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Environment

Environmental macroscopic analysis of shallow wells containing water for human consumption in rural properties in Brazil

Análise macroscópica ambiental de poços rasos com água de consumo humano em propriedades rurais no Brasil

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ABSTRACT

Water is an essential natural resource for maintaining life and its quality is influenced by the land use and occupation within a watershed. Furthermore, water quality has a direct impact on the health and well-being of a population. The present study aimed to carry out a macroscopic environmental analysis in shallow wells found in rural properties distributed in the states of Rio Grande do Sul and Santa Catarina, including the Uruguay River Basin. The evaluation period of the macroscopic parameters took place in April 2021. The physical characteristics of the water and the state of preservation of the shallow wells and their surroundings were visually evaluated in rural properties with predominant land use and occupation through dairy production, swine farming activity and seasonal crops (agricultural crops). As results obtained for the environmental macroscopic analysis, through the weighting of the characteristics observed in each parameter about the state of preservation of the shallow wells, it was verified that they presented different classifications, ranging from the Very Good class to the Poor, being possible to identify the main sources that cause negative impacts on the evaluated locations (state of vegetation, use by animals, protection of the area and proximity to residences). Therefore, rural producers were advised to carry out protection and care measures around these wells that presented lower classifications, Fair (38,10%) and Poor (19,09%) to improve the conditions and aspects that directly influence the quality of water for human consumption.

Keywords: Level of preservation; Water quality; Land use and occupation

RESUMO

A água é um recurso natural essencial para a manutenção de vida e sua qualidade é influenciada pelo uso e ocupação do solo dentro de uma bacia hidrográfica, sendo que sua qualidade interfere diretamente na saúde e bem estar de uma população. O presente estudo teve por objetivo realizar a análise macroscópica ambiental em poços rasos de propriedades rurais distribuídas entre os Estados do Rio Grande do Sul e Santa Catarina, contemplando a Bacia Hidrográfica do Rio Uruguai. O período de avaliação dos parâmetros macroscópicos ocorreu no mês de abril/2021. Foram avaliados de forma visual as características físicas da água e o estado de preservação dos poços rasos e o seu entorno em propriedades rurais possuindo uso e ocupação do solo predominante através da produção leiteira, atividade de suinocultura e culturas de época (culturas agrícolas). Como resultados obtidos para a análise macroscópica ambiental, através da ponderação das características observadas em cada parâmetro acerca do estado de preservação dos poços rasos, verificou-se que os mesmos apresentaram diferentes classificações, variando da classe ótima a ruim, sendo possível identificar as principais fontes causadoras de impactos negativos nos locais avaliados (estado da vegetação, uso por animais, proteção da área e proximidade de residências). Portanto, é necessário que os produtores rurais realizem medidas de proteção e cuidados no entorno daqueles poços rasos que apresentaram classificações inferiores, Razoável (38,10%) e Ruim (19,09%), visando melhorar as suas condições e aspectos que influenciam diretamente na qualidade da água de consumo humano.

Palavras-chave: Grau de preservação; Qualidade da água; Uso e ocupação do solo

1 INTRODUCTION

Water is an extremely important element that ensures life on the planet (Oliveira Neta, 2013; Çavuş, Şen, 2023), that is, it is considered the renewable resource that most acts as a limiting element in the development of the population and other organisms live (Hamed *et al.*, 2020). The quality of water intended for human consumption (drinking water) is a key aspect to sustain human life (Muhammad; Usman, 2022). However, in recent years water resources have deteriorated in quality, caused mainly by human activities through improper occupation of preservation areas and carrying out polluting activities (Cabanelas; Moreira, 2007). Nowadays, in terms of Brazilian public basic sanitation, there has been a great deficit in terms of the potability of the water that reaches the tap of many homes (Franco, 2021).

In the case of the Uruguay River Hydrographic Region (RS/SC, Brazil) , industrial agriculture is among the leading causes of water pollution, such as poultry, pig,

domestic (human) effluents and pesticides (COMITÊ IBICUÍ, 2018). This basin is extremely important to the southern region of Brazil, covering 73% of the territory in Rio Grande do Sul and 27% in Santa Catarina. According to the National Water Agency (ANA) (2015), in this watershed there are low levels of effluent treatment, and dilution and assimilation of effluents can be observed from urban and rural areas in water resources, as the water has attributes that provide the conformation of its quality, including transport and the capacity of dissolution (Brasil, 2006).

One of the alternative sources to obtain water for consumption is through shallow wells (Ismail; Shareef; Alatar, 2019), which are common in many countries around the world, however they are more susceptible to contamination, mainly by wastewater, due to its shallow depth. Also known by the term domestic wells, they tend to often present quality parameters with values above the established standards for potability (Backer; Tosta, 2011). For the most part, shallow wells are located on properties that have cesspools or septic systems as a form of treatment for their domestic effluents, this form of treatment can allow the leaching of the effluent and lead to the contamination of groundwater through pathogenic organisms. and chemical contaminants (Bremer, Harter, 2012). Therefore, it is important to evaluate the state in which the waters are in order to use them safely (Bhuiyan; Ray, 2017), with macroscopic analysis being an effective method to assess the preservation of water resources.

Macroscopic analysis is used to verify the environmental impacts that occur in water sources. Based on their results, mitigating measures can be proposed, such as management activities and environmental education in the area where the water sources are located. In this way, the macroscopic analysis constitutes a practical and simple application method, which express results considered satisfactory in terms of identifying negative environmental impacts (Felippe; Magalhães; 2012). Environmental impacts are defined as physical, chemical and biological changes caused by human activities that can affect the health, safety and well-being of the population, biota

and social and economic activities. Carvalho, Porto and Oliveira (2020) comment that watershed management helps to identify negative environmental impacts that affect water. These impacts on the watersheds must be identified, so that measures to improve the environment can be taken. Considering that water quality can be altered by pollution, compacted soil can interfere with water infiltration and the lack of protection in the surroundings of water sources can expose it to the circulation of organisms, as well as animals trampling (Leal 2017), thus leading to a deterioration in the water quality (Wu; Zhang; Zhou, 2020).

Thus, taking into account the importance that preservation in the surroundings of springs and wells represents for the water quality, the present study aimed to carry out a macroscopic environmental analysis in shallow wells of rural properties that are under different conditions, land use and occupation. After carrying out this analysis, measures that can be taken to better protect water resources and users´ health are suggested to landowners.

