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Invisible pollutants: environmental, economic and social impacts as threats to water quality

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ABSTRACT

The objective of the article is to analyze the environmental, social and economic impacts of invisible pollutants as threats to water quality and sustainability. The Methodology used was inductive logic through bibliographic research. It is concluded that the reason for apprehension/attention/consideration is that these small molecules are resistant to conventional water treatments. They can even become increasingly toxic, contaminating the most noble resource: water. Therefore, even treated water can contain residual contaminants, becoming toxic when such contaminants reach their concentration limits, causing changes in aquatic communities. These contaminants are neither included in the routine monitoring programs of the health and environmental agencies, nor in the environmental control legislation or regulations. This is a critical situation since all the impacts of these molecules are not yet fully known.

KEY WORDS: invisible pollutants, water, environment, sustainability.

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Contaminantes invisibles: impactos ambientales, económicos y sociales como amenazas a la calidad del agua.

RESUMEN

El objetivo del artículo es analizar los impactos ambientales, sociales y económicos de los contaminantes invisibles como amenazas para la calidad y la sostenibilidad del agua. En cuanto a la metodología, se usó lógica inductiva a través de la investigación bibliográfica. Se concluye que la razón de la aprensión/atención/consideración/es que estas pequeñas moléculas son resistentes a los tratamientos convencionales de agua. Incluso, pueden volverse cada vez más tóxicos, contaminando nuestro recurso más noble: el agua. Por lo tanto, incluso el agua tratada puede contener contaminantes residuales, volviéndose tóxicos cuando tales contaminantes alcanzan sus límites de concentración, causando cambios en las comunidades acuáticas. Estos contaminantes no están incluidos en los programas de monitoreo de rutina de las agencias ambientales y de salud, ni en la legislación o regulaciones de control ambiental. Situación crítica, ya que todos los impactos de estas moléculas aún no se conocen por completo.

PALABRAS CLAVE: contaminantes invisibles, agua, medio ambiente, sostenibilidad.

Introduction

The negative environmental, social and economic deterioration of water quality is reflected, among other aspects, in the loss of biodiversity, an increase in waterborne diseases, an increase in the cost of water treatment intended for domestic supply and industrial use, loss of productivity in livestock rearing and agriculture, a reduction in fish stocks, and a reduction in touristic, cultural and landscape values.

Brazilian society faces major challenges in the management of water quality because it is a cross-sector issue that requires a joint effort among the areas of water resources, environment, sanitation, health, industry and agriculture. It is essential to promote reflection on that topic through studies that contribute to effective planning and that are based on measurable indicators, enabling efficient recovery and maintenance of the quality of Brazilian surface waters.

In view of this scenario, the **subject** of this study is a discussion of the environmental, social and economic impacts of invisible pollutants as threats to water quality and sustainability.

The **objective** of this analysis is to discuss the environmental, social and economic impacts of invisible pollutants as threats to water quality and sustainability. Therefore, the work was divided into sections: first, the analysis of the importance of water quality to achieve sustainability; second, the analysis of the Brazilian legal system in relation to water resources, and third, the discussion of the challenges of maintaining water quality in the face of the negative environmental, social and economic impacts of invisible pollutants. This study is **justified** by the need to mitigate the degradation of water quality as a threat to achieving sustainability, and to review the indices for monitoring water, since conventional monitoring no longer meets the environmental needs. Moreover, there is a lack of research on the consequences of water pollution, bearing in mind that it can even have trans-border implications and create problems for the polluting and for the neighboring countries. Therefore, this is an issue that requires cross-border discussion¹.

In terms of **methodology**, inductive logic was used, through a literature review, including the Cartesian method for data collection and the final report, and the inductive method with the techniques of referent, category, operational concepts, bibliographic research, and annotation.

¹ Duarte, G. M. (2010). Águas transfronteiriças-Qualidade e questões ambientais/econômicas com interesse ao desenvolvimento Sul Americano. *Revista do Instituto Geológico*, 31(1-2), 53-65.

