

**IMPACTS ASSOCIATED WITH GROUNDWATER TABLE LOWERING:  
ENVIRONMENTAL AND SOCIAL CONSEQUENCES AND STRATEGIES FOR  
SUSTAINABLE MANAGEMENT**

**IMPACTOS ASSOCIADOS AO REBAIXAMENTO DO NÍVEL DO LENÇOL FREÁTICO:  
CONSEQUÊNCIAS AMBIENTAIS, SOCIAIS E ESTRATÉGIAS PARA UMA GESTÃO  
SUSTENTÁVEL**

**IMPACTOS ASOCIADOS AL DESCENSO DEL NIVEL FREÁTICO: CONSECUENCIAS  
AMBIENTALES, SOCIALES Y ESTRATEGIAS PARA UNA GESTIÓN SOSTENIBLE**



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**Suelen Rodrigues Carvalho<sup>1</sup>, Álvaro Luiz Jesus dos Santos<sup>2</sup>, Lucas Galvão Pinho<sup>3</sup>,  
Natasha Sales Xavier<sup>4</sup>, Juliana Do Amor Divino Tavares<sup>5</sup>, Anna Virgínia Muniz  
Machado<sup>6</sup>, Gustavo Augusto Teixeira de Fatima<sup>7</sup>**

**ABSTRACT**

The groundwater plays an essential role in environmental preservation. It ensures the availability of subterranean water, vital for the survival of fauna and flora, and is also crucial for maintaining ecological balance. Responsible management of this resource is indispensable to protect ecosystems and prevent issues such as contamination and depletion of aquifers. This article explores the importance of groundwater in the context of environmental sustainability, with an emphasis on the need to care for subterranean water. Practical examples will be presented, such as studies conducted in Maceió (AL), Pelotas (RS), and Ribeirão das Neves (MG), which show the risks and best practices related to groundwater lowering. Additionally, the Sustainable Development Goals (SDGs) 6, 14, and 15, which address the protection of water resources and terrestrial and aquatic life, will be discussed. Brazilian legislation will also be addressed, such as Bill 1281/2021, which seeks to regulate the use of subterranean water in a balanced and sustainable manner. This work aims to highlight ways to ensure the preservation of this crucial resource for the future generations.

**Keywords:** Groundwater. Aquifer. Lowering. Environmental Impact.

<sup>1</sup> Undergraduate Student in Water Resources and Environmental Engineering. Universidade Federal Fluminense. E-mail: [suelenrodrigues@id.uff.br](mailto:suelenrodrigues@id.uff.br)

<sup>2</sup> Graduated in Industrial Design. Universidade Federal Fluminense. E-mail: [alvaro\\_santos@id.uff.br](mailto:alvaro_santos@id.uff.br)

<sup>3</sup> Undergraduate Student in Electrical Engineering. Universidade Federal Fluminense.  
E-mail: [pinholucas@id.uff.br](mailto:pinholucas@id.uff.br)

<sup>4</sup> Graduated in Industrial Design. Universidade Federal Fluminense. E-mail: [salesnatasha@id.uff.br](mailto:salesnatasha@id.uff.br)

<sup>5</sup> Undergraduate Student in Electrical Engineering. Universidade Federal Fluminense.  
E-mail: [tavares\\_juliana@id.uff.br](mailto:tavares_juliana@id.uff.br)

<sup>6</sup> Dr. in Civil Engineering. Universidade Federal Fluminense. E-mail: [annavirnia@id.uff.br](mailto:annavirnia@id.uff.br)

<sup>7</sup> Undergraduate Student in Water Resources and Environmental Engineering. Universidade Federal Fluminense. E-mail: [gustavo\\_fatima@id.uff.br](mailto:gustavo_fatima@id.uff.br)

## RESUMO

Os lençóis freáticos desempenham um papel essencial na preservação do meio ambiente. Eles garantem a disponibilidade de água subterrânea o que é vital para a sobrevivência da fauna e flora, além de serem fundamentais para manter o equilíbrio ecológico. Uma gestão responsável desse recurso é indispensável para proteger os ecossistemas e prevenir problemas como a contaminação e o esgotamento dos aquíferos. Este artigo explora a importância dos lençóis freáticos no contexto da sustentabilidade ambiental, com ênfase na necessidade de cuidar das águas subterrâneas. Serão apresentados exemplos práticos, como os estudos realizados em Maceió (AL), Pelotas (RS) e Ribeirão das Neves (MG), que mostram os riscos e as boas práticas relacionadas ao rebaixamento do lençol freático. Além disso, serão abordados os Objetivos de Desenvolvimento Sustentável (ODS) 6, 14 e 15, que tratam da proteção dos recursos hídricos e da vida terrestre e aquática. Também será discutida a legislação brasileira, como o Projeto de Lei 1281/2021, que busca regulamentar o uso das águas subterrâneas de maneira equilibrada e sustentável. Este trabalho pretende destacar caminhos para garantir a preservação desse recurso tão importante para futuras gerações.

