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Regenerative Design And Sustainability: Making Legal Protection Of The Environment A Reality

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Abstract:
This study examines how regenerative design and the circular economy can contribute to realizing the fundamental right to an ecologically balanced environment, promoting sustainable development. It contextualizes the global environmental challenge and the limitations of traditional sustainable approaches, introducing regenerative design as a necessary evolution that seeks to restores ecosystems and fosters symbiosis between the biosphere and the technosphere. The circular economy, in turn, proposes a break with the linear model of consumption and production, emphasizing reuse and waste reduction. This study aims to investigate the intersection of regenerative design and the circular economy, proposing guidelines for their practical application in public policies and private initiatives, by analyzing their principles, contributions to sustainability, and relevance to environmental law in Brazil. The research is justified by the need to address gaps in the practical application of these concepts, particularly in developing countries. Methodologically, the research adopts a qualitative approach, based on documentary analysis and bibliographic review, with a focus on academic works, legislation and case studies. The results indicate that regenerative design and the circular economy not only mitigate environmental impacts but also create structures that regenerate natural systems while integrating economic development and social justice.

Key Word: *Regenerative Design. Circular Economy. Sustainability. Economic development.*

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I. Introduction

Environmental degradation is one of the most pressing challenges facing humanity, with direct consequences for quality of life, biodiversity and climate stability. The fundamental right to an ecologically balanced environment, enshrined in the 1988 Federal Constitution, represents a crucial normative milestone in environmental protection in Brazil. It establishes that the defense and preservation of the environment are shared responsibilities of public authorities and society at large. In this context, exploring and implementing innovative approaches to make this right effective in the contemporary setting is paramount.

Two emerging strategies - regenerative design and the circular economy – stand out as essential tools for promoting and implementing sustainable practices. While regenerative design fosters to restore natural ecosystems and encourage production systems that emulate natural cycles, the circular economy, on the other hand, proposes a break away from the traditional linear model of production and consumption, prioritizing, in theory, resource reuse and waste minimization. These approaches not only have the potential to mitigate environmental impacts but also play a vital role in realizing the fundamental right to a balanced environment by fostering sustainable development.

In this context, however, simply immersing oneself in sustainability is neither sufficient nor plausible[1]. Instead of just mitigating environmental damage, society must interact more deeply with the biosphere. Sustainability fosters the development of an organic and functional consciousness, establishing a symbiosis between society, the production and consumption chain, trade systems, construction, and other areas discussed in the introduction, justification and objectives of this research project.

Climate change has produced a series of consequences for various sectors of society. Mitigation measures[2] along with adaptations, aligned with sustainability, have prompted a set of actions necessary to deal with the plurality of subjects and risks involved. Thus, the creation and dissemination of public policies at a transnational level have resulted in instruments such as: (i) institutional arrangements; (ii) command and control measures; and (iii) economic models and instruments, which foster proactive attitudes and support the formulation of sustainable designs.

Concepts inspired by economic permaculture[3] aim to move beyond the linear economic model (extraction, use and disposal) in favor of a circular economy (use, functionality and performance). Based on science and technology, viable hypotheses for sustainable innovations seek to align efforts with the institutional instruments, within an "eco-developmentalist" perspective. This exposes the risk society (Risikogesellschaft)[4], highlighting the origins and consequences of environmental degradation at the heart of modern society. A risk-exposed society defines its characteristics by globality resulting from modernization, and contemporary risks and threats are distinguished from their medieval counterparts, which often appear superficially similar, primarily due to the global scope of their impact (affecting humans, fauna and flora) and their modern causes. These are the risks of modernization[5].

Modernization, driven by the Industrial Revolution, unveiled an unprecedented of environmental resources that was unprecedented in the history of civilization. Machinery replaced manufacturing, and technological advances culminated in the technical-scientific revolution, which significantly intensified the risks observed. As mentioned, institutional arrangements have been established to protect society from risk. In 1972, during the First World Climate Conference, the United Nations Environment Programme and the World Meteorological Organization were established, which later led to the creation of the Intergovernmental Panel on Climate Change (IPCC). This panel provided the theoretical and scientific basis for the drafting of the United Nations Framework Convention on Climate Change (UNFCCC)[6], adopted at Rio-92 (Earth Summit).

Significant changes have been enshrined through principles aligned with sustainability, such as the principle of "common but differentiated responsibilities " (CBDR), or mutual and reciprocal responsibilities, and the "polluter pays" principle. In this context, although environmental problems are global, it is the responsibility of industrialized countries to prevent their worsening, with the support of developing countries[7]. The formulation of sustainable designs is a guiding element for the institutional arrangements established by the global community. Concurrently, an eco-friendly stance has gradually emerged, as well as the promotion of the "eco-identity" of nation states and the encouragement of circular socio-economic thinking. Undoubtedly, there is a cross-cutting and transdisciplinary nature in linking the perception, and concept, of "circularity" and sustainability to the global reality of the risk society, through schools that promote the Circular Economy (CE) for the benefit of 21st century society, and possibly anchoring the perception of the Solidarity Economy, as will be discussed in due course.