2. MATERIAL AND METHODS

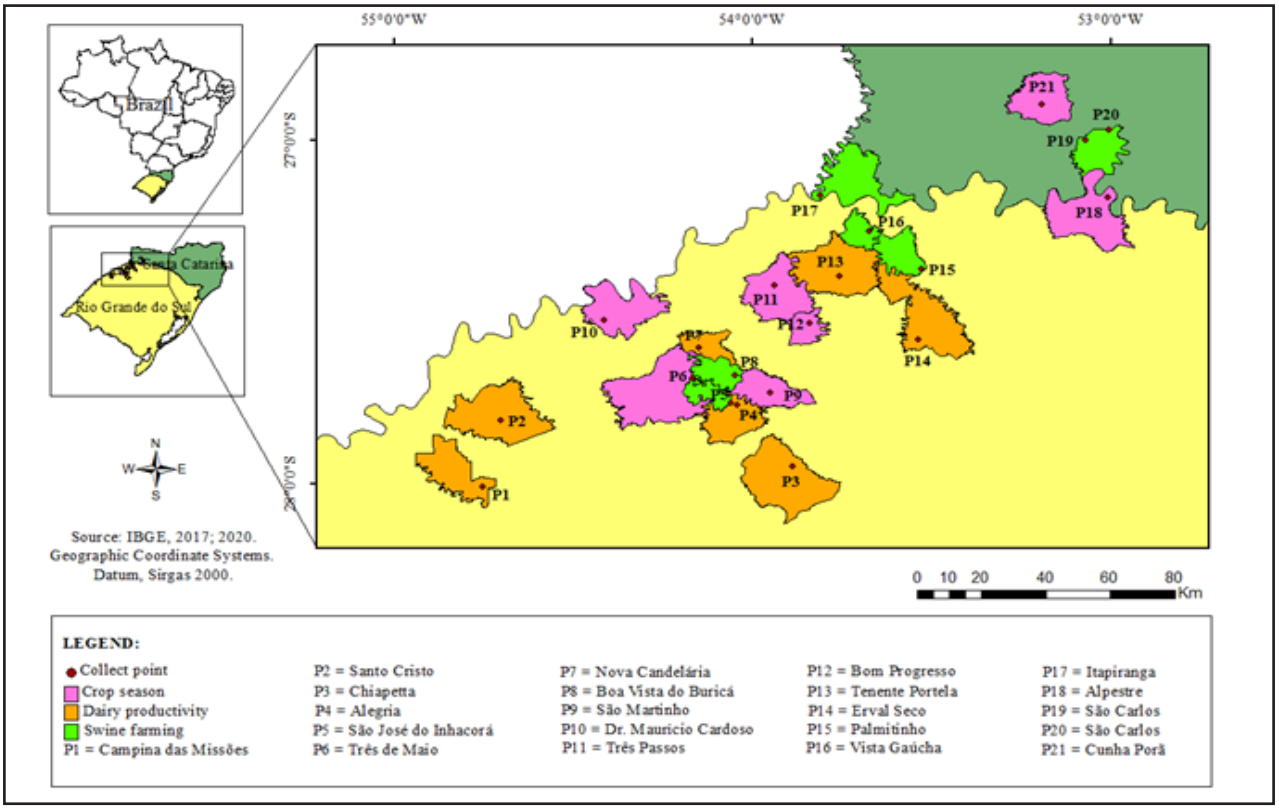
2.1 Characterization of the study area

The study area comprises municipalities located in the state of Rio Grande do Sul (RS) and Santa Catarina (SC) in Brazil, belonging to the Uruguay River Hydrographic Region (Figure 1). In order to carry out the macroscopic environmental analysis, 21 rural properties in the two states were defined (17 properties in RS and 4 properties in SC) that have shallow wells as a way of supplying water used for human consumption.

The macroscopic environmental analysis was carried out in April 2021, in which seven rural properties had land use and occupation of seasonal crops such as soybean, corn, wheat, among others (in the municipalities of São Martinho, Três Passos, Três de Maio, Dr. Maurício Cardoso, Bom Progresso and Alpestre - RS and Cunha Porã - SC), seven other rural properties (Nova Candelária, Alegria, Erval Seco, Chiapetta, Tenente Portela, Santo Cristo and Campina das Missões – RS) and the

main activity was dairy productivity. The other seven rural properties of the total analyzed (São José do Inhacorá, Vista Gaúcha, Palmitinho and Boa Vista do Buricá - RS and Itapiranga and São Carlos - SC) developed pig farming.

Figure 1 - Location of shallow wells evaluated and land use and occupation



Source: Authors (2023)

2.2 Evolution of environmental macroscopic analysis

To carry out the macroscopic environmental analysis in the rural properties studied, the methodology adapted from Gomes, Melo and Vale (2005) was used, in which some aspects (parameters) that influence water quality were observed in the field. The parameters that were observed are described in Table 1.

In order to classify the environmental impact index around the area, each rural property was scored based on the aspects presented in Table 1. After quantification, the total sum of each studied location was calculated. A score was obtained from this, which will be used to verify the respective classification regarding the level of

preservation of the site. Classes ranged from A to E, as follows: Class A (Very Good), Class B (Good), Class C (Fair), Class D (Poor) and Class E (Very poor) (Table 2).

Table 1 - Quantification used for the analysis of macroscopic environmental aspects

Water color	(1) Dark	(2) Clear	(3) Transparent
Water smells	(1) Strong	(2) Weak	(3) Absent
Garbage around	(1) A lot	(2) Little	(3) Absent
Floating materials	(1) A lot	(2) Little	(3) Absent
Foams	(1) A lot	(2) Little	(3) Absent
Oils	(1) A lot	(2) Little	(3) Absent
Domestic wastewater	(1) A lot	(2) Little	(3) Absent
Vegetation (preservation)	(1) Insertion area	(2) Low degradation	(3) Preserved
Use by animals	(1) Presence	(2) Only marks	(3) Not detected
Use by humans	(1) Presence	(2) Only marks	(3) Not detected
Area protection (fences)	(1) Absent	(2) Protection – With Access	(3) Protection - Without access
Proximity to residence	(1) < 50 m	(2) 50 to 100 m	(3) > 100 m
Insertion area	(1) Absent	(2) Private area	(3) Protected area

Source: Gomes, Melo e Vale (2005)

Table 2 - Classification regarding the degree of preservation of the analyzed sites

Class	Level of ptotection	Final Score
A	Very good	37-39 points
B	Good	34-36 points
C	Fair	31-33 points
D	Poor	28-30 points
E	Very poor	< 28 points

Source: Gomes, Melo e Vale (2005)

3 RESULTS AND DISCUSSION

The classification and final quantification of the macroscopic environmental analysis performed for the shallow wells of the present study can be observed through the scores assigned to each macroscopic parameter evaluated in the rural properties (Table 3).

