in itself], but a cultural standard that

¹ For the purposes of this paper, the terms water resources and hydric resources are used interchangeably.

adds confidence and improves the efficiency of the organizations [...] involved in the water business". It is not only a matter of finding alternatives to combat water scarcity, but rather of learning how to live and cope with it (Silva, 2003; 2007; Tundisi, 2008).

Anchored in the relevance of an efficient and effective WRM in this Brazilian region, this article aims to outline an analysis of the public opinion regarding water resource issues. To do so, undergraduate students of the Federal University of Pernambuco (UFPE) and, in particular, from its Academic Centre of Agreste (CAA), were chosen to represent such an opinion. The reasons for interviewing them are twofold. First, insofar as they are attending the higher education system, it is expected these students hold a broader and more critical knowledge on this matter. Second, Brazilian Northeast semiarid is daily reality to them. Their households are located within the Mesoregion of Agreste Pernambucano (MAP) (Instituto Brasileiro de Geografia e Estatística [IBGE], 2016; 2017).

Due to the wide array of elements which composes the WRM, this paper will focus its analysis on three environmental issues, that of (i) water scarcity, (ii) water waste, and (iii) effluent reuse. In so doing, the discussion addressed in this article brings forth insights to the formulation of WRM public policies, which hold potential to minimize many issues concerning those environmental issues that impinge on the WRM in the Northeast Region. It is suggested that this may be implemented through governmental subsidies, judicial decisions, state public communication campaigns, technological and organizational innovations, just to name a few examples (Secchi, 2010).

2. WATER SCARCITY AND WASTE AND REUSE OF EFFLUENTS

2.1. Water Shortage

According to the Water National Agency (ANA), Brazil holds roughly 12% of all available fresh water on Earth. Nonetheless, such a natural resource in the country is disproportionate distributed amongst its regions (Rebouças, 1997; Whately, 2016). According to Table 1, the Brazilian northeast is the third most densely populated region. Nonetheless, it concentrates the smallest amount of water (Agência Nacional de Águas [ANA], 2018). Inasmuch as its regional demographic density is relatively high, the data seems to suggest an unfavorable scenario to the northeasterners in terms of water management.

Table 1: Relationship between population density and distribution of water resources in Brazilian regions

Region	Demographic Density (Inhabitant/km ²)	Concentration of Water Resources (%)
North	4,12	68,5
Northeast	34,15	3,3
Midwest	8,75	15,7
Southeast	86,92	6,0
South	48,58	6,5

Legend: "km²": square kilometer.

Source: ANA (2018).

Historically, Brazil's northeastern geographical landscape is often mentioned by the national academic literature due to its semiarid climate and severe water shortage. In conjunction with this, such a region lures the attention of the Brazilian politicians who incorporated into their political discourses matters on regional class and stigmatizing local social problems. In the mid-1950s, geo-social issues of this region were highlighted by the economist Celso Furtado. According to him, Brazilian federal government tactics and operations to deal with drought issues in this region were very ineffective, as well as contributed to justifying the maintenance of this region's economic status quo (Silva, 2003).

Although most of the drought-related issues in the Brazilian Northeast Semiarid is caused by both natural forces and human interference in the environment. In what follows, Campos & Studart (2001) identified four main causes of drought in this region: (i) climatological, (ii) hydrologic, (iii) social, and (iv) edaphic. In fact, these issues were heightened by climatological phenomena, such as El Niño and the Atlantic Dipole (Melo, 1999; Marengo, 2009). At the beginning of the 16th century, for instance, a part and parcel of the water scarcity difficulties experienced by people in this region stemmed from the European colonization. Europeans imposed their sedentary way of life, in conjunction with their practice of agriculture and livestock, upon Brazilian native indigenous people, who were used to adopt nomadic life styles in order to avoid moments of extreme water scarcity (Paula, 2013). Rainfall scarcity, associated with dry farming techniques, is responsible for increasing the likelihood of water shortage in the semiarid. Apart from this, drought has also a social side. It is characterized by intense social problems such as hunger, migration and family breakdown (Campos & Studart, 2001).

