

Environmental sustainability: a dialogue between ecological economics and bioethics

Sostenibilidad ambiental: un diálogo entre economía ecológica y bioética

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ABSTRACT

The article aims to characterize the dialogues between Ecological Economics and Bioethics to develop a conceptual and practical framework that fosters sustainable and ethically grounded economic growth. The adopted methodology follows a qualitative approach structured into two main stages. The first involved the use of search equations in databases such as WoS, Scopus, Scielo, and Redalyc, covering a temporal horizon of 20 years. In the second stage, the PRISMA method was applied to filter and categorize 194 documents, resulting in the selection of 123 academic articles, 54 institutional reports, and 17 critical reviews. This process enabled the identification of key categories such as strong sustainability, environmental ethics, intergenerational justice, and biodiversity valuation. The interdisciplinary analysis highlighted the interaction between these approaches, demonstrating that both emphasize the necessity of respecting the planet's biophysical limits and adopting economic models that integrate ethical principles. The primary conclusion underscores that the dialogue between ecological economics and Bioethics is transformative and essential for addressing contemporary sustainability challenges. This integration promotes sustainable public policies and practices that balance human well-being with environmental preservation, ensuring intergenerational equity and ecological resilience as critical elements for an ethically responsible future.

Keywords: Ecological economics, bioethics, sustainability, biodiversity

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RESUMEN

El artículo tiene como objetivo caracterizar los diálogos entre la Economía Ecológica y la Bioética con el fin de desarrollar un marco conceptual y práctico que fomente un crecimiento económico sostenible y éticamente fundamentado. La metodología adoptada sigue un enfoque cualitativo estructurado en dos etapas principales. La primera consistió en el uso de ecuaciones de búsqueda en bases de datos como WoS, Scopus, Scielo y Redalyc, abarcando un horizonte temporal de 20 años. En la segunda etapa, se aplicó el método PRISMA para filtrar y categorizar 194 documentos, lo que resultó en la selección de 123 artículos académicos, 54 informes institucionales y 17 revisiones críticas. Este proceso permitió identificar categorías clave como sostenibilidad fuerte, ética ambiental, justicia intergeneracional y valoración de la biodiversidad. El análisis interdisciplinario resaltó la interacción entre estos enfoques, demostrando que ambos enfatizan la necesidad de respetar los límites biofísicos del planeta y de adoptar modelos económicos que integren principios éticos. La conclusión principal subraya que el diálogo entre la Economía Ecológica y la Bioética es transformador y esencial para enfrentar los desafíos contemporáneos de la sostenibilidad. Esta integración promueve políticas públicas y prácticas sostenibles que equilibran el bienestar humano con la preservación ambiental, asegurando la equidad intergeneracional y la resiliencia ecológica como elementos críticos para un futuro éticamente responsable.

Palabras clave: Economía ecológica, bioética, sostenibilidad, biodiversidad

I. INTRODUCTION

The dialogue between Ecological Economics-EE and Bioethics-B is embedded in the complex relationship between the environment, economics, and ethics in decision-making processes. Both approaches share the fundamental goal of seeking a sustainable balance between economic development and environmental preservation, considering the ethical implications of human actions regarding biodiversity and natural resources (Aliciardi, 2009; Carpintero, 2006). As a branch of economics, Ecological Economics acknowledges the connections between the economy and the ecosystem. Unlike traditional approaches that often disregard natural limits, it focuses on the symbiotic relationship between economic activity and the ecological systems that sustain it. Thus, it views the economy as a subset of the biosphere, aiming to integrate principles of sustainability, justice, and resilience into economic models (Oliveira and Osman, 2017; Naredo, 2006).

Bioethics, on the other hand, is an interdisciplinary field exploring emerging ethical dilemmas in biology, medicine, and technology, emphasizing the dignity and inherent rights of living beings. The interaction between Bioethics and Ecological Economics addresses critical issues regarding how economic decisions impact both humans and biodiversity and ecosystems in general (Gorz, 2012). Ecological Economics provides

a framework for evaluating the value of ecosystem services and natural resources, recognizing their finitude and the severe consequences their degradation may have for future generations. In this context, Bioethics raises fundamental questions about intergenerational equity and responsibility toward non-human life forms (Purvis *et al.*, 2019; Maldonado, 2015).