Table 3 – Environmental macroscopic quantification of the shallow wells studied

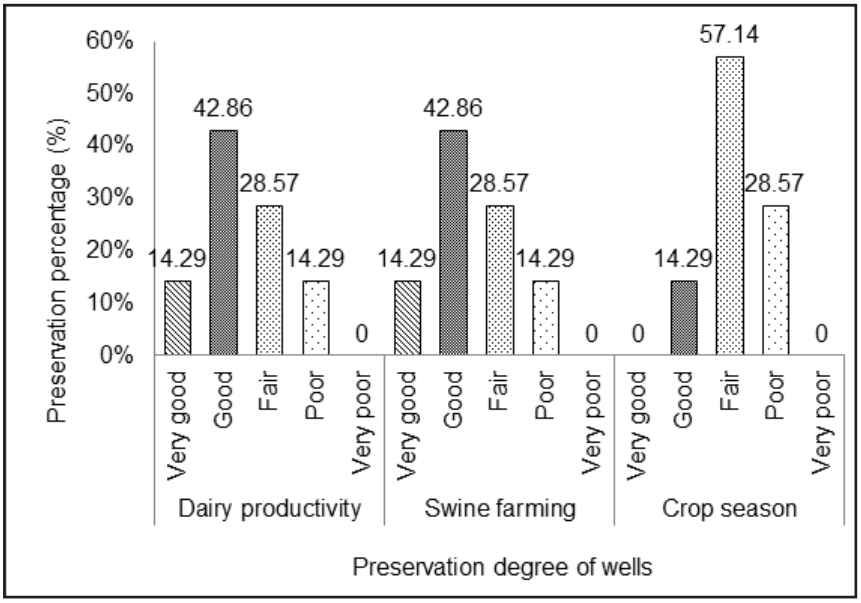
		Water color	Water smells	Garbage around	Floating materials	Foams	Oils	Domestic wastewater	Vegetation (preservation)	Use by humans	Uso by animals	Area protection (fences)	Proximity to residence	Insertion area	Somatório	Class	Degree of preservation
Conditions of land use and ocupation	**Dairy productivity**	3	3	3	3	3	3	3	3	3	2	2	3	2	36	B	Good
		3	3	3	3	3	3	3	1	2	1	1	2	2	30	D	Poor
		3	3	3	3	3	3	3	1	1	3	2	1	2	31	C	Fair
		3	3	3	3	3	3	3	3	3	3	3	3	2	37	A	Very good
		3	3	2	3	3	3	3	2	1	3	2	1	2	31	C	Fair
		2	3	3	3	3	3	3	3	3	2	3	3	2	35	B	Good
		3	3	3	3	3	3	3	3	2	2	2	2	2	34	B	Good
	Crop season	3	3	3	2	3	3	3	1	2	2	1	3	2	31	C	Fair
		3	3	2	3	3	3	3	2	2	2	2	2	2	32	C	Fair
		3	3	3	3	3	3	3	1	1	1	2	1	2	28	D	Poor
		2	3	3	3	3	3	3	3	3	3	3	2	2	36	B	Good
		3	3	3	3	3	3	3	1	1	2	2	1	2	29	D	Poor
		3	3	3	3	3	3	3	1	1	2	1	3	2	31	C	Fair
		3	3	3	3	3	3	3	1	1	3	2	1	2	30	C	Fair
	Swine farming	3	3	3	3	3	3	3	3	3	3	3	3	2	38	A	Very good
		3	3	3	3	3	3	3	1	1	3	2	1	2	30	D	Poor
		3	3	3	3	3	3	3	1	2	2	1	2	2	31	C	Fair
		3	3	3	2	3	3	3	3	2	2	2	2	2	32	C	Fair
		3	3	3	3	3	3	3	1	2	3	3	2	2	34	B	Good
		3	3	3	3	3	3	3	2	2	2	2	3	2	34	B	Good
		3	3	3	3	3	3	3	3	3	3	2	1	2	35	B	Good

Source: Authors (2023)

In the land use and occupation areas predominated by dairy production and pig farming, the macroscopic environmental analysis showed in 14.29% of the shallow wells Very Good preservation - Class A (1/7). In 42.86% of the wells, Good preservation was found - Class B (3/7), 28.57% of the wells showed Fair preservation – Class C (2/7) and 14.29% had Poor preservation – Class D (1/7). For rural properties whose land use

and occupation occur through seasonal crops, there was a level of Good preservation – Class B (1/7) at 14.29%. In 57.14% of the shallow wells, preservation was observed as Fair – Class C (4/7) and in 28.57% the classification was Poor – Class D (2/7) (Figure 2).

Figure 2 – Degree of preservation around the shallow water wells studied according to the uses and occupation of the soil



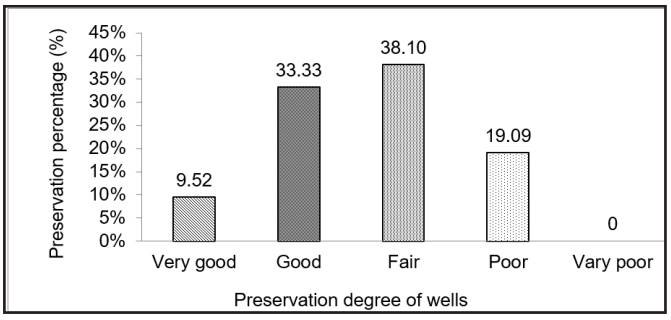
Source: Authors (2023)

Only a shallow well located in a rural property that was predominantly for land use and occupation through dairy productivity and a well with pig farming showed a Very Good level of preservation. Among the other shallow wells and land use and occupation, the classes were shown to be lower. However, none of the shallow wells evaluated in the present study showed a Very Poor level of preservation. Among all the shallow wells in the present study, the highest score was classified as Fair - Class C (38.10 %), followed by Good preservation - Class B (33.33 %), Poor preservation - D (19.09 %), Very Good preservation (9.52 %) – Class A and Poor classification – Class E (0.00 %) (Figure 3).

The color of the water of the shallow wells studied was clear in only one of the rural properties studied, which is under land use and occupation through seasonal crops. Bearing in mind that in the week preceding the macroscopic analysis there was

no rainfall in the studied locations, this factor may explain the lack of water color. In accordance with CETESB (2016), the color presented by the waters is associated with the presence of dissolved solids, which may be in an organic, inorganic or colloidal state. When the waters are transparent, there is no interference of light passing through them (Botelho *et al.,* 2001). Marchini *et al.* (2021) report having verified a light coloration of the water for places where there is high anthropic activity in the vicinity and little vegetation in the surroundings, a fact that leads the present study to corroborate the authors. In the study by Santos *et al*. (2021), a total of 10 sites were evaluated through macroscopic analysis, of these, only four had transparent water coloration, justified by anthropic disturbances.

Figure 3 – Total percentage of shallow wells and respective degrees of preservation.



Source: Authors (2023)

Regarding the vegetation in the vicinity of the wells, it proved to be little or degraded in most of the evaluated locations, as human activities are very close to water sources. The absence or presence of degraded vegetation influences the low score of the macroscopic analysis, thus contributing to lower classifications of water resource preservation (Rocha; Fonseca; Sousa, 2017). The presence of vegetation in the vicinity of water resources contributes favorably to the ecosystem, so that it helps in water infiltration from rainfall close to the ground, contributing to recharging the water table (Pinto *et al.,* 2004; Medeiros *et al.,* 2015), thus maintaining the continuity of the source, contributing to the existing biodiversity and the hydrological cycle (Primack; Rodrigues, 2007). The lack of vegetation compromises water quality parameters, such as turbidity

and color (Athaydes; Parolin; Crispim, 2022). Regarding odor, this parameter was not detected in any of the wells evaluated in the present study, corroborating with the macroscopic study carried out by Fonseca and Gontijo (2021).