2.2. Water Shortage

There is still a widespread belief in Brazil that water is an inexhaustible resource. As Ferreira, Ferreira-da-Silva, & Pinheiro (2008) and Olivo & Ishiki (2014) states, it is perceived by many as a resource flowing in abundance in rivers, lakes, seas and oceans. As a result, with the exception the Northeastern people, Brazilians tend to waste a significant amount of water resources every day (Moraes & Jordão, 2002; Almeida, Santos Jr., Nunes & Liz, 2019). On average, there exist neither an awareness of or an interest in the WRM from most of this population.

The issues on water waste are a requirement imposed upon societies in general. Nowadays, nations hold at their disposal a vast array of water scarcity indexes, in order to help them to manage this matter. Actually, most governments and their citizens are fully aware of the vital importance of this natural resource in social daily life (Leme, 2010). Nonetheless, despite the awareness efforts on the importance of water rationing, its scarcity has reached levels never before conceived (Olivo & Ishiki, 2014).

In terms of anthropic activity, agriculture is the one that consumes more water resources. In particular, the crop irrigation wastes roughly 60% of the water in its percolation and/or evaporation processes (Rebouças, 2003; Aisse & Bastos, 2019). An expressive part of Brazilian agriculture offers its commodities — such as sugar, meat and soy — to the international market. This supply model is configured by high levels of water waste to attend not only internal the internal demands of Brazil, but mainly the international ones (Carmo, Ojima, Ojima, & Nascimento, 2007).

As a result, Brazilian government has lured national farmers' attention to manage the water resource in a further efficient way by becoming more conscious about its use, as much as applying rational management techniques to deal with it adequately. For instance, farmers might use technology to calculate the ideal amount to be used in order to irrigate the crop field (Coelho, Coelho Filho, & Oliveira, 2005). Apart from this, it is also possible to reduce water waste through the reuse of domestic and industrial effluents (Hespanhol, 2008).

2.3. Effluent Reuse

The growing demand for water supply services to agriculture, industry and the urban population has impinged substantial adverse effects on hydric reserves, such as increased levels of environmental pollution and water stress. In such a scenario, water reuse policies have been adopted as a favorable alternative to efficiently manage the distribution of water to both rural and urban areas, and thereby relieving the pressure on supply sources and preserving aquifers. In effect, greater water availability may be guaranteed, in so far as wastewater can be reused through effluent treatment processes (Cunha, Oliveira, Ferreira, & Milhades, 2011).

In consonance with this, water waste treatments are a common practice around the globe since classical antiquity. Historical documents show that adequate sewage disposal is applied in

water irrigation systems in Ancient Greece. The use of sewage plays, still today, a pivotal roles in sustainable WRM policies, since it is adopted as an alternative for an adequate use of water and the conservation of good quality water (Cunha et al., 2011; Aisse & Bastos, 2019). In this respect, some counties and industries, for instance, have long embraced an either "indirect"/"unplanned" or "direct"/"planned" water reuse processes. This former refers to a process in which there is an upstream discharge of effluents in the river basin, thereby this discharge may be captured again downstream in an unintentional and uncontrolled manner. The latter consists, in turn, in treating effluents internally or externally for different purposes. After being treated, effluents may be forwarded to the discharge point in order to be reused (Fernandes, 2006, pp. 4-5). In what follows, there are several effluent reuse processes in Brazil. Each of them hold its own techniques and performances measures. Regardless of this, this country still needs to further encourage the application of these processes.

Faced with the effects of water crisis in most MAP region in 2017, the Companhia Pernambucana de Saneamento (COMPESA) carried out a project in partnership with the Universidade Federal Rural de Pernambuco (UFRPE) for the reuse of effluents generated by the Sewage Treatment Plant (STS) in the county of Garanhuns in the state of Pernambuco (Companhia Pernambucana de Saneamento [COMPESA], 2017). The aim of this project was to foster the production of ornamental plants and forest species. It is worth mentioning that this initiative is already reproduced by the STSs in other counties within such a state. This project is seen by governmental agencies and local people as a productive application of water saving policy, mainly used for irrigation, through reusing treated effluents. Apart from the project aforementioned, there are also the following ones in Pernambuco: (a) the experimental research carried out by STS at the Mutuca district, in the county of Pesqueira, wherein domestic effluents are used for the production of corn, sunflower and sorghum (Carvalho, Montenegro, Tabosa, Almeida, Silva, & Silveira, 2020); and, (b) the implantation of effluent treatment and reuse systems in the jeans laundries in Toritama (Silva & Xavier, 2020). In times of severe water within MAP, these projects bring forth alternatives for water saving — particularly, used for agriculture, domestic activity and industry — through the reuse of treated effluents. Those are three local examples of very productive solutions for this matter. Nevertheless, the number of projects for this purpose and their scales are still limited in Pernambuco.