Water: essential for achieving sustainability

Proper water resources management is essential to achieve an ecologically balanced environment since access to water is a fundamental right for a healthy quality of life. Among natural resources, water is highlighted:

Water is the most abundant simple substance of the biosphere. It exists in liquid form (salty and freshwater), solid (freshwater) and steam (freshwater), oceans and seas, polar icecaps, glaciers, lakes, rivers, groundwater, and in the atmosphere, comprising approximately 1,500 million cubic kilometers. Around 97% of water is salty, consisting of oceans and seas; 2.25% is located at the polar icecaps and in glaciers, in solid form (ice) and the remaining 0.72% is in rivers, lakes, etc.; and there is a tiny amount in the atmosphere (0.03%). (da Silva, 2011, p. 126)

Water is vital for human, animal and plant life. It is part of essential ecological processes such as photosynthesis, chemosynthesis and respiration. It acts as a habitat and ecological niche for numerous animal organisms and plant species. Its mobility, power of solubility, density variation, characteristic as thermo regulator, and especially its surface tension are attributes that account for its extraordinary ecological function (free translation).

Water is a natural resource of indispensable usefulness to society as a whole. However, it is very limited, considering its use for human consumption. Clean, safe, drinking and sufficient water is vital for the survival of all living organisms, as well as for the proper functioning of ecosystems, communities and economies (ANA, 2013). However, the quality of water resources worldwide is under increasing threat because human populations are growing and industrial and agricultural activities are expanding, all these actions trigger climate changes and can cause major changes in the hydrological cycle. Low quality water endangers human health and ecosystems, reduces the availability of drinking water and resources for other purposes, limits economic productivity, and reduces development opportunities.

According to the ANA (2013) -*Agência Nacional de Águas* (National Water Agency) regarding water resources, the average contribution of the Amazon River basin, in the Brazilian territory, is around 133,000 m³/s (73% of the country's total). Meanwhile, the contribution of water flow from foreign territories to the hydrographic region is approximately 76,000 m³/s.

Table 1.

Region	Water Resources (%)
North	68.50
Central West	15.70
South	6.80
Southeast	10.80
Northeast	18.30

Source: **Universidade da Água: www.uniagua.or.br**

Barros (2009) believes that because Brazil holds this significant portion of all the world's fresh water: "Brazilians have the false idea that water is an unlimited mineral resource, and that therefore, it will always be available whenever it is needed" (p. 02).

Low quality water endangers human health and ecosystems, reduces the availability of drinking water and resources for other purposes, limits economic productivity, and reduces the opportunities for development. There is an urgent need for the global community (public and private sectors) to unite and take up the challenge to protect and enhance the water quality of rivers, lakes, aquifers and taps. Hence, greater commitment is needed to prevent water pollution in the future, by treating contaminated waters and restoring the quality and health of rivers, lakes, aquifers, wetlands and estuaries. Consequently, these bodies of water will be able to meet a broader spectrum of needs of human beings and ecosystems, by adhering to the precepts of sustainability.

Sustainability²: a challenge for the future

The current paradigm of humanity is sustainability. This is the desire to articulate a new society capable of perpetuating itself over time, with decent conditions. Sustainability comprises not only the relationship between economic and environmental factors, but also human equilibrium, faced with other issues (Ferrer, 2012).

Until the beginning of the 1970s, the prevailing world view was that the environment is an inexhaustible source of resources, and that any actions to exploit

² Part of this research on Sustainability was developed in the work *Teoria Jurídica e Transnacionalidade*. Souza, M.C & Antunes, G.K. (2014). *Sustentabilidade e sociedade de consumo: avanços e retrocessos*. In M.C Souza & Armada, Ch. A. (eds.), *Teoria jurídica e transnacionalidade. Vol. I.* (pp. 170-187). Itajaí: UNIVALI.

nature would be unlimited. However, phenomena such as droughts, acid rain and thermal inversion have alerted society, bringing this environmental world view into question³⁻⁴.