On the other hand, the arguments in favor of the circular economy and its schools of thought establish a dissociation from the linear economic model (extraction-production- disposal) and an alignment with the circular economic model (use, reuse, remake, and recycle) appropriate to the risk society in the 21st century, which according to its own definition "is concerned with the future and the risks linked to modernity itself, seeking to deal with dangers and insecurities"[8], through scientific-technological promotion.

Circular economy schools of thought promote science and technology as tools to benefit the risk society, fostering social and environmental resilience by driving new "eco- efficient" economic paradigms. In this context, re-signifying science and technology through sustainable practices: (i) Performance Economy (closed-loop and performance economy); (ii) Industrial Ecology; (iii) "Cradle-to-Cradle" (C2C); (iv) Biomimicry; (v) Natural Capitalism, and; (vi) Regenerative Design, reflects an eco-developmentalist constructivism

This new circular thinking promotes the construction of the technological-scientific framework with new contours, emphasizing the emergence of arguments about the so-called Solidarity Technoscience, understood as the cognitive consequence of the action of a collective of producers on a work process which, due to a socio-economic context (which generates collective ownership of the means of production) and a social agreement (which legitimizes associativism), provides self-management control and voluntary and participatory cooperation in the productive environment. This dynamic leads to a change in the product generated, the material result of which can be appropriated according to the decision of the collective (solidarity enterprise)[9].

Considering the proposition outlined above, there is a regenerative attitude fostered by mechanisms for disseminating knowledge, integrating knowledge and new values to the production and consumption chain capable of generating sustainability. This research will highlight how the risk society becomes sensitive to solidarity technoscience in the context of the different schools of thought on the circular economy.

The fact is that "eco-efficiency" seeks to present solutions to the emerging challenges of global society in a participatory way. The social, economic and environmental "eco- revolution", based on dissociating the linear economic model and adhering to the "Cradle-to- Cradle" circularity "[10] , is gradually taking shape. Thus, the Industrial Revolution, which gave rise to modern capitalism, significantly expanded humanity's possibilities for material development. While this process continues to this day, but at a severe cost. Since the mid-18th century, more of nature has been degraded than in all previous history. While industrial systems have reached peaks of success, amassing vast levels of man-made capital, the natural capital on which civilization depends to create economic prosperity is rapidly declining[11].

Therefore, this work seeks to investigate how regenerative design and the circular economy can serve as effective instruments for realizing the fundamental right to an ecologically balanced environment, positioning sustainable development as a central axis for achieving this goal, which will be done by (i) analyzing the

fundamental principles of regenerative design and their applicability in environmental and economic projects; (ii) studying the concepts and practices of the circular economy, focusing on their contribution to sustainability; (iii) examining the intersection of these approaches with the fundamental right to an ecologically balanced environment, considering the challenges and opportunities; (iv) proposing guidelines for the implementation of public policies and private initiatives based on these practices.

The choice of this topic is justified by the urgency of finding effective solutions to the global environmental crisis and the need for mechanisms that implement constitutional principles related to the environment. Despite advances in the field of sustainability, there is still a significant gap in the practical understanding of how concepts such as regenerative design and the circular economy can be integrated into public policies and the private sector to promote a sustainable economy. This article aims to contribute to filling this gap by providing an in-depth and interdisciplinary analysis of these approaches, placing them in the context of law and sustainable development.

Although literature on sustainability has grown exponentially in recent decades, few studies explore the joint application of regenerative design and the circular economy as legal and practical tools for realizing the fundamental right to an ecologically balanced environment. In addition, there is a lack of research analyzing the implementation of these strategies in developing countries such as Brazil, where the socio-economic and environmental challenges assume unique characteristics.

This study adopted a qualitative approach, based on documentary analysis and literature review. The research focused on scientific works, legislation, reports from international organizations and case studies that address the central themes of the article. The aim was to understand the interrelationships between regenerative design, the circular economy and environmental law, as well as to identify good practices that could be replicated in the Brazilian context.

The criteria for selecting sources included their relevance to the objectives of the study´s objectives, the credibility of the publications and the timeliness of the information. Databases such as Scopus, Web of Science and Google Scholar were used to locate relevant academic literature. In addition, Brazilian and international legislation related to the environment and sustainable development was analyzed, such as the National Solid Waste Policy (Law No. 12.305/2010) and the UN Sustainable Development Goals (SDGs). The data were analyzed using the content analysis method, which allowed for the identification of patterns, convergences and divergences between the sources researched. This method was chosen for its ability to systematize large volumes of information, generating insights relevant to the research problem.

