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Review Article

Agro-Industrial Waste: A Possible Solution to the Serious Problem of Endocrine Disruptors?

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Abstract

For some time researchers have been trying to warn of the dangers that endocrine disruptors and their immense range of substances and products can cause in ecosystems and for humanity. With the water shortage that worsens, it will be increasingly necessary to reuse water, which if not properly treated, will be the main vector of contamination of the endocrine disrupters for humanity. Based on this, this work aimed to construct a literature review addressing the problem of water with a focus on endocrine disruptors, stressing the capacity and advantages that plant biomass has for the production of adsorbents and how they can help in the treatment of this problem. This review also serves to praise that many researchers are already developing adsorbents using agro-industrial waste and some of them prove to be promising. In writing the review it became clear the concern of some academics and agencies in how the problem evolves. In addition, it is a current subject of extreme importance for several areas of knowledge, such as engineering, health, and the environment, working to solve this serious problem for humanity.

Keywords: Vegetable Biomass; Adsorption; Public Health; Endocrine System; Future of Humanity

Introduction

From a very early age, we learn that water is essential for the maintenance of life on the planet, as all living beings that inhabit it need, directly or indirectly, this resource. However, it is often observed in the media that a large part of the drinking water is being contaminated by various types of waste, whether solid, liquid, or both, leading to an even greater depletion of this resource. Additionally, water is necessary for several human activities that require a minimum quality standard, as it contributes to the maintenance and constant evolution of these activities [1].

Within the research group of the Biomass Chemistry Laboratory - LQB, at the Federal University of Campina Grande - UFCG, and its partnerships, there are frequent debates about the main forms of water contamination and how to solve these problems. Among them are the discharge of industrial and domestic sewage into water bodies, known as effluents, which often contain high levels of organic and inorganic pollutants, ultimately compromising terrestrial and aquatic ecosystems, both on the surface and underground [2,3]. Within these organic-loaded waste materials, there are endocrine disruptors, which are diverse groups of natural or artificial chemical substances that can accumulate in living organisms and, at very low concentrations (μg. L-1 to ng. L-1), alter various systems and vital functions of organisms, especially over long periods. These disruptors have been the subject of research conducted by the LQB. For example, the steroid hormones secreted by men and women have been the focus of studies due to the alarming situation of their difficult removal from water bodies [4,5].

The main sources of endocrine disruptors include agricultural and livestock residues, urban waste, as well as various byproducts from food processing and aquatic algae. If treated with appropriate technology, these waste materials can be transformed into valuable resources for humanity. In addition to assisting in the treatment of endocrine disruptor contamination, they can be used as alternative energy sources and in the production of byproducts or commercial products within the industry [6].

In light of this concern, various research studies are being conducted to find ways to remove these disruptors from effluents [7-9]. Among the methods being employed, there is adsorption using activated carbons, which can act on a wide range of substances in different physical states, such as gases, solids, or liquids [10], utilizing waste materials for the production of these adsorbents [11-13].

Activated carbon produced from agro-industrial residues is cost-effective and, with appropriate technological processes, can achieve efficient adsorption rates. This is highly beneficial for the environment, and collective health, and serves as a tool in engineering, particularly in effluent treatments, preventing serious contamination and diseases. Moreover, it makes processes more efficient by recycling certain substances that can be reused. Furthermore, the use of waste materials that were once indiscriminately disposed of in inappropriate places can now be transformed into new products, including within industries, where they complement various industrial operations [14-16].

Considering the importance and technical feasibility of using agro-industrial residues for the production of adsorbents, this review aims to strengthen the scientific foundations for the utilization of this material in the treatment of endocrine disruptors. It addresses crucial points for understanding the issues still unknown to the general public regarding this group of contaminants, their vectors, actions, and potential solutions.

Desreguladores endocrinos

What are they and how do they act?

The World Health Organization (WHO) defines endocrine disruptors as exogenous agents capable of altering the synthesis, secretion, transport, reception, action, or elimination of natural hormones in the body, including developing fetuses [5]. They are responsible for maintaining the normal functions of organisms, such as reproduction, development, and behavior [17], where they mimic, stimulate, or inhibit the production of natural hormones [18].