In 2000, in order to analyze the major global problems, the UN established **8 Millennium Development Goals**, - MDG, which in Brazil, are called *8 Jeitos de Mudar o Mundo* [8 Ways to Change the World] – and which must be met by all countries by 2015. They are: **goal 1**, to eradicate extreme poverty and hunger; **goal 2**, to achieve universal elementary education; **goal 3**, to promote gender equality and empower women; **goal 4**, to reduce infant mortality; **goal 5**, to improve maternal health; **goal 6**, to combat HIV/AIDS, malaria and other diseases; **goal 7**, to ensure environmental sustainability; **goal 8**, to establish a global partnership for development⁵.

In relation to the Millennium Development Goals, Real (2008) explains that all the goals are fully relevant to the ideal of sustainability, not only number seven, since together, they enable social harmony:

Sustainability is more related to the Millennium Development Goals, which govern the action of humanity. The objective is to ensure the environmental conditions that make it possible for human life on the planet. In contrast, the other two aspects of sustainability, social, which has to do with inclusion, how to avoid marginalization, and incorporate new models of governance, and the economic aspects, which are related to the growth and distribution of wealth. Sustainability says

³ SENADO FEDERAL. Da Conferência das Nações Unidas para o Meio Ambiente Humano, em Estocolmo, à Rio-92: agenda ambiental para os países e elaboração de documentos por Comissão Mundial sobre Meio Ambiente e Desenvolvimento. **Revista em discussão**. Available at: <http://www.senado.gov.br/noticias/Jornal/emdiscussao/rio20/a-rio20/conferencia-das-nacoes-unidas-para-o-meio-ambiente-humano-estocolmo-rio-92-agenda-ambiental-paises-elaboracao-documentos-comissao-mundial-sobre-meio-ambiente-e-desenvolvimento.aspx>.

⁴ In 1972, as a consequence, the United Nations Conference on the Human Environment was held in Stockholm, and produced the Declaration on the Human Environment, establishing principles for international environmental issues, including human rights, management of natural resources, and prevention of pollution, giving rise to international environmental law, raising the world political culture with respect to ecology, and serving as the first invitation for the elaboration of new economic paradigm and civilization for those countries. The Stockholm meeting led to a time of observation and global alert about environmental degradation. The Declaration of the UN Conference on the Environment described it thus: "protecting and and improving the environment for current and future generations became a key goal for humanity". Thus, the Stockholm Conference created the World Commission on Environment and Development, inaugurating the environmental agenda, and enabling the start of the relationship between the environment and development, giving the first references to Sustainable Development, which at the time was known by the term "Ecodevelopment". These were the first steps towards green thinking. In 1983, the Brundtland Report, written by the head of the World Commission on Environment and Development, gave the following concept of Sustainable Development as development that: "meets the needs of the present without compromising the ability of future generations to meet their own needs". The report adds that: "a world in which poverty and inequality are endemic will always be prone to ecological crises, among others"

"Sustainable development requires that societies meet human needs both by increasing productive potential and by ensuring equal opportunities for all". Report of the World Commission on Environment and Development. **The Brundtland report** "Our Common Future". Available at: <http://www.un.org/documents/ga/res/42/ares42-187.htm>.

⁵ About the theme suggests to search in **the Millennium Goals**. Available at: <http://www.objetivosdomilenio.org.br/>.

that is not enough to guarantee survival, but the requirements of the human condition to ensure a dignified life⁶. (free translation)

According to Boff (2012) it is not only a matter of taking corrective measures to the system that created the current ecological crisis, it is also necessary to educate for its transformation. This means overcoming the still prevalent reductionist and mechanistic view and assuming a culture of complexity.