The methodology also included analyzing representative case studies that illustrate the practical application of regenerative design and the circular economy in different contexts. These examples provided a basis for discussing and proposing guidelines in the legal and practical spheres. Finally, recognizing the inherent limitations of this type of research, such as the reliance on secondary sources and the lack of empirical data collection, the study seeks to contribute a critical and integrative perspective that can support future research and practical interventions.

II. Discussion

Circular Epistemes Culminating In Regenerative Design

The circular economy is an approach that aims to break away from the linear model of production and consumption, in which resources are extracted, transformed into products and discarded after use. Inspired by natural cycles, the circular economy proposes that materials and resources remain in use for as long as possible, reducing resource extraction and waste generation.

Its fundamental strategies are (i) Reduction (minimizing the use of resources); (ii) Reuse (extending the life cycle of products); (iii) Recycling (transforming waste into new materials or products; (iv) Remanufacturing (restoring products to conditions similar to the original ones. In this way, the circular economy promotes the Sustainable Development Goals (SDGs), especially SDG 12, which deals with sustainable consumption and production patterns. It also contributes to SDG 13 (action against global climate change) by reducing greenhouse gas emissions associated with the extraction and processing of natural resources.

The concept of regenerative design, in turn, represents an evolution of sustainable approaches, seeking not only to minimize the negative impacts of human activities, but also to restore and regenerate natural ecosystems. It is therefore a design process that promotes harmonious interaction between human and ecological systems, enabling both to strengthen each other[12].

The principles of regenerative design include total integration between natural and built systems, the use of sustainable technologies and the promotion of co-creation processes with nature. This approach aims to establish a symbiotic relationship between humans and the environment, reversing centuries of environmental degradation caused by extractive practices. Its relevance to environmental law, for example, lies in its ability to make the principle of sustainability a reality, promoting not only the conservation but also the active restoration of ecosystems.

Although regenerative design and the circular economy have different origins, their objectives and methods converge to promote an ecologically balanced environment. These concepts offer complementary approaches that strengthen the practical application of environmental law.

The performance economy[13] is grounded in principles such as conservatism, resource productivity, cultural and social ecology, and limited toxicity[14]. This holistic perspective maximizes use value for as long as possible, aiming to create wealth through science, technological innovation, and knowledge dissemination. Prevention and sufficiency strategies are central to addressing the challenges of a risky society and advancing the "age of sustainability"[15].

The "ecological economy" seeks to engage human beings, as it encompasses: (i) economics; (ii) economics of natural resources; (iii) economics of the environment, and; (iv) ecology; The use of "eco-expressions" has become widespread and, in this sense, a core focus of this framework lies in production cycles, considering the flow of low-entropy natural resources that transform during production and consumption processes. These resources return to nature as waste, which may either accumulate in the environment or reenter biogeochemical cycles. With the aid of solar energy, they reintegrate into low-entropy structures that can be reused by the economy[16].

The evaluation of inputs that enter the production chain emphasizes the role of entropy in 21st century economic activity, particularly with materials that may not be fully recycled[17]. An example of this reality is BRASKEM[18], a thermoplastic resins petrochemical industry, which pursues carbon neutrality through circular economy and performance economy; its carbon-neutral program may serve as a sustainability paradigm.

Industrial ecology (IE), rooted in systems analysis, highlights the interaction between industrial and natural systems, viewing the world as interconnected networks. An industrial ecosystem represents a transformation of the traditional model of industrial activity. In the traditional model, each factory operates in isolation, demanding raw materials, generating products for sale and producing waste for disposal. In contrast, the industrial ecosystem promotes a more integrated system, where energy and material consumption are optimized, and the effluents from one process serve as raw materials for another[19].

EI "looks at the flows of materials and energies, angling its perception at systems on different scales"[20], including industrial symbiosis within local, regional, and global economies. This cyclical reorientation of industrial processes and business flows aims to assess sustainable industrial development. By observing the convergence of numerous elements, IE validates sustainable systems, conducting thorough investigations in favor of the economy to replace the current linear model. This approach is exemplified by BRACELL[21], dissolving wood pulp industry that applies industrial ecology concepts to its activities in the pursuit of sustainability

Cradle to cradle" (C2C) focuses on designing for efficiency in product management and reducing negative externalities by eliminating the linear economic model's central concept - waste. Eco-efficiency, in this context, transcends zero-emission approaches, prioritizing the development of products and industrial systems that maintain or enhance the quality and productivity of materials throughout their subsequent life cycles. The C2C concept also addresses the main limitations of traditional eco-efficiency approaches: their inability to meet the need for a fundamental redesign of material flows, their inherent antagonism to long-term economic growth and innovation, and their insufficiency in addressing toxicity problems[22].