3. METHODOLOGICAL PROCEDURES

It is reiterated that: (i) the objective of the research that founded this article was to analyze people's knowledge about WRM, with emphasis on water scarcity, water waste and effluent reuse; (ii) the subjects and reference research space were graduated in Administration (A), Civil Engineering (CE) and Production Engineering (PE) — five students from each course, composing groups, henceforth entitled "GA", "GCE" and "GPE", respectively — from CAA/UFPE, installed in the Caruaru (PE) city. The data collection was undertaken through semi-structured interviews — applied in June 2019, at the university campus — which addressed the theme WRM — or, with more specificity, the subthemes water scarcity, water waste and effluent reuse. The three undergraduate courses — A, CE and PE — were selected because they contain curricular components that deal with WRM, directly or indirectly; and, in each course, the subjects (S) interviewed were randomly selected to compose the groups (G).

Initial contacts with the potential interviewees took place at the CAA/UFPE's campus. Undergraduate students were approached by an interviewer, who asked the following filter questions: "whether they were undergraduate students of that educational institution?" and "if they have already attended curricular components that dealt with water resources themes?". The student who answered yes to both filter questions was considered eligible to participate in this research. After showing interested in taking part in this research, the interviewer asked their permission to record their opinion on the phenomenon under investigation. The interview protocol covered the basic questions concerning WRM presented in Table 2.

Table 2: Themes and categories of the interview protocol

Theme	Category
Water scarcity	• Attention received by society • Quantity and WRM relation
Water waste	• Solution(s) for reduction • Reuse
Effluent reuse	• Safe, economically viable and sustainable measure • Water distribution ten years from now

The ordering and interpretation of primary data and information, in a qualitative study, are mostly done in words (Miles, Huberman, & Saldaña, 2014). They can be grouped or divided into segments, and they can also be regrouped to allow researchers to make comparisons — denoting similarities and/or dissimilarities —, identify and/or construct patterns, for example. Based on this preamble, basic qualitative analysis was used here. It is not concerned with following specific methods and techniques, but maintains the characteristics of qualitative research, seeking to understand things from the perspective of a *corpus* (Merriam & Tisdell, 2015). In the present research, finally, the search was made through the similarities and/or dissimilarities found in the answers to the questions asked to the subjects. The analytical process was undertaken accordingly the following steps: (a) creation of the research *corpus*; (b) transcription of the recorded interviews; (c) coding interviewees' responses according to the themes and categories; and (d) content analysis of the *corpus*.

4. RESULTS AND DISCUSSION

4.1. Water Shortage

About the attention that water scarcity receives from society, the subjects (S) of GA claim that it depends on the region where people live. For example, for them, those in the semiarid areas of the Northeast are more sensitive to the drastic limitations of water resources. The speech excerpt (SE) from S3 of this group — S3GA— illustrates the statement:

Those who lives in situations of extreme (water) scarcity obviously pay more attention to the problem; those who lives in places with an water abundance, as in São Paulo city, pay attention only when they go through privations.

The SGCE generally agreed with those of the SGA, but state that, in the case of the Northeasterners, it would be necessary not only to pay attention to the problem, but always to act in a manner consistent with the demands of reality. This is speech excerpt of the S2GCE:

Water shortage here is no joke. It is not temporary. My family's been talking about it for decades, and they are going to keep talking, up front. But it's not enough to talk. You must act accordingly, even when it rains.

The SGPE, in turn, had a somewhat different view of the problem. They claim that even among the people of the semiarid region, there is a lack of attention to water scarcity at present — a contradictory behavior. Here is an illustrative SE launched by S3GPE:

It seems that today the problem is not receiving enough attention. It's as if the people are forgetting the hell it's seen here, without water.