The presence of few residues was detected around the studied site and was found in only one shallow well, corroborating in this aspect with the study carried out by Reis *et al.* (2021). Waste reaches water resources through different ways, such as, for example, through inappropriate deposit on site, by the action of winds (light waste) (MARCHINI *et al.,* 2021) or by the action of heavy rainfall (Beckauser; Nakashima; Silva, 2019), facts that happen due to the absence of proper protection of water sources and access by humans (FUNASA, 2004). For Galvan *et al*. (2020), the presence of solid waste around water sources causes water pollution, and this can cause a change in its quality, and also contribute to the development of vectors of diseases and parasites (Martelli, 2013; Fonseca; Gontijo, 2021).

Floating materials in the water from the shallow wells were observed in small amounts at only one collection point. Oil and sewage were not present. The present study corroborated the study carried out by Resende *et al*. (2020) in which the presence of oil, sewage and floating materials in the water was not detected, in turn, Marchini *et al*. (2021) found the presence of little to many floating materials in the water, their presence can be associated with foam from washing clothes (domestic effluent) (Athaydes; Parolin; Crispim; 2022). Santos *et al*. (2021) verified the appearance of floating materials, oils and sewage, the aforementioned authors associate the presence of oil resulting from the contact of water with effluents and domestic waste.

In a large number of the shallow wells studied, there were signs of humans and/or animal use in the surroundings. According to Mattos and Silva (2002) and Athaydes, Parolin, Crispim (2022), the presence of warm-blooded animals around wells can lead to water contamination by pathogenic organisms of the coliform group, especially the Escherichia coli bacterium. Thus, wells should have a Good level of preservation and animal waste should be treated before being released into the ground. Furthermore,

use by humans and animals can cause soil degradation, compaction and erosion (Galvan *et al.,* 2020).

Regarding the protection of the site with fences, it was found that out of the 21 shallow wells evaluated, four did not have any type of fences in the surroundings, twelve had fences with access, and five were fenced without access. The presence of fences is of great importance (Malaquias; Cândido, 2013), as it contributes positively to the water sources, as they prevent the access of animals, thus avoiding the trampling of animals (change in the color and turbidity of the water), defecation (presence of fecal coliforms and change in water odor) (Athaydes; Parolin; Crispim, 2022) and soil degradation (Ferraz; Lago; Bagos, 2017), thus allowing the regeneration of nearby plant species (Rangel; Oliveira; Moreira, 2006). Gomes, Melo and Vale (2005) report that when there is no protection system, the probability of human interference on water becomes greater. Thus, the more protected the water resource, the better its quality will be.

The proximity of residences to the shallow wells varied, ranging from distances of less than 50 meters to more than 100 meters. Thus, the greater the proximity between water sources and population dwellings, the greater the chances of human intervention that negatively affects water resources. For Coelho *et al*. (2017), the lack of properly treating effluents and the proximity of livestock around water wells can result in changing the natural characteristics of the waters. Galvan *et al*. (2020) add that anthropic uses in the vicinity of the water resource can cause soil degradation (compaction, erosion processes) and the presence of waste. Regarding the type of area, all the shallow wells are located on private rural properties. Shallow wells are an alternative widely used by rural properties, especially when there is no public water supply, however attention must be paid to the water quality provided by these wells, as they are influenced by the type of soil and the place where the well is built on the rural property (LEAL, 2012).

This study corroborated the work developed by Galvan *et al*. (2020), in which

the authors associate water quality problems with the lack of preservation around the shallow wells, which detected only two protected springs out of a total of nine studied. In the macroscopic environmental analysis performed by Lazarotto *et al*. (2020), in the municipality of Caiçara - RS, the authors found a Fair and Poor level of preservation for the shallow wells analyzed, and in the present study the highest percentage of levels of preservation was also reasonable. Malaquias and Cândido (2013), when carrying out the macroscopic analysis, found that the largest proportion of the water resources evaluated was characterized as Class C, that is, with a Fair degree of preservation, and the smallest proportion as Class B, representing Good degree of preservation.

Seben *et al.* (2021) evaluated springs in the North and Plateau regions of the state of RS and found similar results with the present study of classification of the macroscopic environmental analysis for pig farming, obtaining one property that scored Class A – Very Good and four Class B - Good. Regarding the condition of land use and occupation of seasonal crops (soybean), two rural properties that were ranked Class A – Very Good and one rural property Class – B (Good) were observed by these authors. Schneider *et al.* (2021), observing the quality of water from springs, shallow wells and deep wells, found that the deeper the origin of the water, the better its quality. Also, the authors highlight the importance of protection in the surroundings of water resources used for human consumption, since protection helps to improve water quality.

Anthropogenic activities such as proximity to homes, lack of sanitary sewage, inadequate disposal of solid waste, lack of vegetation and presence of animals are factors that contribute to the degradation of water resources (Silva *et al.,* 2018). In this way, sustainable practices must be adopted as a method of promoting the improvement of the quality of water used for human consumption, Lazarotto *et al*. (2020) comment that places where the shallow wells are located can be isolated and local vegetation can still grow, using fences that prevent animal and human access.

Lira, Souto, Duarte, (2019), when carrying out land use and occupation

assessment in a given period of time, human interference in the environment was noted, as there was an increasingly constant demand for consumption and land use and occupation. Lemos Filho, Ferreira and Lyra (2017) point out how much the use of natural resources has been increasing within the hydrographic basins, which can thus lead to the degradation of the hydrographic system constituents,caused by activities that have not undergone a planning process (Freitas, 2020). As a result, the waters have been subjected to a large load of natural stressors - climate change, erosion processes, oxidation of mineral rocks and weathering; and anthropogenic - discharge of effluents, input of nutrients, pesticides, changes in land use (Chatanga *et al.,* 2019) and suppression of vegetation (Saleem *et al.,*2019), resulting in the degradation of its quality (Badeenezhad *et al.,* 2020; Muhammad *et al.,*2022).

Schleder *et al. (*2017) found that shallow water wells located in places that have land use and occupation due to intensive agriculture have a greater tendency to present contamination through fertilizers, and the authors add that the presence of the Escherichia coli bacterium may be associated with the presence of domestic effluents, as well as livestock effluent, such as animal waste. Galvan *et al.,* (2020) in addition to carrying out the macroscopic analysis, they promoted the analysis of the water quality of the studied place, being verified the presence of Escherichia coli in all the analyzed samples, the authors attributed the results obtained to the contamination of the water by domestic effluents and animal feces, which possibly reached the water resource through surface and underground runoff processes. Felipe e Magalhães Júnior (2012) highlight the concern with consumers of contaminated water in rural areas, in view of the presence of pathogenic microorganisms.