Economic decision-making becomes an ethical exercise transcending purely financial considerations. Questions arise about how to value ecosystems that not only sustain the human economy but are also essential for the existence of diverse species. From this perspective, Bioethics introduces ethical reflections on whether economic activities respect the autonomy, integrity, and biological diversity (Alier & Jusmet, 2015; Maldonado, 2014). Clear examples of these dilemmas include the management of natural resources. Overexploitation of forests, unsustainable fishing, or soil degradation not only pose economic challenges but also raise ethical questions: Is it legitimate to compromise essential resources for the survival of other species and ecological balance in favor of short-term economic growth? (Aguilera, 2020; Casado, 2011).

The integration of Ecological Economics and Bioethics advocates for the development of policies that simultaneously consider the economic and ethical impacts of human decisions. This approach implies adopting a precautionary perspective, reflecting on the potential long-term consequences of economic actions on biodiversity and ecosystems (Rendón & Gómez, 2022; Asnariz, 2002). Against this backdrop, this article aims to characterize the dialogues between these approaches, developing a conceptual and practical framework that fosters sustainable and ethically responsible economic development. The central premise of this analysis holds that integrating Ecological Economics and Bioethics seeks not only to optimize short-term human well-being but also to preserve the health and integrity of ecosystems for future generations. The article's structure includes an introduction, methodology, presentation of results, discussion, conclusions, and a comprehensive review of the utilized bibliography, ensuring the rigor of the conducted analysis.

II. METHODOLOGY

The methodology employed adopts a qualitative approach divided into two methods. First, a bibliometric search equation is applied to the analytical categories "Ecological Economics" and "Bioethics." This is conducted over a 20-year observation window, utilizing recognized national and international databases such as Web of Science (WOS), Scopus, Scielo, and Redalyc (Aguilera *et al.*, 2020; Barbosa *et al.*, 2020; Rushforth, 2016; see Table 1 and 2).

Table 1
Example of search equation for the category BIOETICA OR BIOETHICS

DATABASE	DATABASE
WoS	Tema: ("BIOETICA OR BIOETHICS") Índices=SCI-EXPANDED, SSCI, A&HCI, ESCI Período de tiempo=Todos los años
	Tema: ("BIOETICA OR BIOETHICS") Refinado por: Años de publicación: (2016 OR 2017 OR 2010 OR 2013 OR 2015 OR 2012 OR 2009 OR 2011 OR 2014 OR 2008 OR 2020 OR 2021 02 2022 OR 2019 OR 2018 OR 2006 OR 2005 OR 2004 oR 2003 OR 2002 02 2001 oR 2000) Índices=SCI-EXPANDED, SSCI, A&HCI, ESCI Período de tiempo=Todos los años
	Tema: ("BIOETICA OR BIOETHICS") Índices=SCI-EXPANDED, ESCI, A&HCI, SSCI Período de tiempo=Todos los años
	TITLE-ABS-KEY ("BIOETICA OR BIOETHICS") TITLE-ABS-KEY (("BIOETICA OR BIOETHICS")) TITLE-ABS-KEY (("BIOETICA OR BIOETHICS ")) AND (LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013) OR LIMIT-TO (PUBYEAR, 2012) OR LIMIT-TO (PUBYEAR, 2011) OR LIMIT-TO (PUBYEAR, 2010) OR LIMIT-TO (PUBYEAR, 2009) OR LIMIT-TO (PUBYEAR, 2008) OR LIMIT-TO (PUBYEAR, 2000) OR LIMIT-

Note: Process by Researcher

Table 2
Example of search equation for the category ECONOMÍA ECOLÓGICA OR ECOLOGICAL ECONOMY