Together, among the three groups of subjects, an alignment can be observed regarding the agreement that the level of attention to water scarcity is related to the region where people live and, despite the high level of attention, they need to act appropriately to live with the semiarid reality. In this sense, coexistence with the scarcity of water resources is, in fact, something natural and cultural — as Rebouças (1997) states. However, as far as this culture is concerned, there is a need for continuous reinforcement of valorization so that it remains vivid.

Regarding the relationship between amount of water and WRM, the subjects of GA, GCE and GPE affirmed that the main challenge to be faced in the semiarid region is not its small amount *per se*, but its inefficient and ineffective management. In addition, the search for local solutions is also pointed out as another demanding issue concerning this water management. The ES of subjects 2GA, 4GCE and 5GPE clarify the statement, respectively:

I cannot forget the physical limitations of the region, of course. That would be stupid. But I'm sure the situation would be better if we could take good care of what little there is.

There are places in the world that are drier than here, but they live better with the lack of water than we do. Why is that? They must know things we don't. So, everyone should find a way to solve their problems.

The natural factors cannot be ignored, but it seems that we are careless with the problem, or I can only believe that we are bad at WRM.

The three GS agreed that the main challenge in the region is to improve WRM and, in particular, to seek such improvement in the light of solutions pertinent to each of the multiple local realities — the semiarid northeast is vast and diverse. The current planning units — approached according to river basins of macro, meso or micro dimensions — and the river basin committees are an evolution in favor of the WRM — as Porto and Porto (2008) and Tundisi (2008) point out — however, it seems that the positive results are not yet recognized and valued by the people.

4.2 Water Waste

About solution(s) for waste reduction, the SGA indicated some for domestic purposes, such as reuse of bath water for toilet flushing. Only S2GA indicates one solution for non-domestic purposes, drip irrigation. As for that, here is an excerpt from the S2GA:

Dripper irrigation reduces evapotranspiration and therefore water consumption.

The SGCE, in this case, demonstrates a diverse level of knowledge. The subjects 1GCE, 3GCE and 5GCE indicated the reuse of grey water to wash floors and water gardens; S2GCE indicates the awareness process as the main solution; and S4GCE does not indicate one, because it is unknown. The ES of the S4GCE supports their response well:

Actually, I never thought about it. I don't know anything about it.

The SGPE show a similar level of knowledge as SGCE. Three of them — 1GPE, 4GPE and 5GPE — also indicated reuse of water for domestic purposes; as well as subject 4GA, one of the GPE — S2 — indicated awareness campaigns; and another — S3GPE — did not indicate solution(s). The ES of the S3GPE supports their response:

I don't know of any mechanism to reduce water waste.

Because the subjects interviewed made up a social segment with a high educational status, in addition to addressing the issue of WRM in the curricular components of their courses, they were expected to have an appropriate level of knowledge about solutions to reduce water waste. It is surprising, however, that there are subjects who indicate that they still have no knowledge of any

solution. Perhaps, these subjects represent well the validity of the tendency to waste, which Moraes & Jordão (2002) mention.

About water reuse, all SGA indicated that it is possible — solutions exist and, in themselves, they are not difficult to put into practice. For them, the obstacles focus on the lack of interest of ordinary people in adopting them, perhaps because of the financial cost and/or change, perhaps because of ignorance of their stocks. Almost all SGCE and SGPE agree on this, however, they indicate that the need is decisive to the solutions and improvements in the water distribution system may be conveying counterproductive notions that the current situation is more comfortable than, for example, a century or a half ago. The ES of subjects 4GA, 1GCE and 4GPE set out, respectively, the opinions of the groups:

Reusing water somehow is not something that requires genius. It's a matter of goodwill.

Perhaps the people don't think about reusing water because they have the trucks of the city halls and the army; or even because today they can pay for private water.

Today, the cisterns ease the situation. But it is certain that they have limits. In the long run, they alone will not be able to cope with the shortage.