In this sense, Hora *et al.,* (2021) mention that the characteristics of environmental storage make a community more susceptible to health problems caused by waterborne diseases. Therefore, the authors point out that there is a need to promote health practices, such as water treatment used for human consumption in places, such as wells and springs that lack this. In view of this, it is important to emphasize

that conserving the environment and its natural resources must become a practice of society, not leaving responsibility only to public and private bodies, that is, there must be the participation of the entire population. It is worth mentioning that the preservation of water resources goes far beyond the environmental axis, also reaching socioeconomic and political instances, which are focused on issues of infrastructure, information and society's income (Malaquias; Cândido, 2013).

Having said that, all interventions carried out by human beings on the planet can lead to negative aspects, involving financial aspects and even their health (Lira; Souto; Duarte, 2019). In the case of rural areas, in many places, basic sanitation conditions are of inferior quality, thus evaluating and monitoring wells helps to provide evidence of the risks to human health, as well as recognizing the sanitation conditions (Coelho *et al.,* 2017). Therefore, seeking understanding and carrying out the analysis of the complex relationships existing in the environment contribute to the generation of subsidies regarding the planning and actions for the preservation of water resources (Reis *et al.,*2021), as was the case of the present study.

4. CONCLUSION

Based on the results found for the macroscopic environmental analysis, in the different studied land uses and occupation, the parameters that presented low preservation (vegetation status, animal use, protection of the area and proximity to residences) may be interfering with the water consumed by rural producers. Therefore, it is recommended that measures be taken, such as isolating and protecting shallow wells, preventing animal access, as well as allowing the growth of vegetation in the vicinity.

Furthermore, the importance of correctly applying animal waste near the soil is highlighted, as such effluents must undergo a stabilization process for a period of 120 days before being used as organic fertilizers. Using them in places close to shallow wells should also be avoided, so as not to lead to water contamination used for human

consumption by pathogenic microorganisms.

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REFERÊNCIAS

ATHAYDES, T. V. S.; PAROLIN, M.; CRISPIM, J. de Q. Análise macroscópica de nascentes protegidas por meio de técnica Solo-Cimento nos municípios de Campo Mourão e Luiziana, PR. **Terrae Didática**, Campinas-SP, v. 18, p. 1-8, 2022. DOI: https://doi.org/10.20396/td.v18i00.8670816. Disponível em: https://periodicos.sbu.unicamp.br/ojs/index.php/td/article/view/8670816. Acesso em: 29 mar. 2023.

BACKER, L. C.; TOSTA, N. Direct from CDC: Unregulated drinking water initiative for environmental surveillance and public health. **Journal of Environmental Health***, [S.l], v. 73, n. 7, p. 31-32, 2011. Disponível em: https://www.scopus.com/record/display.uri?eid=2-s2.0-79953305369&origin=inward&txGid=91e220af8425de664dd754b8b04eecc9. Acesso em: 31 mar. 2023.*

BADEENEZHAD, A.; TABATABAEE, H. R.; NIKBAKHT, H.; RADFARD, M.; ABBASNIA, A.; BAGHAPOUR, M. A.; ALHAMD, M. Estimation of the groundwater quality index and investigation of the affecting factors their changes in Shiraz drinking groundwater, Iran. **Groundwater for Sustainable Development**, *[S.l],* v. 11, 100435, 2020. DOI: https://doi.org/10.1016/j.gsd.2020.100435. Disponível em: https://www.sciencedirect.com/science/article/pii/S2352801X19302796?via%3Dihub. Acesso em: 29 mar. 2023.

BECKAUSER, M. C.; NAKASCHIMA, P.; SILVA, L. M. A utilização de análise macroscópica de nascente como ferramenta de educação ambiental. **Revista brasileira de Educação Ambiental**, *[S.l],* v. 14, n. 2, p. 252-267, 2019. Disponível em: https://periodicos.unifesp.br/index.php/revbea/article/view/2635. Acesso em: 30 mar. 2023.

BOTELHO, C. G.; CAMPOS, C. M.; VALLE, R. H. P.; SILVEIRA, I. A. **Recursos naturais renováveis e impacto ambiental: água**. Lavras: UFLA/FAEPE, 2001. 187 p.

BRASIL. Ministério da Saúde. **Vigilância e controle da qualidade da água para consumo humano**.Secretaria de Vigilância em Saúde. Brasília: 2006, 212 p. Disponível em: https://bvsms.saude.gov.br/bvs/publicacoes/vigilancia_controle_qualidade_agua.pdf. Acesso em: 04 jan. 2022.

BREMER, J. E.; HARTER, T. Domestic wells have high probability of pumping septic tank

leachate. **Hydrology and Earth System Sciences**, *[S.l],* v. 16, p. 2453-2467, 2012. DOI: https://doi.org/10.5194/hess-16-2453-2012. Disponível em: https://hess.copernicus.org/articles/16/2453/2012/hess-16-2453-2012.pdf. Acesso em: 31 mar. 2023.

BHUIYAN, C.; RAY, P. K. C. Groundwater Quality Zoning in the Perspective of Health Hazards. **Water Resour Manage**, *[S.l],* v. 31, p. 251-267, 2017. DOI: https://doi.org/10.1007/s11269-016-1522-4. Disponível em: https://link.springer.com/article/10.1007/s11269-016-1522-4#citeas. Acesso em: 31 mar. 2023.

CABANELAS, I. T. D.; MOREIRA, L. M. A. Estudo sobre o estado de preservação das nascentes do rio Sapato, Lauro de Freitas-BA. Revista de Ciências Médicas e Biológicas, Salvador, v.6, n.2, p.160-162, 2007. http://dx.doi.org/10.9771/cmbio.v6i2.4192.CEMBRANEL, A. S. *et al*. Qualidade ambiental de nascente em área urbana. **Tecnologia e Ambiente**, *[S.l],* v. 25, p.145, 2019. DOI: https://doi.org/10.18616/ta.v25i0.4589. Disponível em: https://periodicos.ufba.br/index.php/cmbio/article/view/4192. Acesso em 31 mar. 2023.

CARVALHO, C. G. dos S.; PORTO, R. A.; OLIVEIRA, U. R. Avaliação macroscópica de impactos ambientais em nascentes do Rio de Ondas no Oeste da Bahia. **Revista Geociências**, São Paulo, v. 39, n. 3, p. 831-845, 2020. DOI: 10.5016/geociencias.v39i03.15074. Disponível em: https://www.periodicos.rc.biblioteca.unesp.br/index.php/geociencias/article/view/15074. Acesso em: 05 jan. 2021.

FRANCO, M. L.; CASTRO, M. A. B.; GUIMARÃES, M. A. A.; OLIVEIRA, G. H. B.; SILVA, R. S. S. S .Proposta de dispositivo de baixo custo para monitoramento de qualidade da água. **Communications and Innovations Gazette**, Santa Maria, v.5, n.1, p.44-55, 2021. DOI:10.5902/2448190462024. Disponível em: https://periodicos.ufsm.br/coming/article/view/62024. Acesso em: 05 jan. 2021.