**Palavras-chave:** Lençol Freático. Aquífero. Rebaixamento. Impacto Ambiental.

## RESUMEN

Los niveles freáticos desempeñan un papel esencial en la preservación del medio ambiente. Garantizan la disponibilidad de agua subterránea, lo que es vital para la supervivencia de la fauna y la flora, además de ser fundamentales para mantener el equilibrio ecológico. Una gestión responsable de este recurso es indispensable para proteger los ecosistemas y prevenir problemas como la contaminación y el agotamiento de los acuíferos. Este artículo explora la importancia de los niveles freáticos en el contexto de la sostenibilidad ambiental, con énfasis en la necesidad de cuidar las aguas subterráneas. Se presentarán ejemplos prácticos, como los estudios realizados en Maceió (AL), Pelotas (RS) y Ribeirão das Neves (MG), que muestran los riesgos y las buenas prácticas relacionadas con el descenso del nivel freático. Además, se abordarán los Objetivos de Desarrollo Sostenible (ODS) 6, 14 y 15, que tratan sobre la protección de los recursos hídricos y de la vida terrestre y acuática. También se analizará la legislación brasileña, como el Proyecto de Ley 1281/2021, que busca regular el uso de las aguas subterráneas de manera equilibrada y sostenible. Este trabajo pretende destacar caminos para garantizar la preservación de este recurso tan importante para las futuras generaciones.

**Palabras clave:** Nivel Freático. Acuífero. Descenso. Impacto Ambiental.

## 1 INTRODUCTION

The lowering of the water table is characterized as a human intervention that has great environmental, social and economic relevance, often necessary for the execution of civil works, agricultural activities and industrial processes. This phenomenon, when not properly managed, can trigger a series of negative impacts that may or may not go beyond the local level, affecting entire ecosystems, public health, and the socioeconomic structures of the communities involved. The main objective of this article is to demonstrate these multiple consequences, establishing a critical dialogue with Sustainable Development Goals (SDGs) 6, 14 and 15, which respectively talk about drinking water and sanitation, aquatic life and terrestrial life.

The relationship between groundwater and surface water configures a dynamic and complex system, fundamental for the maintenance of environmental homeostasis. As demonstrated by Nevill et al. (2010), the large exploitation of groundwater resources, a common practice on a global scale, can irreversibly compromise aquatic and terrestrial ecosystems, due to the interdependence that characterizes hydrological cycles. The disturbance of the water table triggers a series of chain changes, affecting from strictly underground organisms to complex river ecosystems.

The consequences of downgrading manifest themselves in complex ways, including saline intrusion into coastal regions, soil subsidence, and degradation of aquatic habitats. As Kath and Dyer (2017) point out, socio-ecological systems dependent on groundwater resources face increasing challenges, requiring integrated management approaches that consider both the hydrological aspects and the human dimensions involved. The social dimension of these impacts deserves particular attention, since rural and peri-urban communities are the most affected by water scarcity.

In the Brazilian context, characterized by a rich hydrogeological diversity with aquifer systems of global importance, the regulation of the use of groundwater has advanced unevenly. Bill 1281/2021 represents a significant legislative effort to establish stricter guidelines on the exploitation of these resources. However, the effective implementation of these policies comes up against structural challenges, including technical limitations and scarcity of financial resources.

This article seeks to analyze innovative strategies to mitigate the impacts of the lowering of the water table, with special attention to nature-based solutions and sustainable technologies. Through a multidisciplinary approach that integrates knowledge of geology, biology and public policies, the study aims to contribute to the development of management

practices that harmonize economic development with environmental preservation, ensuring water security for present and future generations.

## 2 METHODOLOGY

The methodology used in this study was based on a broad bibliographic search with the objective of identifying relevant situations and discussions that related the lowering of groundwater to its environmental, social and economic consequences. 12 previously selected scientific articles were analyzed, obtained through platforms such as Google Scholar BR and EJA, in addition to the motivation generated by the reading of reports and documents located in the university repository, which served as an initial basis for the delimitation of the theme. This approach sought to ensure a global perspective, including studies carried out in Brazil and abroad, in order to understand different contexts and practices related to the management of water resources in civil works.