Most of the subjects interviewed indicate that water reuse is not the core of the problem, here — they align themselves, then, with the thoughts of Coelho *et al.* (2005) and Hespanhol (2008). The core is linked, yes, to a set of measures that stimulate people to reuse, and this must be done, mainly, by the public power, through public policies.

4.3 Effluent Reuse

As for the reuse of effluents, or rather their application as a safe, economically viable and sustainable measure to mitigate the scarcity of water resources, SGA states that it is part of a larger solution. It cannot be attributed to the obligation to eliminate such wide-ranging problems. Not only because it does not carry sufficient benefits alone, but also because it requires refined safety systems, which can compromise its economic viability, making it unsustainable to the reality of MAP counties. The S1GAES serves to consolidate the argument:

When you see that the costs of treating wastewater are enormous, you understand that the measure is not exactly feasible.

The SGCE agrees with the SGA statements. But they draw attention to a detail linked to the measure: the dependence linked to the purpose of the reuse, which influences the required quality standard. The ES of S1GCE summarizes this:

In the short term, it is clear that it will not be possible to reuse of effluents in noble activities; however, in the less demanding ones, yes.

The SGPE also state that they agree with those of the SGA and SGCE. However, they are more concerned with public safety and health. The ES of the S5PE is exemplary:

Investment is indispensable. The problem is to invest heavily and still have to hope that the system works perfectly. If it fails, a lot of people will die.

Almost all subjects interviewed, directly or indirectly, declare to understand well the benefits of the measure, showing themselves to be aware of what is versed by Cunha et al. (2011). However, they also show clear signs of strong reservations regarding economic feasibility and risks. They deduce that the measure is quite complex.

As for water distribution ten years from now — a period of time that in organizational planning is usually equivalent to the long term — the SGA, SGCE and SGPE declare that the main measures should be focused on the elaboration and implementation of more precise policies, with emphasis on the mitigation of water resource pollution. In an isolated manner, the other variables associated with the WRM will work better. It does not make as much sense to worry about the future distribution of water if it continues to be polluted as it does today. The ES of subjects 2GA, 2GCE and 1GPE, respectively, are also exemplary:

I think for the future to be promising, everything must start with people polluting less the waters, now.

The situation is only getting worse. I'm not sure how it'll be in ten years. But today, I'd focus on fighting pollution. I'd start here, next door, near us. I'd start with the Ipojuca river.

Due to the shortage of water [...] and the pollution of the rivers, my expectations are the worst possible.

There is a certain degree of pessimism among the subjects about the distribution situation ten years from now. In fact, their statements demonstrate an adequate level of knowledge about the relevance of conserving good water quality — taking into account what Cunha *et al.* (2011), Fernandes (2006), Aisse & Bastos (2019) point out.

4.4 Theme's Joint Analysis

The analyses of the themes and categories are quite alarming in this research. The CAA/UFPE is located within a region well-known by its scarcity of water resources. Undergraduates' responses on the WRM themes — i.e., water scarcity, water waste, and effluent reuse —, in semiarid region of Pernambuco state, revealed two interrelated patterns, i.e., their lack of awareness this subject, and, thereby, their tendency to reproduce waste water behaviors. In the eyes of many scholars, these patterns are quite common in developing countries like Brazil — Rebouças (2003), Silva (2003; 2007), Coelho *et al.* (2005), Hespanhol (2008), Tundisi (2008), Leme (2010) and Fernandes (2017). Nonetheless, it is mandatory that WRM must be handled with extra care and attention by governments and their populations. In such a scenario, local higher education system holds a pivotal role in raising WRM awareness and encourages behavioral changes.

5. CONCLUDING THOUGHTS

The studies and research that supported this article allowed to analyze people's knowledge about water resources management (WRM), based on a *corpus* of primary data and information, linked to university graduates who study and live in a semiarid region of Pernambuco, Brazil. However, due to the wide scope of the WRM theme, it was decided, now, to emphasize the sub-themes of water scarcity, waste of water and reuse of effluents.