ÇAVUŞ, A.; ŞEN, F. Chemical and microbiological properties of Lake Aygır in Turkey and usage of drinking, fisheries, and irrigation. **Brazilian Journal of Biology**, São Paulo, v. 83, p. 1-9, 2023. DOI: 10.1590/1519-6984.244494. Disponível em: https://www.scielo.br/j/bjb/a/FLhvczgfChNLFFKjBxH6qxy/?lang=en#. Acesso em: 05 jan. 2021.

CHATANGA, P.; NTULI, V.; MUGOMERI, E.; KEKETSI, T.; CHIKOWORE, N. V. T. Situational analysis of physico-chemical, biochemical and microbiological quality of water along Mohokare River, Lesotho. **Egyptian Journal of Aquatic Research**, *[S.l],* v. 45, p. 45-51, 2019. DOI: https://doi.org/10.1016/j.ejar.2018.12.002. Disponível em: https://www.sciencedirect.com/science/article/pii/S1687428518300876?via%3Dihub. Acesso em: 29 mar. 2023.

COMPANHIA AMBIENTAL DO ESTADO DE SÃO PAULO. Significado ambiental e sanitário das variáveis de qualidade das águas e dos sedimentos e metodologias analíticas e de amostragem. **Qualidade das águas interiores no Estado de São Paulo.** São Paulo: CETESB, v. 1, n. Série Relatórios, 53 p. 2016.

COELHO, S. C.; DUARTE, A. N.; AMARAL, L. S.; SANTOS, P. M. dos; SALLES, M. J.; SANTOS, J. A.

A. dos; SOTERO-MARTINS, A. Monitoramento da água de poços como estratégia de avaliação sanitária em Comunidade Rural na Cidade de São Luís, MA, Brasil. **Revista Ambiente e Água**, Taubaté, n. 12, v. 1, p. 157-167, 2017. DOI: 10.4136/ambi-agua.1962. Disponível em: https://www.scielo.br/j/ambiagua/a/q6YqwDvZ5ctjNMYs3fzD8bg/?lang=pt. Acesso em: 31 jan. 2021.

COMITÊ IBICUÍ. **Região hidrográfica do Rio Uruguai.** Bacia Hidrográfica. Alegrete – RS, 2018. Disponível em: http://www.comiteibicui.com.br/bh_002.html. Acesso em: 28 jan. 2022.

FELIPPE, M. F.; MAGALHÃES JÚNIOR, A. P. Impactos ambientais macroscópicos e qualidade das águas em nascentes de parques municipais em Belo Horizonte/MG. **Geografias**, Belo Horizonte, v. 8, n. 2, p. 08-23, 2012. DOI: 10.35699/2237-549X%20.13336. Disponível em: https://periodicos.ufmg.br/index.php/geografias/article/view/13336. Acesso em: 27 nov. 2021.

FERRAZ, F.; LAGO, G. M. T.; BARGOS, D. C. Mapeamento e classificação do nível de degradação das nascentes da microbacia do ribeirão dos passos (mbrp) como subsídio ao planejamento ambiental. **Caminhos de Geografia**, Uberlândia, v. 18, n. 64, p. 78-90, 2017. Disponível em: https://seer.ufu.br/index.php/caminhosdegeografia/article/view/40913. Acesso em: 29 mar. 2023.

FONSECA, A. R.; GONTIJO, R. A. N. Impactos ambientais macroscópicos e qualidade microbiológica das águas em nascentes da área urbana de Santo Antônio do Monte – MG. **Revista Meio Ambiente e Sustentabilidade**, Curitiba, v. 10, n. 20, p. 87-101, 2021. Disponível em: https://webcache.googleusercontent.com/search?q=cache:AicEf5Hdj5AJ:https://www.revistasuninter.com/revistameioambiente/index.php/meioAmbiente/article/view/966/456&cd=2&hl=pt-BR&ct=clnk&gl=br. Acesso em: 29 mar. 2023.

FREITAS, A. R. de. Degradação ambiental na bacia hidrográfica do Rio das Antas, Sudeste do Paraná: análise quantitativa e qualitativa mediante a utilização da metodologia do IDA. **Revista GEOgrafias**, *[S.l],* v. 28, n. 1, p. 22-42. 2020. DOI: 10.35699/2237-549X%20.2020.21485. Disponível em: https://periodicos.ufmg.br/index.php/geografias/article/view/21485#:~:text=A%20metodologia%20adotada%20na%20an%C3%A1lise,declividade%20e%20a%20press%C3%A3o%20demogr%C3%A1fica. Acesso em: 10 ago. 2023.

Fundação Nacional de Saneamento. **Manual de saneamento**. FUNASA: 2004. Disponível em: http://www.funasa.gov.br/sitefunasa/pub/pub00.htm. Acesso em: 10 ago. 2023.

GALVAN, K. A.; MEDEIROS, R. C.; NETO, R. P. M.; LIBERALESSO, T. GOLOMBIESKI, J. I.; ZANELLA, R. Análise ambiental macroscópica e a qualidade da água de nascentes na bacia do Rio São Domingos/SC, Brasil. **Revista Ibero-Americana de Ciências Ambientais**, Aracaju, v. 11, n. 1, p. 165-176, 2020. DOI:10.6008/CBPC2179-6858.2020.001.0016. Disponível em: https://www.researchgate.net/publication/338837870_Analise_ambiental_macroscopica_e_a_qualidade_da_agua_de_nascentes_na_bacia_do_Rio_Sao_DomingosSC_Brasil. Acesso em: 18 out. 2021.

GOMES, P. M.; MELO, C. de; VALE, V. S. do. Avaliação dos impactos ambientais em nascentes na cidade de Uberlândia – MG: Análise Macroscópica. **Sociedade & Natureza**, Uberlândia, v. 17, n. 32, p. 103-120, 2005. Disponível em: https://seer.ufu.br/index.php/sociedadenatureza/article/view/9169/5638. Acesso em: 12 dez. 2021.

HAMED, E. A. E.; KHALED, A.; AHDY, H.; AHMED, H. O.; RAZEK, F. A. A. Health risk assessment of heavy metals in three invertebrate species collected along Alexandria Coast, Egypt. **Egyptian Journal of Aquatic Research,** [S.l], v. 46, p. 389-395, 2020. DOI: https://doi.org/10.1016/j.ejar.2020.11.001. Disponível em: https://www.sciencedirect.com/science/article/pii/S1687428520300959?via%3Dihub. Acesso em: 31 mar. 2023.