Gradually, humanity is becoming aware of the need for new values and behaviors to harmoniously administer natural laws. Society requires a new destiny; one that is less violent, more noble, in which man distances himself from the tortuous paths; therefore, attitudinal and behavioral change are needed in order to enable interpersonal relationships and eco-dependence of all human beings. Consequently, it is necessary to deal with environmental issues in a global and integrated way. Freitas (2012) asserts that sustainability:

(...) it is the constitutional principle that determines, with direct and immediate effectiveness, the responsibility of the State and society for achieving solidarity of development, both material and immaterial, socially inclusive, durable and equitable, a clean, innovative, ethical and efficient environment, in order to ensure, preferably in preventive and cautious mode, at present and in the future, the right to well-being. (p. 41) (free translation)

There is something worse than the human relationship with the environment, it is humans relationship with themselves, since reaching a collective consensus on the absolute need for environmental preservation, sustainable development, and finally, sustainability cannot articulate effective measures management.

It is essential for humanity to be aware of the need of new values and behaviors in order to harmoniously administer the natural laws. Otherwise, the world's water resources will soon collapse, since the population growth, increased water consumption, and decrease in drinking water sources of the planet will all contribute to this sad scenario. It is therefore necessary to contribute to the dissemination of knowledge, respect for the environment, and zeal for the planet's finite resources, all of which are among the objectives of sustainability.

⁶ "La sostenibilidad se encuentra más bien relacionada con los Objetivos del Milenio, que son la guía de acción de la humanidad. El objetivo de lo ambiental es asegurar las condiciones que hacen posible la vida humana en el planeta. En cambio, los otros dos aspectos de la sostenibilidad, los sociales que tienen que ver con la inclusión, con evitar la marginalidad, con incorporar nuevos modelos del gobernanza, etcétera, y los aspectos económicos, que tienen que ver con el crecimiento y la distribución de la riqueza. Tienen que ver con dignificar la vida. La sostenibilidad nos dice que no basta con asegurar la subsistencia, sino que la condición humana exige asegurar unas las condiciones dignas de vida" [Author's translation]. Ferrer, G.R. (2008). *El derecho ambiental y el derecho de la sostenibilidad*. Programa regional de capacitación en derecho y políticas ambientales (PNUMA). Available at: <<http://www.pnuma.org/deramb/documentos>>.

Resources in Brazil: legal provision

Water management in Brazil has had different approaches throughout history. From 1500 to 1940, water was considered an agricultural input; later, from 1950 to 1960, interest arose in its industrial use; from 1964 to 1985, the environmental movement was “deemed counterrevolutionary or subversive”; after this phase, due to international pressure, a ministry for environmental causes was created, and it was only after 1995 that water management became the responsibility of the Ministry of the Environment (Barros, 2009).

The legal protection of water has advanced; according to Almeida (2002), the following is a brief trajectory:

Both water and environment protection **started** indirectly with the publication of economic and health regulations, additional to the treatment linked to the right to property and neighborhood (Brazilian Civil Code); it was raised to the category of a legally protected asset that deserve its own legislation (Código das Águas – Water Code). In a **second phase**, the reception of the environmental issue by the legal system was based on the utilitarianism of the assets; the fragmentation of the object protected, and the legislative apparatus. Finally, the need for water protection was recognized within the global environmental structure, based on an integrated management of water resources with the environment, with a view to sustainable development and the maintenance of an ecologically balanced environment, as recognized by the CONSTITUIÇÃO DA REPÚBLICA FEDERATIVA DO BRASIL (Constitution of the Republic of Brazil, CRFB). The turning point in the protection of water resources was the promulgation of the 9,433/97 – Lei das Águas (Water Act). (p. 02) (free translation -words in bold by the authors-)

It is recorded that even at the beginning of the last century, legal professionals viewed the problem of drinking water as something limited to neighborhood disputes or its use for electrical energy. Even under the regulation of the Water Code of 1934, the issued had a perspective of private law rather than of public law. It is reiterated that the change in treatment only came with the Constitution of the Federative Republic of Brazil (1988), with the implementation of this new order and it became consecrated with the promulgation of Law 9,433/97, which instituted the National Policy on Water Hydric Resources⁷ and created the National System for the Management of Water Resources (Freitas. 2008).