These compounds are found in pharmaceutical products, personal care products, chemical pesticides, antioxidants, plastics, surfactants, and various industrial products [19]. They can also accumulate in water treatment plants, groundwater, rivers, and lakes [7] because some are excreted in animal urine and feces in the form of steroids from the endocrine system [20]. Although present in very low quantities, measured in micrograms per liter (μg/L) and nanograms per liter (ng/L), their accumulation can cause serious short-term or long-term problems.

Ferreira states [21] that there are several substances classified as endocrine disruptors, such as natural substances (phytoestrogens), synthetic chemicals (alkylphenols, pesticides, phthalates, polychlorinated biphenyls, and bisphenol A), natural estrogens (17β-estradiol, estrone, and estriol), and synthetic estrogens (17α-ethinylestradiol) used in contraceptive methods [19,22]. Additionally, new compounds synthesized and released into the environment may have consequences that are still unknown to science. Several years ago, some authors estimated that over 80,000 man-made chemical compounds, commonly used and therefore found in effluents, exist, along with their degradation products [23-25]. Unfortunately, these compounds have been affecting animals, plants, and humans and likely have increased significantly in recent years due to population growth, increased consumption of industrial products, inadequate or untreated effluent discharges, and the synthesis of new products. An additional factor to consider is that many endocrine disruptors have already been found in processed foods [26].

As mentioned by Reis Filho [19], the issue is not new, and the first hypothesis regarding the effects of endocrine disruptors was raised in the 1980s with the observation of feminine characteristics in male colonial birds in the Great Lakes region (USA-Canada) exposed to chemical pesticides. The same phenomenon was reported in populations of alligators in Florida lakes [27]. Katsu and colleagues also revealed the same problem in various species of fish, amphibians, and reptiles [28,29].

Castro conducted relevant global literature research [4] and compiled studies where estrogens were found in surface waters worldwide. For example, in Germany, concentrations ranged from 0.1 ng/L to 3.5 ng/L; in Japan, from 0.6 ng/L to 94 ng/L; and in the United States, from 0.27 ng/L to 2.82 ng/L. In Brazil's water treatment plants, concentrations ranged from 6 ng/L to 40 ng/L, indicating that the problem affects both developed and developing countries. Huerta and colleagues [30] conducted a scanning analysis of the Segre River in Spain, which receives effluents from a water treatment plant and found 44 pharmaceutical residues, including analgesics, anti-inflammatory agents, antibiotics, antihelminthic and antiplatelet agents, calcium blockers, diuretics, histamine and H1 and H2 inhibitors, lipid regulators, psychiatric drugs, synthetic glucocorticoids, tranquilizers, and beta-blocking agents. Although some were present in small quantities, they accumulated in the river water and sludge.

Fernández and Olea [31] warn that these substances can affect children who will become future parents, potentially transmitting undesirable characteristics due to the absorption of endocrine disruptors, leading to a significant public health problem [32]. The WHO alerts to problems in humans such as accelerated menopause in women, issues in the male and female hormonal and reproductive systems, the formation of defective genes, and even carcinomas. Other studies associate endocrine disruptors with obesity [33], fertility problems [25], cardiovascular issues [34], and neurobehavioral deficiencies [35], among others, as reviewed by Tapia-Orozco and other researchers around the world [36,37].

Concerned about all of this, government agencies are seeking solutions to reduce and even eliminate such substances from our effluents. If they cannot be removed, water reuse will be unfeasible, and consequently, the problem of water scarcity will worsen. As a result, numerous researchers are trying to find effective techniques for the removal of these substances and prevent all the inconveniences they cause. Among these solutions, activated carbon adsorption has been gaining prominence [5,38,39].

How do they reach the environment?

As previously mentioned, the main route of contamination by endocrine disruptors is through effluents. When not properly treated and discharged into inappropriate locations, they end up contaminating the soil and bodies of water. Water is essential for humanity, not only for vital functions but also for various activities that depend on parameters ensuring a minimum quality necessary for its use. Activities such as agriculture, livestock, industry, energy production, and hygiene are crucial for the maintenance and constant evolution of human life [1]. However, these activities are also responsible for serious environmental contamination.

In a study by Von Sperling [40], average water distribution on Earth was reported as 97% in oceans, 2.9% in non-oceanic sources, 1.91% in glaciers, 0.098% in groundwater sources, 0.01646% in lakes, 0.00366% as soil moisture, 0.00095% in the atmosphere, 0.00009% in rivers, and 0.00007% as a component of living organisms. However, the author emphasizes that the data is often inconsistent and transmitted with errors. Reporting precise values is challenging due to the complex and dynamic nature of water transformations on the planet, which undoubtedly change over time due to human actions.