HORA, A. B.; LIMA, A. S.; MELO, C. M. de; CAVALCANTI, E. B.; MARQUES, M. N. Socio-environmental aspects and diseases related to contaminated water in vulnerable communities in the Northeast of Brazil. **Research, Society and Development**, Vargem Grande Paulista – SP, v. 10, n. 10, e458101019044, 2021. DOI:10.33448/rsd-v10i10.19044. Disponível em: https://rsdjournal.org/index.php/rsd/article/view/19044. Acesso em: 20 jan. 2022.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. **Malha Municipal**. Downloads. Município_2017. Geociências. Rio de Janeiro: IBGE, 2017. Disponível em: https://www.ibge.gov.br/geociencias/organizacao-do-territorio/malhas-territoriais/15774-malhas.html?=&t=downloads. Acesso em: 10 jan. 2021.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. **Malha Municipal**. Downloads. Município_2020. Geociências. Rio de Janeiro: IBGE: 2020. Disponível em: https://www.ibge.gov.br/geociencias/organizacao-do-territorio/malhas-territoriais/15774-malhas.html?=&t=downloads. Acesso em: 10 jan. 2020.

ISMAIL, A. H.; SHAREEF, M. A.; ALATAR, F. M. Hydrochemistry of Groundwater and its Suitability for Drinking and Irrigation in Baghdad, Iraq. Environmental Processes, [S.l], v. 6, p. 543-560, 2019. https://doi.org/10.1007/s40710-019-00374-x. Disponível em: https://link.springer.com/article/10.1007/s40710-019-00374-x. Acesso em: 31 mar. 2023.

LAZAROTTO, D.; VOLPATTO, F.; GOLOMBIESKI, J. I.; HOFSTÄTTER, K.; BAUCHSPIESS, K.; SCHNEIDER, S. I.; TARONE, V. F. Análise da potabilidade da água em poços rasos no município de Caiçara no Rio Grande do Sul. **Ciência e Natura**, Santa Maria, v. 42, e86, p. 1-8, 2020. DOI: 10.5902/2179460X40496. Disponível em: https://periodicos.ufsm.br/cienciaenatura/article/view/40496/html. Acesso em: 18 out. 2021.

LEAL, J. T. C. P. Água para consumo humano na propriedade rural. Belo Horizonte: EMATER-MG, 2012. 18 p. Disponível em: https://www.emater.mg.gov.br/doc/intranet/upload/DETEC_Ambientalcartilha%20%C3%A1gua%20para%20consumo%20na%20propriedade%20rural.pdf. Acesso em: 31 jan. 2022.

LEAL, M. S. *et al*. Caracterização hidroambiental e nascentes. **Revista Ambiente & Água**, Taubaté, v.12, n.1, p.146-155, 2017. DOI: 10.4136/ambi-agua.1909. Disponível em: https://www.scielo.br/j/ambiagua/a/SdCmZSRf6NjVktjxN8cVLft/abstract/?lang=pt. Acesso em: 13 jan. 2022.

LEMOS, L. C. A. L; FERREIRA, L. L. N.; LYRA, D. L. de. Variabilidade espacial de atributos do solo indicadores de degradação ambiental em microbacia hidrográfica. **Revista Agro@ambiente On-line**, Boa Vista – RR, v. 11, n. 1, p. 11-20, janeiro – março, 2017. DOI: 10.18227/1982-8470ragro.v11i1.3413. Disponível em: https://revista.ufrr.br/agroambiente/article/view/3413. Acesso em: 12 jan. 2022.

LIRA, M. V.; SOUTO, M. V. Silva; DUARTE, C. R. Análise Multitemporal da Dinâmica da Paisagem para os Municípios de Barroquinha e Chaval, Noroeste do Estado do Ceará - Brasil, pelo Uso e Cobertura da Terra. **Anuário do Instituto de Geociências – UFRJ**, v. 42, n. 1, p. 471-482, 2019. Disponível em: https://ppegeo.igc.usp.br/index.php/anigeo/article/view/13151. Acesso em: 14 nov. 2021.

MALAQUIAS, G. B.; CÂNDIDO, B. B. Avaliação dos impactos ambientais em nascentes do Munícipio de Betim, MG: análise macroscópica. Revista Meio **Ambiente e Sustentabilidade**, [*S.*l], v.3, n.2, p. 51-65, 2013. DOI: https://doi.org/10.22292/mas.v3i2.174. Disponível em: https://www.revistasuninter.com/revistameioambiente/index.php/meioAmbiente/article/view/174. Acesso em: 29 mar. 2023.

MARCHINI, D. M.; CARNEIRO, V. A.; SOUZA, J. C. Análise ambiental macroscópica do Córrego dos Macacos em Terezópolis de Goiás (GO) – Um relato de experiência. **Revista Eletrônica da Associação dos Geógrafos Brasileiros Seção Três Lagoas**, [*S.*l], v. 1, n. 33, 2021. Disponível em: https://webcache.googleusercontent.com/search?q=cache:KGySNE4IQWYJ:https://periodicos.ufms.br/index.php/RevAGB/article/view/12776/9248&cd=2&hl=pt-BR&ct=clnk&gl=br. Acesso em: 30 mar. 2023.

MARTELLI, A. Educação ambiental aliada ao método de recuperação por plantio em uma nascente localizada na área urbana do município de Itapira – SP. **Revista Eletrônica em Gestão, Educação e Tecnologia Ambiental** – REGET, Santa Maria – RS, v. 17, n. 17, p. 3357-3365, 2013. DOI: https://doi.org/10.5902/2236117010889. Disponível em: https://periodicos.ufsm.br/reget/article/view/10889?source=/reget/article/view/10889. Acesso em: 30 mar. 2023.

MATTOS, M. L. T.; SILVA, M. D. da. Controle da Qualidade Microbiológica das Águas de Consumo na Microbacia Hidrográfica Arroio Passo do Pilão. Comunicado Técnico Ministério da Agricultura Pecuária e Abastecimento. Embrapa: Pelotas, p. 3, 2002. Disponível em: https://ainfo.cnptia.embrapa.br/digital/bitstream/item/31545/1/comunicado61.pdf. Acesso em: 14 dez. 2021.

MEDEIROS, T. F.; SILVA, F. R. da; MORANDI, E. R.; NASCIMENTO, P. C.; DUTRA, A. R.; STACHIW, R. Avaliação da qualidade de água de nascentes sob diferentes ocupações do solo. **Revista Brasileira de Ciências da Amazônia**, [S.l.], v. 4, n. 1, p. 14 – 28, 2015. Disponível em: https://www.scielo.br/j/cerne/a/fwFZsKZV4mVXqLX98sYtcHb/?lang=pt. Acesso em: 25 nov. 2021.

MUHAMMAD, D.; USMAN, Q. A. Heavy metal contamination in water of Indus River and its tributaries, Northern Pakistan: evaluation for potential risk and source apportionment. **Toxin Rewiews**, [*S.*l.], v. 41, p. 380-388, 2022. DOI: https://doi.org/10.1080/15569543.2021.1882499. Disponível em: https://www.tandfonline.com/doi/abs/10.1080/15569543.2021.1882499?journalCode=itxr20. Acesso em: 29 mar. 2022.