⁷ Created as a consequence of Law 9,443/97, known as the Lei das Águas [Water Act], the National Water Agency (ANA) has institutional and operational characteristics that differ slightly from those of other regulatory agencies. The law gave the Federal Executive Authorities the task of implementing the National System for the Management of Water Resources (Singreh) and the National Policy on Water Resources (PNRH). In addition, it created an authority responsible for issuing rights to use the water resources in rivers within the national territory, i.e. those that cross more than state, or those that border with other countries. To this end, Law 9,984/2000 created the ANA, which since then, has adopted actions directly or indirectly related to regulatory activities. The PNRH established five management instruments: plans for the water resources; the classification of water bodies, according to their prevalent uses; the granting of rights to use the water resources; charging for the use of water resources, and the Information System on Water Resources (Snirh). [BRASIL. *O Balanço das Águas é uma revista anual que resume as principais atividades da Agência Nacional de Águas* - V. 1 n. 1 – Financial year 2011].

Finally, Law 9,984 of July 17, 2000 established the National Water Agency as the federal entity responsible for implementing the National Policy on Water Resources, and for coordinating the National Management System of these resources (ANA, 2013).

It is important to emphasize that some changes were defined at the administrative level through the National Congress of Environment (CONAMA) resolutions 20/86 and 06/87. The former deals with the classification of drinking water, brackish water and salt water of the national territory, defining the quality standards for each of these classes, according to the main uses designated for them. The latter, regulates environmental licensing of concession-holders for the exploration, generation and distribution of energy, and finally, no. 06/90, which regulates the production, import, marketing and use of chemical dispersants to control oil spills.

Although Brazil has a good legal framework to regulate its water resources, there is still inefficiency in complying with the current legislation for management and monitoring, considering that the instruments used as indicators of water quality do not contemplate the presence of various substances that are harmful to the environment.

The challenges of maintaining water quality regarding the negative environmental, social and economic impact of invisible pollutants

A broad spectrum of human and natural processes affect the biological, chemical and physical characteristics of water and impact its quality. Various human activities, such as agriculture, industry, mining, human waste disposal, population growth, urbanization and climate change have an impact on water quality. Agriculture can cause contamination by nutrients and pesticides and increase the salinity of the water. Contamination caused by excess nutrients has become one of the most widespread problems worldwide in terms of water quality, and the application of agrochemicals is already estimated at more than two million tons per year. Each year, industrial activities are between three hundred and four hundred million tons of heavy metals, solvents, toxic sludge and other effluents and solid wastes into the world's water systems (ANA, 2013).

Human activities, as well as natural processes, can change the physical, chemical and biological characteristics of water, with specific implications for human health and the ecosystem. Water quality is affected by changes in levels of nutrients, sediment, temperature, pH, heavy metals, non-metallic toxins, persistent organic and agrototoxic components, and biological factors, among many others (CARR, 2008).

Each year, more people die due to unsafe water than to violence, including wars; children under five years of age are the most unfortunate victims. Unfit water and the lack of treatment and adequate provision of domestic sewage and hygiene are

the causes of approximately 3.1 % of all deaths - more than 1.7 million per year - and 3.7 % of years of lost lives due to health problems considered as the highest impact worldwide (ANA, 2013. p. 18).

It is known that a wide range of other organic and inorganic contaminants also have direct and indirect impacts on human health. Metals such as mercury, copper and zinc occur naturally in the environment and, at low concentrations, they are essential for the proper functioning of the ecosystem and human health. However, prolonged exposure to high levels of these metals can have serious consequences for humans, as they tend to bioaccumulate in the body tissues (ANA, 2013).

In 1962, in the work *Primavera Silenciosa*, Carson (2010) was already warning about the use of chemical pesticides and pollution to the environment. The author stated that synthetic pesticides enter and remain in the bodies of fish, birds, reptiles and wild and domestic animals in universal form. They have been found in nearly all the major river systems and even in underground water courses flowing unseen through the Earth.