With regard to water scarcity in the Brazilian semiarid region investigated, this study suggests that people's levels of attention to it vary accordingly to their living places. In accordance to subjects' perception, such a scarcity is caused by both natural and cultural phenomena. Most importantly, they are aware that inefficiency WRM's policies are more serious and demanding than the typically low amount of water in this region. There is also another interesting fact that was found: development in water distribution in this semiarid region has led people toward a counterproductive belief that water scarcity is not a serious concern than it used to be in a near past.

In terms of water waste, there is a considerable and appropriate level of people's awareness and knowledge on the alternatives aimed at diminishing it. Nonetheless the subjects a high level of education, it is worth noting that some of them were not familiar with any technological solution to cope with water waste.

The effluent reuse processes were perceived as a partial solution to the WRM issue. In fact, people showed a great deal of awareness on its benefits. They also reckoned the hurdles involved in putting it into practice within the semiarid region of Pernambuco though, due to the high demands on technological investment and safety requirements. These two factors shape people's perceptions and, therefore, commitment in providing sustainable solutions. For instance, subjects have shown a certain degree of pessimism about the distribution of water resources with adequate quality standards in the long term. As result, they were more willing in carry out with immediate actions to mitigate water pollution.

Previous studies about WRM have revealed a lack of attention on water waste issues and an absence of awareness about them. This research endorses previous findings on this matter, as much as calls attention to the WRM in the context of semiaridity, wherein the problems related to water scarcity are aggravated. It is recommended that local HEIs take part in their role to reinforce the WRM theme in their curricula, with an emphasis on water waste awareness and management, as well as people's behavior change.

References

- Aisse, M. M. & Bastos, R. K. X. (2019). *Reúso de água, produtividade agrícola e sustentabilidade em bacias hidrográfica*. In: PHILIPPI Jr., A.; SOBRAL, M. do C. (Editores). *Gestão de bacias hidrográficas e sustentabilidade* (pp. 624-659). Barueri, São Paulo: Manole.
- ANA – Agência Nacional de Águas. (2018). *Conjuntura dos recursos hídricos no Brasil 2018: informe anual*. Brasília, Brasil: ANA.
- BRASIL. (1997). Lei nº 9.433, de 8 de janeiro de 1997. *Política Nacional de Recursos Hídricos*. Brasília, Brasil: Casa Civil.
- Campos, J. N. B., & Studart, T. M. C. (2019). Secas no Nordeste do Brasil: origens, causas e soluções. *IV Diálogo Interamericano de Gerenciamento de Águas*. Associação Brasileira de Recursos Hídricos (ABRH), Foz do Iguaçu, 2001. Disponível em: http://www.deha.ufc.br/ticiana/Arquivos/Publicacoes/Congressos/2001/Secas_no_Nordeste_do_Brasil_08_de_junho_def.pdf
- Carmo, R. L. D., Ojima, A. L. R. D. O., Ojima, R., & Nascimento, T. T. D. (2007). Água virtual, escassez e gestão: o Brasil como grande "exportador" de água. *Ambiente & sociedade*, 10(2), 83-96.
- Carvalho, A. A., Montenegro, A. A. de A., Tabosa, J. N., Almeida, T. A. B., Silva, A. G. O. da, & Silveira, A. V. M. (2020). Reuso hidroagrícola: uma solução para convivência com a escassez hídrica no Sertão e Agreste pernambucano. *Journal of Environmental Analysis and Progress*, 5(2), 140-150.
- Coelho, E. F., Coelho Filho, M. A., & Oliveira, S. L. (2005). Agricultura irrigada: eficiência de irrigação e de uso de água. *Bahia Agrícola*, 7(1), 57-60.
- COMPESA – Companhia Pernambucana de Saneamento (2019). *Projeto propõe reutilizar efluente tratado para o cultivo de plantas ornamentais*. 2017. Disponível em:

<https://servicos.compesa.com.br/projeto-propoe-reutilizar-efluente-tratado-para-o-cultivo-de-plantas-ornamentais/>

Cunha, A. H. N., Oliveira, T. H. O., Ferreira, R. B., Milhardes, A. L. M., & Silva, S. D. C. (2011). O reúso de água no Brasil: a importância da reutilização de água no país. *Enciclopédia biosfera, Centro Científico Conhecer-Goiânia*, 7(13), 1225-1248.