Database	Search equations
WoS	Tema: (("ECONOMÍA ECOLÓGICA OR ECOLOGICAL ECONOMY")) Índices=SCI-EXPANDED, SSCI, A&HCI, ESCI Período de tiempo=Todos los años
	Tema: (("ECONOMÍA ECOLÓGICA OR ECOLOGICAL ECONOMY ")) Refinado por: Años de publicación: (2021 OR 2022 OR 2023 OR 2024 OR,2016 OR 2017 OR 2010 OR 2013 OR 2015 OR 2012 OR 2009 OR 2011 OR 2014 OR 2008 OR 2020 OR 2021 02 2022 OR 2019 OR 2018 OR 2006 OR 2005 OR 2004 oR 2003 OR 2002 02 2001 oR 2000) Índices=SCI-EXPANDED, SSCI, A&HCI, ESCI Período de tiempo=Todos los años
	Tema: ("ECONOMÍA ECOLÓGICA OR ECOLOGICAL ECONOMY") Índices=SCI-EXPANDED, ESCI, A&HCI, SSCI Período de tiempo=Todos los años
	TITLE-ABS-KEY ("ECONOMÍA ECOLÓGICA OR ECOLOGICAL ECONOMY")
Scopus	TITLE-ABS-KEY ((ECONOMÍA ECOLÓGICA OR ECOLOGICAL ECONOMY")) AND (LIMIT- TO (PUBYEAR, 2018) OR LIMIT- TO (PUBYEAR, 2017) OR LIMIT- TO (PUBYEAR, 2016) OR LIMIT- TO (PUBYEAR, 2015) OR LIMIT- TO (PUBYEAR, 2014) OR LIMIT- TO (PUBYEAR, 2013) OR LIMIT- TO (PUBYEAR, 2012) OR LIMIT- TO (PUBYEAR, 2011) OR LIMIT- TO (PUBYEAR, 2010) OR LIMIT- TO (PUBYEAR, 2009) OR LIMIT- TO (PUBYEAR, 2008) OR LIMIT-TO (PUBYEAR, 2000) OR LIMIT-

Note: Process by Researcher

Subsequently, the PRISMA method was implemented, allowing the establishment of analytical and emerging categories derived from the investigative exercise. These categories are detailed in the results section, providing a structured basis for analysis and discussion (Gómez, 2023; Castro *et al.*, 2017; Gómez & Rincón, 2023). The PRISMA method (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) is defined as a set of standardized guidelines designed to ensure methodological quality and transparency in systematic reviews and meta-analyses (Page *et al.*, 2021). This approach seeks to guarantee rigor in identifying, selecting, and synthesizing studies, promoting an accurate and comprehensive presentation of results (Van Eck & Waltman, 2009). Clear exclusion criteria were applied: (A) studies published outside the 2000-2023 period, (B) documents without peer review, and (C) articles not available in full text. Among the limitations, there is a potential bias toward publications in English/

Spanish and underrepresentation of non-academic local perspectives, which may affect the generalizability of the findings.

In the context of Ecological Economics and Bioethics, this method identified a total of 194 relevant documents, prioritizing those that explicitly identify the links between these disciplines. Through the application of inclusion and exclusion criteria, documents were filtered based on their relevance to key categories such as strong sustainability, intergenerational justice, and environmental ethics.

In a subsequent stage, data from the selected documents were systematically recorded, including 123 academic research articles, 54 institutional reports related to environmental and economic analysis, and 17 critical reviews. This process ensures a solid and coherent foundation for synthesizing knowledge on the connections between Ecological Economics and Bioethics, contributing to advancing integrative policies and studies in both areas. The problem question posed was: How do Ecological Economics and Bioethics dialogue in the pursuit of Environmental Sustainability?

III. RESULTS

The dialogue between Ecological Economics and Bioethics opens a crucial conversation on balancing economic progress with ethical responsibility toward biodiversity and ecosystems. Both fields share concerns about sustainability but differ in their approaches and priorities. While both disciplines focus on sustainability and ethics in human-nature relations (Maldonado *et al.*, 2006; Maldonado, 2012), the emerging categories derived from the analytical categories are outlined in Table 3.

Table 3
Relationship between analytical and emerging categories

General objective	Analytical categories	Emerging categories
To characterize the dialogues between Ecological Economics and Bioethics to develop a conceptual and practical framework that fosters sustainable and ethically responsible economic growth.	Ecological economics, Bioethics.	Similarities, differences, biophysical limits and environmental ethics, intergenerational justice, ethical valuation of territory and biodiversity, inequality, and distributive ethics.