During the analysis, the focus was to identify methods, impacts, and legislation associated with the topic, finding a common pattern among the articles that highlight environmental risks, such as saline intrusion, aquifer contamination, and biodiversity reduction, as well as the economic and social challenges arising from these practices.

## 3 RESULTS AND DISCUSSIONS

The sustainable management of underground resources requires integrated planning and the use of technological solutions to mitigate impacts. Sousa and Silva (2020), highlight the effectiveness of technologies such as drainage tips and deep wells, associated with rigorous monitoring, as in the case of the San-tinho WWTP, in Minas Gerais, where the use of these techniques ensured the stability of the work and reduced environmental impacts. In addition, tools such as Geographic Information Systems (GIS) allow the identification of vulnerable areas and the planning of mitigation strategies, according to Nevill et al. (2010).

Practical cases, such as the use of observation wells in Pelotas (RS) to monitor the dynamics of the water table (Martins et al., 2012), demonstrate the importance of technical solutions to avoid negative impacts. Additionally, Brazilian legislation, such as PL 1281/2021, can play a relevant role in regulating groundwater extraction and ensuring alignment with the SDGs.

Integrated management and long-term monitoring are key to ensuring the sustainability of groundwater resources, contributing to environmental conservation and social well-being. Effective public policies, the use of advanced technologies and awareness

are essential aspects to minimize the impacts of lowering the water table and ensure the responsible use of this resource.

The lowering of the water table, a common practice in civil works, can generate significant environmental impacts, affecting ecosystems and water resources essential for sustainability. This process is directly related to the goals of the Sustainable Development Goals 3 (SDGs), such as SDG 6, which seeks to ensure drinking water and sanitation for all (UN, 2020); SDG 14, aimed at the conservation of aquatic life (Fogasa et al., 2018); and SDG 15 (UN, 2023), which promotes the protection and recovery of terrestrial ecosystems (Cabral et al., 2006; Nevill et al., 2010).

Among the main problems related to the lowering of the water table is the reduction of soil moisture, a factor that compromises vegetation and ecosystems dependent on this resource, as described by Fan et al. (2023), who analyze the effects of groundwater availability on productivity and plant composition. The excessive withdrawal of groundwater reduces soil moisture, compromising the survival of ecosystems that depend on this water resource, especially in arid and semi-arid regions, as reported in research that highlights the influence of the water table on productivity and plant composition (The lowering of the water level in mining and civil works).

In semi-arid regions of Brazil, as highlighted by studies by Nevill et al. (2010), desertification is an alarming consequence, putting at risk the goal of SDG 15 to curb soil degradation and restore areas already affected. The sustainable management of groundwater resources, therefore, is not only an environmental necessity, but a fundamental step to ensure a balanced and resilient future in the face of global challenges. The degradation of ecosystems that depend on groundwater is an alarming consequence of the lowering of the water table. Lowering water levels can destroy wetlands and aquatic habitats, threatening biodiversity. As Nevill et al. (2010) point out, these impacts may be irreversible, directly affecting Sustainable Development Goals 14 and 15, which prioritize the preservation of aquatic and terrestrial life. In coastal regions, the problem is aggravated by saline intrusion, when seawater invades aquifers, compromising the quality of drinking water.

A clear example is the case of Maceió, described by Souza et al. (2006), where excessive groundwater extraction led to salinity contamination, harming both human supply and agricultural activities. This phenomenon is directly linked to SDG 2, which seeks to promote food security through sustainable agricultural practices. Another significant impact is the reduction of the base flow of rivers and lakes, which accelerates siltation and degradation of water quality. According to Iglesias et al. (2020), this decrease affects the

regeneration capacity of water bodies, compromising aquatic ecosystems and making it difficult to achieve the goals of SDG 6 (clean water and sanitation) and SDG 14.