The pursuit of eco-efficiency through deficiency assessment is a crucial strategy for redesigning material flows and fostering long-term scientific-technological innovations. This approach is illustrated by Hewllet Packard (HP)[23], which implements the cradle-to-cradle circular model to advance sustainability.

Biomimicry, innovative in its vision of "designs of things" and their applicability to humanity´s success in its habitat, looks to nature for solutions to society at risk. It is based on the idea that the human race should imitate nature, incorporating its models, systems and elements into both projects and processes in order to solve complex problems. In a biomimetic world, manufacturing would follow the methods used by animals and plants, using solar energy and simple compounds to create fibers, ceramics, plastics and totally biodegradable chemical products. Farms, inspired by the prairies, would be self-fertilizing and pest resistant. For discovering new drugs or crops, animals and insects that have used plants for millions of years to stay healthy and nourished would be observed[24].

Biomimetic design envisages the metabolism of the biosphere with the reuse, recycling and absorption of discarded matter and the metabolism of the technosphere[25], produced by human beings, which becomes waste that can be "reused" as raw material for new products. In addition to proposing eco-effective solutions to complex situations in a simple and effective way. This reality has been exposed by the State University of Paraíba - UEPB, through the dissemination of knowledge in projects like the ZIKA Project[26].

Natural capitalism redefines natural assets as natural capital[27]. The proponents of a forthcoming industrial revolution, as referenced earlier, outline the "sustainable commodification" of natural capital with strategies to increase resource efficiency; service and flow economy; biomimicry and investment in natural capital[28]. The sustainable commodification promoted by this theory requires four types of capital to function properly: "a) human capital; b) financial capital; c) manufactured capital, and d) natural capital." This is

demonstrated by stock exchanges, such as B3[29], which are exploring the future market for decarbonization credit commodities, an aspect of natural capitalism in favor of sustainability.

Regenerative design emphasizes regenerative practices through the sustainable use of water, land, energy and building design; an "instruction manual" of use for planet earth, the risk society and solidarity economy. This theory is a precursor to the avant-garde school of thought that goes beyond mere sustainability design.

Sustainability is just one stage of restoration and regeneration. In this sense: (Stage 1) the abandonment of conventional practices, used since the first period of the industrial revolution; (Stage 2) "greening" - the search for improvements relating to the individual's perception of the biosphere, i.e. the "greening" of relationships, including human right[30]; (Stage 3) sustainable design - a neutral point where no harm is done to the biosphere, but sufficiency is mitigated in the face of humanity's possible stagnation in practices based on the first stage; (Stage 4) restorative design where human-biosphere interaction generates an intimate relationship fostered by actions in favor of nature, e.g., (Stage 5) reconciliatory design, where man would be an integral part of nature, with a "reconciliation" of the biosphere and technosphere through the social appropriation of knowledge, human expertise based on science and technology, where designs express this reconciliatory interaction.

Only after the reconciliation stage (Stage 5) would the risk society be prepared for regenerative design, with the genesis of creative and participatory cultures capable of interacting with each other. Resilience to the changes brought about by the natural evolution of humanity and its modernization, making it possible to hand to the next generations a richer and more regenerated system than the one we received from previous generations (Stage 6)[31].

For regenerative design, sustainability is not an adequate goal, as it does not clearly define what it aims to sustain[32]. Instead of merely reducing damage to the environment, it is crucial to learn how to interact with it, using the health of ecological systems as a foundation for design. [...] The transition from a fragmented worldview to a mental model of integrated systems is the significant change our culture must make - delineating and understanding the interrelationships of the living system in an integrated way. A local approach is an effective way of achieving this understanding[33].

From the Latourian perspective, design[34] emerges as a critical framework with five essential advantages for success: (i) Humility, The concept of design conveys modesty absent in "construction," avoiding the "arrogance" associated with creating something entirely new and instead emphasizing the importance of acknowledging what already exists; (ii) Attention to detail: Unlike the Promethean dream of radical transformations, design values skill, expertise, and obsessive attention to detail, prioritizing care over abrupt changes; (iii) (Re)signification and interpretation: Design always carries meaning, transcending the practical function of objects. It transforms artifacts into "things" full of questions and interpretations, distancing itself from the modernist view of objects as mere matters of fact; (iv) Redesign, not creation Ex Nihilo: Design involves re-elaboration and adaptation, improving upon what exists rather than starting from scratch; (v) Ethical dimension, design inherently raises the question: "Is this good design or bad design?" This question connects directly to political, ethical, and socio-environmental dimensions, compelling designers to confront the moral responsibility of their choices; in order to rework something, designers, in whatever path, are instigated to face up to the moral responsibility of the choices made.