For the most part, this pollution is invisible, revealing its presence when hundreds or thousands of fish die, but the lack of detection is even more common. The chemicals used to ensure water purity do not have routine tests for these organic pollutants, nor any method to remove them, as was observed by Carson (2010).

The current treatment system is still not prepared to detect and eliminate many of these harmful elements to water quality, and it is necessary to develop invest and employ more specific treatment and complex techniques, otherwise, the environment will continue to suffer serious and irreversible damage.

Through the development of more sensitive methods, chemical substances, previously unknown, have begun to be detected, identified and defined in terms of their potential risks to the environment. This is the case of the so-called "invisible" contaminants, *i.e.*, compounds used for decades, but which have only recently been assessed and monitored (Pedroso, 2007).

The term "invisible or emerging pollutant" can be used to define a special group of substances with peculiar characteristics due to its increasing level of use by society and its real potential for contamination; such pollutants do not need to persist in the environment to cause negative effects (Reis Filho, 2007). Invisible pollutants are chemical compounds present in a variety of commercial products such as medicinal products for veterinary use, food packaging, hygiene products, and pesticides released directly into water bodies or the sewerage network.

Invisible pollutants belong to different classes of compounds, with large-scale applications, such as drugs (antibiotics, anti-inflammatories, analgesics and

lipid regulators); beauty products (suntan lotions, antiseptics, insect repellents and fragrances); industrial chemicals (plasticizers, wood preservatives, cleaning products, anticorrosives, and gasoline additives); hormones and steroids; and pesticides (Abreu, 2015).

In most cases, these compounds are not degraded by conventional methods of treatment (biological processes); thus, even after passing through treatment plants, they remain in free form in the environment, and can reach drinking water. Potential health and environment risks include dysfunctions in the endocrine and reproductive systems of humans and animals, miscarriages, metabolic disorders, and malignant cancers, as well as the induction of more resistant bacteria (Reis Filho, 2007). Due to the exposure to these substances, morphological changes and extinction of some species have been recorded (Arias, 2015).

These chemicals are increasingly present in the world's water systems and when they reach the environment, they cause damage to the ecosystem and human health. Their propagation in seas, rivers and reservoirs is a result of the growth of cities and new industrial processes (Arias, 2015). However, it is time to take a global stance, faced with the challenge of protecting and improving the quality of the planet's water reserves, preventing pollution, treating polluted water, and even eliminating invisible pollutants and restoring ecosystems, mitigating the environmental impacts caused by the action of man.

Conclusions

Water quality management is one of the major challenges faced by society, and requires a joint effort among the areas of water resources, environment, sanitation, health, industry and agriculture. It is essential to establish an effective planning, based on measurable indicators that will enable efficient recovery and the maintenance of the quality of surface waters.

Waters designated as potable and used by the population are contaminated by a type of pollutant that is invisible to the naked eye, difficult to detect, has serious consequences, and is not regulated in Brazil. This constitutes a major concern, as it is present in domestic sewage, which unlike industrial effluents, does not have a high concentration of a particular compound, but it has lower concentrations of different compounds, making it more complex to understand and treat.

The instruments and tools used do not match the current reality for the proper management of water resources, bearing in mind the gaps and failures of their elaboration and implementation, through to the joint functioning of powers at the different levels.

Low quality water endangers human health and ecosystems, reduces the availability of drinking water and resources for other purposes, limits economic productivity, and reduces the development opportunities.

While there are treatment technologies that produce water that only just meet the current regulatory standards, these do not ensure the proper removal of many invisible contaminants, including antibiotics and hormones. The supply system of purified water is at risk and there is serious damage to the environment. The problem of invisible pollutants is far from resolved, and the environmental consequences are unpredictable. There have been studies on the potential carcinogenic effects and endocrine deregulation that directly affect living beings.

These contaminants are not included in routine monitoring programs, the environmental and health bodies; neither are they inserted in the standards or legislation for environmental control. This situation is critical because we do not know yet all the impacts on the environment, especially in the long term.

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