In addition, lowering the water table can cause soil subsidence, a phenomenon in which the earth's surface sinks due to the loss of water pressure in the soil pores. In karst areas, such as Sete Lagoas (MG) and Cajamar (SP), the dissolution of limestone rocks expands underground cavities, leading to soil collapse and the formation of craters, as highlighted by Cabral et al. (2006). In the springs of Muritiba, analyzed by Santos et al. (2015), the lowering of the water table impairs the maintenance of water flow, making these water sources dependent exclusively on rainfall. In extreme cases, this can lead to the extinction of springs, aggravating environmental degradation. These examples show that, without proper planning and monitoring, the lowering of the water table can trigger a series of problems, such as water contamination, loss of ecosystems, saline intrusion and soil subsidence. To mitigate these impacts, it is essential that engineering practices are aligned with the SDG goals, promoting the sustainable use of water resources and the protection of the environment 4 . Only with conscious and integrated actions will it be possible to guarantee long-term sustainability.

### 3.1 SOCIAL AND ECONOMIC IMPACTS

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### 3.2 GOOD PRACTICES FOR LOWERING GROUNDWATER

The practice of lowering groundwater requires extreme care and thorough planning to avoid significant environmental and social impacts. Studies such as the one by Sousa and Silva (2020), on the method used in the construction of the Santinho Effluent Treatment Plant (ETE), and the one by ABAS (2007), which addresses the lowering of the water level in mining activities and civil works, offer valuable guidance on effective techniques and good practices to control groundwater, especially in urban and industrial environments.

The use of technologies such as draining tips and deep wells, combined with careful planning for the responsible disposal of extracted water, is essential to mitigate the negative impacts of this process. A practical example is the case of the Santinho WWTP, described by Sousa and Silva (2020), where the application of draining tips ensured the stability of the work. This success, however, was only achieved with the adoption of continuous and rigorous monitoring of water levels, a fundamental measure to avoid damage to local ecosystems and preserve the quality of available water resources.

The adoption of appropriate techniques and efficient planning are crucial to protect both the quality of the water and the soils in the vicinity of the works. In addition, respecting environmental regulations and incorporating good management practices is essential to ensure that these processes are conducted safely and responsibly.

Tools such as Geographic Information Systems (GIS) play an important role in this context. As pointed out by Nevill et al. (2010), GIS is essential to identify and analyze areas that are more vulnerable to the impacts of lowering the water table, offering accurate information on soil types and their ability to filter contaminants. This detailed mapping allows you to better understand the associated risks and define effective strategies to mitigate environmental impacts, ensuring the execution of projects in a sustainable and balanced manner.

With careful planning, the use of advanced technology, and compliance with regulations, it is possible to lower groundwater responsibly, minimizing risks and preserving natural resources for future generations.

### 3.3 GROUNDWATER VULNERABILITY TO MISMANAGEMENT

Efficient management of groundwater resources is increasingly relevant, especially in countries facing serious water scarcity challenges. In the study by Margane et al. (2009), protection and management strategies adopted by Jordan are discussed, an example of a country with limited water resources. The research highlights that the lack of adequate regulation and inspection can lead to overexploitation of aquifers, a problem that also

manifests itself in regions of Brazil, such as Pelotas, RS, as pointed out by Delgado et al. (2012).

To prevent aquifer depletion and groundwater contamination, it is critical to implement continuous monitoring systems that keep track of variations in groundwater level. Technologies such as piezometers are valuable tools in this process, as they help detect changes in water levels and allow for preventive interventions, protecting aquifers and ensuring their sustainability.

The study by Iglesias et al. (2020), which analyzes the management of water resources in the Mediterranean region, reinforces the need for strategic planning for the use and distribution of groundwater. According to the authors, an integrated approach that takes into account the needs of different users is essential to ensure the sustainability of water resources and preserve environmental balance. This collaborative management is indispensable to avoid conflicts over water use, especially in areas with high population density or intensive agriculture.

Both Margane et al. (2009) and Iglesias et al. (2020) make it clear that sustainable groundwater management is a global priority. These resources are critical for water supply, agricultural production, and ecosystem maintenance. Without proper regulation and enforcement, environmental impacts can be severe and often irreversible. Therefore, it is essential that public policies promote the conscious use of these resources, with measures such as continuous monitoring of water levels and the adoption of technologies that help preserve aquifers. Thus, it is possible to ensure water security and sustainability for future generations.

### 3.4 INTEGRATED MANAGEMENT AND LONG-TERM MONITORING

Sustainable groundwater management requires an integrated approach that combines continuous monitoring and effective public policies. As demonstrated by Martins et al. (2012), systematic monitoring of groundwater levels is crucial to understand the impacts of climate change and prevent contamination. Technologies such as piezometers and level gauges allow for accurate monitoring of aquifer dynamics, which is essential for responsible interventions.