The framework of information across the various schools of thought in the circular economy culminates in regenerative design. Imbued with Latourian perception, it embodies Prometheus's caution and steps toward a design philosophy. This alignment underscores that "sustainability" alone is insufficient. By seeking the social appropriation of knowledge, the risk society aims emphatically at achieving a neutral interaction between the biosphere and the technosphere. This perspective emphasizes the importance of disseminating knowledge and fostering a productive culture oriented toward regeneration. This approach is regarded as the next step toward achieving the "sustainability goals" advocated by various schools of thought associated with the circular economy.

As Maturana stated in The Tree of Knowledge – The Biological Bases of Human Knowledge, "the world that everyone sees is not the world, but a world that we produce with others (...) the world will only be different if we live differently."[35] This perspective reinforces the idea that individual interaction and participation in the environment are essential, transcending the mere adoption of sustainable attitudes. Here, the "environment" encompasses not only the natural world but also the human being embedded within the risk society, continually exposed to and adapted to the dynamics of both the technosphere and the biosphere.

In this context of continuous evolution, regenerative design emerges as a central approach, enhanced by practices aligned with reconciliatory, restorative and sustainable design. These perspectives promote the "greening" of productive relations, encouraging the abandonment of traditional methods rooted in the paradigms of the first industrial revolution. This transition paves the way for a transformative production model that aligns more harmoniously with natural cycles and the principles of sustainability.

The symbiosis of designs, through the social appropriation of knowledge, rather than relying solely on transnational and local institutional arrangements, binds humanity to regenerative postures, surpassing mere neutrality, as emphasized by the culture of environmental sustainability.

The human biological foundation as a natural condition lies in conservation and self- preservation. From the perspective of the natural condition discourse, linking self- preservationist ideopolitics with the environment-economy binomial becomes a Herculean task. It is understood that self-regulation is insufficient; likewise, regulation can exist and have legal efficacy but lack social effectiveness. In this scenario, sustainability ideals are recognized as transindividual, extending beyond the individual sphere to protect collective, diffuse, local, and global interests.

Is Sustainability A Fundamental Right?

Environmentalism is a plural social phenomenon that encompasses a diversity of perspectives on the environmental crisis. It integrates multiple views on the causes of ecological problems, varied interpretations of the relationship between humans and nature, diverse interests in environmental preservation, and a range of representations of key concepts such as nature, environment, environmental issues, and socio-environmental conflicts. This multiplicity reflects the complexity and breadth of the subject, extending far beyond any singular or homogeneous approach.

In response to the environmental crisis, initial attempts classified reactions in a binary and exclusionary manner, opposing ecological forces to developmentalist forces. This dualism sought to defend environmentalism while criticizing the traditions of classic economic growth, creating a polarized conflict.

Over time, the environmental crisis deepened the antagonism between the classic development model and sustainability approaches. However, this initial and seemingly irreconcilable opposition gave way to new syntheses and points of convergence. The result was the emergence of the concept of sustainable development - a fusion that integrates environmental and economic concerns, offering pathways to reconcile ecological preservation with human progress.

Sustainable development, in turn, finds its first formal definition—and is often considered the first international regulatory framework—in the 1987 Brundtland Report, Our Common Future, released in 1988 by the United Nations World Commission on Environment and Development[36]. However, beyond development, the pursuit of a post-development approach "addresses these multiple contradictions by adopting principles of repair and natural regeneration, starting with local responsibility" (McMichael, 2021, p. 89)[37].

The second international regulatory milestone was the Earth Summit in 1992, also known as the United Nations Conference on Environment and Development (ECO-92). This conference marked a significant turning point, as it formally recognized and established sustainable development as one of humanity's greatest challenges. ECO-92 introduced several principles, including Principles 4 and 5, which explicitly affirm sustainable development[38].

The principles reflect how nations envision sustainable development and environmental protection, emphasizing the importance of international cooperation to eradicate poverty. Sustainable development has become an indispensable requirement in the global effort to reduce disparities and improve living standards for the world's population. It places a responsibility on society to meet its needs equitably, fostering increased productivity and creating political, economic, and social opportunities accessible to all individuals.

This approach requires a careful balance, ensuring that human progress does not compromise essential resources for life on Earth, such as the atmosphere, water, soil, and ecosystems. It is a continuous process of transformation in which resource exploitation, economic policies, and present and future population dynamics must be aligned to achieve harmony between growth and preservation[39].

Although economic activities are largely conducted by private initiative, achieving sustainable development requires active government intervention, particularly in critical areas such as social justice, environmental protection, the economy, public health, and social order. This state involvement is fundamental to upholding democratic principles and ensuring that everyone has access to a decent quality of life. In many cases, such intervention includes regulating business practices, monitoring environmental impacts, and formulating policies that promote the efficient use of natural resources.