Note: Process by researcher

These categories are exemplified in the analyzed literature. For instance, the notion of 'biophysical limits' (Rockström *et al.*, 2009) contrasts with bioethical critiques of their violation (Maldonado, 2019), while the 'ethical valuation of biodiversity' appears in economic models that internalize ecological costs.

Similarities

Both Ecological Economics and Bioethics adopt a complex approach (Alier & Jusmet, 2015). Ecological Economics recognizes the links between the economy and the environment, while Bioethics considers the ethical relationship between humans and other forms of life. Both approaches share a concern for sustainability. Ecological Economics supports economic practices respecting natural resource limits, while Bioethics emphasizes preserving biodiversity and ensuring ethical balance in human interventions in nature (Molina, 2013; Alier, 2011; 2009).

Moreover, both fields acknowledge the importance of intergenerational responsibility. Ecological Economics highlights the need to preserve resources for future generations, and Bioethics identifies the ethics of human actions concerning future generations (Rojas & Lara, 2014; Naredo, 2003). The dialogue between these disciplines reveals opportunities for deeper integration and the critical need for interdisciplinary collaboration. The convergence of these fields promises more robust and ethical approaches to sustainable development, recognizing the complexity of current challenges (Sarmiento, 2013; Siurana, 2010).

Differences

Ecological Economics primarily focuses on the economic system and its relationship with ecosystems, whereas Bioethics addresses ethical issues emerging in biology, medicine, and technology, including but not limited to the environmental impact of these disciplines (Sotomayor, 2007; Passet, 1996). Furthermore, Ecological Economics tends to value nature in economic terms, considering ecosystem services, while Bioethics may adopt a more intrinsic perspective, recognizing biodiversity's inherent value regardless of its economic utility (Zarta, 2018; Useche, 2008).

Bioethics often places strong emphasis on autonomy and human rights, particularly in biomedical research, while Ecological Economics seeks a balance between human well-being and ecosystem health (Mohammadian, 2005; 2004). Aspirations for an equitable and sustainable model respecting Earth's life diversity reflect a deeper awareness of humans' connection to their environment. Ethical responsibility toward all life forms and future generations becomes central to this approach, challenging us to consider the long-term consequences of present actions (Kottow, 2023; León, 2020; Maldonado, 2018; 2017).

Biophysical limits and environmental ethics

The links between biophysical limits and environmental ethics represent a key topic in sustainability debates, particularly from the perspective of strong sustainability. Biophysical limits, defined as the maximum capacities of ecosystems to absorb human impacts and regenerate resources (Rodríguez, 2024; Rockström *et al.*, 2009), provide a scientific basis for restricting human activities within planetary boundaries. From an ethical perspective, recognizing and respecting these limits is essential to prevent irreversible degradation of ecological systems vital for life (Maldonado, 2019; Baquedano Jer, 2013).

Strong sustainability posits that certain components of natural capital are irreplaceable and must remain intact to ensure the continuity of critical ecosystem services (Gómez, 2024; Turner *et al.*, 2001). In this context, environmental ethics promotes principles such as intrinsic respect for nature, the precautionary principle, and intergenerational equity, challenging traditional narratives of economic development based on unlimited growth (Maldonado, 2019; Rozzi, 2001).

Additionally, applying these ethical principles involves designing public policies prioritizing the conservation of critical natural capital and developing sustainable technologies respecting biophysical limits. For example, transitioning to energy systems based on renewable sources not only addresses the physical constraints of fossil fuels but also aligns with ethical responsibility toward future generations and other species (Engelhardt, 2006).

Lastly, biophysical limits emphasize the importance of global governance recognizing the interdependencies between ecosystems and human societies. This approach demands decision-makers consider both ecosystems' carrying capacities and ethical values ensuring equitable access to essential natural resources (Gómez *et al.*, 2024; Mejía, 2006). Integrating environmental ethics with scientific understanding of biophysical limits provides a solid framework for transitioning toward genuine sustainability.