Common knowledge, influenced by media reports and a compilation of studies organized by the World Resources Institute in 2015, unanimously asserts that the rapidly growing human population worldwide (in some countries, without control) is negatively impacting the quality and quantity of water on the planet. These changes involve air pollution with harmful gases, contamination of soil and surface, and groundwater with chemical products, often accompanied by the presence of endocrine disruptors, leading to significant imbalances in various ecosystems [1].

Furthermore, according to estimates from the same institute, by 2025, 3.5 billion people may face severe water scarcity issues due to a lack of quality and quantity. To mitigate water scarcity, some government agencies propose water reuse, particularly from the effluents generated by individuals, cities, and industries, which are typically discharged into soil, rivers, and seas after appropriate treatment. However, the extent to which these effluents are treated is a crucial factor. Incorrect treatment can worsen the spread of contamination from endocrine disruptors if the reused water contains even small amounts of these substances, as previously mentioned.

In Brazil, one of the world's largest freshwater reservoirs, regulations are established through norms and resolutions, such as NBR 9800 from 1987, which defines effluents as liquid waste from industrial and domestic activities, varying according to the industry type and containing organic, inorganic, or both types of compounds [41]. Effluents with organic loads, such as animal and human waste from sewage, food remnants, blood, and animals from the food industry and slaughterhouses, among others, promote the development of microorganisms that directly compete with aquatic ecosystem inhabitants for dissolved oxygen, altering the so-called biological oxygen demand (BOD) [42]. Effluents with concentrations of inorganic loads, such as those originating from metallurgy, tanneries, and domestic sources, among others, can alter the physical and physicochemical properties of water, including pH modification, turbidity, salinity, and even accumulation in organisms, hindering or inhibiting biological processes [43,44].

This legislation (NBR 9800/1987) also requires industries to assess the potential impact their effluents may have based on their composition. The physical, chemical, and biological characteristics of industrial effluents vary according to the industry type, making the liquid effluent soluble or with suspended solids, with or without coloration, organic or inorganic, and with low or high temperatures [45]. Additionally, Brazil has Resolution 357 from 2005, amended in 2009 and 2011, which classifies water bodies and establishes environmental guidelines for their classification, as well as conditions and discharge standards for effluents. Both amendments contribute to reducing the impact caused by water pollution and emphasize the reuse of properly treated water, addressing the issue of water scarcity, which has been a concern for many years. However, as can be seen, Brazil has legislation from 1987, 2009, and 2011, all predating the problem brought to light by the WHO in 2012, suggesting room for improvement.

Due to these issues, government inspections and demands from civil society and some NGOs have led to the call for new laws and solutions to reduce the emission of effluents with contaminating residues or to subject them to effective treatment. Proper treatment and reuse have become essential environmental marketing strategies for industries, especially those in the agro-industrial sector, which generate a vast amount of effluents and solid waste [45,46].

With this demand, there has also been a growing appreciation for these waste materials through their proper technological utilization. This approach is increasingly encouraged as it can contribute to pollution reduction and economic value creation, transforming them into commercial by-products [47]. This aligns with the need for research on endocrine disruptors, becoming a research focus for scholars in various fields aiming to solve or minimize several issues, such as reducing contaminating waste in the environment and treating effluents using transformed waste as adsorbents for water reuse [19,31].

Agroindustrial residues as adsorbent, possible solution?

In a general and simplified definition, waste refers to everything that is discarded and not utilized in human activities. It is commonly produced in industrial, commercial, and residential activities, often referred to as trash or garbage. In industrial activities, especially in agro-industries, a significant amount of waste is generated, such as plant and animal residues. Due to a lack of appropriate technical knowledge for their reuse, these wastes are often not utilized in various other activities, such as extraction of stabilizers, enzymes, human and animal nutrition, and, in the context of this review, the production of adsorbents, thus avoiding their accumulation and various types of pollution [48-52].