Furthermore, sustainable development is not merely a technical or political commitment; it represents a paradigm shift that demands collective awareness of the impact of human actions on the planet. This involves fostering a culture of environmental and social responsibility, where companies, governments, and citizens share co-responsibility for building a fairer and more balanced future. Environmental education, sustainable technological innovation, and international cooperation are indispensable tools in this global endeavor.

In this context, the concept of sustainable development must be adapted to regional specificities, acknowledging existing social and economic inequalities. In developing countries such as Brazil, it also presents an opportunity to address historical disparities, promoting inclusive growth and the preservation of natural resources as legacies for future generations. It is, therefore, a universal challenge that requires integrated actions and creative solutions to reconcile human progress with environmental preservation.

Sustainable Development is also a principle of Brazil's legal system, recognized as "the prima principium of Environmental Law[40]. This statement is justified because this principle serves as a harmonizing pillar with the

arduous task of balancing environmental prevention, social equity, and economic growth - a tripod of mandatory observance[41]. This principle is enshrined at the end of the heading of Article 225 of the Federal Constitution, which emphasizes its relevance by addressing the needs of present and future generations.

The concept of sustainable development, intrinsically linked to the economy through the conservation of resources without depleting their availability, finds its roots in eco- development, a framework proposed by Maurice Strong in 1973. This pioneering approach laid the foundational principles that continue to shape the global environmental agenda. Its main pillars include: the satisfaction of basic human needs, solidarity with future generations, the active participation of affected communities, the preservation of natural resources and the environment, the creation of social systems that guarantee employment, security and respect for cultural diversity, as well as the promotion of educational programs that foster environmental awareness.

In Brazil, the importance of environmental issues was significantly reinforced by the 1988 Federal Constitution, which established an innovative milestone by linking the right to an ecologically balanced environment to the concept of human dignity. This recognition elevates environmental law to a third-dimension fundamental right, transcending individual and national interests and assuming a global character. Environmental preservation, therefore, is no longer an isolated prerogative of individual states but a shared priority of the entire international community.

At the international level, instruments such as the Stockholm Declaration (1972), the Rio de Janeiro Declaration (1992), the Kyoto Protocol, and Agenda 21 have reinforced the collective commitment to sustainability. These agreements established significant guidelines for governments, companies, and individuals to collaborate in building a more balanced and just future. For instance, Agenda 21 outlined a comprehensive action plan for implementing sustainable practices globally, while the Kyoto Protocol emphasized the urgent need to address climate change by reducing greenhouse gas emissions.

Furthermore, the interconnection between the principles of eco-development and fundamental rights highlights the importance of social participation as a central element in advancing sustainability. It is not enough just to create public policies or legislation; it is essential that the population is engaged in protecting the environment and using natural resources responsibly. In this context, environmental education is a strategic tool for transforming collective awareness, promoting more conscious attitudes and effective actions.

In short, the concept of eco-development not only influenced the foundations of sustainable development but also continues to serve as a reference for initiatives that integrate economic growth, social inclusion, and environmental preservation. In Brazil, the constitutional recognition of the right to an ecologically balanced environment as a fundamental right reflects the evolution of this debate, reaffirming the shared responsibility of the state, society, and individuals to protect natural resources for future generations.

Considering the above, the chapter on the environment is considered one of the most important and advanced provisions in the 1988 Constitution. By principle, it recognizes the environment as a universal right and a common good essential for public use, ensuring a healthy quality of life for all.

The concept of sustained economic development is an interdisciplinary construct that, in addition to being a legal principle, incorporates the expression "economic development" from the field of economics, enriched by the ecological notion of environmental sustainability. Ultimately, it signifies economic development that is sustained through the preservation of the environment as a universal right, essential to a healthy quality of life, and therefore to be safeguarded for present and future generations, as provided in Article 225, caput, of the Federal Constitution.

The idea of unconditionally preserving the environment is, however, a misconception; such caution must be positioned within the "middle ground" advocated by the concept of environmentally sustainable economic development, which aims to ensure resources for future generations.

The third regulatory framework is the 1988 Federal Constitution. Sustainable development is explicitly addressed in Article 170, which establishes a balance between "economic growth," "environmental preservation," and "social equity." This provision outlines the foundations and principles of the economic order, including private property, the social function of property, and environmental protection, all directed toward valuing human labor, free enterprise, and social justice. The inclusion of environmental protection as a principle of economic order, under Article 170, VI, highlights the constitutional mandate to harmonize economic activity with environmental preservation.