Kath and Dyer (2017) highlight the need for integrated groundwater management, which is often neglected in relation to surface resources. Koundouri et al. (2010) reinforce that the lack of adequate regulation has generated irreversible damage to aquifers, requiring strict policies to control extraction and regulate agricultural and industrial practices. Singh et

al. (2015) argue that exploration should be aligned with environmental preservation, considering the interdependence between terrestrial and aquatic systems.

These studies converge on the importance of integrating groundwater management with broader environmental policies, balancing human needs and ecosystem protection. Long-term monitoring, associated with collaborative governance, is essential to ensure water security and the sustainability of groundwater resources in the face of global challenges.

### 3.5 THE CONNECTION WITH THE SDGS AND BRAZILIAN LEGISLATION

The responsible management of groundwater is directly related to the Sustainable Development Goals, especially SDG 6, which seeks to ensure universal access to safe drinking water. The implementation of PL 1281/2021, which regulates the granting of groundwater, is an important example of how legislation can help protect water resources. The bill highlights the need for a plan for the reuse and proper disposal of extracted water, in line with SDGs 14 (Life in Water) and 15 (Life on Land). This approach aims to protect aquatic and terrestrial ecosystems, ensuring the sustainability of human activities and long-term environmental preservation.

### 3.6 CASE STUDIES

Lowering the water table is a key technique in areas with high groundwater levels, especially when the water table is too close to the surface and can interfere with construction activities. This practice aims to ensure the stability and safety of the works, in addition to preventing problems such as water infiltration and flooding, which can compromise the integrity of the structures.

An example of this occurred in the construction of the Santinho Sewage Treatment Plant (ETE), in Ribeirão das Neves, Minas Gerais. For this project, the method of lowering by draining tips, also known as "well points", was used. This process was chosen for its effectiveness in keeping the site dry during excavations, controlling the rise of water from the water table without the conduction of fine particles. This avoided the settlement of neighboring structures and brought a more economical solution.

Barbosa and Miranda (2023), point out that the lowering of the Santinho WWTP was carried out with the constant monitoring of the technical team, which monitored the positioning of the lowering pumps, the installation of the tips and the drainage of the water. The implementation of this technique proved to be efficient in ensuring soil stability and safety of the work, emphasizing the importance of rigorous monitoring and the choice of appropriate methods.

Another example occurred in a civil construction site in the Areal neighborhood, in Pelotas/RS (Martins et al., 2012), where the water table varied between 1.29 m and 0.54 m deep. In this case, the lowering planning considered the permeability of the soil and the depth of the excavation. The use of PVC pipes with porous blankets in observation wells allowed an efficient monitoring of the dynamics of the water table, avoiding environmental impacts and groundwater contamination.

These practical examples show that, with the appropriate choice of the lowering method and continuous monitoring, it is possible to ensure the stability of the works and environmental protection, in addition to optimizing resources and reducing costs. The success of lowering the water table in large works depends on proper planning, well-chosen techniques and constant supervision.

#### **4 CONCLUSION**

The lowering of the water table is an essential practice for the development of civil works, but it requires a careful and multidimensional approach to avoid significant environmental, social and economic impacts. As demonstrated throughout this study, inadequate groundwater extraction can trigger serious consequences, including desertification, saline intrusion, soil subsidence, reduced biodiversity, and compromise of sensitive ecosystems, with direct effects on the water and food security of populations.

The results presented show that the sustainability of groundwater resources depends fundamentally on three interrelated pillars: (1) the adoption of appropriate technologies, such as drainage tips, deep wells and continuous monitoring systems; (2) the implementation of effective public policies, represented by instruments such as PL 1281/2021; and (3) integration with the Sustainable Development Goals, particularly SDGs 6, 14 and 15.

The practical cases analyzed, such as those of the works at ETE Santinho (MG) and Pelotas (RS), demonstrate that it is possible to reconcile infrastructural development with environmental preservation through adequate planning, careful choice of techniques and rigorous monitoring. However, the vulnerability of aquifers to mismanagement, exemplified by cases such as that of Maceió, warns of the urgent need for effective regulation and constant inspection.

The integrated management of groundwater resources emerges, therefore, as a strategic imperative for the twenty-first century, demanding a collaborative approach that involves public authorities, the private sector, academia and civil society. Only by balancing development needs and conservation imperatives will it be possible to guarantee the water

security of present and future generations, preserving these vital resources in the face of the challenges of climate change and urban and agricultural growth.

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