Among agro-industrial residues, plant biomass residuals stand out, including peels, fruits, bagasse, seeds, branches, and cores, which are usually discarded during sorting or preprocessing operations, as well as at various stages of manufacturing or even in supermarkets [53]. The production of adsorbents using these materials is entirely feasible, especially due to their low cost and the possibility of efficient recovery of the adsorbate and regeneration of the adsorbent. Recently, activated carbon adsorption has attracted considerable interest from researchers [9,13-16].

We focus on plant biomass residues because they require little processing to enhance their adsorption capacity. Some of these residues have already been dehydrated, dried, cut, pressed, or undergone other processes. Examples include paper mill sludge, wood, palm residues, various seeds and grains, dry sewage waste, green macroalgae, and rice husk ash, among others. These materials have already been explored for their technical feasibility to remove contaminants through academic studies [54-57].

Furthermore, these residues consist of macromolecules such as humic substances, lignin, cellulose, hemicellulose, proteins, and pectin [58]. These macromolecules possess functional groups such as thiol (-SH), sulfate (-OSO3H), carbonyl (>C = O), carboxyl (-COOH), amine (-NH2), amide (-CONH2), hydroxyl (-OH), phosphate (-OPO3H2), and others. These functional groups are considered the main contributors to adsorption efficiency [55,59].

Adsorption involves the transfer of constituents, which can be gases or liquids, from a fluid to the surface of a solid [60]. According to Atkins and Paula [61], the substance being adsorbed is called the adsorbate, while the material that adsorbs is referred to as the adsorbent or substrate. The bonding of the substance particles to the solid surface of the adsorbent can occur either physically or chemically [11]. Activated carbon, a widely used adsorbent, offers high adsorption capacity for organic and inorganic pollutants [12,62,63].

Physical adsorption occurs when the intermolecular attractive forces between the molecules of the substance to be treated and the surface of the adsorbent are stronger than the forces of attraction between the substance molecules themselves [64]. For example, the adsorption of a turbid liquid (with suspended particles) involves the molecules of the substance being adsorbed onto the porous surface of the adsorbent, forming multilayers and establishing an equilibrium between the adsorbed portion (particles) and the remaining substance in the liquid phase (filtered substance).

Chemical adsorption involves chemical interactions, primarily due to differences in electrical charges between the adsorbed substance and the adsorbent solid (activated carbon). Through electron transfer, chemical bonds form between the adsorbate and the adsorbent, creating a monolayer [65]. For example, the adsorption of a liquid loaded with negatively charged heavy metals (such as Pb, Cu, Cr-, and Ni) using an adsorbent activated with positive charges (+) results in the molecules of the substance being adsorbed and binding to the adsorbent surface due to the difference in charges, thereby removing the negative charges from the liquid.

To test the forces involved in these adsorption processes, curves are constructed to correlate the equilibrium between the adsorbate concentration and the concentration of adsorbed particles on the substrate at a given temperature [66]. Several mathematical models, known as adsorption isotherms, are used for this correlation [67]. The most commonly used equations for testing the adsorption of activated carbons, which also measure the surface areas of these carbons and test the monolayers or multiple layers that can occur during the activation process, are the Freundlich, Langmuir, and BET models [68].

The Freundlich model accurately predicts data from adsorption experiments with carbons [67]. It considers the solid to be heterogeneous, meaning it possesses various active adsorption sites, and the application is based on an exponential distribution to characterize sites with different adsorption energies [60,69]. The Langmuir model assumes adsorption occurs in a monolayer, with all sites having the same adsorption energy, and the adsorption is reversible without any interaction between the adsorbed molecules and neighboring sites [70]. According to the same author, the BET model complements the Langmuir model by assuming the possibility that one layer can produce adsorption sites by overlapping layers. Thus, each adsorbed molecule on the surface of the adsorbent provides another site for a new layer of molecules, and so on [71].

As observed, the interactions between the adsorbate and the substrate are complex, although it is possible to predict behavior through mathematical modeling. The activated carbon used in these processes is predominantly made of carbon, with developed pores of various sizes, providing a large internal surface area [66]. This enables it to aggregate substances in different physical states within its structure, making it an important clarifier, deodorizer, and purifier for liquids and gases [10].