However, private property, as outlined in Article 170, II, reflects the constitutive value of Brazilian society, which is "founded on the capitalist mode of production and the corollary of free enterprise."[42], objectively, private property, as established in Article 170, II, reveals the promotion of economic growth as a fundamental value.

However, the social function of property, art. 170, III, delimits parameters to avoid abuses in the use of property causing harm to the community, which ultimately demonstrates the constitutional incentive for the preservation of the environment in addition to respect for social issues.

A joint analysis of subsections II and III of Article 170 of the Federal Constitution (CF/88) demonstrates that the principle of sustainable development encourages economic growth (principle of private property) while promoting social equity and environmental protection (principle of the social function of property). Together, these provisions establish a condition for the socio-environmental function of property.

The notion of an "ecologically balanced environment" in Article 225 versus the idea of "economic development" in Article 170, VI, of the CF/88 highlights the challenge of reconciling these constitutional mandates. To address this, a "middle ground" must be found for their application. Balancing these concepts allows for a more nuanced understanding of their interrelation within specific socio-cultural, political, economic, and ecological contexts, considering the space-time dimension[43].

The ideology of sustainability within Brazil's legal system can be broken down into four components for better understanding: a) Environmental sustainability – maintaining the metabolic functions and components (biological and technological) of biomes and ecosystems; b) Economic sustainability – implementing public policies and measures that align environmental and social concepts; c) Socio-political sustainability – focusing on human development aimed at humanizing the economy; d) Cultural sustainability – addressing how society interacts with natural resources.

It is important to clarify that the "polyhedral" dimensions of sustainability are closely tied to the new paradigms proposed by the Circular Economy. These paradigms emphasize observing natural and technological metabolism, implementing public policies to protect natural capital, and humanizing the economy within the framework of the new circular economic model (C2C). Together, they highlight the primacy of the environment and sustainability as a greater good.

Socio-Economic Disruption Established By Circular Economy Epistemes And Their Concretizing Impact

The World Commission on Environment and Development (WCED) defines sustainable development as "that [development] which meets the needs of the present without compromising the ability of future generations to meet their own needs" (CMMAD, 1991, p. 46). This concept, introduced by the Brundtland Report, was later incorporated into the framework of ECO-92.

Jurisprudential experience reflects this understanding, establishing that the principle of sustainable development is influenced by its constitutional foundation. This principle underscores the Brazilian state's duty to seek a fair balance between economic activity and ecological preservation, in alignment with international commitments[44].

It is worth noting that the concept of sustainability is intrinsically linked to economic development that does not harm the environment. This is where the influence of the circular economy (CE) becomes evident, as sustainability is fostered through a series of actions aimed at balancing human development with the preservation of natural resources, ensuring their availability for future generations. These initiatives include the controlled exploitation of plant resources, which demands not only the responsible use of forests but also replanting whenever necessary to ensure the renewal and health of ecosystems. Simultaneously, the integral preservation of green areas for environmental conservation is crucial to maintaining biodiversity and the ecosystem services that sustain life on Earth[45].

The Brazilian Federal Constitution, in its economic dimension, enshrines environmental preservation as a fundamental value from the outset, recognizing the possibility of economic exploitation provided it is conducted responsibly and in a balanced manner. The environment is emphasized as an asset of paramount importance, whose protection must be harmonized with economic development. Legislation plays a crucial role in establishing the parameters that ensure this coexistence.

Economic law cannot be reduced to an instrumental function solely in favor of economic growth; it must necessarily align with the realization of social justice. Economic production, far from being an isolated activity, is deeply intertwined with the construction of social life, reflecting and shaping its dynamics. In this context, economic environmental law has emerged as an indispensable tool for balancing the relationship between economic development and the conservation of natural resources. By integrating environmental and economic law, this field aims to rationalize and democratize productive activities, reinforcing the inseparability of these legal branches.

The principle of sustainable development synthesizes this interdependence, serving as the foundational connection between environmental and economic law. It establishes that development must meet the needs of the present without compromising the ability of future generations to meet their own demands. Beyond this, it ensures that natural resources are used in a balanced manner, preserving their availability and integrity for future generations.

Sustainable development promotes harmonious interaction between the economy and ecology, where economic gains are achieved alongside environmental preservation. This balance imposes limits on environmental degradation by defining acceptable levels of impact and guiding economic progress within these parameters. The goal is to create synergy that not only fosters growth but also contributes to social well-being, ensuring justice

and quality of life for both current and future generations. This approach reaffirms that sustainable development is not an obstacle to progress but rather the foundation for a truly inclusive and regenerative economic model.

The integration of environmental considerations into the economic order clearly reflects the principle of sustainable development, establishing state control over economic activities that exceed acceptable limits of environmental exploitation. This regulatory framework harmonizes previously independent spheres, ensuring a healthy quality of life for all. However, the intensity of such control is intrinsically linked to the political priorities of the government in office, which can significantly influence its practical application.