OLIVEIRA NETA, M. R. de. **Recursos hídricos: água um bem precioso para a humanidade**. Conteúdo Jurídico, Brasília - DF, 2013. Disponível em: https://conteudojuridico.com.br/consulta/Artigos/34680/recursos-hidricos-agua-um-bem-precioso-para-a-humanidade. Acesso em: 17 jan. 2022.

PINTO, L. V. A.; BOTELHO, S. A.; DAVIDE, A. C.; FERREIRA, E. Estudo das nascentes da Bacia

Hidrográfica do Ribeirão Santa Cruz, Lavras, MG. **Scientia Forestalis**, Piracicaba, n. 65, p. 197-206, 2004. Disponível em: https://www.ipef.br/publicacoes/scientia/nr65/cap19.pdf. Acesso em: 05 jan. 2022.

PRIMACK, R. B.; RODRIGUES, E. **Biologia da conservação**. Londrina - PR: Editora Vida, 2007. 327p.

RANGEL, A. R. M.; OLIVEIRA, V. P. S.; MOREIRA, M. A. C. O programa rio rural no estado do Rio de Janeiro: a experiência na microbacia canal Jurumirim, município de Macaé. **Revista Monografias Ambientais-REMOA/UFSM**, Santa Maria, v. 15, n.1, p. 302-322, 2006. DOI: https://doi.org/10.5902/2236130819948. Disponível em: https://periodicos.ufsm.br/remoa/article/view/19948. Acesso em 29. Mar. 2023.

REIS, A. L. M.; COSTA, T. T. da; PINTO, M. G. F.; FARIA, A. L. L. de; COSTA, L. M. da; BERNARDES, R. C. Parâmetros macroscópicos para avaliação do estado de conservação de nascentes em área de proteção ambiental. **Humboldt - Revista de Geografia Física e Meio Ambiente**, Rio de Janeiro, v. 1, n. 3, e55667, 2021. Disponível em: https://www.e-publicacoes.uerj.br/index.php/humboldt/article/download/55667/39448. Acesso em: 30 mar. 2023.

RESENDE, K. M. G. de; ALCANTRA, E.; FONSECA, L. R. da; MARQU, R. F. P. V. Análise macroscópica como subsídio para um plano de manejo de uma nascente urbana no Sul de Minas Gerais. **Revista Augustus**, Rio de Janeiro, v. 24, n. 49, p. 260-277, 2020. Disponível em: https://revistas.unisuam.edu.br/index.php/revistaaugustus/article/view/481/261. Acesso em: 25 nov. 2021.

ROCHA, B. F.; FONSECA, A. R.; SOUSA, F. F. Análise Macroscópica e Parâmetros Microbiológicos de nascentes da área urbana de Cláudio, Minas Gerais, Brasil. **Conexão Ciência**, [S.l.] v. 12, n. 3, p. 17-33, 2017. DOI: 10.24862/cco.v12i3.567. Disponível em: https://periodicos.uniformg.edu.br:21011/ojs/index.php/conexaociencia/article/view/567. Acesso em: 12 fev. 2022.

SALEEM, M.; IQBAL, J.; SHAH, M. H. Seasonal variations, risk assessment and multivariate analysis of trace metals in the freshwater reservoirs of Pakistan. **Chemosphere**, [S.l.], v. 216, p. 715-724, 2019. DOI: https://doi.org/10.1016/j.chemosphere.2018.10.173. Disponível em: https://www.sciencedirect.com/science/article/pii/S0045653518320447?via%3Dihub. Acesso em: 29 mar. 2023.

SANTOS, L. B. dos.; SANTOS, E. O.; SCHWANTZ, P. I.; BOHRER, R. E. G.; PRESTES, M. M. B.; LARA, D. M. DE. Análise ambiental de nascentes do bairro Fontes no município de Soledade (RS), Brasil. **Revista em Agronegócio e Meio Ambiente**, Maringá-PR, v. 14, Supl. 2, e8771, 2021. DOI: DOI: 10.17765/2176-9168.2021v14Supl.2.e8771. Disponível em: https://periodicos.unicesumar.edu.br/index.php/rama/article/view/8771/6852. Acesso em: 30 mar. 2023.

SCHLEDER, A. A.; VARGAS, L. M. P.; HANSEL, F. A.; FROEHNER, S.; PALAGANO, L. T.; FILHO, E. F. da R. Evaluation of occurrence of NO_3^- , Coliform and atrazine in a karst aquifer, Colombo, PR. **Revista Brasileira de Recursos Hídricos**, Porto Alegre, v. 22, e20, 2017. DOI: 10.1590/2318-0331.0117160452. Disponível em: https://www.scielo.br/j/rbrh/a/m8q43hMXGKTWty7fGcLgJsr/?lang=en. Acesso em: 26 jan. 2022.

SCHNEIDER, S. I.; GOLOMBIESKI, J. I.; SEBEN, D.; MENEGAZZO, K. C.; WASTOWSKI, A.D.; BORBA,

W. F.; DECEZARO, S. T.; MEDEIROS, R. C. Water Quality In Individual Groundwater Supply Systems In Southern Brazil. **Ciência e Natura**, [S.l.], v. 43, p. 1-21, 2021. Disponível em: https://periodicos.ufsm.br/cienciaenatura/article/view/65195. Acesso em: 10 jan. 2022.

SEBEN, D.; TOEBE, M.; WASTOWSKI, A. D.; HOFSTÄTTER K.; VOLPATTO, F.; ZANELLA, R.; PRESTES, O. D.; GOLOMBIESKI, J. I. Water quality variables and emerging environmental contaminant in water for human consumption in Rio Grande do Sul, Brazil. **Environmental Challenges**, [S.l.], v. 5, 100266, 2021. DOI: 10.1016/j.envc.2021.100266. Disponível em: https://www.sciencedirect.com/science/article/pii/S2667010021002456. Acesso em: 03 mar. 2022.

SILVA, T. S. S.; BRITO, P. L. C.; SANTOS, C. G.; MAGALHÃES, I. D.; SOUZA, R. B.; ALMEIDA, C. A. Diagnóstico ambiental de nascentes na bacia hidrográfica do Rio Piauí, Alagoas. **Revista Verde de Agroecologia e Desenvolvimento Sustentável**, [S.l], v. 13, n. 3, p. 399-403, 2018. DOI: 10.18378/rvads.v13i3.5844. Disponível em: https://www.researchgate.net/publication/329037113_Diagnostico_ambiental_de_nascentes_na_bacia_hidrografica_do_Rio_Piaui_Alagoas#fullTextFileContent. Acesso em: 29 mar. 2023.

WU, J.; ZHANG, Y.; ZHOU, H. Groundwater chemistry and groundwater quality index incorporating health risk weighting in Dingbian County, Ordos basin of northwest China. **Geochemistry**, Jena, v. 80, ed. 4, p. 125607, 2020. Disponível em: https://www.sciencedirect.com/science/article/abs/pii/S0009281919301229. Acesso em: 17 jan. 2022.

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