Activated carbon is obtained through controlled burning of various materials at different temperatures to prevent complete carbonization and loss of pores. The specific structure depends on the predominant structure of the initial material. It can be chemically activated with positive or negative particles by using chemical reagents or physically activated by prolonged exposure of the biomass to inert gases (CO2 and N2). The final product is available in powder or granulated form [72]. Due to the high temperatures and chemical reagents involved in the process, some activated carbons still have a high cost. Therefore, research on low-cost adsorbent materials, often derived from industrial waste and with high adsorption capacity, has gained increasing attention, particularly those originating from agro-industries [12,73-75].

The potential applications of activated carbon are varied, highlighting its importance for the development of various sectors. As mentioned earlier, it is used in processes that aim to separate, remove, or purify substances from fluids or gases, particularly in the food, beverage, pharmaceutical, chemical, air, and water treatment industries [72]. More recently, it has been used in the removal of endocrine disruptors [10].

Once the biomass is properly prepared, it can undergo physical activation, which involves the oxidation of carbon. This process occurs when the material is subjected to high temperatures ranging from 800°C to 1000°C, with a low oxygen content and controlled burning to prevent carbonization. Activation occurs when water vapor, air, or carbon dioxide is injected into the material. Reactions and gas formation take place as a result of the reactions between the activating agents and carbon [76].

Waste materials can also undergo chemical activation, which involves mixing the raw material with a solution of chemical activating agent and carbonizing the resulting mixture in the absence of oxygen. The carbonized product is then cooled and washed. The temperatures used typically range from 400°C to 1000°C, and the most commonly used substances as chemical activating agents are zinc chloride, iron chloride, potassium sulfide, potassium thiocyanate, sulfuric acid, sodium hydroxide, calcium chloride, and phosphoric acid. These agents can confer acidic or basic characteristics to the activated carbon [77].

Perspectives?

In the face of the problem of effluent contamination, as mentioned throughout this review, particularly with endocrine disruptors, as well as the diverse forms and accumulation of various types of agro-industrial waste in the environment, and their possibilities for transformation, it is important to question what the prospects are for the future?

In recent years, numerous studies have been conducted using activated carbon derived from various agro-industrial waste sources, as can be seen in table 1. These studies aim at the production, characterization, and comparison with other commercially available carbons, indicating a growing research field of academic and industrial interest. The plant-based materials used in these "biosorptions," as referred to by the authors, could provide an appropriate technological solution to the problem. They can be used as complementary forms of treatment, either as secondary or tertiary processes in the treatment of effluents or even in the treatment of water that is already considered treated [78,79].

In summary of what was shown in table 1, important comments can be made about the results of some studies cited regarding adsorption rates for toxic metal ions, such as cadmium (Cd2+), on activated carbons produced from coconut fibers and activated with NaOH. The adsorption efficiencies for cadmium ranged from 92.6% to 99.9% at pH 5.0 and 25°C [54]. In another study, using NaOH-activated activated carbon derived from orange peels and

Study	Residue	Objective
Rossner., *et al.* (2009)	Coconut fiber [80]	Adsorption of pharmaceutical compounds.
Sousa., *et al.* (2010)	Coconut fiber [54]	Adsorption of heavy metals.
Franca., *et al.* (2010)	Coffee beans [81]	Characterize and compare efficiency with other types of coal.
Mussatto., *et al.* (2010)	Brewery waste [82]	Characterize the ligninic components.
Wen., *et al.* (2011)	Mud [83]	Purification of formaldehyde gas.
Foo e Hameed (2012)	Jackfruit peel [84]	Characterize and compare efficiency with other types of coal.
Souza., *et al.* (2012)	Orange peel and pomace [85]	Chromium adsorption.
Carrier., *et al.* (2012)	Sugarcane bagasse [86]	Characterize and compare efficiency with other types of coal.
Djilani., *et al.* (2012)	Beans of coffee melon and orange [87]	Adsorb nitrophenol.
Ioannou e Simitzis (2013)	Pressed olive trees [88]	Compared with commercial coal.
Román., *et al.* (2013)	Sunflower [89]	Compare raw material transformation processes into charcoal.
Silva e Tavares (2013)	Açaí [90]	Characterize and compare efficiency with other types of coal.
Silva e Pires (2014)	Peach palm [91]	Copper adsorption.
Barros., *et al.* (2014)	Pineapple peels [92]	Lead adsorption.
Baccar., *et al.* (2014)	Pressed olive trees [93]	Removal of disruptors like ibuprofen and naproxen.
Sales., *et al.* (2015)	Corn cob [94]	Characterize and produce activated carbon.
Arampatzidou., *et al.* (2016)	Potato peel [95]	Bisphenol-A Endocrine Disruptor Removal.
Loffredo., *et al.* (2016)	Coffee beans, almond shell [96]	Eliminate pesticides and estrogens from water treatment plant.
Jawad., *et al.* 2017	Coconut fiber [97]	Reduction in coloration of methylene blue.
Rawal., *et al.* 2018	Sugarcane bagasse [98]	Characterize and produce activated carbon.
Liu., *et al.* 2019	Seaweed [99]	Mercury removal.
Ogungbenro., *et al.* 2020	Seeds [100]	Characterization of activated carbon from biomass date seeds for carbon dioxide adsorption
Baldania., *et al.* 2021	pine wood [101]	Synthesis of activated carbon
Xue., *et al.* 2022	The raw agricultural waste [102]	Adsorption of methylene blue
Yurtay and Kiliç 2023	Hazelnut shell, rice husk, and corn stalk [103]	Adsorption of metronidazole