The principle of sustainable development should not be interpreted as an impediment to technological or economic progress. On the contrary, it serves as a guideline for the rational management of natural resources, aimed at preventing unrestrained environmental degradation. This approach ensures that the needs of the current generations are met without compromising essential resources for future generations, promoting a balance between exploitation and preservation.

By being elevated to the level of a principle of economic order, care for the environment makes productive activities conditional on respect for ecology. This recognition empowers public authorities to intervene decisively, whenever necessary, to ensure that economic exploitation remains within sustainable standards. There is, therefore, no material separation between the economy and ecology; the two are deeply intertwined, as the foundation of productive relations lies in nature. Nature, in turn, must be understood as an integral part of human relations and, consequently, of economic dynamics.

This interdependence is reflected in the Brazilian legal system, where Articles 225 and 170 of the Federal Constitution complement and reinforce each other. Article 225 enshrines the right to an ecologically balanced environment, while Article 170 incorporates environmental protection as a principle of economic order. Together, these provisions ensure that free economic initiative and environmental preservation are not mutually exclusive choices but complementary pillars for achieving a dignified existence.

The economic dimension of environmental law rests on the premise that the rational and sustainable use of natural resources is essential for human quality of life. As fundamental economic assets, natural resources must be managed to guarantee their continued availability and enhance social well-being. Economic law, as a branch regulating state intervention in the economy, works alongside environmental legislation to impose limits and establish standards for business activities that impact on the environment.

Although Brazilian environmental legislation includes specific rules aimed at preserving species and improving the quality of human life, it also focuses on regulating economic activities involving the direct or indirect use of natural resources. This regulatory framework seeks to implement sustainable development, defined as the responsible use of the environment without depleting, degrading, or rendering it unviable for future generations.

Finally, the pursuit of quality of life serves as the link between economic and environmental rights. Achieving this balance requires reconciling economic well-being— represented by material growth and prosperity—with environmental well-being, reflected in physical and mental health and the preservation of natural heritage. Only through this integration will it be possible to establish a development model that is fair, balanced, and sustainable.

III. Conclusion

Final Considerations

This study explored how regenerative design, and the circular economy can serve as essential tools for realizing the fundamental right to an ecologically balanced environment. The research demonstrated that achieving a truly sustainable development model requires going beyond damage mitigation to adopt practices that promote the regeneration of natural systems and a harmonious interaction between the biosphere and the technosphere.

The analysis revealed that sustainable development is not merely a normative concept but a dynamic and interdependent principle integrating environmental, social, and economic dimensions. This integration is essential to addressing the global challenges of the risky society, characterized by complexity and systemic interconnections. In this context, regenerative design emerges as an evolution of traditional sustainability approaches, proposing a symbiotic relationship with nature, while the circular economy emphasizes efficiency in resource management, contributing to waste reduction and the optimization of production cycles.

A qualitative analysis, based on a literature review and case studies, identified key guidelines for implementing these strategies in the Brazilian context. The research highlighted that Brazil's legal framework, particularly Articles 170 and 225 of the Federal Constitution, provides fertile ground for integrating these concepts. However, significant challenges persist, including the need for specific regulations, economic incentives, and robust public policies to facilitate the transition to regenerative and circular production models.

The study underscored the transformative potential of regenerative design and the circular economy to reshape economic and social relations. These approaches can promote intergenerational justice by ensuring the

preservation and renewal of natural resources for future generations. Additionally, they foster technological innovation, create green jobs, and reduce social inequalities, aligning with the United Nations' Sustainable Development Goals (SDGs).

The importance of environmental education and collective awareness was also emphasized as central elements for adopting these practices. The cultural transformation required for the effective implementation of sustainable development necessitates the active engagement of all sectors of society. Thus, the dissemination of knowledge, combined with training and social inclusion initiatives, is crucial to consolidating a more inclusive, equitable, and resilient economy.

In conclusion, this work reaffirms that regenerative design and the circular economy are not merely practical tools; they represent a paradigm shift in how humanity interacts with the planet. These concepts offer an integrative vision in which economic progress and environmental preservation are not opposing goals but complementary elements. To realize this vision, it is essential that public policies, private initiatives, and academic efforts converge toward creating economic and social systems that not only conserve but actively regenerate natural resources.

Finally, it is imperative that future research delves deeper into specific case studies and examines the feasibility of implementing these strategies across diverse economic and social contexts. Only through continuous and integrated efforts can sustainable development transcend theoretical discourse and materialize into tangible practices. These practices must address the challenges of the 21st century, ensuring a balanced and prosperous future for all generations.

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