Fernandes, V. M. C. (2006). Padrões para reuso de águas residuárias em ambientes urbanos. *II Simpósio nacional sobre o uso da água na agricultura*, Passo Fundo.

Ferreira, M. I. P., Ferreira-da-Silva, J. A., & Pinheiro, M. R. D. C. (2008). Recursos hídricos: água no mundo, no Brasil e no Estado do Rio de Janeiro. *Boletim do Observatório Ambiental Alberto Ribeiro Lamego*, 2(2), 29-36.

Garjulli, R. (2003). Os recursos hídricos no semiárido. *Ciência e Cultura*, 55(4), 38-39.

Hespanhol, I. (2008). Um novo paradigma para a gestão de recursos hídricos. *Estudos Avançados*, 22(63), 131-158.

IBGE – Instituto Brasileiro de Geografia e Estatística (2016). *Divisão territorial brasileira 2016*. Rio de Janeiro, Brasil: IBGE.

IBGE – Instituto Brasileiro de Geografia e Estatística. (2017). *Divisão regional do Brasil em regiões geográficas imediatas e regiões geográficas intermediárias: 2017*. Rio de Janeiro, Brasil: IBGE

Melo, J. C. (1999). O fenômeno El Niño e as secas no Nordeste do Brasil. *Raízes: Revista de Ciências Sociais e Econômicas*, (20), 13-21.

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative research: a guide to design and implementation*. [sine loco]: John Wiley & Sons.

Miles, M. B., Huberman, A. M., & Saldanã, J. (2014). *Qualitative data analysis: a methods sourcebook*. [sine loco]: Arizona State University.

Moraes, D. S. L., & Jordão, B. Q. (2002). Degradação de recursos hídricos e seus efeitos sobre a saúde humana. *Revista Saúde Pública*, São Paulo, 36(3), 370-374.

Marengo, J. A. (2009). Mudanças climáticas: detecção e cenários futuros para o Brasil até o final do século XXI. Cavalcanti, I. F. A.; Ferreira, N. J.; Silva, M. G. J.; Silva Dias, M. A. F. (Orgs.). (2009). *Tempo e Clima no Brasil*. São Paulo: Ed. Oficina de Textos, 407-424.

Paula, A. M. N. R. de. (2013). O sertão das águas: o velho Chico e suas gentes de rio e beira-rio. In: Borges, M. C., & Leal, A. F. (Orgs.). (2013). *Etnocartografia do Rio São Francisco: comunidades tradicionais ribeirinhas do Norte de Minas Gerais* (pp. 69-102). Uberlândia, Brasil: Editora da Universidade Federal de Uberlândia.

Porto, M. F. A., & Porto, R. L. L. (2008). Gestão de bacias hidrográficas. *Estudos Avançados*, 22(63), 43-60.

Rebouças, A. C. (2003). Água no Brasil: abundância, desperdício e escassez. *Bahia Análise & Dados*, Salvador. 13 (special edition), 341-345.

Rebouças, A. C. (1997). Água na Região Nordeste: desperdício e escassez. *Estudos Avançados*, 11(29), 127-154.

Santana, P. N. de, Valença, S., Ramos, D., Nascimento, A. C. L do, & Soares, I. C. da S. (2019). Percepção de moradores e visitantes sobre o gerenciamento do Parque Nacional do Catimbau (Pernambuco, Brasil). *Journal of Perspectives in Management – JPM*, 3(1), 2-16.

Silva, R. M. A. (2003). Entre dois paradigmas: combate à seca e convivência com o semiárido. *Sociedade e Estado*, Brasília (DF), 18(1-2), 361-385.

Silva, R. M. A. (2007). Entre o combate à seca e a convivência com o semiárido: políticas públicas e transição paradigmática. *Revista Econômica do Nordeste*, 38(3), 466-485.

Secchi, L. (2010). *Políticas públicas*. São Paulo, Brasil: Cengage Learning.

Tundisi, J. G. (2008). Recursos hídricos no futuro: problemas e soluções. *Estudos Avançados*, 22(63), 7-16.

Whately, M. (2016). *O século da escassez: uma nova cultura de cuidado com a água: impasses e desafios*. São Paulo, Brasil: Claro Enigma.



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