Table 1: Scientific research using different agro-industrial residues for the production of activated carbon.

bagasse, efficient adsorption of chromium III (Cr_2O_3) was also observed, ranging from 90% to 98% [85]. Another study using $ZnCl_2$-activated activated carbon produced from corn cobs and tested for the adsorption of the dyes Orange G (OG) and methylene blue (MB) showed efficiencies of 95% (OG) and 97% (MB) according to the Langmuir model, and 90% (OG) and 95% (MB) according to the Freundlich model [94].

Regarding other groups of substances that include endocrine disruptors, an adsorbent produced from cellulose extracted from plant waste adsorbed 82.8% of tetracycline and 85.9% of sulfamethazine [104]. Baccar and colleagues reported adsorbing 90.45% of ibuprofen using activated carbon produced from olive cake after oil extraction [93]. More recently, an adsorbent made from cellulose obtained after flaxseed oil extraction was reported to adsorb approximately 100% of amoxicillin [78].

Regarding the specific surface area and other characteristics that define activated carbon as a versatile and efficient adsorbent, activated carbon produced with $(NH_4)_2HPO_4$ using rice straw was mentioned to have an apparent surface area of 1,154 m2/g, a total pore volume of 0.670 cm3/g, and a maximum adsorption capacity of 129.5 mg/g. This highlights the great capacity of this material to adsorb different types of substances in any phase [105].

After considering all the information and scientific data used in this work, can we answer the question that title this review? The authors believe that the use of agro-industrial waste is gaining prominence and scientific support in engineering fields and its applicability in various processes, including for endocrine disruptors. They are evolving and already showing efficiency for some types of components, while also transforming waste that was previously discarded into a new product. This is important for various industries and helps reduce environmental contamination. It is also seen as a potential tool for health by providing a vast quantity of adsorbents that can adsorb numerous endocrine disruptors. The scientific community should continue exploring new plant materials, production processes, and their efficiencies in various endocrine disruptors.

Conclusion

As we have already mentioned, there is a problem with the presence of endocrine disruptors for living organisms, as highlighted by the World Health Organization (WHO). It is also evident that there are currently numerous studies focusing on the characterization of plant raw materials, particularly those originating from agro-industrial processes. Various biomass sources are being utilized, showcasing their potential for transformation into adsorbents. This highlights the immense possibilities of low-cost raw materials that can be compared to commercial carbons, varying in terms of different biomass types, temperatures, activation methods, types and concentrations of ionic charges, and the substances to be adsorbed.

Based on the discussions within our research group, which works with adsorbents from various plant biomass sources, and in writing this review, it became clear that many researchers have published articles and reviews from North America, Latin America, Europe, and Asian countries, aiming to address the issue from different perspectives. Some focus on regional aspects, while others take a global approach, but all share a great concern about the evolving situation and strive to alert the entire scientific community to seek solutions. Furthermore, given the current relevance and extreme importance of this topic for various fields of knowledge, such as the application of engineering in physical, chemical, and biological processes, along with public health and the environment, this study can serve as a starting point for generating ideas within the Brazilian academic community to attempt to address this serious issue of the human-environment relationship.

Conflict of Interest

There is no conflict of interest in this publication, given that it is a literature review. Although studies that deepen the monitoring of the situation in the world in practice may present serious conflicts.

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