Intergenerational justice

Intergenerational justice is an ethical principle aiming to ensure that future generations enjoy environmental conditions and natural resources equivalent to those available to current generations. This concept is fundamental to environmental bioethics, as it emphasizes the responsibility of present actions on the well-being of future generations (Correa, 2017; González, 2009).

In the realm of Ecological Economics, intergenerational justice translates into the need to adopt policies and practices that secure the sustainability of natural resources.

This involves acknowledging the biophysical limits of the planet and avoiding ecosystem overexploitation, thereby guaranteeing that future generations can meet their needs without compromising environmental integrity (Leyton, 2007; Leff, 2004).

Integrating intergenerational justice into Bioethics and Ecological Economics requires a complex approach that considers ethical, economic, and ecological aspects. This approach promotes adopting sustainable and equitable practices that respect the rights of future generations and foster a coherent relationship between humanity and the environment (Purvis *et al.*, 2019; Pérez-Rincón, 2014).

Ethical valuation of territory and biodiversity

The ethical valuation of territory and biodiversity is a central aspect at the intersection of bioethics and ecological economics. This approach recognizes that ecosystems and species possess intrinsic value beyond their economic utility to humans. Environmental ethics argues that biodiversity should be preserved not only for its benefits but also for its inherent right to exist (Rauchecker & Chan, 2016; Rozzi, 2001).

In the context of Ecological Economics, this ethical perspective is integrated into economic models by recognizing the fundamental role of biodiversity and ecosystem services in human well-being. However, traditional economic valuation methods often capture only a fraction of the total value of goods and services associated with biodiversity, leading to undervaluation and degradation.

Environmental bioethics proposes a holistic vision that considers the interrelationships between humans and nature, promoting an ethics of care and responsibility toward the natural environment (Cribbs & Perera, 2017; González, 2009). This approach emphasizes the need for sustainable practices that respect the biophysical limits of the planet and ensure biodiversity conservation for present and future generations.

Incorporating the ethical valuation of territory and biodiversity into public policies and economic planning is essential for promoting truly sustainable development. This entails recognizing and respecting the intrinsic value of nature beyond its economic utility and adopting management approaches that preserve the integrity of ecosystems and biological diversity (Durante, 2018; Miles and Laar, 2018).

Inequality and distributive ethics

Inequality and distributive ethics are central topics between Bioethics and Ecological Economics, especially from the perspective of strong sustainability. Distributive ethics addresses how resources and benefits are allocated in a society, emphasizing justice and equity in this distribution. In the context of environmental bioethics, this implies ensuring that all communities, present and future, have equitable access to natural resources and a healthy environment (Gordijn and Ten Have, 2018).

Ecological Economics, in turn, acknowledges that economic activities are intrinsically linked to ecological systems and that unrestrained exploitation of natural resources can lead to unequal distribution of benefits and environmental burdens. This discipline advocates reevaluating conventional economic discourse (classical and neoclassical schools), promoting models that integrate ecological and ethical considerations into economic decision-making (Gracia, 2008; Leyton, 2007).

Strong sustainability holds that natural capital is essential and irreplaceable and that its preservation is fundamental to long-term human and ecological well-being. From this perspective, distributive ethics demands that public policies and economic practices focus not only on efficiency and growth but also on intergenerational equity and ecosystem protection. This involves adopting approaches that limit environmental degradation and promote a fair distribution of resources, recognizing that the most vulnerable communities are often the most affected by environmental issues (Martínez *et al.*, 2024; González, 2009).

Integrating distributive ethics into Bioethics and Ecological Economics requires a commitment to social and environmental justice, recognizing that human health and ecological integrity are deeply interconnected. This approach encourages adopting policies that ensure equitable resource distribution and inclusive participation in environmental decision-making, guaranteeing that the needs of present and future generations are met sustainably and fairly (Haire, 2018; Gracia, 2014).

IV. DISCUSSION

The findings of this article align with Renk *et al.* (2021) Lee & Jung, 2019; Georgescu-Roegen, (1975), who emphasize that Ecological Economics is based on the idea that the economy is an inseparable part of ecosystems. Although both fields emphasize intergenerational justice (Purvis *et al.*, 2019), authors like Alier (2011) question whether Bioethics sufficiently addresses global economic inequalities, revealing tensions unaddressed in dominant literature. This perspective highlights the importance of acknowledging biophysical limits and the interdependence between economic activity and environmental health. Ecological Economics addresses critical issues such as resource overexploitation, biodiversity loss, and environmental degradation.

Similarly, this investigation resonates with Beauchamp & Childress (2001), who argue that Bioethics addresses ethical issues related to life, including biomedical research, healthcare, and human intervention in nature. Its primary focus is ensuring that human actions respect autonomy, beneficence, non-maleficence, and justice, considering both humans and other life forms (Maldonado, 2023; Rincón, 2023).

In fact, this article concurs with Sganzerla *et al.* (2021); Laverde *et al.* (2020), who assert that nature valuation in Ecological Economics is based not only on its economic utility but also on its intrinsic value. Bioethics considers biodiversity's intrinsic value but often focuses on the ethics of human intervention. Additionally, the temporal perspective of Ecological Economics underscores the importance of long-term sustainability and intergenerational responsibility. In contrast, Bioethics often concentrates on present ethical issues but also addresses responsibility toward future generations (Gómez, 2021; Cantú, 2020).

Moreover, the article aligns with the principles of Sánchez de la Iglesia (2020) Hinkelammert & Mora (2008) emphasizing autonomy. Ecological Economics considers autonomy regarding ecosystems' ability to sustain and regenerate. Conversely, Bioethics places strong emphasis on human autonomy, particularly in decisions related to health and biomedical research. Notably, the article also aligns with those advocating that Ecological Economics uses tools such as ecosystem service valuation to integrate environmental considerations into economic models. In contrast, Bioethics relies on ethical principles to guide decision-making in fields like medicine and research (Georgescu-Roegen, 1996; 1994; Amo, 2017).

Both Ecological Economics and Bioethics, committed to sustainability, positively impact resource conservation and biodiversity preservation, promoting responsible natural resource management and limiting indiscriminate exploitation of living organisms (Cantú, 2021; Rodríguez *et al.*, 2021). While Ecological Economics seeks innovative solutions for economic development with minimal environmental impact, Bioethics sets ethical boundaries in research, ensuring equitable benefit and burden distribution (Maldonado, 2014; Alier, 2009).

Both fields emphasize valuing ecosystem services in economic models, recognizing the critical role of natural resources, and promoting their sustainable management (Rossi, 2017; Alier, 2011). They also highlight intergenerational equity, ensuring that current economic decisions do not compromise future generations' well-being while respecting biodiversity's intrinsic value and ecological systems' integrity (Hale *et al.*, 2019).

These perspectives propose ethical economic policies that acknowledge the interdependence between human well-being and environmental balance, fostering interdisciplinary research that aligns economic theory with ethical concerns in biology,

medicine, and technology (Rosas, 2012). Moreover, they promote educational and awareness programs that strengthen informed citizenship and encourage ethical and sustainable decision-making, consolidating collaboration among experts in both fields (Gómez & Barbosa, 2024; Gómez, 2020).

V. CONCLUSIONS

- The convergence between Ecological Economics and Bioethics emphasizes an integrative approach that combines ethical principles with ecological analysis to address sustainability challenges. The proposed integration requires concrete policies, such as taxes on resource overexploitation, and interdisciplinary educational frameworks. This would translate ethical principles into measurable actions, bridging the gap between theory and practice. These connections support policies and practices that balance human well-being with environmental preservation, recognizing the interdependence between economic and ecological systems as a crucial element for intergenerational equity and ecosystem resilience.
- Both fields highlight the importance of respecting the planet's biophysical limits and valuing biodiversity not merely from an economic perspective but also from an intrinsic ethical standpoint. This necessitates a shift toward development models that prioritize the conservation of critical natural capital, employing technologies and strategies that minimize environmental degradation while respecting the dignity of all forms of life.
- The interdisciplinary dialogue between Ecological Economics and Bioethics reshapes decision-making frameworks, endowing them with greater ethical robustness and sustainability. Furthermore, it encourages the implementation of educational and awareness programs that foster an informed and committed citizenry, capable of making decisions aligned with the principles of environmental justice and strong sustainability.

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